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Relationship between Personal hygiene and Environmental Sanitation to the Presence of Escherichia coli Bacteria in Food

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ABSTRACT

Food safety is one of the significant public health issues, especially in developing countries. The extraordinary incidence of food poisoning and a high number of cases of gastrointestinal infections in Malang City indicate infection with the bacteria that cause dysentery, namely *E.coli.* This study evaluated *hygiene*-sanitation practices at food stalls in Area Terusan Ambarawa Malang City. This study aimed to identify *Escherichia coli* bacteria in 11 food stalls and assess the relationship of environmental sanitation and personal *hygiene* of food handlers to the presence of *E.coli*. This study used a quantitative descriptive design with a cross-sectional approach, data collection using a checklist observation questionnaire sheet, and laboratory tests to determine the number of *E.coli* bacteria. Based on laboratory tests, 10 (90.1 percent) of 11 food samples exceeded the *E.coli* quality standard according to the requirements of the Indonesian Ministry of Health Regulation 2023, the results of chi-square analysis of the relationship between environmental sanitation (p is 0.012) and the relationship between personal *hygiene* (p is 0.012), both variables have a significant relationship to the presence of *E.coli*. There is a relationship between personal *hygiene* and environmental sanitation and *Escherichia coli* contamination in food sold in Area Terusan Ambarawa Malang City.

1. Introduction

Foodborne disease remains a significant global health burden until today. In 2020, foodborne disease cases caused 5.987 people to experience illness in the United States (CDC, 2022). Foodborne disease cases in Indonesia are currently a serious problem which in 2019 BPOM reported that East Java Province had the highest poisoning rate, namely 1,312 cases with 134 cases of poisoning caused by microbial contaminated food and beverages (BPOM RI, 2020). In 2020 in Malang City, based on data from the Mojolangu Community Health Center, 89 people were found to have food poisoning caused by microbial contamination, causing diarrhea (Ramadhani, 2018). Poisoning can be caused by several factors, one of them is contamination by bacteria on food, as evidenced by data from the BPOM annual report in 2020 which shows that the most coomon food poisoning agent is microbiology as much as 69.44% (BPOM RI, 2023). Biological contaminants that are often found in food are Coliform group bacteria, namely Escherichia coli (Arini & Wulandari, 2017).

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In Indonesia, there are several regulations regarding food safety that regulate acceptable microbial limits in food. Permenkes RI Number 2 of 2023 regulates the number of acceptable microbial limits in ready-to-eat processed food, which is <3.6 MPN/gr (Permenkes, 2023). Microbes found in food can be caused because the food is contaminated. One of the factors of food contamination is due to the application of poor hygiene and sanitation in the production of the food. In line with research by Sakdiyah (2021) the lack of application and implementation of personal hygiene practices by food handlers is significantly associated with the presence of Coliform bacteria contamination in food. In addition, the sanitation of food processing places also affects the presence of pathogenic bacteria in food (Ramadhani, 2018).

Although in Indonesia food safety has been regulated in the Permenkes, the implementation of the policy has not been fulfilled properly. Until now there are still many foods contaminated with Escherichia coli bacteria. E.coli is a group of bacteria that often appears in food, the environment, and the gut of animals and humans, Some people with an E.coli infection can develop serious complications that are potentially life-threatening. In a study by Yulistiani, et al. (2023) conducted to traders in the Penjaringan Surabaya Culinary center showed that all samples (100%) contained positive coliform bacteria and 8 of 12 food samples (66.67%) were positive for Escherichia coli bacteria. Meanwhile, E.coli bacteria can cause disorders in the body system to cause death. According to WHO (2018) it is estimated that up to 10% of patients with E.coli infection experience a case-fatality rate of 3-5%. In 2014-2018 in several European regions in a multinational study, there were 2.961 cases of mortality or death from 30.923 incidents of infection by E.coli bacteria (MacKinnon et al., 2021). In 2022, Malang City experienced an Extraordinary Event of Food Poisoning known as KLB-KP which caused 74 people become ill (Dinkes Kota Malang, 2023). Lowokwaru sub-district, Malang City in 2023 became the highest sub-district for digestive tract infections with 4.312 morbidity rates of vomiting or gastroenteritis, which can be caused by infection with the bacteria that cause dysentery, namely E.coli (BPS, 2024)

Escherichia coli stands apart from other bacteria that induce food poisoning due to its unique characteristics. While E.coli normally resides in the intestines of humans and animals, certain strains like E.coli O157 can produce toxins capable of causing severe illness through contaminated food or water (Pokharel et al., 2023). Hygiene-sanitation is often an indicator of food safety. In some studies, there are inconsistent results regarding the relationship between personal hygiene and environmental sanitation to the presence of E.coli bacteria. Research by Abidin, et al. (2021)states that hygiene-sanitation has a significant relationship with E.coli contamination in food. This is different in the research of Azzahro, et al. (2021) which states that there is no relationship between hygiene-sanitation and contamination of food. Seeing the inconsistencies in the results of previous studies, it is necessary to further analyze the factors that influence the presence of E.coli bacteria in food, which in this case is seen from the sanitation of food processing places and the hygine of food handlers with observations using the Indonesian Permenkes 2011 which was not used in previous studies.

The large number of food poisoning cases in Malang City indicates that the food consumed is not fully safe from potential contamination. Based on food poisoning cases in Malang City and the high number of gastroenteritis cases in Lowokwaru Village, it is necessary to do food testing, especially in the Terusan Ambarawa area, Lowokwaru Village, Malang City. Based on the results of interviews with the head of RW 03, the population density of the Terusan Ambarawa Area until 2023 is ± 1,142 people. Besides having a high density, this

location is also a strategic area because it is close to several schools and universities. The purpose of this study was to identify the level of E.coli bacterial contamination in food being sold, as well as to determine the relationship between sanitation of the place of selling and the hygiene practices of food handlers to the presence of E.coli bacteria in food stalls along the Terusan Ambarawa Area. It is hoped that the findings from this study can provide a basis for the government to regulate and supervise food stalls and for business actors to serve food with higher hygiene standards. This aims to protect the public from the risk of various diseases that can be transmitted through food consumption.

2. Method

This study used a cross-sectional approach with a quantitative descriptive design. The independent variables explored were personal hygiene of food handlers and sanitation of the selling environment, while the dependent variable was the number of Escherichia coli bacteria in food. This research was conducted at Terusan Ambarawa Area, Lowokwaru District, Malang City and was conducted from September to December 2023. This study has obtained ethical approval from the ethics commission of Universitas Airlangga faculty of dental medicine health research ethical clearance commission. The selection of samples in this study was carried out through a purposive sampling method based on certain criteria, namely a) A1 food stalls, namely food stalls that are integrated with homes / residences, b) food samples taken are the most popular foods for buyers, c) willing to be researched. Based on preliminary studies, a total of 11 food stall samples were taken.

Sanitation level of the selling place and personal hygiene behavior were measured using a checklist questionnaire as a description of the object under study. E.coli contamination was measured using the Most Probable Number (MPN) method at the Regional Health Laboratory of Malang City. Data were analyzed using the chi-square test to determine if there was a relationship between the dependent and independent variables at the 5% significance level. The MPN method is a method of enumerating microorganisms that using data from the results of the growth of microorganisms on a specific liquid medium in a series of tubes planted with solid or liquid samples so that specific liquid medium in a series of tubes that are planted with solid or liquid samples so that resulting in a range of microorganism counts in approximate amounts (Yulistiani et al., 2023).

3. Result and Discussion

Table 1 Laboratory Results of Escherichia coli Examination in Food in Terusan Ambarawa Area in 2023

Sample	Results	Quality Standard	Description
Sample 1	3,6	<3,6	Not qualified
Sample 2	3,6	<3,6	Not qualified
Sample 3	15	<3,6	Not qualified
Sample 4	1100	<3,6	Not qualified
Sample 5	35	<3,6	Not qualified
Sample 6	150	<3,6	Not qualified
Sample 7	150	<3,6	Not qualified
Sample 8	150	<3,6	Not qualified
Sample 9	15	<3,6	Not qualified
Sample 10	<3,0	<3,6	Qualified
Sample 11	28	<3,6	Not qualified

Source: Primary Data, 2023

Based Table 1. Laboratory examination showed the presence of *Escherichia coli* bacteria in food in the Terusan Ambarawa Area, as many as 10 out of 11 or 90.9% of the food samples tested did not meet the quality standards for *E.coli* bacteria. The quality standard of *E.coli* as required by Permenkes 2023 is <3.6 MPN/gr

Table 2 Observation Results of Environmental Sanitation and Personal Hygiene Conditions of Food Stalls in the Terusan Ambarawa Area in 2023

No.	Observation Object	Total Stalls	
		Yes	No
	Environmental Sanitation Variable		
A.	Food Processing Overview:		
1	Processed food sources are kept intact and undamaged.	5	6
2	Foodstuffs processed in original packaging, registered, labeled and not expired.	11	0
3	Food processing area is not used as a sleeping area	11	0
4	Work areas should have adequate floor space for workers, separate from sleeping areas or laundry areas.	1	10
5	The food processing area should be free of unnecessary items (they are stored neatly in the warehouse).	1	10
6	Proper handling of potentially hazardous foods involves attention to the temperature, method and duration of storage, preparation, serving and transportation of food. It is also important to soften frozen foods before cooking.	5	6
7	Good handling of potentially hazardous foods that are not covered or re-served.	4	7
8	1 (one) refrigerator available	3	8
	Location, building and facilities:		
9	Areas that are clean, well-organized, not damp, and at least 500 meters away from places that might harbor flies or dump garbage, and do not emit unpleasant smells or pollute from pollution sources.	1	10
10	The building should be structurally sound, secure, well-maintained, clean, and not have unnecessary items or waste around it.	2	9
11	The floor surface should be waterproof, flat, non-slip, non-cracking, well-maintained, and easy to clean.	3	8
12	Walls and ceilings should be well-constructed, maintained, and free of debris such as dust (which can harbor cobwebs).	2	9
13	The part of the wall that is exposed to splashing water is coated with waterproof material as high as 2 (two) meters from the floor	5	6
14	The doors and windows are well-made and strong.	4	7
	Sanitation Facilities Overview:		
15	Sufficient trash cans are available, covered, fly, cockroach, rat proof and lined with plastic bags that are lifted every time they are full.	3	8
16	Wastewater discharge from kitchen areas, bathrooms, toilets and storm drains should be smooth, efficient and not cause unwanted waterlogging.	10	1
17	Clean water sources are safe and sufficient in quantity	11	0
18	Work areas and equipment are equipped with effective ventilation systems to ensure optimal air circulation and avoid excessive humidity.	2	9
19	Handwashing stations and toilets are available in sufficient numbers, have soap, are comfortable to use and easy to clean.	1	10
20	Lighting should be tailored to the needs and not create distracting shadows. Light intensity should be at least 10 fc in the work area.	10	1

No.	Observation Object	Total Stalls	
		Yes	No
21	Protection of food utensils and cookware includes measures to properly clean, store, use and maintain them.	3	8
22	Disposable cutlery and cooking utensils are not reused.	0	11
23	The cleaning process involves a series of steps, starting with removing food debris, then soaking, washing and rinsing.	11	0
24	Not adjacent to / there are toxic materials / pesticides around food ingredients	2	9
25	Food processing is protected from insects, rodents, pets and other nuisance animals.	0	11
B.	*Personal Hygiene* Variabel		
1	All individuals involved in the food handling process must be free from communicable diseases such as skin diseases, abscesses, open wounds and upper respiratory tract infections (ISPA).	4	7
2	Hand hygiene measures include washing hands regularly, keeping nails short, avoiding the use of cosmetics on hands, and exhibiting good hygienic behavior.	2	9
3	Wear clean work clothes, keep hair short, and avoid wearing body jewelry.	8	3

Source: Primary Data, 2023

Based on Table 2. the results of observations of environmental sanitation and personal hygiene at food stalls in the Terusan Ambarawa Area show that there are still many points that are not fulfilled by food stall owners. However, there are some stalls that have demonstrated good hygiene practices, such as implementing the use of clean work clothes, keeping hair short, and avoiding the use of jewelry, as many as 8 out of a total of 11 stalls observed. However, principles such as washing hands regularly, cutting nails short, avoiding the use of cosmetics, and demonstrating hygienic behavior are still not consistently applied by some stalls.

Personal hygiene of food handlers was assessed using an ordinal measurement scale with a data scale of a) very good: ≥ 9-11 points; b) good: ≥ 6-8 points; c) bad: ≥ 3-5 points; and d) very bad: ≤ 5 points. The data scale for environmental sanitation variable used is of a) very good: ≥ 45-49 points; b) good: ≥ 31-44 points; c) bad: ≥ 16-30 points; and d) very bad: ≤ 15 points.

The results of the observation analysis of food stalls in the Terusan Ambarawa Area show that most of them are still not good at environmental sanitation and personal hygiene aspects. Based on the observation results, there is only 1 food stall with very good criteria on environmental sanitation and personal hygiene variables (Figure 1).

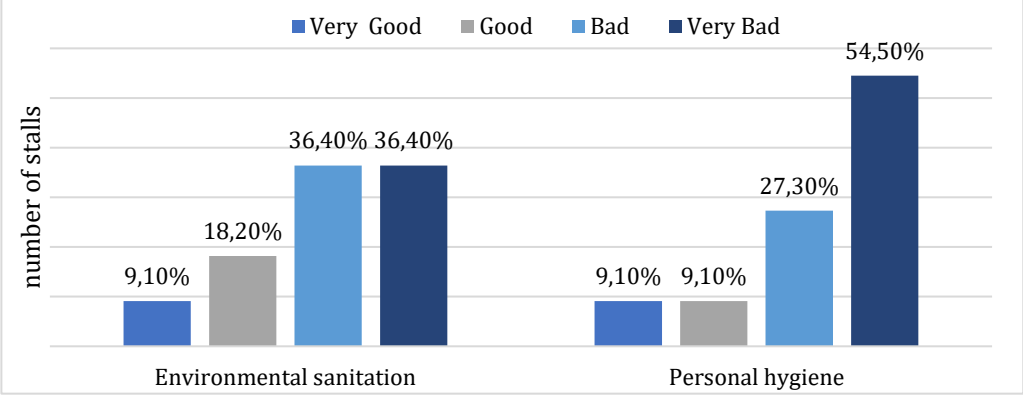

Figure 1 Results of Environmental Sanitation and Personal Hygiene Analysis at Food Stalls in the Terusan Ambarawa Area in 2023

Table 3 Chi-square Test Results Environmental Sanitation with Escherichia coli Bacteria

Sanitasi Lingkungan	*Escherichia coli* Result			
	Not Qualified	Qualified	Total	sig
Very Good	0	1	1	0,012
Good	2	0	2	
Bad	4	0	4	
Very Bad	4	0	4	
Total	10	1	11	

Source: Primary Data, 2023

Based on table 3. the results of statistical tests on the relationship between environmental sanitation and the presence of *E.coli* bacteria in food, the sig value is 0.012. This value is <0.05, so there is a relationship between environmental sanitation and the presence of *E.coli* bacteria

Table 4 Chi-square Test Results Personal Hygiene with Escherichia coli Bacteria

Personal Hygiene	*Escherichia coli* Result			
	Not Qualified	Qualified	Total	sig
Very Good	0	1	1	0,012
Good	1	0	1	
Bad	3	0	3	
Very Bad	6	0	6	
Total	10	1	11	

Source: Primary Data, 2023

Based on table 4. the results of statistical tests on the relationship between personal hygiene and the presence of *E.coli* bacteria in food, the sig value is 0.012. This value is <0.05, so there is a relationship between personal hygiene and the presence of *E.coli* bacteria.

3.1 Presence of *Escherichia coli* Bacteria in Food Sold in Terusan Ambarawa Area

The area located along the Terusan Ambarawa Area in Malang city is one of the main focal points for economic growth and social development in the region. In the Regional Spatial Plan (RTRW) of Malang city which is valid from 2010 to 2030, the Terusan Ambarawa Area is declared as part of the higher education area. As a result, this area is one of the areas that has

a high population density because a large number of individuals migrate to this city every year, especially students who are the majority of these newcomers (Wahyuningsih et al., 2023). Food stalls in the Terusan Ambarawa Area sell a variety of foods such as fried rice, meatballs, chicken and many others. Food stalls are open from morning to night. This research was conducted in the morning, 11 samples were taken in the form of the most popular food from each food stall.

Escherichia coli has become an indicator in the assessment of sanitation levels in food and beverage products. The presence of this microorganism is often considered a reflection of inadequate sanitation quality, and often indicates contamination by human or animal feces (Avifah, 2021). *E.coli* bacteria will cause foodborne diseases in the form of diarrhea, cholera, dysentery, and others if consumed by humans. Symptoms of the disease caused by *E.coli* bacteria can appear in varying periods of time, either a few moments after consumption or several months later. Clinical signs generally begin with the appearance of liquid diarrhea within the first 24-hour period after exposure, which is then followed by symptoms of bleeding and vomiting (Azizah, 2018)

According to the requirements set out in Permenkes RI 2023 regarding the maximum limit of microbial contamination in food, the maximum limit of *Escherichia coli* contamination in food is less than 3.6 MPN/gr, meaning that processed food should not contain more than the limit of *E.coli* contamination. Based on the study findings, it is known that only 1 out of 11 food stalls studied met the requirements of the maximum limit of *E.coli* microbial contamination (Table 1).

The presence of *E.coli* bacteria in food can be influenced by a number of diverse factors. These factors include direct or indirect contamination by various sources of contaminants, such as water, dust, air, soil, and processing equipment, whether it occurs during the production or food preparation stages (Selfiana et al., 2017). Unhygienic food management and sanitation can trigger contamination by *Escherichia coli* bacteria as pathogenic microorganisms (Abidin et al., 2021).

Based on Figure 1, it can be seen that most of the conditions of environmental sanitation and personal hygiene of food handlers in the Terusan Ambarawa Area are poor. Lack of hygiene of the food handlers and the environment will lead to poorer food quality or the presence of more *E.coli* bacteria (Wantik, 2018).

3.2 Environmental Sanitation of Food Stalls in the Terusan Ambarawa Area.

The environmental sanitation facilities of food stalls are important to consider. Environmental determinants have a strong relationship with several infectious diseases such as diarrhea, hepatitis A, typhoid fever, and tuberculosis. Inadequate environmental sanitation conditions can increase the risk of infectious diseases in humans (Politon & Novarianti, 2022). Sanitation-related diseases caused by exposure to fecal pathogens cause a substantial global disease burden, annually 1.7 billion children under 5 years experience diarrhea. Access to adequate sanitation could reduce an estimated 0.5 million deaths and 26 million diarrhea events annually, especially in low-middle income countries (Prüss-Ustün et al., 2019)

Based on the study findings, information was obtained that only 1 of the 11 food stalls studied was classified as very good in the environmental sanitation variable, 2 in the good category, 4 in the bad category and 4 in the very bad category. The environmental sanitation

variables in this study include food processing sanitation, building and facility location sanitation, and sanitation facilities based on the sanitation inspection assessment in the Minister of Health Regulation No. 1096 of 2011. Based on the observation results, the most dominant thing that is still lacking attention is related to sanitation facilities.

Regarding food processing, only three stalls complied with the standard on the point of good handling related to potentially dangerous food because it was not covered or food that was re-served. Based on observations that have been made, there are still many food stalls that have not applied good food sanitation principles such as cooked food that is not stored in a proper place. There are still traders whose containers/storage areas used are dirty and not maintained. Storing food in closed containers is important to keep it away from dust, disease vectors and other sources of contamination. Food storage in the open and in poor conditions can increase the risk of harmful contamination (Suryaningsih & Wijayanti, 2020). Food storage must be free from animals such as insects and rats. Implementing the FIFO (First In First Out) system, keeping storage areas clean and well-maintained, and ensuring that storage containers are always closed can prevent food from being contaminated by disease vectors. In addition, the provision of refrigerators to store ready-to-eat food ingredients, as well as fruits and vegetables that do not run out on the same day is also one of the things that can be provided to prevent contamination of food ingredients (Rohmah et al., 2018).

Based on observations, the points of food ingredients processed in original packaging, registered, labeled, and not expired have been met by all food stalls. In addition, none of the food stalls used the food processing area as a sleeping area. Safe and adequate clean water sources have also been fulfilled by the food stalls studied. Water quality that does not meet the standards indicates the presence of microorganism contamination that can cause cooking utensils to be contaminated (Nurbaya et al., 2023).

Regarding location, buildings and facilities, the point that the building does not smell bad / unpleasant odors coming from pollution sources is only fulfilled by 1 of the 11 stalls studied. The condition of the location of food stalls in the Terusan Ambarawa Area, which is close to sources of odor/smoke/dust/dirt pollution, causes a high risk of contamination of the food sold. The possibility of significant levels of bacterial contamination is often rooted in open sales locations, where food is vulnerable to exposure to dust and air, allowing bacteria to easily contaminate the food product (Selfiana et al., 2017).

Regarding the sanitation facilities of food points protected from insects, rats, pets and other nuisance animals, it was found that in the research location the entire sample (100%) still found nuisance animals around the research location. Food processing needs to avoid animals that can be a source of pollution to food. Environmental conditions that support the growth of insect and rodent populations tend to increase in various locations, especially in buildings, storage areas, kitchen spaces, water supply systems, inadequate sanitation, and solid waste management facilities. In addition, poor attitudes and practices of food handlers are also significant contributing factors to these conditions, which can be found in many locations (Firdani et al., 2022). Animals/insects, such as flies, usually carry disease pathogens that can contaminate food (Thoriqoh et al., 2020).

None of the stalls studied (100%) fulfilled the requirements related to single-use food and cooking utensils not being reused. Pathogenic bacteria can be transferred from one food item to another through the use of the same kitchen utensils during the cooking process.

Therefore, it is essential that cooking and eating utensils that come into direct contact with food should be made of materials approved for food safety (food grade), so that they are guaranteed to be safe and not endanger human health (Permenkes RI No. 1096., 2011)

Similar to the results of research by Azzahroh, et al. (2021), food irregularities are the cause of contamination in food, therefore traders must pay attention to food storage to protect food from dust or other contaminants. The cleanliness of the container where food is stored must be kept clean, finished food storage must be stored using a clean and closed container to avoid the possibility of contamination of food. Food storage conditions are the main parameter for maintaining food quality and safety (Iqbal & Rochmah, 2023).

Therefore, traders in the Terusan Ambarawa Area are expected to comply with procedures and add sanitation facilities in accordance with applicable regulations to prevent contamination of food to be served to the public. Food safety points that are potentially dangerous or re-served must be stored using clean containers and according to food grade materials. It is also necessary to pay attention to the food processing process so that it is free from animals such as insects, rats and other nuisance animals.

3.3 Personal hygiene of food handlers in food stalls in Terusan Ambarawa Area

Personal hygiene is an important thing that must be fulfilled by a food trader. Personal hygiene of food vendors as food handlers is related to body hygiene. Handler hygiene is an effort made by food handlers to maintain hand hygiene, work clothes, hair hygiene and personal health (Suherman et al., 2013). Based on observations that have been made, overall food traders in the Terusan Ambarawa Area have very poor personal hygiene categories. There are 1 trader with very good criteria, 1 trader with good criteria, 3 traders with bad criteria and 6 traders with very bad criteria. The personal hygiene variable includes 3 points, namely, handlers free from infectious diseases, hand hygiene and related personal hygiene, Eight out of eleven handlers have implemented practices related to clean work clothes, short hair, and jewelry-free bodies. Although the use of aprons and head coverings as part of work clothing does not directly impact *E.coli* contamination, it can reduce the risk of physical, chemical and biological contamination of food.

In terms of personal hygiene, observations showed that vendors were not consistent in washing their hands before touching food, even though hand hygiene is a key factor in preventing food contamination (Rutaro et al., 2024). The practice of washing hands with running water and soap before and after handling food is also considered important but is often not implemented by vendors. Hands play a vital role in the spread of disease because they can be a place for microorganisms, including bacteria, to develop on the skin and nails (Suryaningsih & Wijayanti, 2020).

During observations of food handlers' activities, it was observed that they performed various actions such as directly touching equipment that had been used, cleaning equipment, wiping tables, receiving and returning money, and continuing to sell without washing their hands first. Such practices have the potential to cause contamination, where microorganisms can be transferred to food. This finding is in line with research conducted by Suherman, et al. (2013), which states that the behavior of traders as food handlers before serving buyers is one of the significant sources of contaminants to food hygiene. Hand washing using soap and running water aims to prevent cross-contamination, either from person to person or through

contaminated objects to people, as well as to reduce the risk of transferring microorganisms that can cause disease (Wardhana et al., 2021)

The lack of supervision and guidance from health sanitation workers to food handlers in the Terusan Ambarawa Area is evident in the lack of application of food hygiene sanitation principles by most food handlers. Indifference to safe food management and the lack of knowledge of food handlers are significant factors contributing to the prevalence of foodborne illness. An integrated approach to preventing foodborne illness involves educating and training food handlers on food safety. This finding is supported by the results of research conducted by Kusuma, et al. (2017), which showed a 22% increase in knowledge after counseling on personal hygiene. It is expected that good knowledge of food hygiene-sanitation will be reflected in food management practices. Applying the principles of optimal food hygiene and sanitation can produce quality food products that are free from contamination (Moelyaningrum et al., 2023).

3.4 The relationship between personal hygiene and environmental sanitation on the presence of *Escherichia coli* bacteria

Maintaining food hygiene and sanitation is very important. A quality environment and adequate sanitation facilities as cited in the book Hazard Analysis Critical Control Point (HAACCP) by Irawan (2023) can prevent the entry of bacteria or pathogens that cause infection. A good environment must provide a sense of security to individuals in the vicinity. The necessary environmental sanitation facilities include aspects such as adequate clean water supply both in terms of quantity and quality, regular waste management to prevent contamination, and landfills that are in accordance with standards, made of waterproof materials, easy to clean, and have covers (Yulia, 2016). Food sanitation, which includes the location of the building, food ingredients, food handlers and the environment where food is managed, needs to comply with established standards. Food sanitation needs to be fulfilled properly by food stalls so that the food produced can be safely consumed.

Based on the study findings, it is known that the regulations that require food to contain *E.coli* <3.6 MPN/gr are still not fulfilled according to Permenkes 2023 in food stalls in the Ambarawa Forward Area, Malang City (Table 3). This can be influenced by aspects of environmental sanitation and poor personal hygiene of food handlers according to the results in this study, resulting in *E.coli* contamination in the food sold. However, these results are not in line with the results of research by Azzahra, et al. (2021) that hygiene-sanitation does not have a significant relationship with *E.coli* contamination. Meanwhile, the findings of this study are in line with the results of research by Abidin, et al. (2021) which show that there is a relationship between food sanitation, sanitation facilities and hygiene behavior of food handlers on *E.coli* contamination in food. This is supported by the statement of Politon & Novarianti (2022) that environmental sanitation of food processing places that are less qualified has a 12 times chance of the presence of *E.coli* bacteria compared to food processing sanitation that meets the requirements.

Table 4. reflects that the majority of food handlers in food stalls in the Terusan Ambarawa Area have poor hygiene behavior. Based on the correlation analysis between personal hygiene and the presence of *E.coli* bacteria, the significance value is 0.012, which means that there is a significant correlation between the personal hygiene of the seller and the presence of *E.coli* bacteria. This finding is consistent with the results of research conducted by

Yunus, et al (2019), the variable that has the most influence on *E.coli* bacterial contamination is the personal hygiene of food handlers. Research by Nisa & Handayani (2019) also stated that personal hygiene of food handlers is the most dominant factor in food contamination.

Food stalls as places that manage food for sale to the public should pay attention to hygiene-sanitation that has been established. It is expected that food handlers always pay attention to personal hygiene, including the cleanliness of their hands, hair and nails. In addition to this, cleanliness in the work environment and the availability of adequate hygiene facilities such as hand washing stations, soap, clean tissues, brooms, and closed trash cans are also important to note. Participating in counseling and training held by the Malang City Health Office is also necessary for food stalls to reduce the risk of *E.coli* bacteria contamination in food.

3.5 Recommendations on Food Sanitation Aspects (Hygiene-Sanitation) of Food Stalls in Terusan Ambarawa Area

The following are some recommendations for the government, consumers and food stalls in the Terusan Ambarawa Area to be fulfilled in order to produce safe food and prevent disease due to contaminated food. These recommendations can be used as evaluation material and are expected to be useful for all parties so that they can be implemented and produce safe food (Table 5).

Table 5 food sanitation aspect recommendations

No.	Food Stall Business Owners	Government	Consumers
1	Ensure food production facilities are free from animals	Provide food safety education facilities for food stall operators	Pay attention to the cleanliness of the food stall environment before deciding to buy
2	Changing cooking and eating utensils to food-grade materials	Food safety evaluation needs to be conducted every certain period	Washing hands, this is especially important after using the bathroom and before eating food.
3	Replace trash cans as required		
4	Foodstuffs and prepared foods need to be stored in closed and well-maintained containers		
5	In addition to always washing your hands, you can also wear gloves when handling food.		
6	Separete raw and cooked foods. Separate raw meats, fish, poultry, and eggs from other foods until they're cooked		

Source: Primary Data, 2023

4. Conclusion

Based on the results of the analysis of the study conducted, it is known that there is a significant relationship between personal hygiene of food handlers and environmental sanitation on the presence of E.coli bacteria in food in the research area of Terusan Ambarawa Area, Lowokwaru Village, Malang City. Most of the food sold in the Terusan Ambarawa Area is not safe for consumption, this is evidenced by 10 of the 11 foods tested positive for E.coli

exceeding the established quality standards. This can be influenced by aspects of environmental sanitation and poor personal hygiene according to the results on the study findings, such as washing hands regulary, cutting nails short, and food processing is protected from insects, rodents and other nuisance animals are still not fulfilled according to Permenkes 2011.

Hygiene-sanitation needs to be considered by food stall operators. Based on the analysis conducted in this study, it is evident that food hygiene-sanitation affects the presence of E.coli bacteria in food. Special attention to food stalls in the Terusan Ambarawa Area is needed because this area has high mobility and population density. Food stall operators need to understand the hygiene-sanitation principles that have been established through the Permenkes 2023 regulation, this can be done with interventions from various related parties by socializing the importance of hygiene-sanitation to prevent contamination of food in this study area so that the food sold to the public is safe for consumption. Other related matters that need to be researched include determining the main source of E.coli contamination in food.

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