



A CROSS-SECTIONAL STUDY ON FOOD SAFETY KNOWLEDGE PRACTICES, FOOD HYGIENE, AND AFLATOXIN CONTAMINATION AWARENESS OF STREET FOOD VENDORS IN URBAN AREAS OF MOROGORO MUNICIPALITY, TANZANIA

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ABSTRACT

This study aimed to evaluate the food safety and hygiene practices, as well as the awareness of aflatoxin contamination, among street food vendors in urban areas of Morogoro Municipality, Tanzania. The study was conducted from November, 2024 to December 2024, the research utilized a cross-sectional design. Data were collected from 76 street food vendors selected through convenience sampling. A structured questionnaire and observation method were employed simultaneously to gather data. The collected information was entered and analyzed using the Statistical Package for Social Scientists (SPSS) version 20.0. The majority of participants were female (69.7%), while males accounted for 30.3%. Most respondents (31.6%) were aged between 26 and 35 years. Regarding education, 27.6% had completed primary school, while 25% had no formal education. Food hygiene knowledge was generally low, with mean scores below 3 on most indicators. Only 9.2% of participants were aware of aflatoxins, and 18.4% believed aflatoxins could impact food quality and safety. Furthermore, only 5.3% were aware of the long-term health risks, such as cancer. The study concluded that street food vendors in the area exhibit inadequate food safety and hygiene practices and have limited knowledge of aflatoxin contamination. It recommends providing vendors with comprehensive training and information on food safety, personal hygiene, and aflatoxin risks. Additionally, implementing appropriate control measures and enforcing health and safety regulations across the food supply chain is essential to prevent foodborne illnesses.

KEYWORDS: Street food vendors; food safety knowledge; food hygiene, aflatoxin awareness, Tanzania.

INTRODUCTION

Street food vending is an age-old practice^[1] prevalent in many countries^[2] as a source of income. It offers affordable meals accessible to the population and often reflects the culture of local and traditional foods.^{[3],[4]} The World Health Organization^[2] defines street food as foods and beverages prepared and sold by vendors in public spaces for immediate consumption. Research on street food has spanned over three decades, with numerous studies published from the 1990s to the 2020s.^{[5],[6],[7]} According to the Food and Agriculture Organization, street foods are "ready-to-eat foods and beverages sold by vendors or hawkers in streets or similar public areas".^[8] Street foods are integral to public life, particularly for low-income populations.^[9] Globally, street foods serve a significant portion of urban populations, especially in developing countries such as Dhaka, Mumbai, Bangkok, and Mexico City.^[10] Approximately 2.5 billion people consume street food daily,^{[11],[12]} However, concerns about food safety in

street-vended foods persist across the developing world.^{[13],[14],[15],[16],[17]}

The street food industry provides vital income for low-income earners, especially women^[18], and contributes significantly to urban diets.^[19] It is an essential part of daily food consumption for millions in developing countries, including Tanzania.^{[20],[21]} Street food is often the most affordable and convenient option for meals outside the home.^[22] Despite its importance, street food poses significant health risks due to microbial contamination from preparation areas, utensils, raw materials, and vendors' hygiene practices. Extrinsic contamination can occur at any stage of the food chain, and many vendors lack knowledge of safe food handling. The WHO^[23] survey across 100 countries identified factors like inadequate infrastructure, limited access to potable water, and improper waste disposal as contributors to foodborne diseases. Norovirus, Salmonella, and other pathogens were reported as leading causes of foodborne illness outbreaks.^[24]

In developing countries, street food vendors often operate in unsanitary conditions, lacking access to potable water, toilets, and proper waste disposal systems.^[25] These challenges, combined with limited regulatory enforcement, exacerbate food safety risks. Vendors are frequently untrained in food safety, increasing the likelihood of foodborne illness outbreaks.^[26] Proper training has been shown to improve vendors' food safety knowledge and practices, thereby reducing hazards.^[27]

Aflatoxins, toxic byproducts of fungi like *Aspergillus flavus* and *Aspergillus parasiticus*, pose additional risks in street-vended foods. These toxins thrive in tropical regions, contaminating crops and contributing to severe health issues, including liver cancer.^{[28],[29]} Indeed, street foods chain is vulnerable to recycled food deemed unfit for human consumption. Peanuts, an ingredient widely used in Indonesian cuisine are heavily contaminated with aflatoxins and was found in 17% of the street vended foods^[30]. Likewise, 19% of aflatoxins contaminated corn, peanut, wheat, and rice, which were detected in Nepal street foods. Similarly, 68% of the Nigerian street vended snacks based on corn, wheat, and groundnut reported presence of aflatoxins in concentrations exceeding the maximum limits set by the Codex Alimentarius.^[31]

In Tanzania, few studies have assessed food safety knowledge and practices among street food vendors, and none have specifically examined aflatoxin contamination awareness in urban areas of Morogoro Municipality. This study aims to fill this gap by evaluating food safety and hygiene practices, as well as the knowledge and awareness of aflatoxin contamination among street food vendors in this region. This study will provide valuable information on the food safety practices and knowledge gaps among street food vendors in Morogoro Municipality. The findings will inform policymakers, health authorities, and food safety organizations about the need for training programs and interventions to improve food safety and reduce the risks of foodborne illnesses, including aflatoxin contamination. By addressing these gaps, the study aims to contribute to safer street food practices and improve public health outcomes in the community.

The main objective of the study is to assess the level of knowledge, adherence to food safety practices, hygiene standards, and awareness of aflatoxin contamination among street food vendors in Morogoro Municipality. The study will aim to identify gaps in food safety practices, determine the extent of knowledge regarding aflatoxins, and recommend interventions to improve food safety and public health.

MATERIALS AND METHODS

A cross-sectional survey design with a quantitative approach was employed for this study, conducted between November and December 2024. Two wards, Mji

Mkuu and Kingo, out of the 29 wards in Morogoro Municipality, were purposively selected due to the high concentration of street food vendors in these areas. Morogoro Municipality was chosen as the study location not only for its strategic position and diverse cultural norms and practices but also because it represents a hub of economic activities and urbanization. The migration of people from rural to urban areas in search of better livelihood opportunities has led to increased population density and a rise in informal business activities, including street food vending.

Manning and Effendy, as cited in Rahayu et al.^[32], noted that street vendors often choose locations that are highly beneficial, strategically situated, and densely populated with potential customers, such as trade centers, educational institutions, or office areas. Similarly, Carr, cited in Herdianto^[33], highlighted that factors such as pedestrian traffic and the availability of sidewalks attract street vendors to specific locations, facilitating their activities in these areas.

Study population

The study population comprised street food vendors engaged in food vending activities within the urban areas of Morogoro Municipality. These vendors are predominantly concentrated in locations with high demand, driven by the presence of low- and middle-income urban residents. Common vending areas include traditional open-air markets and their surroundings, transportation terminals, bus stops, commercial streets, schools, construction sites, and office vicinities.

Sampling and Sample Size Determination

A purposive sampling technique was utilized to select the study areas, with Mji Mkuu and Kingo wards chosen due to the diverse range of foods sold along their streets. For respondent selection, convenience sampling, a non-probability sampling method, was employed. This approach was advantageous in optimizing time and effort in identifying participants, given the absence of an existing sampling frame or detailed information about the street food vendors. Since the exact population of street food vendors was not known, the sample size was estimated using the Kothari and Garg equation^[34]:

$$n = Z^2 P (1-P) / e^2$$

Where; n = sample size to be estimated, Z^2 = critical value (Z-Score), corresponding to the desired confidence level (for this study, a 95% confidence level, $Z=1.96$), p= estimated proportion of an attribute present in the population ($p=0.05$) and e = acceptable margin of error (precision or estimation error), set at 4.9% ($e=0.049$) for this study. By substituting these values into the Kothari and Garg equation^[34], the sample size for the study was calculated to be 76 respondents.

Data Collection

The data collection for this study involved both a

questionnaire and an observational checklist. The questionnaire included categorical/multiple-choice nominal questions, Yes/No questions, and Likert rating scale questions. The Likert scale used a five-point range: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5), allowing the researcher to calculate mean and standard deviation values for each response. Food safety knowledge was categorized as good (score of 4.1-5.0), moderate (2.71-4.0), or poor (1.00-2.7), with respondents scoring below the mean classified as having "poor knowledge" and those scoring at or above the mean as having "good knowledge." Food hygiene knowledge was assessed using a multiple-choice knowledge test (MCKT), while the Guttman scale was employed to measure the strength of respondents' agreement or disagreement with statements. This scale helped determine not only the respondents' beliefs but also the intensity of those beliefs. Observations were made to complement the survey data and minimize self-reporting bias, using a structured observation tool to assess the respondents' hygiene practices.

Statistical Data Analysis

The data collected from the completed questionnaires were organized and entered into an Excel sheet, then imported and coded using the Statistical Package for Social Sciences (SPSS) for Windows, version IBM 20.0. Descriptive statistics were employed to summarize the variables of interest. The results were presented in the form of frequencies, percentages, means, and standard deviations to provide a clear overview of the data.

Ethical Consideration

Ethical considerations are crucial in ensuring the

integrity and safety of research. The primary goal of ethics in research is to protect participants from harm and adverse consequences. In this study, permission to conduct the research was obtained from the office of the Morogoro Municipal Director. Respondents were informed about their rights, the confidentiality of their responses, and their ability to withdraw from the study at any time. Prior to data collection, respondents were briefed on the purpose and significance of the study, and verbal consent was obtained from each participant. The researcher assured the respondents that their information would remain confidential and anonymous, and emphasized that the findings would be used solely for academic purposes.

RESULTS

Socio-demographic characteristics of respondents in the study area

The socio-economic and demographic characteristics of the respondents, including gender, age, marital status, and educational level, are summarized in Table 1. The majority of street food vendors were female, accounting for 69.7% of the total respondents, while 30.3% were male. In terms of age, 31.6% of respondents were between 18 and 25 years old. Regarding marital status, 11.8% were married, 33.3% were unmarried and living without a partner, 23.7% were unmarried but living with a partner, 18.4% were separated, 10.5% were divorced, and 6.6% were widowed. Educationally, most respondents (27.6%) had completed standard seven, followed by 25% with no formal education. Only 21.1% had completed form four, and 11.8% had attained tertiary education.

Table 1: Socio-demographic of respondents in the study area (n=76).

Variables	Category	Frequency (%)
Gender	Male	23(30.3)
	Female	53(69.7)
Age(years)	10-17 years	9(11.8)
	18-25 years	21(27.6)
	26-35 years	24(31.6)
	36-45 years	14(18.4)
	45 and above	8(10.5)
Education level	No formal education	19(25.0)
	Standard seven	21(27.6)
	Form four	16(21.1)
	Form six	11(14.5)
	College/University	9(11.8)
Marital status	Married	9(11.8)
	Unmarried and Living with a partner	22(29.0)
	Unmarried without living with a partner	18(23.7)
	Separated	14(18.4)
	Divorced	8(10.5)
	Widowed	5(6.6)

Street Food Vendors' Level of Knowledge on Food Safety practices

Table 2 shows food safety practices profile among the respondents in in urban areas of Morogoro Municipality.

Table 2: Street Food Vendors' Level of Knowledge on Food Safety Practices.

Indicators	SA	A	N	D	SD	Mean	SDev.	Interpretation
1. Wearing apron, mask, gloves, and caps is one part of personal hygiene	14.5	11.8	18.4	31.6	23.7	2.618	1.356	Poor
2. The most important rule of food service personal hygiene is that vendors must wash their hands often using water and soap before touching food.	15.8	7.9	22.4	38.2	15.8	2.697	1.286	Poor
3. It is very dangerous and strictly forbidden to mix one day's unsold food into the next day's batch.	14.5	13.2	14.5	32.9	25.0	2.592	1.378	Poor
4. Food borne illnesses are diseases that are carried or transmitted to people by food	15.8	18.4	23.7	25.0	17.1	2.908	1.328	Moderate
5. The most important factors to control the growth of bacteria are temperature and time.	10.5	7.9	18.4	38.2	25.0	2.408	1.246	Poor
6. Serving food using plastic wraps, nylon, foils and covers as a container is very risk to the customer	13.2	9.2	10.5	29.0	38.2	2.303	1.405	Poor
7. When serving food used, I use special serving utensils (spoons, forks etc)	10.5	17.1	22.4	35.5	14.5	2.737	1.215	Moderate
8. Cross contamination is the transfer of harmful substances or micro-organisms to food from food or from a non-food-contact surface, such as equipment, utensils, or hands.	8.8	11.8	23.7	34.2	18.4	2.645	1.251	Poor
9. Cleaning equipment after work can reduce cross contamination	7.9	14.5	22.4	38.2	17.1	2.579	1.169	Poor
10. After washing hands, vendors should avoid touching their hair.	17.1	39.5	23.7	13.2	6.6	2.526	1.125	Poor
11. Proper cleaning and handling of instruments reduce the risk of food contamination	10.5	26.3	17.1	14.5	31.6	3.303	1.424	Moderate
Overall Mean						2.618	1.356	Poor

Legend: Poor knowledge (score of 1.00-2.7), Moderate knowledge (score of 2.71-4.0), Good knowledge (score of 4.1-5.0).

The findings in Table 2 reveal generally low levels of awareness and adherence to essential food safety practices among the respondents, as shown by the mean scores. For example, the mean score for wearing protective gear (2.618) indicates a low recognition of its importance, with 31.6% disagreeing and 23.7% strongly disagreeing. Similarly, frequent hand washing had a mean score of 2.697, with 38.2% disagreeing and 15.8% strongly disagreeing, highlighting limited understanding of its role in food safety. Other practices, such as avoiding hair touching after washing hands (mean score 2.526) and mixing unsold food into the next day's batch (mean score 2.592), also showed poor adherence, with significant disagreement. While awareness of foodborne illnesses (mean score 2.908) was closer to moderate, disagreement was still notable (25% disagree, 17.1% strongly disagree). Knowledge of temperature control and the danger zone was particularly low, with mean scores of 2.408 and 2.303, respectively. The understanding of sanitizer contact time (mean score 2.737) and cross-contamination (mean score 2.645) was also limited. However, the recognition of the effectiveness of cleaning (mean score 3.303) was somewhat better, although 31.6% still strongly disagreed. These results emphasize the need for improved education

on food safety practices. The overall data shows a lack of knowledge and awareness, with low mean scores across most indicators, reflecting a significant variability in responses (standard deviations ranging from 1.125 to 1.424). While half of the respondents recognized the importance of washing and properly storing dishes to prevent contamination, a concerning proportion believed in practices that could introduce contamination, such as drying dishes with a dishtowel (19.74%) or washing dishes the next day (14.47%). Additionally, although 68.42% correctly agreed that food handling should be avoided during gastrointestinal illnesses, 31.58% still believed it was acceptable to handle food while ill, underscoring the need for targeted education on the risks of cross-contamination and the importance of personal health in food safety.

Overall, the data reveals a significant lack of knowledge and awareness about essential food hygiene and safety practices among street food vendors. The low mean scores across most indicators, coupled with high variability in responses, indicate that while some vendors are aware of food safety practices, a large proportion lacks the necessary understanding. There is a clear need for enhanced education and training programs targeting

food safety, hygiene, and proper handling practices to reduce the risk of foodborne illnesses.

The personal hygiene knowledge of street food vendors

The participant's response about personal hygiene has been presented in Table 3.

Table 3: The personal hygiene knowledge of street food vendors (n =76).

Variables	Answer options	Number of respondents (%)
1. Which of the following is the best way to wash your hands when you are preparing foods?	A. Wash hands with warm running water and wipe dry with a clean cloth	4(5.26)
	B. Wash hands with cold running water and wipe dry with a clean cloth	9(11.84)
	C. Wash hands with soap and cold running water and then wipe dry with a clean cloth	11(14.47)
	D. Wash hands with soap and warm running water and then wipe dry with a clean cloth	34(44.74)
	E. Both C and D above are correct	18(23.68)
2. As a food handler, which of the following compels you to wash your hands when you are involved in the preparation and serving of food?	A. After visiting the toilet only	5(6.58)
	B. After picking your nose	16(21.05)
	C. None of the above	22(28.85)
	D. All of the above	33(43.42)
3. As a food handler, I must not handle food when I have diarrhea, even if I wash my hands regularly.	A. True	45(59.21)
	B. False	31(40.79)
4. As a food handler, I must not handle food and money when I have flue and cough	A. True	47(61.84)
	B. False	29(38.16)
5. As a food handler, which of the following is the correct thing to do if you have a wound on your hands or foot?	A. Cover the wound with water-proof dressings/bandage	36(47.37)
	B. Do nothing, if it is not painful	40(52.63)
6. Washing hands with soap regularly after using the toilet is one part of personal hygiene	Agree	43(56.58)
	No	33(43.42)
7. Wearing cap and hand washing after sneezing or blowing is one part of personal hygiene	Agree	41(53.95)
	No	35(46.05)
8. Wearing gloves while handling food is one part of personal hygiene	Agree	48(63.16)
	No	28(36.84)
9. Do you handle food together with money at the same time?	Yes	41(53.95)
	Disagree	35(46.05)
10. I always avoid washing up in unclean surroundings to reduce microbial contamination and after washing, I rinse my dishes in two basins of clean water	Agree	42(55.26)
	No	34(44.74)
11. How should dishes be washed to prevent getting food borne diseases	A. Hand wash and rinse them right after the meal and then dry them with a dishtowel	15(19.74)
	B. Washing the dishes the same day is important as well as proper storage of the clean utensils in order to prevent contamination	38(50.0)
	C. Hand wash them and rinse them right after the meal and keep them in a protected area like the kitchen	12(15.79)
	D. Wash them the next day	11(14.47)
12. Food handling should be avoided during a gastro intestinal illness (diarrhea, vomiting, etc)	Yes	52(68.42)
	No	24(31.58)

The correct response under answer options is in bold

The findings presented in Table 3 highlight significant inconsistencies in hygiene practices and knowledge gaps among the respondents regarding food safety. While 44.74% correctly identified the proper hand washing method, the varied responses indicate a clear need for further education. Only 43.42% were aware of the various situations requiring hand washing, with 28.85% unaware of its importance in key scenarios. Although 59.21% understood that handling food during diarrhea is unsafe, 40.79% mistakenly believed that regular hand washing alone was sufficient, reflecting common misconceptions. Similarly, 61.84% acknowledged the importance of not handling food while sick, but 38.16% disagreed, indicating room for improvement in understanding. Regarding wound care, 47.37% knew to cover wounds, but 52.63% did not see the need, posing a risk for contamination. While 56.58% recognized the importance of regular hand washing, a significant portion did not, which parallels divided opinions on wearing caps (53.95% agreement) and gloves (63.16%). The

practice of handling money while serving food was a concern, with 53.95% of respondents doing so despite the associated contamination risks. Additionally, 55.26% acknowledged the importance of washing dishes in clean surroundings, pointing to the need for clearer hygiene guidelines. Overall, the data reveal varying levels of knowledge and adherence to proper hygiene and food safety practices. While some respondents demonstrated awareness, a significant portion displayed misconceptions or lacked knowledge in critical areas such as when to wash hands, managing illness, covering wounds, and preventing contamination. These findings underscore the necessity for targeted educational interventions to improve food handling safety practices among food handlers.

Street Food Vendors' Level of Knowledge and Awareness of Aflatoxin

Table 4 shows the street food vendors' level of knowledge and awareness on aflatoxin contaminations.

Table 4: Street Food Vendors' Level of Knowledge and Awareness of Aflatoxin contamination.

	Variable	Responses/Categories	Frequency	Percentage (%)
1.	Have you ever heard about aflatoxin?	Yes	7	9.2
		No	69	90.8
2.	If Yes, How did you know?	Mass media	4	57.1
		Agricultural Extension Officers	0	0.0
		Magazines	0	0.0
		Hospitals	3	42.9
		Neighbour/Friends	0	0.0
3.	Are you aware that aflatoxin can contaminate food?	Yes	8	10.5
		No	68	89.5
4.	Do you know that aflatoxin can affect human health?	Yes	5	6.6
		No	71	93.4
5.	If Yes, which health effects?	Cancer	5	100.0
		Vomiting	0	0.0
		Nausea	0	0.0
		Yellow fever	0	0.0
6.	Can you identify food products that are most prone to aflatoxin contamination?	Yes	0	0.0
		No	76	100.0
7.	Can you explain to customers the risks of consuming food contaminated with aflatoxins	Yes	2	2.6
		No	74	97.4
8	Are you aware that aflatoxins are invisible and cannot be detected by taste or smell?	Yes	0	0.0
		No	76	100.0
9	Do you know how to handle food to reduce the risk of aflatoxin contamination during preparation and selling	Yes	6	7.9
		No	70	92.1
10	Do you understand the importance of sourcing raw materials from reliable	Yes	12	15.8

	suppliers to prevent aflatoxin contamination?			
		No	64	84.2
11	Do you believe that aflatoxin contamination can affect the quality and safety of the food you sell.	Yes	14	18.4
		No	62	81.6
12	Are you aware of the long-term health effects of aflatoxin exposure, including cancer	Yes	4	5.3
		No	72	94.7

The data reveal a significant lack of awareness and knowledge about aflatoxins among street food vendors. Only 9.2% of respondents had heard of aflatoxins, with the majority learning about them through mass media (57.1%) and hospitals (42.9%), while no one mentioned sources like agricultural extension officers or magazines. Awareness of food contamination risks (10.5%) and health impacts (6.6%) was also low, with cancer being the only health effect recognized. None of the respondents could identify foods susceptible to aflatoxin contamination or understand that aflatoxins are invisible and undetectable by taste or smell. Additionally, only 2.6% could explain aflatoxin risks to customers, 7.9% knew how to handle food to minimize risks, and 15.8% recognized the importance of sourcing raw materials from trustworthy suppliers. Only 18.4% believed aflatoxins could affect food quality and safety, and just 5.3% were aware of the long-term health effects, such as cancer. These findings highlight a widespread lack of essential knowledge, underscoring the urgent need for targeted education, training on safe food handling, and improved communication about aflatoxin risks to enhance food safety and public health outcomes.

DISCUSSIONS

Socio-demographic characteristics of the study

The majority of the vendors in this study were female (69.7%), which aligns with findings from other global studies that show street vending is predominantly a female activity^{[35],[36],[37],[38],[39],[40],[41],[42],[25],[43]}. Research in Togo, Ethiopia, and Nigeria has also highlighted a higher involvement of women in street food vending, often due to their ability to balance family life with vending activities.^{[44],[45]} Similarly, Assob et al.^[46] observed a higher number of females involved in street food vending than males in Cameroon. Most respondents in this study were aged between 26 and 35 years, an age group often considered the most active and energetic in the workforce.^[47] Studies by Bormann et al.^[48] and^[49] in Ghana also found significant participation of this age group in street food vending. Regarding education, 27.6% of respondents had primary school as their highest level of education, likely due to financial constraints preventing further education.^[10] This finding is consistent with studies by Oladoyinbo et al.^[50] (2015) in Nigeria and Apanga et al.^[51] (2014) in Ghana, where low levels of education among street food vendors were attributed to financial limitations. Low formal education

is a common trait among street food vendors, as vending is often seen as an accessible form of self-employment with minimal capital investment.^{[47],[52]} However, the low educational level can negatively impact food safety knowledge, potentially compromising consumer health.^[53]

Street Food Vendors' Level of Knowledge on Food Safety Practices

The majority of street food vendors in this study demonstrated low levels of food safety knowledge, with an overall mean score of 2.618 and a standard deviation of 1.356, indicating a general lack of awareness on the subject. These findings align with a study conducted in Cotonou (Benin), where food safety knowledge among street food vendors was similarly found to be low.^[54] This lack of knowledge can be attributed to the limited availability of training opportunities for street vendors on proper food safety practices.^[55] The insufficient food safety knowledge among vendors suggests that they are unlikely to consistently produce safe food for consumers, posing a risk to public health.^[56] However, a small proportion of respondents exhibited a moderate level of food safety knowledge, likely due to individual experiences and societal hygiene standards that influenced their personal and food hygiene practices.^[57]

The persona food hygiene knowledge of street food vendors

Personal hygiene is crucial for ensuring safe food production, and the results from the questions related to personal hygiene practices in this study highlight varying levels of knowledge and adherence to proper food safety measures. While some respondents demonstrated awareness, many others showed misconceptions or lacked knowledge in critical areas, such as when to wash hands, how to manage illness, covering wounds, and avoiding contamination (Table 3). This lack of proper hygiene practices can be attributed to the fact that many street food vendors have not received formal training in food hygiene and often work in environments that lack essential resources, such as a reliable supply of potable water, as reported in previous studies.^{[58],[59]} Inadequate personal hygiene knowledge or unsafe food handling can lead to food contamination, increasing the risk of foodborne diseases for consumers.^{[60],[61]} Only a minority of respondents (47.37%) correctly stated that wounds on their hands should be covered with waterproof dressings

or bandages (Table 3). Additionally, 56.58% of respondents reported washing their hands regularly after work. This finding aligns with a study by Apanga et al.^[51] (2014) in Ghana, which found that most street food vendors had a good understanding of hand-washing procedures and the risks associated with improper hand hygiene.

Street Food Vendors' Level of Knowledge and Awareness on Aflatoxin Contaminations

This study reveals a generally low level of knowledge about aflatoxin contamination among street food vendors. The conditions under which street food is prepared and stored may contribute to the production of fungal toxins. Previous studies, such as Jonathan et al.^[62], have shown variations in fungal contamination and aflatoxin levels in foodstuffs collected from different locations in Nigeria. Many street food vendors are illiterate and lack awareness about sanitary practices, which further exacerbates the risk of contamination. For example, a case in Africa found that 85% of food stalls were located near garbage dumping sites.^[63] Certain molds, like *Aspergillus* and *Penicillium*, can survive in environments with low water content, increasing the risk of aflatoxin contamination. Globally, foodborne diseases, including aflatoxin contamination, are rising in both developed and developing countries. Inadequate hygiene practices and poor personal sanitation among food handlers contribute significantly to this public health crisis. Studies have shown that due to a lack of awareness and training among food handlers, aflatoxins are often present in street-vended food. Researchers suggest that public awareness campaigns and education can help reduce the risk of contamination. Training food handlers in food safety principles and sanitation, along with the development of food safety certifications, are essential measures to ensure better food handling practices.

In Nigeria, aflatoxins have been detected in 68% of street-vended snacks, particularly corn-based, groundnut-based, and wheat-based snacks, with levels exceeding the maximum limits set by Codex Alimentarius (15µg/kg or 15ppb). Similar contamination was found in street food items in Cape Coast, Ghana, such as meat pies, banku, beans with gari, dakua, and fufu.^[64] The FAO/WHO^[65] report also highlighted the widespread use of unauthorized additives, like rhodamine B and methanol yellow, by food vendors, particularly in developing countries. These practices, along with the use of prohibited synthetic sweeteners in drinks, pose significant health risks. Contamination of street foods, including the presence of aflatoxins and pesticide residues, has been a global health concern, as indicated by the FAO/WHO.^[65]

The health risks of food are not only determined by the concentration of contaminants but also by the cumulative daily intake of these substances through a consumer's diet. In sub-Saharan Africa, food poisoning is a major

consequence of food contamination.^[66] Many street food vendors, who are often from lower or middle-income groups, prioritize income and quantity over food quality. Many vendors use cheap, improvised materials in food processing, which compromises the safety and quality of their products. Despite these risks, contaminated foods are still sold, especially in countries with high poverty levels, where cheaper, potentially unsafe food is often purchased. Street food vending plays a significant role in the socio-economy of developing countries, making it essential to address the lack of awareness about mycotoxins and improve food safety practices to protect public health.

CONCLUSION

In this research study, the food safety knowledge of street food vendors in Morogoro municipality were investigated. Most respondents demonstrated moderate food safety knowledge but possessed inadequate knowledge areas of food safety in some such as food hygiene, internal cooking temperatures, as well as hot and cold storage temperatures. Most street food vendors were aware that microorganisms could lead to foodborne diseases and possibly death and the majority were aware of the existence of food-borne pathogens. It is recommended that street food vendors receive training with regard to food hygiene practices, food pathogens such as *Salmonella*, *Campylobacter*, *Listeria*, *Clostridium* and *Staphylococcus*. This will enhance street food vendors' knowledge in terms of these critical aspects of food safety.

The findings of this study highlight the significant public health risks posed by street-vended foods. The majority of street food vendors in the study had only received primary school education and had not undergone any formal training in food hygiene and safety. This lack of training likely contributes to unhygienic behaviors and poor food safety knowledge. Of particular concern is the critical lack of awareness about aflatoxin contamination among the vendors, with only 9.2% having heard of aflatoxins. This knowledge gap underscores the need for continuous food hygiene and safety training for street food vendors, as well as the enforcement of appropriate practices to improve food quality and safety.

Specific recommendations based on the findings include

- i. Training on Safe Food Handling: Street food vendors should be trained in safe food handling principles and practices, as suggested by previous studies^{[67],[68]}.
- ii. Prerequisite Training: Basic food safety and hygiene training should be a prerequisite for entering the food vending business. Regular monitoring should be implemented to ensure that vendors apply their acquired knowledge and skills to safe food handling practices.
- iii. Targeted Education on Aflatoxins: There is a clear need for targeted education and training programs to

raise awareness about the risks of aflatoxins and prevention strategies. Training should include how to identify aflatoxin-prone food products, proper storage practices, and signs of contamination.

- iv. Health Risk Awareness: Informing food handlers about the health risks associated with aflatoxin exposure, including long-term effects like cancer, could motivate them to adopt preventive measures.
- v. HACCP Principles: Applying the "Hazard Analysis and Critical Control Points" (HACCP) principles to street food vending is recommended. These principles should be incorporated into the hygienic practices outlined by the Codex Alimentarius Commission to guide both vendors and food inspectors.
- vi. Hygiene Checklist: A simple informative checklist of hygienic practices should be developed to evaluate food safety practices among vendors. This could serve as a tool to emphasize the importance of good hygiene standards and help vendors implement food safety programs.
- vii. Basic Hygiene Training: Basic training in food hygiene should be provided to ensure that vendors adhere to proper hygiene and sanitation practices. This should be accompanied by continuous food safety education, the establishment of a code of practice for the street food industry, and the provision of basic water and waste management utilities.
- viii. Stakeholder Collaboration: Collaboration among all stakeholders including farmers, vendors, consumers, governments, food and health professionals, and development partners is crucial to ensure safe practices in the street food trade. Proper management and coordination would contribute to a safer and healthier society.
- ix. It should be assured that raw materials are not further exposed to contamination from accidental exposure to chemicals or growth of pathogens and toxin production during transport and storage.
- x. Vendors should pay particular attention to containers of pastes, sauces and other food additives, monitoring them for fungal growth and visible deterioration. Such ingredients should be replaced regularly to prevent growth and toxin formation.
- xi. Water used for washing utensils, food and hands should be safe and should not be re-used. As far as possible, running water should be available for these purposes. If this is not feasible, a bucket or similar container can be used for washing, but it should be emptied and cleaned after each washing. Hot water, where available, makes cleaning and washing easier and more effective but is not generally available to street vendors.
- xii. Ice to be used in beverages and food should be prepared from potable water and should be transported and stored in a sanitary manner. Other items, such as food and beverages, should not be stored in the same container used to store ice intended for consumption.

Competing interests

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