

Factors Contributing to Contamination of Street Foods in Bamako, Mali

Demba Dembele¹, Mamadou Wele¹, Bawa Boya², Haziz Sina², Basile Boni Saka Konmy²,
Adolphe Adjanooun³, Lamine Baba-Moussa^{2*}

¹Institute of Applied Sciences, University of Sciences, Techniques and Technologies of Bamako, Bamako, Mali

²Laboratory of Biology and Molecular Typing in Microbiology, Faculty of Science and Technology, University of Abomey-Calavi, Cotonou, Benin

³National Agronomic Research Institute of Benin, Cotonou, Benin

Email: *laminesaid@yahoo.fr

How to cite this paper: Dembele, D., Wele, M., Boya, B., Sina, H., Konmy, B.B.S., Adjanooun, A. and Baba-Moussa, L. (2024) Factors Contributing to Contamination of Street Foods in Bamako, Mali. *Food and Nutrition Sciences*, 15, 199-210.
<https://doi.org/10.4236/fns.2024.153012>

Received: January 17, 2024

Accepted: March 19, 2024

Published: March 22, 2024

Copyright © 2024 by author(s) and Scientific Research Publishing Inc.

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).

<http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

The World Health Organization states that foodborne diseases are a worldwide public health issue. Although street foods can provide nutritious and affordable ready-to-eat meals for city dwellers, their health risks can outweigh the benefits. A cross-sectional study was conducted in the Bamako district, focusing on street food vendors near schools, universities, extensive markets, administrative centers, and major roads. We aimed to sample fifty (50) sellers per municipality, making 300 sellers for the Bamako district. We developed a survey sheet to collect data, and six teams rotated between the municipalities each month. Before starting the collection, the teams were provided administrative papers approved by the municipal authority. The survey revealed three types of sales sites: fixed (65%), semi-fixed (30%), and mobile (4.40%). The proportion of sellers was 26.8%, 23.2%, 19.7%, and 4.2% in municipalities III, IV, and I. In municipalities I, II, III, IV, and VI, respectively, 92%, 95.70%, 93%, 87.2%, and 100% of the sellers were female. The age distribution of sellers was 65.63%, 46.81%, 40.82%, 38.30%, 36.17%, 36%, and 32% in the 25-34 and 35 - 44 age groups. Illiteracy rates were 59.20%, 61.70%, 55.30%, 75%, and 56% in municipalities I, II, III, IV, and VI, respectively. The study identified two categories of sellers: 48.3% in type 1 and 51.7% in type 2. The first category comprised 154 sellers, and the second 165 sellers. The survey found that 66.00%, 56.00%, 48.90%, 44.90%, 38.30%, and 34.40% of municipal V, VI, III, I, II, and IV sales sites were open-air. In municipality I, 63.30% of the sites were under hangars, while in municipalities II and IV, the corresponding percentages were 51.10% and 59.40%, respectively. Moreover, 46.00%, 31.90%, 31.30%, 30.60%, and 27.70% of the sites in municipalities VI, II, IV, I, and III were located next to gutters. In conclusion, this study identified several factors that could compromise the quality of street foods sold in the six

municipalities of Bamako.

Keywords

Factors, Source, Contamination, Street Food, Bamako

1. Introduction

The World Health Organization states that foodborne diseases are a worldwide public health concern [1]. In many developing countries, street food is crucial in providing affordable and accessible meals to urban populations [2]. Street food sales have proliferated in Africa over the past three decades due to urbanization [3]. In Mali, the food sold on the street has become increasingly popular due to the creation of several primary and community schools in working-class neighborhoods [4].

Street foods vary significantly in ingredients, preparations, marketing methods, and consumption. They often reflect local traditional cultures and exist in infinite forms, including meals and drinks [3]. However, street food also poses health risks. As the literature mentions, several factors make street foods more susceptible to public health risks. These factors can be managed to improve the safety of street foods. The risks associated with street foods can be classified into three categories: environmental, chemical, and microbiological. Microbiological contamination is a significant problem, and foodborne pathogens pose a severe health hazard [5]. Additionally, lack of hygiene, inadequate access to drinking water and waste disposal, and an unsanitary environment increase the risks to public health [5].

There are many street food vendors, and street food is sold in urban centers and suburbs [6] [7]. Sales locations include markets, bus and train stations, factories, hospitals, universities, and schools [7]. Insufficient hygiene was observed in cleaning raw materials and kitchen utensils; vendors have little education on food handling, processing, and hygiene practices [8] [9] [10].

In Bamako, the risks associated with the consumption of street food are high [4]. The contamination of market garden products produced in the peri-urban and urban area of Bamako by total and fecal coliforms, as well as by Salmonella, far exceeded the acceptable contamination threshold set by the World Health Organization; lead was detected in all products [11]. These risk factors, often called points of hazard, are present throughout the entire street food business chain. Therefore, this study was conducted to investigate the factors that could be sources of contamination of street foods in Bamako.

2. Material and Methods

2.1. Sampling

The study was conducted in six municipalities located in the Bamako district, a

city in the southwest of Mali situated on both banks of the Niger River. It was a cross-sectional study conducted between June 2019 and July 2020. The survey focused on street food vendors near primary and secondary schools, universities, institutes, extensive markets, administrative centers, and major roads in the six municipalities of Bamako district. Most of the vendors surveyed were women, with an age range between 15 and 65 years, and many of them had a low level of education or no formal education. To ensure a fair distribution per municipality, we aimed to survey fifty (50) vendors per municipality, resulting in 300 vendors surveyed across the Bamako district.

2.2. Data Collection

For data collection, we developed a survey sheet with the help of a multidisciplinary team from the Institute of Applied Sciences of the University of Technical Sciences and Technologies of Bamako (ISA/USTTB). The survey sheet collected information on the socio-demographic characteristics of street food vendors, including gender, age, level of education, and training on good practices in this activity. It also collected information on the nature and condition of the environment of the sales sites for collecting samples. We visited each municipality monthly, and six teams rotated between the cities. At each visit, the teams were provided copies of the investigation sheet, pens, binders, and an administrative paper (Mission Order) issued by the Director of the ISA, which the municipal administration always targeted before starting the collection. Participation in the study was voluntary, and the purpose of the survey and the objectives sought were explained to the vendors in their language before any data collection.

2.3. Data Analysis

At the end of the study, the data was entered into Excel and analyzed using IBM SPSS version 24.0 and R version 4.2.3.

3. Results

3.1. Characteristics of Seller Sites

Based on the analysis of **Figure 1**, we can classify sales sites into three types: fixed, semi-fixed, and itinerant. The percentage of fixed sellers is higher (65%) than that of semi-fixed (30%) and itinerant sellers (4.40%). The difference between these three types of sites is statistically significant, with a p-value of less than 0.001.

3.2. Proportion of Street Food Sellers in the Six Municipalities of Bamako

As per the findings of **Figure 2**, the proportion of sellers in this study was higher in three out of six municipalities. Municipality III had the highest proportion of sellers at 26.8%, followed by municipality IV with 23.2% and municipality I with 19.7%. The lowest proportion of sellers was found in municipality VI at 4.2%.

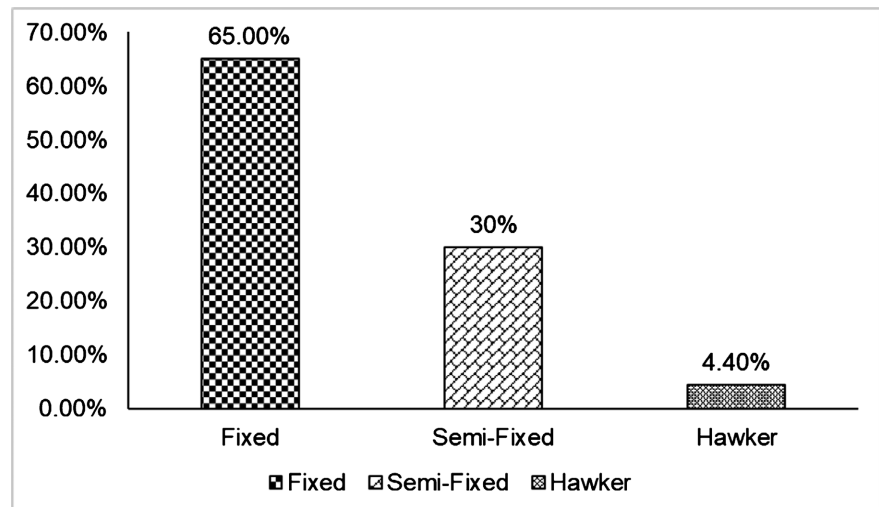


Figure 1. Different types of street food sales sites.

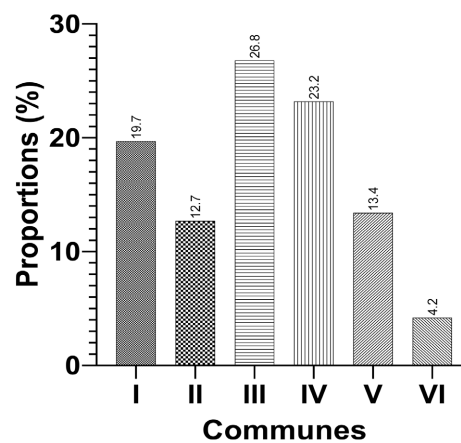


Figure 2. The proportion of street food vendors in the six municipalities of Bamako.

The difference between the results in some municipalities (III, IV, I) was statistically significant ($P < 0.001$) when compared with the results of municipalities II, V, and VI.

3.3. Socio-Demographic Characteristics of Sellers by Gender

The data presented in **Figure 3** shows that women were the majority participants in the activity across all six municipalities of the Bamako district. Municipality I had 92% women, Municipalities II and III had 95.70% women, Municipality IV had 93% women, Municipality V had 87.20% women, and Municipality VI had 100% women. The difference in gender distribution was statistically significant ($P < 0.001$).

3.4. Socio-Demographic Characteristics of Sellers According to Age

According to **Table 1**, most of the surveyed sellers in the six municipalities of Bamako were aged 25 - 34 and 35 - 44 years. The percentage of sellers in these age groups were respectively 40.82% and 30.61%, 36.17% and 21.28%, 38.30%

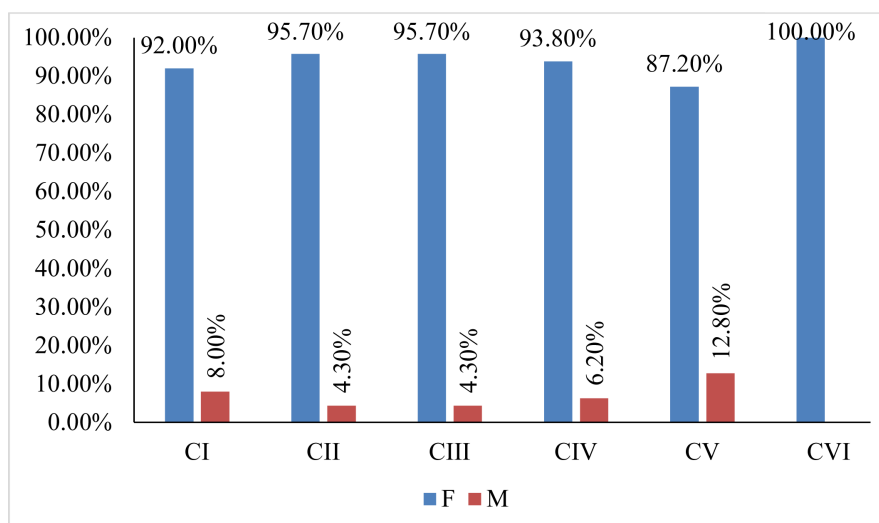


Figure 3. Distribution of food sellers by gender.

Table 1. Age group of food sellers in the six municipalities of Bamako.

	Age group (years old)				
	[15 - 25]	[25 - 35[[35 - 45[[45 - 55[[55 - 65]
Municipality I	12.24%	40.82%	30.61%	12.24%	4.08%
Municipality II	27.66%	36.17%	21.28%	10.64%	4.25%
Municipality III	8.51%	38.30%	31.92%	14.89%	6.38%
Municipality IV	9.37%	65.63%	15.62%	9.37%	None
Municipality V	12.77%	27.66%	46.81%	6.38%	6.38%
Municipality VI	16.00%	36.00%	32.00%	10.00%	6.00%

and 31.92%, 65.63% and 15.62%, 27.66% and 46.81%, and 36% and 32% in municipalities I, II, III, IV, V, and VI.

3.5. Socio-Demographic Characteristics of Sellers According to Level of Education

Based on the findings in **Figure 4**, it can be concluded that most street food vendors in the six municipalities of Bamako did not receive formal education. The education rate was as follows: 59.20% in Municipality I, 61.70% in Municipality II, 55.30% in Municipality III, 75.00% in Municipality IV, 56.00% in Municipality VI, and 53.20% in Municipality V at the fundamental level. At higher levels, the education rate was only 2% in Municipality I, 4.30% in Municipality III, 2.10% in Municipality V, and 2% in Municipality VI. The lowest education rate was recorded in Municipality II at 23.40%, followed by 25.00% in Municipality IV, 28.90% in Municipality VI, 31.90% in Municipality III, and 32.00% in Municipality I.

3.6. Typological Characterization of Street Food Vendors

The analysis of **Figure 5** helped to identify two types of salespeople with different

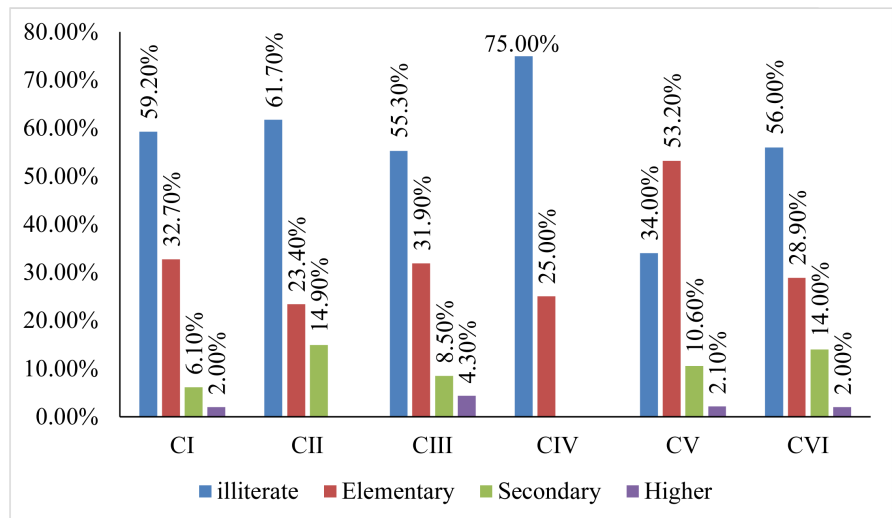


Figure 4. Distribution of street food vendors according to their level of education.

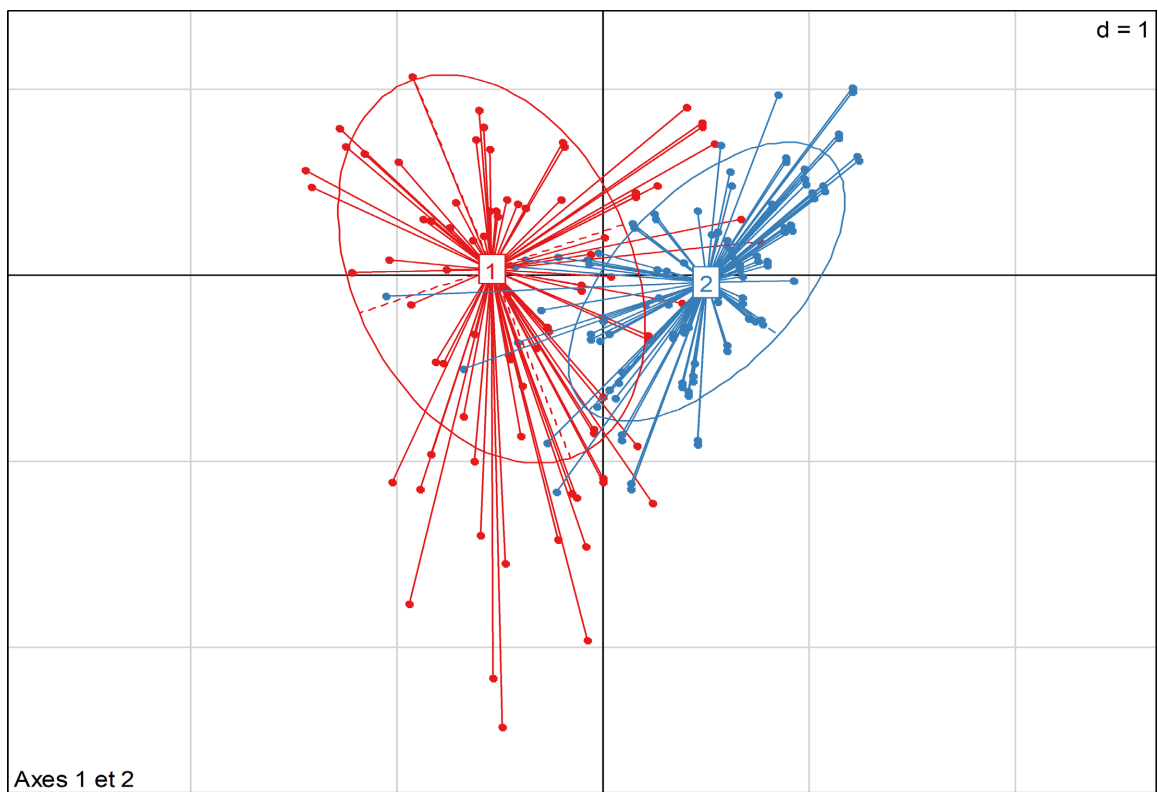


Figure 5. Typology of street food sellers in Bamako.

products for sale and locations. Type I includes 154 sellers, or 48.3% of the total, selling meat products like fish, chicken, and beef. They come mainly from municipalities III and IV. On the other hand, Type 2 includes 51.7% of the total number of sellers, who sell foods with virtually no animal proteins, like Deg_Yaou, Hari-co_Alloco_Frit, Juices, Rice, Spaguetti_Omelette, and Tjeke_Djouka. They mainly come from municipalities I, II, V, and VI. The difference between the two types of sellers is statistically significant ($P < 0.001$).

3.7. Dendrogram of Vendors' Typology Confirmation

Hierarchical classification analysis identified two food vendor categories (Figure 6): the first with 154 sellers and the second with 165 sellers. Dendrogram analysis confirmed the optimal number of classes.

3.8. The Environmental State of Street Food Sales Sites

According to the analysis of the results presented in Figure 7, it was found that

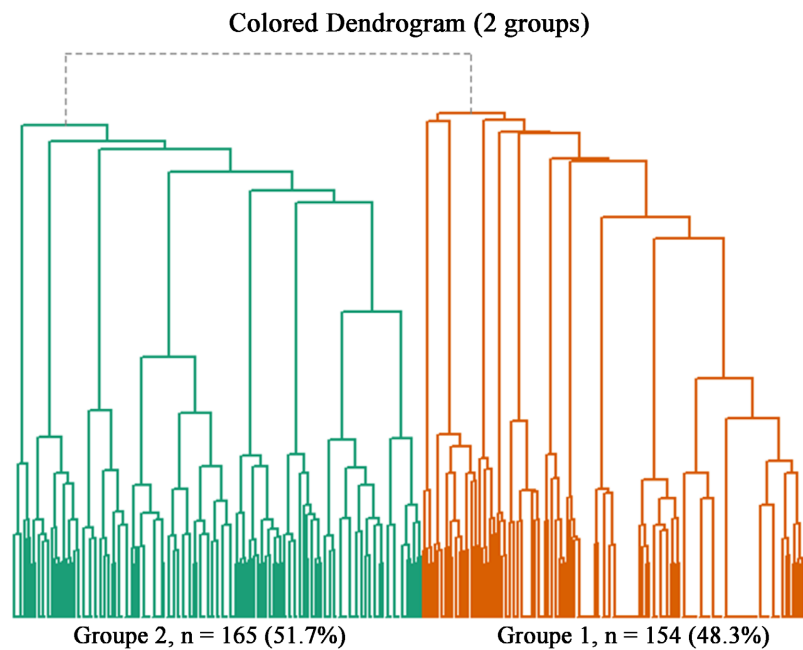


Figure 6. Food vendor typology dendrogram.

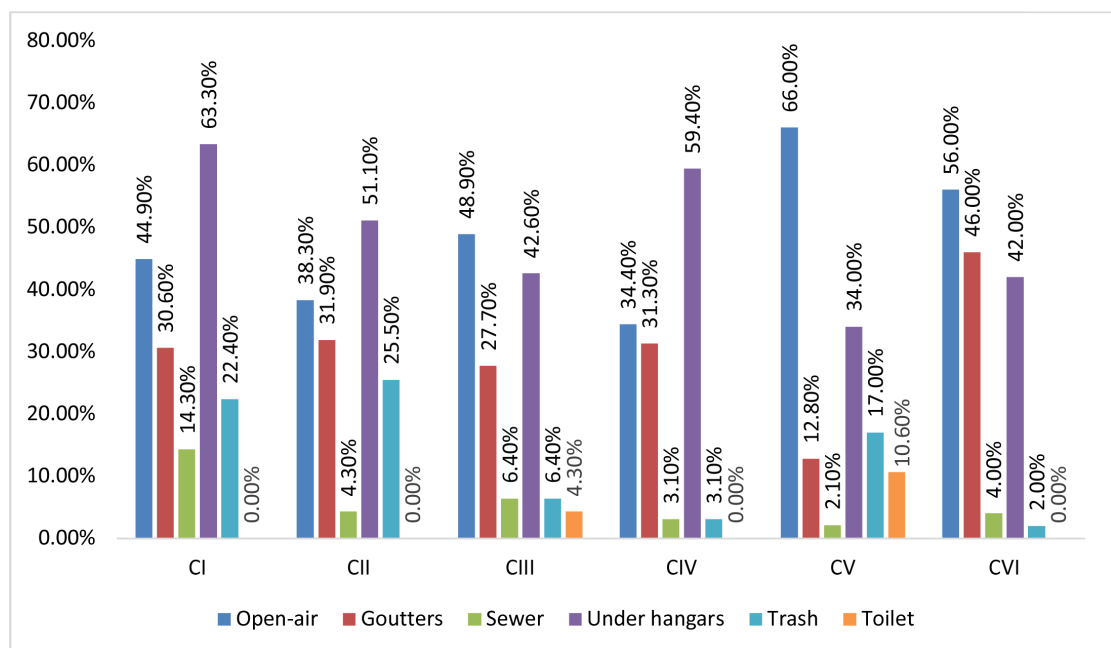


Figure 7. Exposure state of food vendor sites in the six municipalities of Bamako.

all sales sites in the six municipalities were exposed to contamination factors. This was due to the large proportion of open-air sales sites, 66.00%, 56.00%, 48.90%, 44.90%, 38.30%, and 34.40% in municipalities V, VI, III, II, and IV, respectively. For sites under hangars, the proportion was 63.30% in Municipality I, 51.10% in Municipality II, and 59.40% in Municipality IV. Additionally, a significant proportion of sites were located near gutters in the six municipalities of Bamako district, with the highest percentage in municipality VI (46.00%), followed by municipality II (31.90%), municipality IV (31.30%), municipality I (30.60%), and municipality III (27.70%). Such sites can compromise food quality due to the multiplication of vectors in stagnant water, wind, and the odor that prevails in such areas. Also, sites near trash, disgust, toilets, and animals were at a high risk of contamination.

4. Discussion

Our study on street food sales sites in Bamako (Mali) revealed three types of sales sites: fixed, semi-fixed, and itinerant. The rate of fixed vendors (65%) was similar to a study on street food vendors in Ethiopia [12]. On the other hand, the frequency of semi-fixed and itinerant sellers was 30% and 4.40%, respectively, which are lower than the rates obtained in a 2016 study conducted in Cotonou, Benin [8]. This difference could be explained by our study's methodological approach, which mainly focused on fixed sellers, enabling us to appreciate more factors than would have been possible with semi-fixed and itinerant sellers.

The proportion of sellers in our study was 26.8%, 23.2%, 19.7%, 13.4%, 12.7%, and 4.2% in communes III, IV, I, V, II, and VI, respectively. The difference in the results among certain municipalities was statistically significant ($P < 0.001$). Our findings are like those reported by some authors in Accra, Ghana [3], who observed variability in the proportion of sellers depending on the sales location.

A study found that women outnumbered men in street food vending in the Bamako district. The highest percentage of women was in Commune VI, with 100%, followed by Communes II and III, with 95.70% and 93%, respectively. Commune V had 87.20% women, and Commune I had 92%. These figures are consistent with similar studies conducted in different African countries. For example, in a study conducted in Benin, Noumavo *et al.* [13] reported a rate of 100% women among street food vendors. In Ghana, a study conducted in Accra showed that 84.30% of sellers were women [14]. In another study conducted in Dessie, Ethiopia, 2013-2014, 83% of street food vendors were women [15]. Similarly, in South Africa, a study showed that 73.4% of street food vendors were women [16]. The current study provided results by municipality, which is why it has more data than previous studies.

The age group of 25 - 45 years was the most common among street food vendors in the six municipalities of Bamako. The highest percentage of this age group was found in Commune IV, with 65.60%, followed by Commune I, with 41%, and Communes III and V, with 38.30% and 36%, respectively. These re-

sults are like those reported in other studies, such as the study conducted in Benin by Noumavo *et al.* [13], which found that 60.90% of street food vendors are aged between 25 and 45 years. In Ghana, Tuglo *et al.* [14] reported that 40.1%, 32.3%, 38%, 37.1%, 38.7%, and 35.8% of street food vendors fell within the 25-45-year age group.

The study also found that most street food vendors in the six municipalities of Bamako had no formal education. The highest percentage of illiterate vendors was found in Commune IV at 75%, Commune I at 59.20%, Commune V at 56%, Commune III at 55.30%, and Commune II at 32%. Most vendors who had some form of education had only completed primary school. The highest percentage of primary school graduates was found in Commune V, with 53.20%, followed by Communes I, III, VI, and IV. The percentage of vendors who completed secondary school was relatively low in all municipalities, ranging from 6.10% in Commune I to 14.90% in Commune II. The percentage of vendors who had completed upper-level education was lower, ranging from 2% in Commune I and VI to 4.30% in Commune III.

According to previous studies, 58.70% of street food sellers in Benin have not received any training, while 23.90% have primary-level training, and 17.40% have secondary-level training [13]. Similar results were found in other studies, such as Amegah *et al.* [17] in northern Ghana, where they reported 58.70%, 25.20%, 14.10%, and 1.90%, respectively. Another study conducted in Benin by Ohim *et al.* [18] in Cotonou reported rates of 75%, 23.30%, 23.30%, and 1.70%, respectively.

Our study evaluated food sellers' knowledge level of good hygiene practices in the six municipalities of Bamako. Our results showed that most sellers were not trained. The rates were 93.90%, 93.60%, 95.70%, 96.90%, 85.10%, and 96% in municipalities I, II, III, IV, V, and VI, respectively. These rates are similar to previous studies that reported frequencies of 99.3% untrained food operators in Mali [4], 70% untrained sellers in Ethiopia [15], and 56% untrained sellers in Ghana [14].

We conducted a discriminant analysis to identify two types of sellers based on the food they sell. Type 1 includes meat product sellers mainly from municipalities III and IV, comprising 48.3% of the total sellers. The most sold foods are fish and its derivatives, chicken and its derivatives, and beef and its derivatives. Type 2 includes sellers of foods with virtually no animal proteins, mainly from municipalities I, II, V, and VI, comprising 51.7% of the total sellers. Deg_Yaou, Bean, Alloco Frit, Juice, Rice, Spaghetti Omelet, Tjeke, and Djouka are the best-selling foods in this category. The microorganisms isolated from these foods were *E. coli*, *S. epidermidis*, and *S. saprophyticus*. The hierarchical classification analysis also revealed the two categories of food sellers.

The dendrogram analysis confirmed that the optimal number of classes is two. These proportions are like those reported in a previous study of street food vendors in Accra, Ghana [3], which reported frequencies of 55% and 30.5%. Another study in Mali showed that 2/6 rice dishes were contaminated with thermoto-

lerant coliforms, with an average of 3.62 germs [4], and 82.40% of sales sites were not clean.

We also investigated the environmental factors that could be a source of street food contamination. Our results showed that 66%, 56%, 48.90%, 44.90%, 38.30%, and 34.40% of sales sites in municipalities V, VI, III, I, II, and IV were exposed to the open air. The proportion of sites located next to gutters was also significant in the six municipalities of the Bamako district, 46.00%, 31.90%, 31.30%, 30.60%, 27.70%, and 12.80%, respectively, in municipalities VI, II, IV, I, III, and V. The frequency of sites under hangars was 63.30%, 59.40%, 51.10%, 42.60%, 42%, and 34%, respectively, in municipalities I, IV, II, III, VI, and V. The rate of sites next to trash bins was 25.50%, 22.40%, 17%, and 6.40%, respectively, in municipalities II, I, V, and III. Additionally, 10.60% of sites were next to toilets in municipality V. These rates are lower than those of previous studies, which reported frequencies of 86.80% of street food sales sites near gutters, 23.10% next to toilets, and 80.30% next to trash cans [4]. However, the difference in sample size of the two studies could explain this discrepancy.

5. Conclusion

This survey aims to identify the sources of contamination of street foods in Bamako and the factors that increase the risk of public health problems. The main risk factors are related to the environment and hygiene conditions. Once these factors are identified, it will be essential to identify the microorganisms that could potentially cause contamination after consuming street foods.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Torgerson, P.R., Devleeschauwer, B., Praet, N., Speybroeck, N., Willingham, A.L., Kasuga, F., Rokni, M.B., Zhou, X.N., Fèvre, E.M., Sripa, B., Gargouri, N., Fürst, T., Budke, C.M., Carabin, H., Kirk, M.D., Angulo, F.J., Havelaar, A. and de Silva, N. (2015) World Health Organization Estimates of the Global and Regional Disease Burden of 11 Foodborne Parasitic Diseases, 2010: A Data Synthesis. *PLOS Medicine*, **12**, e1001920. <https://doi.org/10.1371/journal.pmed.1001920>
- [2] Kouyaté, M. (2020) Evaluation des connaissances, des attitudes et des pratiques des gargotiers de la commune III du district de Bamako par rapport à la contamination des aliments en 2017. *Mali Sante Publique*, **10**, 19-25. <https://doi.org/10.53318/msp.v10i1.1657>
- [3] Marras, S. and Ag Bendeck M. (2016) Street Food in Urban Ghana A Desktop Review and Analysis of Findings and Recommendations from Existing Literature. Food and Agriculture Organization of the United Nations, 1-78.
- [4] Sako, M., Kone, S., Yaro, F., Traore, A., Diallo, A., Sangare, S. and Keita, S. (2014) Evaluation des risques sanitaires liés à l'alimentation de rue dans le District de Bamako. *Mali Santé Publique*, **4**, 44-47. <https://doi.org/10.53318/msp.v4i01.1454>

- [5] FAO (2007) Les Bonnes Pratiques D'hygiène Dans La Préparation Et La Vente Des Aliments De Rue En Afrique Outils pour la formation. FAO, 1-176.
- [6] Marras, S., AgBendeche, M. and Laar, A. (2016) Street Food Vending in Accra, Ghana Field Survey Report 2016. 1-41.
<https://www.fao.org/documents/card/en?details=b9668d2d-e1cf-4546-a64b-c9bda8dfb6d2%2f>
- [7] Werkneh, A.A., Tewelde, M.A., Gebrehiwet, T.A., Islam, M.A. and Belew, M.T. (2023) Food Safety Knowledge, Attitude and Practices of Street Food Vendors and Associated Factors in Mekelle City, Northern Ethiopia. *Heliyon*, **9**, e15126.
<https://doi.org/10.1016/j.heliyon.2023.e15126>
- [8] Moussé, W., Baba-Moussa, F., Adjanooun, A., Noumavo, P.A., Sina, H., Assogba, S. and Baba-Moussa, L. (2016) Virulence Profiles of Pathogenic *Escherichia coli* Strains Isolated from Street Foods in Benin. *International Journal of Biotechnology and Food Science*, **4**, 52-64.
- [9] Yeleliere, E., Cobbina, S.J. and Abubakari, Z.I. (2017) Review of Microbial Food Contamination and Food Hygiene in Selected Capital Cities of Ghana. *Cogent Food & Agriculture*, **3**, Article ID: 1395102.
<https://doi.org/10.1080/23311932.2017.1395102>
- [10] Ahmed, Z., Afreen, A., Hassan, M.U., Ahmad, H., Anjum, N. and Waseem, M. (2017) Exposure of Food Safety Knowledge and Inadequate Practices among Food Vendors at Rawalpindi; the Fourth Largest City of Pakistan. *Journal of Food and Nutrition Research*, **5**, 63-73.
- [11] Samake, F., Babana, A.H., Yaro, F.K., Cisse, D., Traore, I., Kante, F. and Toure, O. (2011) Risques sanitaires liés à la consommation des produits maraichers cultivés dans la zone urbaine et périurbaine de Bamako. *Mali Santé Publique*, **1**, 27-31.
- [12] Alelign, D., Yihune, M., Bekele, M., Oumer, Y., Beyene, K. and Atnafu, K. (2023) Bacteriological Quality and Antimicrobial Resistant Patterns of Foodborne Pathogens Isolated from Commonly Vended Street Foods in Arba Minch Town, Southern Ethiopia. *Infection and Drug Resistance*, **16**, 2883-2899.
<https://doi.org/10.2147/IDR.S411162>
- [13] Noumavo, A.D.P., Ohin, M.A B., Fadipe, I.G., Hadji, B., Ahouangansi, S., Akin, Y. Y., Baba-Moussa, L. and Baba-Moussa, F. (2022) Knowledge, Hygienic Practices, and Toxi-Infectious Risks Associated with Ready-to-Eat Gbeli: A Particular Chip Derived from Cassava (*Manihot esculenta* Crantz) Tuber Vended in Streets of Abomey-Calavi Municipality, Benin. *BioMed Research International*, **2022**, Article ID: 8399831. <https://doi.org/10.1155/2022/8399831>
- [14] Tuglo, L.S., Agordoh, P.D., Tekpor, D., Pan, Z., Agbanyo, G. and Chu, M. (2021) Food Safety Knowledge, Attitude, and Hygiene Practices of Street-Cooked Food Handlers in North Dayi District, Ghana. *Environmental Health and Preventive Medicine*, **26**, Article No. 54. <https://doi.org/10.1186/s12199-021-00975-9>
- [15] Adane, M., Tekla, B., Gismu, Y., Halefom, G. and Ademe, M. (2018) Food Hygiene and Safety Measures among Food Handlers in Street Food Shops and Food Establishments of Dessie Town, Ethiopia: A Community-Based Cross-Sectional Study. *PLOS ONE*, **13**, e0196919. <https://doi.org/10.1371/journal.pone.0196919>
- [16] Nkosi, N.V. and Tabit, F.T. (2021) The Food Safety Knowledge of Street Food Vendors and the Sanitary Conditions of Their Street Food Vending Environment in the Zululand District, South Africa. *Heliyon*, **7**, e07640.
<https://doi.org/10.1016/j.heliyon.2021.e07640>
- [17] Amegah, K.E., Addo, H.O., Ashinyo, M.E., Fiagbe, L., Akpanya, S., Akoriyea, S.K.

and Dubik, S.D. (2020) Determinants of Hand Hygiene Practice at Critical Times among Food Handlers in Educational Institutions of the Sagnarigu Municipality of Ghana: A Cross-Sectional Study. *Environmental Health Insights*, **14**.

<https://doi.org/10.1177/1178630220960418>

- [18] Ohin, B.M., Adéoti, K., Kouhondé, S.S., Noumavo, P.A., Ogoua, S.M., Wabi, N., Faïnou, M.C., Baba-Moussa, L., Toukourou, F. and Baba-Moussa, F. (2018) Knowledge, Attitudes, and Hygienic Practices of Boiled Hypocotyls (*Borassus aethiopum* Mart) Vended in the Streets of Cotonou City and Its Outskirts, Benin. *BioMed Research International*, **2018**, Article ID: 4825435.

<https://doi.org/10.1155/2018/4825435>