

*Full Length Research Paper*

# Assessments of good hygienic practice in food markets of Maputo, Mozambique and development of Food Safety Index

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**This study evaluated good hygienic practices (GHP) of food establishments in seven food markets in Maputo, Mozambique. A total of 191 food handlers were selected in this study. Information on demographic characteristics and hygienic-sanitary conditions were obtained through semi structured interviews. The results revealed that the majority of food vendors in Maputo are females (92.7%) and all the selected vendors (100%) have not been trained in food handling. Vendors had no access to ablution facilities and in instances where they are available, they are few and located far away from the area where food is prepared. In terms of storage, 91.1% of the food handlers kept their cooked food unrefrigerated with only 9.9% of the vendors having freezers. Of the 191 establishments, 85.76% had Food Safety Index (FSI) between 0.15 and 0.18 scale, being therefore classified as bad. Good hygienic practices are therefore necessary to improve market conditions and consequently prevent foodborne diseases. The recommendations from this study is to properly conduct food safety training for all food vendors improving vending infrastructure and implementing food safety inspections in the food markets of Maputo City.**

**Key words:** Good hygienic practices, food handlers, food establishment.

## INTRODUCTION

In recent years, there has been an increase in the number of people consuming food prepared by food vendors partly due to lifestyle changes influenced by globalization (WHO, 2015a). Eating out has provided a quick and practical solution for people who work and live

in big cities. Public food vending markets in big cities usually have several kinds of food services. These food services play an essential role in the survival of medium and low-income earners in many countries, because they are cheap and easily accessible (McKay et al., 2016).

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Despite the advantages of food vending to the public, it represents a significant risk to public health due to their potential to spread pathogenic bacteria that can cause food-borne diseases (Kubheka et al., 2001).

The World Health Organization (WHO, 2015b) estimated that 600 million people in the world (one in 10 people) suffer from foodborne associated illness and become ill after eating contaminated food and about 420,000 of those affected die every year. Among the deaths caused by food-borne diseases, 125,000 are children under five years old (WHO, 2015b). In the United States, about 48 million people get ill, 128,000 are hospitalized and about 3,000 die each year due to food-borne diseases (FDA, 2019). The incidences are still high in developing countries; as more than 91 million people fall ill every year and 137,000 die due to food-borne diseases in Africa (WHO, 2015a).

Food services generally include catering, schools, and hotel kitchens, restaurants, and street vendors who usually serve ready-to-eat food to the public. Data on the occurrences and incidences of food-borne diseases in Mozambique is limited and is starting to accumulate. Recently, Macaza (2017), conducted a study in Nampula, Mozambique, and found out that 83% of the food samples collected were unsatisfactory due to high counts of Enterobacteriaceae like *Escherichia coli*. The hygienic conditions of foods vended in Maputo is unknown although it is of public record that the conditions of food services inside the public markets are not ideal. Therefore, the aim of this study was to evaluate the Good Hygienic Practices (GHP) and sanitary conditions in seven food markets in Maputo city, and from the results, identify priority control measures to avoid the outbreaks of food-borne diseases.

## MATERIALS AND METHODS

### Study area design

This study was conducted in seven food markets located in Maputo city from January to March 2017. Maputo is the capital of Mozambique, a country with 28.83 million inhabitants. Maputo has more than 1.2 million inhabitants who reside in seven urban administrative districts, and these districts combined have a total of 12 food markets. The seven sampled food markets (Museu, Povo, Mandela, Estrela Vermelha, Benfica, Xipamanine and Peixe) were selected because they are the most visited food markets. Food establishments in markets are called "barracas" (stalls). These establishments are described as small food services or restaurants, where the general public goes to have breakfast and lunch. The foods in these establishments are generally adapted to the conditions of urban life and are prepared for the preferences of public market consumers. Typically, the food preparations involve products like rice and meat, accompanied by lettuce, tomato, and cabbage salads.

### Sampling size

A total number of 191 food establishments were randomly selected

and sampled from seven food markets in Maputo City. Food handlers and establishments were selected randomly from the roster list of food handlers, which was provided by market authorities. The markets were chosen based on the number of vendors operating, so the studied markets had a minimum number of 20 food vendors. Vendors who did not have contact with food were excluded from the interviews.

### Data collection: Tools and procedures

A semi structured questionnaire and secondary sources were used for data collection in this study. This method of data collection was chosen because it is easy to use and can be very efficient to obtain information in a short time. The legal basis for the construction of the questionnaire checklist was the Ministerial Diploma n. 51/84 of October 3rd, 1984, used in Mozambique with some modifications.

The check-list was structured into two different sections. Section one was designed to collect information on respondent's socio-demographics such as gender, age, level of education, and marital status. Part two was designed to collect information about GHP and sanitary conditions in the food services of each market.

### Data quality control

The quality of data was assured by pre-testing of the questionnaire. The data collectors were trained on the objective, the importance of the study, the confidentiality of information, respondent's right, techniques of interview, and inspection of food services. Before the review, twenty food services were visited to pilot test the questionnaires, ensure their validity and reliability of information. Feedbacks from the data collectors were considered and the checklist was improved and approved. Senior investigators ensured the completeness and reliability of the information gathered throughout the data collection process.

### Secondary information on microbial data

Microbial data of previously food surfaces, water, hands of food handlers and food sold in the local markets of Maputo was obtained from reference laboratory of Maputo City Health Directorate and presented in this study.

### Food safety index

To analyze the hygienic-sanitary conditions of the establishments visited in the markets, a Food Safety Index (FSI, Equation 1) was created based on the work of Elias et al. (2015). This index was based on the calculation of the harmonic mean and considers different weights (Table 1) for each group of checklist issues. The presence of potable water and sewage issues were assigned with a weight of 16, considering the importance of these items for public health and food safety. Establishments without potable water and sewage present a very high possibility of causing foodborne diseases.

Questions about the training received weight 8, because without proper training, any control measures could not be by food handlers or vendors. Temperature control weight 6, cross-contamination weight 4, indirect contamination weight 2, and documents importance 1. These weights were based on Da Cunha et al. (2014a) and Elias et al. (2015).

$$FSI = \frac{\sum_{i=1}^N w_i}{\sum_{i=1}^N x_{i+1}} - 1 \quad (1)$$

**Table 1.** Weights of the weighted food safety index questionnaire

Parameter	Weight
Water and sewage	16
Training	8
Temperature control	6
Cross contamination	4
Indirect contamination	2
Documents	1

**Table 2.** Classification according to the level of conformity of the weighting food safety index (FSI).

FSI	Conformity level
0-35	Bad condition
36-75	Satisfactory condition
76-100	Good condition

where  $x_i$  = response of  $i$  question of the questionnaire,  $W_i$  = weight of  $i$  question,  $N$  = number of questions.

### Data processing and analysis

After the interviews, the checklists had been reviewed for completeness. The items were coded and analyzed using SPSS version 25.0. The results were presented in tables and texts using descriptive statistics such as mean, standard deviation, and percentage, to describe the study population with relevant variables. The degree of association between independent and dependent variables had been assessed with a 95% confidence interval, and a level of significance of 0.05 had been used in research. No questionnaire was invalidated because all inquiries had been conducted by the author and a trained team of reviewers. Additionally, FSI was used to classify food establishments into three categories (Table 2).

### Ethical consideration

Ethical approval and clearance was obtained from the Institutional Review Board of the Federal University of Rio Grande do Sul. Permission was also obtained from the administration health office and the City Council of Maputo city. Verbal consent obtained from officials responsible for the markets. Each respondent was assured that the information provided by her/him would be kept confidential and used only for the purposes of this research.

## RESULTS AND DISCUSSION

### Demographic factors

A total of 191 food handlers from seven food markets in Maputo responded to the checklist. The results demonstrated that food handlers in food market establishments were mostly single young women, with

ages ranged from 20 to 30, and incomplete secondary education level (Table 3). This finding was consistent with studies in several parts of the world, such as Brazil (Da Cunha et al., 2014a, b; Rossi et al., 2017), Vietnam (Samapundo et al., 2016), Haiti (Samapundo et al., 2015), and Nigeria (Aluko et al., 2014). According to Allen and Sachs (2007), women are generally responsible for cooking meals worldwide. Furthermore, those ages from 20 to 30 already stop their education and use to cook to sustain their families or to complement ordinary income. According to Grant and Unacla (2012), the sale of ready-to-eat foods in public establishments is an activity that does not require training or significant investments. And it provides work for people who might be unemployed, including women living in urban areas. These findings explain the profile of food vendors in the markets in Maputo.

### Characterization of sewage and water used for food preparation in markets

The finding demonstrated that all markets visited have access to drinking water provided by the public water system government (Table 4). It is a positive development because access to clean water is limited for millions of people around the world, particularly for the countries of Africa (WHO, 2011). Although markets are supplied with potable water, there is only one water collection point for all the markets. Therefore, the establishments do not have piped water, which forces sellers to transport and store water in containers that are rarely sanitized (visually dirty). The lack of piped water reduces the possibility for handlers to perform the procedures of cleaning hands, cleaning, and sanitizing equipment which greatly compromise food safety. The microbiological quality and safety of the food prepared using water that was stored in the establishments is not assessed. However, water from the single distribution point at each market, before the water was stored in the plastic containers of each food service, is periodically tested. Mozambique's regulations do not require periodic monitoring of the water used in food facilities as required by other legislation of other countries like Brazil 2004; Rio Grande do Sul, 2009.

Wright et al. (2004) reported that water analysis performed only at the general source of supply might not reflect the quality of water used for food preparation. Handlers can contaminate water with their own hands or through containers used for storage. This inadequate situation is not unique to Mozambican public markets, since globally, at least 1.8 billion people use a drinking water source contaminated with feces (WHO, 2019).

Among the seven markets visited, only Peixe market was equipped with excellent sewage facilities and adequate facilities for disposal of waste during the peak discharge period (Table 4), as outlined in Ministerial Diploma no. 51/84 of October 3<sup>rd</sup> (Mozambique, 1984). Lack of

**Table 3.** Demographic characteristics of respondents (n = 191).

Socio-demographic characteristics	Frequency	Category	Percentage
Gender	14	Male	7.3
	177	Female	92.7
Age (years)	6	≤20	3.1
	68	21 - 30	35.6
	61	31 - 40	31.9
	33	41 - 50	17.3
	20	51 - 60	10.5
	3	> 60	1.6
Educational Level	84	Primary school	44
	99	Secondary	51.8
	3	University	1.6
	5	No qualification	2.6
Marital status	55	Married (a)	28.8
	88	Single	46.1
	39	Union fact	20.4
	2	Divorced	1.0
	7	Widower	3.7

adequate waste disposal systems contributes to the increase in the number of diarrheal diseases resulting from inadequate sanitation of the environment (WHO, 2015b). Lack of sanitation can force people to defecate in the open, posing a public health hazard and increasing the possibility of contamination of the environment and foods (WHO, 2018). Improving water supply and sanitation can help economic growth in low- and middle-income countries, contributing to poverty reduction (WHO, 2019). Therefore, investments in infrastructure that improve basic hygiene and ensure safe drinking water should be a priority.

### Training

The results of this research demonstrated that all food handlers (100%) in the study have never been trained in food safety issues (Table 4). This situation was considered inadequate since adequate food safety training for handlers is very important to promote Good Hygienic Practices during food preparation. Education and training a fundamental principle of food safety, as they contribute to the reduction of foodborne disease cases (Hassan et al., 2018; Moreb et al., 2017; Osaili et al., 2013). Da Cunha et al. (2014b), investigated the influence of training in food safety and reported that food handlers who received training had higher scores on food safety knowledge. In addition, Soon et al. (2012), evaluated the knowledge about food safety in food

handlers in institutional food services and concluded that trained food handlers demonstrate greater awareness of safe food preparation. Therefore, handlers' training programs in the markets of the city of Maputo in particular and in other parts of the world is essential to promote safe food handling practices in food preparation and sales. A study carried out in Portugal, aimed to evaluate the influence of food safety training in total plate counts of foods, demonstrated that instructions contributed to decreasing about 60% of microbiological counts (Soares et al., 2013).

### Temperature control

In the present study, none of the establishments kept cold foods ready for consumption at less than 5°C (Table 5). Also, none had separate refrigeration and freezing equipment as outlined in Ministerial Diploma no. 51/84 of October 3rd. On the other hand, hot ready-to-eat foods were stored at temperatures above 60°C in 96.3% of the establishments. This practice keeps food safe because pathogenic bacteria do not multiply at temperatures above 60°C, and many of them also are inactivated. Food temperature control is one of the most important factors to be observed to maintain the microbiological safety of food. During the research, we also sought to know the destination of food leftovers since the markets do not have equipment for food preservation. The food handlers responded that they would take them home, keeping



**Table 4.** Answers to the questions about water, sewage and training.

Question	Response (%)	
	Yes	No
Does the establishment have available potable water?	100	0.0
Are the sewers in good condition with watertight ducts able to guarantee complete disposal of waste during the maximum discharge period?	11.0	89.0
Is it ensured frequent minimum hygiene care training to the workers?	0.0	100.0

**Table 5.** Answers to the questions about temperature control.

Question	Response (%)	
	Yes	No
Are perishable cooked foods that are not kept warm, kept at a maximum temperature of 4°C?	0.0	100.0
Are frozen foods stored below 0°C?	12.6	87.4
Are cooked foods that are kept warm stored at a temperature of not less than 60°C?	96.3	3.7
Does the establishment have refrigerators, and distinct freezers for each product nature, in order to ensure the ideal temperature?	8.8	91.2
Is the origin of the ice production water known?	25.1	57.1

them at room temperature until consumption, at dinner. This practice represents a risk to sellers' families. Several studies have already shown that keeping food cooked for more than 2 h at room temperature may be responsible for food borne diseases outbreaks (FDA/NSTA, 2008; Hassan et al., 2018; USDA, 2013).

Regarding the freezing of foods at temperatures below 0°C, only 12.6% (n = 23) responded that they adopt this practice. Freezing does not kill microorganisms but inhibits their multiplication by keeping food safe for long periods (Chattopadhyay and Adhikari, 2014; Harrison et al., 2013; Ojha et al., 2016; Tang and Lum, 2015). These results explained by the fact that most markets do not have freezers for food preservation. Most markets in the city of Maputo did not have a minimum infrastructure, and even electricity was lacking in the establishments. Most markets in the city of Maputo consisted of tents or benches made of precarious material (leftovers of zinc and other materials) and most of them without firm cover. These establishments (pews) were made using parts of tree trunks or zinc plate leftovers even though these materials do not offer much security to the structure of the establishments. About the existence of cold equipment in the markets for food preservation, it was possible to verify that only (n = 23) establishments kept frozen foods. FAO (2016), considers that in low-income countries, such as Mozambique, cooling facilities, and infrastructures for the storage of food is scarce. The lack of cold equipment in the markets visited can also be associated with the small number of meals served daily by each vendor (on average, 23 meals/day). So food is bought and prepared on the same day, with no need for extended storage.

### Cross-contamination

For the evaluation of this item, ten questions were asked to the food handlers (Table 6). Results from this study showed that most handlers (91%) did not wash their hands properly before beginning to work on food preparation or after using the toilets.

Hand washing is an essential measure to prevent the spread of foodborne diseases and is considered one of the primary practices that reduce the transfer of bacteria from person to food (Lambrechts et al., 2014; Sibanyoni et al., 2017).

Several studies have demonstrated that the non-hygienic habits are responsible for many food bone disease outbreak (Lambrechts et al., 2014; Nasrolahei et al., 2017; Todd et al., 2007). A study carried out in Nigeria to evaluate the presence of microorganisms in hand washing water from 246 people detected several food borne micro-organisms like *Staphylococcus aureus*, *Escherichia coli*, *Enterobacter* species, and *Shigella* species (Chinakwe et al., 2012). Understandably, handlers in the markets of the city of Maputo do not have a habit of washing their hands during food handling. Similar results in which most manipulators do not have the habit of washing hands during food handling was reported in Brazil and Ghana, were only 23 and 20%, respectively demonstrated have this practices (Alves da Silva et al., 2014).

Furthermore, the results from this study show that only a part of the food handlers (28.3%) presented clean, with nails cut, hair, and beard in conditions of cleanliness. It had also been observed that usually, the manipulators (67.0%) do not adopt practices (like no smoking, talking,

**Table 6.** Answers to the questions about cross-contamination.

Question	Response (%)	
	Yes	No
Do workers who present one of these symptoms/illnesses (skin disease, infected wounds, diarrhoea, hepatitis, tonsillitis, and tuberculosis) are put away from food preparation?	41.9	58.1
Do the food handlers wash their hands immediately before work, after using the lavatory, and whenever necessary, with potable water and appropriate detergent?	9.9	90.1
Are the toilets equipped with sufficient running water, washbasins with soap and whenever possible with a hand drying system?	9.9	90.1
Are food handlers clean, with fingernails cut, hair and beard clean, and wear no jewelry?	28.3	71.7
Are food intended for consumption without prior washing, cooking or peeling and that have no protecting package, taken with tweezers or other appropriate instruments, avoiding hand contact ?	67.0	33.0
Are the dishes and cutlery used by customers thoroughly cleaned with hot soapy water immediately after use?	0.0	100.0
Do workers have the habit of not smoking, talking, whistling, coughing, eating, manipulating money or practicing other acts that could contaminate food?	23.4	76.6
Do the kitchens have different sectors for: preparation of vegetables, animal origin food preparation and cooking?	0.0	100.0
Does the kitchen have separate refrigerators for the conservation of fruits and vegetables and other deteriorating foods that guarantee the temperature as established?	0.0	100.0

coughing, and manipulating money). This situation compromises the safety of the food sold in these places (Codex Alimentarius, 2006).

During the present research, we observed that in most markets, the slaughter and evisceration of small animals, such as the chicken, was carried out in the same place where meal is prepared. It puts to risk the food safety because these animals are reservoirs of pathogenic microorganisms such as *Salmonella* and *Campylobacter* leading to possible cross-contamination.

Only 19.9% of establishments visited have an adequate layout. Inadequate design can promote food cross-contamination in food establishments. The problem of cross-contamination in food establishments does not only occur in countries with weak structures, such as Mozambique. Djekic et al. (2014) researched three European cities and concluded that inadequate layout and lack of space for the workers', can be several cases of cross-contamination in establishments. Based on this, the Maputo city government must improve market infrastructures to reduce the risks of cross-contamination, minimizing the occurrence of foodborne diseases related to food consumption outside the home.

### Indirect contamination

In the markets of Maputo city, the vendors use coal as a source of energy for food preparation, which can be a source of physical and chemical contamination for food. Soot from the use of fuel causes dark stains on the walls and clothes of the handlers, making them difficult to sanitize. Codex Alimentarius (2006), recommends that food establishments must have bright flooring and walls that are easily sanitized to reduce the risk of contamination in food. Among the establishments analyzed, only 28.3% showed compliance with this item. Similar results, in which most food establishments did not have easily sanitized floors and walls, were found by Adikari et al. (2016) in food establishments in Sri Lanka. A possible microorganism present in food processing environments is *Listeria monocytogenes*. The bacteria are pathogen that can cause a high mortality rate for groups at risk. *L. monocytogenes* is capable of forming biofilms, which are quite tricky to remove and can be found in equipment and utensils, floors and drains, and can contaminate food through cross-contamination (Donlan, 2002; De Souza et al., 2014; Dzieciol et al., 2016).

The markets do not have private sanitary facilities for workers, do not have individual closets for employees, do not have detergents and alcohol for hand hygiene and have no adequate clean facilities for the number of users (Table 7). In the establishments, there is no proper plan or action for controlling flies, insects and rodents which may cause indirect contamination. Curtis et al. (2000) reported that insects and rodents should not have access to storage and consumption areas, because they are reservoirs of enteric pathogens such as *E. coli*, *Salmonella* spp., and *Campylobacter jejune* were detected on surfaces used for food preparation as well as in water reservoirs.

Regarding trash management, only 10.5% of the establishments have an efficient system for the removal of garbage from the handling areas, and 26.2% store garbage in places far from the handling areas.

### Documents

All food establishments did not have written guidelines for food handlers on proper hygiene

**Table 7.** Answers to the questions about indirect contamination.

Question	Response (%)	
	Yes	No
Adequate waste disposal system	10.5	89.5
Are containers used for frequent garbage disposal kept away from production sites in a protected area?	26.2	73.8
Do the toilets have no direct communication with the places of storage, processing, packaging, consumption or sale of food products?	100.0	0.0
Do workers' sanitary facilities have locker rooms with washable, disinfectable cabinets, or individual hangers with a wardrobe for personal clothing and work uniforms?	0.0	100.0
Are the facilities, equipment and utensils kept in perfect hygienic condition with daily cleaning operations?	33.5	66.5
Control and prevention of insects, rodents and other parasites,	0.0	100.0
Are there domestic animals and obsolete objects in the food preparation area?	22.0	78.0
Does the food establishment have washable material floor in places where food is stored, prepared or served?	41.3	58.7
Has the facility been designed, constructed and arranged to allow fast, thorough cleaning and to prevent the penetration of birds, rodents and insects?	19.9	80.1
Is the establishment/Market located in a health and safety area free from smoke, unpleasant odors, dust and that is not subjected to flooding?	69.2	30.8
Do the establishments have no communication with housing?	100.0	0.0
Are the toilets paved, waterproof, washable and sanitizable?	100.0	0.0
Is the number of toilets as indicated in the regulation? (1 toilet for 9 workers, 2 toilets for 10 to 24 workers, 3 toilets for 25 to 49 workers)?	0.0	100.0
Are there showers in number that satisfies the type of the establishment and that corresponds to the number of workers?	0.0	100.0
Are there sanitary facilities only for workers?	0.0	100.0
Do the establishments have hygienic services available to the public, in adequate numbers for the establishment capacity?	0.0	100.0
Does the establishment have separate locations for kitchen, warehouse and dining room?	16.2	83.8
Does the kitchen have waterproof washable walls up to 1.80 meters high?	25.7	74.3

and other hygiene habits. Only 42.9% had a sanitary license to perform the service (Table 8). A study done in Brazil, in 2013 concluded that the items related to documentation and safety registers are generally deficient in food establishments (Sacco et al., 2013), results that corroborate with the present study.

The fact that the food services are producing foods even without a sanitary license is a legal problem that can also reflect in food safety because sanitary officers use to check if the food establishments have the minimal conditions to produce food. However, even having a sanitary license, there is the possibility of food contamination by the environment, equipment, and utensils, and if handlers do not accomplish

the Good Hygienic Practices (GHP). For example, a study carried out in Kenya-Nairobi revealed the presence of *Entamoeba histolytica* and *Giardia lamblia* on the hands of workers at certified establishments (Kamau et al., 2012). Thus, inspections are an essential part of the process to prevent foodborne illness, but the best way to protect the consumer is to prevent contamination by proper implementation of GHP (DeWaal, 2007).

#### Secondary information on microbial data

Microbial data from the reference laboratory carried out by the city health showed that the

maximum and minimum values of total coliforms obtained in all samples were between  $4.38 \pm 0.58$  and  $0.1 \pm 0.31$  log CFU/ml. Water from the general deposit did not present any significant contamination. However, water from the containers of the establishments was contaminated by total coliforms ( $0.58 \pm 0.63$  CFU/ml), an indication of the lack of hygiene in food preparation. As shown in Table 11, hands and utensils did not contain *E. coli* counts. Also, utensils did not reveal the presence of *Staphylococcus aureus*. However, total and fecal coliforms were found in both type samples. This contamination may have its origin from the water used for the preparation of food, but also from food handlers. It is known that the manipulator's hands are a potential way for

**Table 8.** Answers to the questions about documents.

Question	Response (%)	
	Yes	No
Is there in the lavatory sector, a clearly written notice and drawings indicating the obligation to wash the hands after using the toilet?	0.0	100.0
Does the establishments have a sanitary license to exert the activity	40.3	59.7

**Table 9.** Classification of food markets based on the FSI (Food Safety Index) in Maputo City.

Name of market	Average	Category
Peixe	0.44	Medium
Estrela vermelha	0.16	Low
Xipamanine	0.15	
Mandela	0.15	
Povo	0.18	
Museu	0.18	
Benfica	0.17	

**Table 10.** Frequency distribution of values of weighted Food Safety Index according to low, medium and high level.

FSI	N	%
Low	6	85.7 ~ 86.0
Medium	1	14.3 ~ 14.0
High	0	0

bacteria pathogenic transmission and may be a possible cause for outbreaks (Assefa et al., 2015).

**Food safety index (FSI)**

In order to analyze the level of conformity of the

establishments visited in the markets, FSI had been calculated. Table 2 presents the frequency of the distributed index into three categories: bad condition, satisfactory condition, and good condition. It is possible to state in a general way that the establishments (stalls) in the markets presented a very low FSI, an average of 0.18. The market stalls of Mandela and Xipamanine were those with minimum FSI values (0.15), and the Peixe market stalls showed maximum values of FSI (0.44) (Table 9). So we can say that out of a total of 191 stalls in the seven food markets visited, none got rated as in good conditions. In addition, 86% (n = 6) scored in bad condition and only one, 14% (n = 1) scored satisfactory condition (Table 10). The Peixe market was the one that presented an average rating. This market, compared to the others, presented better scores on the issues related to the exposure of food, practices that prevent cross-contamination and issues related to cross contamination. This situation is because this market benefited from rehabilitation one is the reference in the sale of shellfish and to be a tourist point.

The remaining markets obtained low FSI due to the lack of procedures like control of temperature, high exposure time after food preparation, lack of actions to prevent pests on the premises, lack of knowledge on the origin of water used for preparation of ice and also the sewers were not in right conditions, do not have an adequate disposal system, the establishments are not paved and not made of natural sanitizing material.

**Association of socio-demographic and good practice variables**

Socio-demographic variables were statistically tested for association according to the good practice procedures, using the Chi-square test with a significance level of 5%. Age and gender did not generally affect proper practice procedures in food outlets. Stratev et al. (2017) also noted that there was no significant difference (p>0.05) on food safety practices among students based on their ages. There was only a significant difference between the level of schooling and the habit of carrying out hygienic operations at the facilities (Pearson's Chi-square p = 0.043). It was evident that the more education the interviewed people had, the more care was taken to clean the facilities. Kennedy et al. (2011), suggested that the lack of knowledge of young people about the principles of domestic hygiene is justifiable by the fact that they are generally less involved in domestic activities, so, it seems essential to educate them from an early age so to stimulate GHP (Taché and Carpentier, 2014).

The Peixe market stood out to be the best of all the other markets studied (Table 5). There were also differences between markets. Peixe Market and Museu food handlers which had the habit of not smoking, talking, whistling or manipulating money during food manipulation (p = 0.03), and even concerning the floors of establishments that was easily sanitized (p <0.05). So we can conclude that there were significant differences (p<0.05)



**Table 11.** A list of all the food samples tested and quantification microorganisms analyzed.

Type of sample	Performed analysis	Results (CFU)/ml ou g
Network Water (general deposit)	Total coliforms	(n=20) 0.0
Water from market Reservoirs	Total coliforms	(n= 15) (n=3)0.58± 0.63 UFC/ml
	<i>Escherichia coli</i>	(n=10) 0.0 UFC/ml
Hands	Total coliforms	(n=10) 0.52±0.62 CFU/ml
	Fecal coliforms	(n=10) 0.27±0.57 CFU/ml
	Staphylococcus coagulase positive	(n=10) 0.1±0.31 CFU/ml
Utensils	<i>Escherichia coli</i>	(n=10) 0.0
	Total coliforms	(n=10) 0.80±0.66 CFU/ml
	Fecal coliforms	(n=10) 0.53±0.58 CFU/ml
	Staphylococcus coagulase positive	(n=10) 0.0
Vegetables and salads	Total coliforms	(n=10) 4.38±0.58 CFU/ml
	Total coliforms	(n=10) 3.27±0.58 CFU/ml
Rice	Fecal coliforms	(n=10) 0.0
	Staphylococcus coagulase positive	(n=10) 0.0
	<i>Bacillus cereus</i>	(n=10) 0.0
Curry	<i>Escherichia coli</i>	(n=5) 0.0
	Total coliforms	(n=5) 0.0
	Fecal coliforms	(n=5) 0.0
	Sulfite-reducing Clostridium	(n=5) 0.0
Soups	Total coliforms	(n=10) 0.0
	Fecal coliforms	(n=10) 0.0
	<i>Bacillus cereus</i>	(n=10) 0.0
	Sulfite-reducing Clostridium	(n=10) 0.0

in markets and procedures on good practices.

Taking into account the priorities of the markets that presented a low FSI which allowed classifying them in markets of bad condition, we can suggest the control of water as a priority concerning food and ice preparation. It is necessary to ensure that the water used in the markets visited is free of contamination after its deposit in barrels, and this can be done employing the hygiene of the containers.

The second priority is to improve the infrastructure conditions of the markets. There must have facilities that allow vendors to have refrigerators to conserve leftover food so that they can be eaten safely in their homes. Improved facilities will also allow vendors to use other sources of energy to allow the walls and floors of the facilities to be easily rinsed and sanitized.

Analyzing the actions of salespeople, we can consider training as the third priority. Training vendors of food can be able to recognize the importance of hand hygiene

before handling food.

## Conclusion

The hygienic-sanitary conditions of food establishments in the public markets of Maputo were evaluated in this study. The public consuming food from food markets are at risk of food borne diseases because the hygienic-sanitary conditions of food preparation in Maputo city markets do not comply with the minimum requirements of the Mozambican legislation, as well as international law. There is a need for periodic inspections by local authorities to verify the conformity of minimum requirements for food safety. Implementation of training programs for food handlers, emphasizing the need for the application of GHP is also important to minimize foodborne diseases' risk.

In the priorities of the markets, the use of drinking water

in all food services for food preparation is a short-term priority. It should be followed (in the medium term) by improving the infrastructure conditions of the markets. So the vendor can use equipment like a refrigerator and freezers for food preservation and also for the use of other energy sources such as domestic gas (liquefied petroleum gas) for food preparation. The third priority would be training food handlers on personal hygiene and GHP in food services. In the long term, the Mozambican government promotes safe food handling by integrating food safety into national policies and programs through several communication ways. Also, it is vital that the government prioritizes food safety and public health by ensuring that food suppliers act responsibly and provide safe food to consumers.

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## CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

## REFERENCES

- Adikari AMNT, Rizana MSF, Amarasekara TP (2016). Food Safety Practices in a Teaching Hospital in Sri Lanka. *Procedia Food Science* 6:65-67.
- Allen P, Sachs C (2017). Women and food chains: The gendered politics of food. *International Journal of Sociology of Agriculture and Food* 15:1-23.
- Aluko OO, Ojeremi TT, Olaleke DA, Ajidagba EB (2014). Evaluation of food safety and sanitary practices among food vendors at car parks in Ile Ife, southwestern Nigeria. *Food Control* 40:165-171.
- Alves da Silva S, Cardoso RCV, Góes JÁW, Santos JN, Ramos FP, de Jesus RB, do Vale RS, de Silva PST (2014). Street food on the coast of Salvador, Bahia, Brazil: A study from the socioeconomic and food safety perspectives. *Food Control* 40:78-84.
- Assefa T, Tasew H, Wondafrash B, Beker J (2015). Contamination of bacteria and associated factors among food handlers working in the student cafeterias of Jimma University Main Campus, Jimma, South West Ethiopia. *Alternative and Integrative Medicine* 4:1-8.
- Chattopadhyay P, Adhikari S (2014). Freezing of foods: Growth and survival of microorganisms. *Encyclopedia of Food Microbiology* 968-971. [https://www.researchgate.net/publication/323813217\\_Freezing\\_of\\_Foods\\_Growth\\_and\\_Survival\\_of\\_Microorganisms](https://www.researchgate.net/publication/323813217_Freezing_of_Foods_Growth_and_Survival_of_Microorganisms)
- Chinakwe EC, Nwogwugwu NU, Nwachukwu IN, Okorundu SI, Onyemekara NN, Ndubuisi-Nnaji UU (2012). Microbial quality and public health implications of hand-wash water samples of public adults in Owerri, South-East Nigeria, <https://www.interesjournals.org> (accessed 21 September 2018).
- Codex Alimentarius (2006). *Codex Alimentarius: Higiene dos Alimentos Textos Básicos*. 2006. Epub ahead of print 2006. DOI: 10.1017/CBO9781107415324.004. Available at: [https://acisat.pt/wpcontent/uploads/2016/10/codex\\_alimentarius.pdf](https://acisat.pt/wpcontent/uploads/2016/10/codex_alimentarius.pdf).
- Curtis V, Cairncross S, Yonli R (2000). Domestic hygiene and diarrhoea - Pinpointing the problem. *Tropical Medicine and International Health* 5:22-32.
- Da Cunha DT, De Oliveira ABA, Saccol ALF, Tondo EC, Silva EA Jr, Ginani VC, Montesano FT, de Castro AKF, Stedefeldt E (2014a). Food safety of food services within the destinations of the 2014 FIFA World Cup in Brazil: Development and reliability assessment of the official evaluation instrument. *Food Research International* 57:95-103.
- Da Cunha DT, Stedefeldt E, de Rosso VV (2014b). The role of theoretical food safety training on Brazilian food handlers' knowledge, attitude and practice. *Food Control* 43:167-174.
- De Souza EL, Meira QGS, Barbosa I de M, Athayde AJAA, da Conceição ML, de Siqueira JP Jr (2014). Biofilm formation by *Staphylococcus aureus* from food contact surfaces in a meat-based broth and sensitivity to sanitizers. *Brazilian Journal of Microbiology* 45:67-75.
- DeWaal CS (2007) Food safety and security: What tragedy teaches us about our 100-year-old food laws. *Vanderbilt Journal of Transnational Law* 40:921-935.
- Djekic I, Smigic N, Kalogianni E, Rocha A, Zamioudi L, Pacheco R (2014). Food hygiene practices in different food establishments. *Food Control* 9:34-40.
- Donlan MR (2002). Biofilms: Microbial Life on Surfaces. *PERSPECTIVE - Emerging Infectious Diseases* 8:9.
- Dzieciol M, Schornsteiner E, Muhterem-Uyar M, Stessl B, Wagner M, Schmitz-Esser S (2016). Bacterial diversity of floor drain biofilms and drain waters in a *Listeria monocytogenes* contaminated food processing environment. *International Journal of Food Microbiology* 223:33-40.
- Elias SO, Tomasco PV, Alvarenga VO, Sant'Ana AS, Tondo EC (2015). Contributor factors for the occurrence of salmonellosis during preparation, storage and consumption of homemade mayonnaise salad. *Food Research International* 78:266-273.
- Food and Agriculture Organization (FAO) (2016). *Street Food in Urban - A Desktop Review and Analysis of Findings and Recommendations from Existing Literature*. Accra, Ghana, Food and Agriculture Organization of the United Nations.
- FDA (2019). *FDA Food Safety Modernization Act (FSMA Available @: https://www.fda.gov/Food/GuidanceRegulation/FSMA/default.htm*
- FDA/NSTA (2008). *Science and our food supply: Food safety A to Z reference guide*. <https://www.fda.gov/media/90663/download>. (accessed 23 September 2018).
- Grant U (2012). Education for all global monitoring report. Youth and skills: Putting education to work; Urbanisation and the employment opportunities of youth in developing countries. Available at: [https://pdfs.semanticscholar.org/50ec/c1acf63368483827be721f25e68e7270201.pdf?\\_ga=2.154119608.102045370.1561359341-1938752534.1561359341](https://pdfs.semanticscholar.org/50ec/c1acf63368483827be721f25e68e7270201.pdf?_ga=2.154119608.102045370.1561359341-1938752534.1561359341).
- Harrison D, Corry JEL, Tchórzewska MA, Morris VK, Hutchison ML (2013). Freezing as an intervention to reduce the numbers of campylobacters isolated from chicken livers. *Letters in Applied Microbiology* 57:206-213.
- Hassan HF, Dimassi H, Karam ZN (2018). Self-reported food safety knowledge and practices of Lebanese food handlers in Lebanese households. *British Food Journal* 120:518-530.
- Kamau P, Aloo-Obudho P, Kabiru E, Ombacho K, Langat B, Mucheru O, Ireri L (2012). Prevalence of intestinal parasitic infections in certified food-handlers working in food establishments in the City of Nairobi, Kenya. *Journal of Biomedical Research* 26:84-89.
- Kennedy J, Nolan A, Gibney S, O'Brien S, McMahon MAS, McKenzie K, Healy B, McDowell D, Fanning S, Wall PG (2011). Determinants of cross-contamination during home food preparation. *British Food Journal* 113:280-297.
- Kubheka LC, Mosupye FM, Von Holy A (2001). Microbiological survey of street-vended salad and gravy in Johannesburg city, South Africa. *Food Control* 12:127-131.
- Lambrechts AA, Human IS, Doughari JH, Lues JFR (2014). Bacterial contamination of the hands of food handlers as indicator of hand washing efficacy in some convenient food industries. *Pakistan Journal of Medical Sciences* 30:755-758.
- Macaza BS (2017). Avaliação da qualidade e segurança microbiológica de alimentos de rua vendidos nos mercados municipais da cidade de Nampula, Moçambique *Environmental Science & Technology* 51:4735-4737.
- McKay FH, Singh A, Singh S, Good S, Osborne RH (2016). Street vendors in Patna, India: Understanding the socio-economic profile, livelihood and hygiene practices. *Food Control* 70:281-285.

- Moreb NA, Priyadarshini A, Jaiswal AK (2017). Knowledge of food safety and food handling practices amongst food handlers in the Republic of Ireland. *Food Control* 80:341-349.
- MOZAMBIQUE (1984). Diploma Ministerial no. 51, de 03 de outubro de 1984. Fixa os requisitos higiénico-sanitários dos estabelecimentos alimentares (1984). Available at: <https://extwprlegs1.fao.org/docs/pdf/moz2672.pdf>.
- Nasrolahei M, Mirshafiee S, Kholdi S, Salehian M, Nasrolahei M (2017). Bacterial assessment of food handlers in Sari City, Mazandaran Province, north of Iran. *Journal of Infection and Public Health* 10:171-176.
- Ojha KS, Kerry JP, Tiwari BK, O'Donnell C (2016). *Freezing for Food Preservation*. Elsevier. Epub ahead of print. DOI: 10.1016/B978-0-08-100596-5.03108-5.
- RIO GRANDE DO SUL (2009). Portaria n. 78 de 28 de janeiro de 2009. Aprova a Lista de Verificação em Boas Práticas para Serviços de Alimentação, aprova Normas para Cursos de Capacitação em Boas Práticas para Serviços de Alimentação e dá outras providências. BRASIL: Diário Oficial do Estado do Rio Grande do Sul.
- Rossi MSC, Stedefeldt E, da Cunha DT, de Rosso VV (2017). Food safety knowledge, optimistic bias and risk perception among food handlers in institutional food services. *Food Control* 73:681-688.
- Saccol ALF, Serafim AL, Hecktheuer LHR, Medeiros LB, Spinelli MGN, de Abreu ES, Chaud DMA (2013). Hygiene and sanitary conditions in self-service restaurants in São Paulo, Brazil. *Food Control* 33:301-305.
- Samapundo S, Cam Thanh TN, Xhaferi R, Devlieghere F (2016). Food safety knowledge, attitudes and practices of street food vendors and consumers in Ho Chi Minh city, Vietnam. *Food Control* 70:79-89.
- Samapundo S, Climat R, Xhaferi R, Devlieghere F (2015). Food safety knowledge, attitudes and practices of street food vendors and consumers in Port-au-Prince, Haiti. *Food Control* 50:457-466.
- Sibanyoni JJ, Tshabalala PA, Tabit FT (2017). Food safety knowledge and awareness of food handlers in school feeding programmes in Mpumalanga, South Africa. *Food Control* 73:1397-1406.
- Soares K, García-Diez J, Esteves A, Oliveira I, Saraiva C (2013). Evaluation of food safety training on hygienic conditions in food establishments. *Food Control* 34:613-618.
- Soon JM, Baines R, Seaman P (2012). Meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers. *Journal of Food Protection* 75:793-804.
- Stratev D, Odeyemi OA, Pavlov A, Kyuchukova R, Fatehi F, Bamidale FA (2017). Food safety knowledge and hygiene practices among veterinary medicine students at Trakia University, Bulgaria. *Journal of Infection and Public Health* 10:778-782.
- Taché J, Carpentier B (2014). Hygiene in the home kitchen: Changes in behaviour and impact of key microbiological hazard control measures. *Food Control* 35:392-400.
- Tang A, Lum DJ (2015). Food safety focus-Frozen foods - are they safe? Hong Kong, Available at: [https://www.cfs.gov.hk/english/multimedia/multimedia\\_pub/multimedia\\_pub\\_fsf\\_109\\_01.html](https://www.cfs.gov.hk/english/multimedia/multimedia_pub/multimedia_pub_fsf_109_01.html).
- United Nations Advisory Committee of Local Authorities (UNACLA) (2012). Job creation and local productivity. Report from the United Nations Advisory Committee of Local Authorities (UNACLA).
- United States Department of Agriculture (USDA) (2013). How Temperatures Affect Food. Available at: [https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/safe-food-handling/how-temperatures-affect-food/ct\\_index](https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/safe-food-handling/how-temperatures-affect-food/ct_index).
- World Health Organization (WHO) (2015a). WHO estimates of the global burden of foodborne diseases. WHO2015; 1-255.
- World Health Organization (WHO) (2015b). WHO's first ever global estimates of foodborne diseases find children under 5 account for almost one third of deaths, Available at: <http://www.who.int/news-room/detail/03-12-2015-who-s-first-ever-global-estimates-of-foodborne-diseases-find-children-under-5-account-for-almost-one-third-of-deaths>.
- World Health Organization (WHO) (2011). Guidelines for drinking-water quality: Fourth edition incorporating the first addendum. Epub ahead of print 2011. DOI: 10.1016/S1462-0758(00)00006-6.
- World Health Organization (WHO) (2018). Drinking-water. WHO, Available at: <http://www.who.int/news-room/fact-sheets/detail/drinking-water>.
- World Health Organization (WHO) (2019). Food safety. WHO, Available at: <http://www.who.int/news-room/fact-sheets/detail/food-safety>.
- Wright J, Gundry S, Conroy R (2004). Household drinking water in developing countries: A systematic review of microbiological contamination between source and point-of-use. *Tropical Medicine & International Health* 9:106-117.