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RESEARCH PAPER

HANDLING, SAFETY AND HYGIENIC PRACTICES OF FROZEN MEAT AND FISH DURING VENDING IN THE KUMASI METROPOLIS

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ABSTRACT

This study assessed the extent to which cold store operators and table-top meat and fish sellers in Kumasi, employed safe meat and fish handling practices. The meat and fish safety knowledge and attitudes of food vendors and household consumers were also assessed. Data was collected from 155 respondents comprising 53 cold store operators, 42 table-top vendors and 60 consumers using semi-structured questionnaires. The majority of respondents were females aged between 20 – 40 years. Cold store operators were generally more educated than the table-top meat and fish sellers who had only basic or no formal education. However, formal education had little effect on respondents' knowledge and adoption of meat handling and safety practices. Neither meat and fish vendors nor consumers considered hygiene as necessary in their selection of suppliers and purchase of products. Although most claimed to be aware of meat and fish contaminants, they could not mention specific pathogens that contaminated either products. While most table-top vendors wore overalls, the purpose was not to reduce contamination of meat and fish but to promote personal cleanliness. The findings indicate the need for further studies and interventions to bridge the existing gap between knowledge and practice in the frozen meat and fish industry. We propose a conceptual framework for an integrated approach involving all key stakeholders for safe vending of frozen fish and meat. Other urban cities in developing nations could adopt the framework to promote safe and hygienic practices in the frozen meat and fish industry.

Keywords *frozen meat and fish, hygienic practices, cold store operators, table-top vendors, consumers*

INTRODUCTION

Ensuring food safety remains one of the most critical challenges of public health in both developed and developing countries with developing countries being the most vulnerable (Luo *et al.*, 2019; Odeyemi & Bamidele, 2016). The challenge is more acute for the meat and fish industry as fresh animal products are highly susceptible to microbial contamination (high risk foods) due to their high nutrient and moisture content. A number of researchers have therefore investigated some of the key challenges associated with processing and vending these high-risk foods to safeguard consumers' health (Pesewu *et al.*, 2018; Rani *et al.*, 2017; Sulleyman *et al.*, 2018). Such research has become more important as rapid population growth coupled with urbanisation, improved education and higher income levels have resulted in increased consumption of meat, fish and their products (Sofos, 2008; Walker *et al.*, 2005). For example, Rani *et al.* (2017) identified the distribution stage of the value chain as the most susceptible to contamination due to poor handling practices of meat in South Africa while Haileselassie *et al.* (2013) reported a food safety knowledge gap among butchers and abattoir workers in Mekelle, Ethiopia. A study in China indicated that less than 50% of consumers had adequate food safety knowledge although all respondents were tertiary students with about two-thirds pursuing health related courses (Luo *et al.*, 2019). A further investigation on the food safety knowledge, attitude and practises among consumers in developing countries revealed that Asians had better food safety knowledge than Africans and further situated household storage and handling practices as key existing challenges (Odeyemi *et al.*, 2019).

With increased consumer demand for convenience foods, the interest in animal protein consumption has been directed to frozen meat and fish (Kusi *et al.*, 2015; Osei, 2010). This has led to the establishment of frozen meat and fish companies or cold stores and supermarkets in most West African countries (Johnson, 2009; Thow *et al.*, 2014). These cold stores and supermarkets, generally have the infrastructure to support cold storage for enhanced safety. As Kunadu *et al.* (2018) have pointed out in their work, these commercial establishments do not always guarantee a functioning cold chain and can be a source of contamination. In addition, the proliferation of small scale frozen meat and fish vendors (table-top vendors) usually found in markets in cities and urban areas pose a huge risk to consumer health and safety (Onyeneho & Hedberg, 2013). This is especially so since the table-top vendors do not have the needed cold storage facilities, and the necessary training and certification to ensure safe handling of meat, fish and meat products. Of most concern is the on-going promotion of animal protein in diets of children for enhanced development (Neumann *et al.*, 2002; Semba, 2016).

It is imperative that existing knowledge on safety, hygienic and handling practices are therefore examined and documented with the aim of informing policy for enhanced safe meat, fish and meat products, particularly in commercial cities of developing countries where population growth and urbanization add its peculiar challenges. Ghana is one such notable trade centre in Africa and its largest City, Kumasi, is the trade centre for most of her neighbouring countries. Research to address the challenges of meat handling, safety and hygiene have focused primarily on butchers and microbial load of produce from cold stores (Antwi-Agyei & Maalekuu, 2014; Kunadu *et al.*, 2018; Pesewu *et al.*, 2018; Sulleyman *et al.*, 2018), with scarce investigations on the frozen meat and fish industry. In this study we assessed meat and fish safety knowledge, and practices of cold store operators and table-top meat and fish sellers in Kumasi. In addition, meat and fish safety knowledge and attitudes

of food vendors and household consumers were investigated with the aim of generating an adaptable conceptual framework towards mitigating safety and hygienic challenges in the sale of frozen fish and meat.

MATERIALS AND METHODS

Study area

The study was conducted in Kumasi, the second largest city in Ghana, and the capital of the Ashanti Region. The Kumasi metropolis is one of the fastest growing cities in Africa and serves as home to a high number of immigrants (GSS, 2012; Rheinländer *et al.*, 2008).

Kumasi has three major markets namely, Kumasi Central Market, Bantama Market and Asafo Market. The survey was conducted at all three markets and also at Ayigya Market, a smaller market that serves the Kwame Nkrumah University of Science and Technology (KNUST) and its environs (Figure. 1).

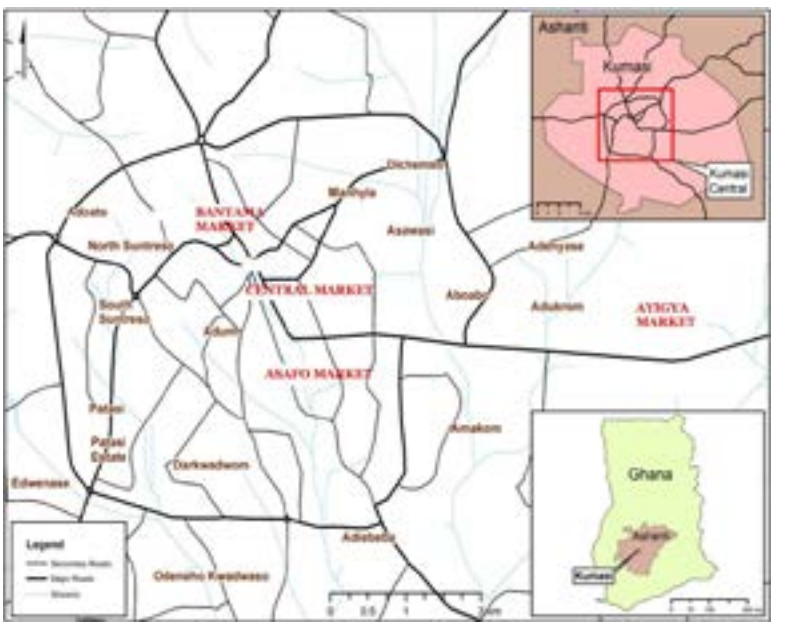

Figure 1. Geographical location of study areas. Surveyed markets in red-coloured fonts. *Adapted, Cobbinah & Niminga-Beka (2017).*

The Kumasi Central Market is the single largest market in West Africa and it is located in the central business area of Kumasi. The Asafo Market houses several wholesale and retail meat and fish cold stores which serve the Middle - Northern belts of Ghana. The Bantama Market is also a central trade point for many peri-urban and rural communities in the Ashanti Region.

Study design

The study was stratified into three: cold store operators, table-top meat and fish sellers and consumers. The consumers comprise food vendors operating in the markets, and household consumers purchasing frozen meat or fish at the time of the interview. The convenience sampling method was used; as many respondents under the various

categories in the given markets who were willing to participate were interviewed. The interviews were conducted in May and June, 2019.

Data collection

Interviews were conducted using semi-structured questionnaires to assess the level of meat and fish safety knowledge and practice among the three target groups. The questionnaires were made up of both close and open-ended questions to enable the respondents express their views while providing reliable and comparable qualitative data. Data was collected from 155 respondents comprising 53 cold store operators, 42 table-top vendors and 60 consumers from the four markets. All questionnaires were divided into four sections: demographics of the respondents, meat and fish patronage, safety issues (with focus on the handling and hygienic practices of the respondents) during vending, as well as respondent's awareness / knowledge on product safety.

Ethical considerations

The consent of each respondent was sought by first ensuring that objective of the study was clearly explained to respondents to enable them participate voluntarily. A respondent could choose to stop the interview at any time. Respondents' confidentiality during and after the survey was also guaranteed.

Statistical analysis

Data collated was thoroughly screened and incomplete responses excluded from the analysis. The data obtained was summarized using descriptive statistics such as frequencies and percentages. Preliminary cross-tabulation analyses revealed that all the combinations have at least one cell with a frequency of less than five. The Fisher's exact test was therefore used to determine the relationship between educational level and sex of respondents and other relevant categorical variables. Significant levels of the various data sets were assessed at 90%, 95% and 99% confidence levels. The Statistical Package for Social Science (SPSS) statistical software version 21 (version 21; model year 2012) was employed for all analyses.

RESULTS AND DISCUSSION

Demographic characteristics of respondents

The demographic profile of respondents is summarized in Table 1. Females dominated all categories assessed except for cold store operators where an approximately 1:1 ratio (27 females: 26 males) was obtained. The present study corroborates earlier reports that women are the main workforce in the food vending business in most developing countries (Ababio & Lovatt, 2015; Akabanda *et al.*, 2017; Levin *et al.*, 1999).

This fact could be attributed to the disposition of most culture in developing countries that assign household chores and up keep (including food preparation) to women and girls. A large majority of respondents were Christians: 98.1% for cold store operators and 100% for table-top vendors. This reflects the religious demographics of Ghana with about 70% of the total population being Christians (GSS, 2012). No clear relationships could be established between these and safe handling of produce.

Cold store operators and table-top vendors

Respondents were mostly within the economically active age group of 30–50 years (Table 1).

The operations of cold stores and table-top vending in particular, requires considerable amount of physical activity such as lifting meat/fish packages as well as cutting and this requires able-bodied people who will be found within this age group (Salifu and Teye, 2006).

Table 1: Demographic characteristics of respondents

Variable	Frequency (%)			
	Vendors		Consumers	
	Cold store operators (n = 53)	Table-top meat vendors (n = 42)	Household consumers (n = 39)	Food vendors (n = 21)
Sex				
Female	27 (50.9)	42 (100)	29 (74.4)	21 (100)
Male	26 (49.1)	0 (0)	10 (25.6)	0
Age				
< 20	1 (1.9)	0 (0)	1 (2.6)	0
20 – 30	9 (17.3)	7 (16.3)	23 (59.0)	6 (28.6)
31 – 40	23 (44.3)	16 (33.1)	11 (28 .2)	8 (38.1)
41 – 50	17 (32.7)	18 (42.9)	4 (10.3)	7 (33.3)
Above 50	3 (5.8)	1 (2.4)	0	0
Marital Status				
Single	14 (26.4)	9 (21.4)	25 (64.1)	4 (19.1)
Married	37 (69.8)	32 (76.2)	14 (35.9)	15 (71.4)
Divorced	1 (1.9)	1 (2.3)	0	2 (9.5)
Widowed	1 (1.9)	0	0	
Religion				
Christian	52 (98.1)	42 (100)	38 (97.4)	15 (71.4)
Muslim	1 (1.9)	0	1 (2.6)	4 (19.0)
Traditional	0	0	0	2 (9.5)
Level of education				
Basic	12 (22.6)	33 (78.6)	17 (43.6)	14 (66.7)
Secondary	27 (50.9)	4 (9.5)	8 (20.5)	1 (4.8)
Tertiary	11 (20.8)	0	14 (35.9)	2 (9.5)
No formal education	3 (5.7)	5 (11.9)	0	4 (19.0)
Family size				
< 5	35 (66.0)	34 (81.0)	30 (76.9)	8(38.0)
5 – 10	18 (34.0)	8 (19.0)	9 (23.1)	12 (57.1)
Above 10	0	0	0	1 (4.8)

Respondents had varied educational backgrounds. Most cold store operators (50.9%) had secondary education followed by tertiary (20.8%) while the table-top vendors were predominantly basic school graduates (78.6%).

Approximately ten per cent of table-top vendors had secondary education while 12% had no formal education. According to Mutegi *et al.* (2013), these educational characteristics are common in African markets as table-top (traditional) vendors generally have low level education compared to the more established (and presumed sophisticated/ polished vending) shop operators (Mutegi *et al.*, 2013).

Consumers (household and food vendors)

A total of sixty consumers comprising 39 household consumers at the point of sale and 21 food vendors operating in the target markets were interviewed. A majority of the consumers were female: 74.4% among household respondents and 100% for food vendors, further reinforcing the essential role of women in food vending and preparation (Ababio & Lovatt, 2015). More than 90% of the consumers had some formal education; many of which were at the basic level - 43.6% and 66.7% for household consumers and food vendors, respectively. About three quarters of respondents were between the ages of 20 to 40 years (Table 1). Only one respondent was

younger than 20 years mainly because the survey was done during a period when schools were in session and school-age pupils (17 years and below) would have been at school.

Meat patronage

The most frequently purchased products from cold stores and table-top vendors were in the following order: chicken, fish and frankfurter-type sausages (Table 2). This is similar to the observations of Nkegbe *et al.* (2013) who studied meat consumption trends in Accra. Table-top vendors were more likely to sell fish than the commercial cold stores. The relatively lower price of fish compared to chicken, beef or pork makes it more affordable to the less financially endowed table-top vendors as compared the cold store operators (Morales & Higuchi, 2018).

Sausages were the third most purchased item from both cold stores and table-top vendors. The finding further situates sausage as a key protein source in contemporary Ghanaian diet. This supports the fact that increased incomes of people leads to higher consumption of animal products and processed ones in particular (Delgado, 2003; Nikmaram *et al.*, 2018).

Table 2: Meat, fish and sausage sold or purchased by vendors and consumers

Meat/fish sold or purchased	Frequency[1] (%)							
	Vendors				Consumers			
	Cold store Operators (n = 53)		Table-top meat and fish vendors (n = 43)		Household Consumers (n = 39)		Food vendors (n = 21)	
	Yes	No	Yes	No	Yes	No	Yes	No
Chicken	51 (96.2)	2 (3.8)	23 (54.8)	19 (45.2)	30 (76.9)	9 (23.1)	12 (57.1)	9 (42.9)
Fish	47 (88.7)	6 (11.3)	33 (78.6)	9 (21.4)	29 (74.4)	10 (25.6)	17 (81.0)	4 (19.0)
Sausage	40 (75.5)	13 (24.5)	7 (16.7)	35 (83.3)	13 (33.3)	26 (66.7)	5 (23.8)	16 (76.2)
Beef	18 (34.0)	35 (66.0)	2 (4.8)	40 (95.2)	5 (12.8)	34 (87.2)	1 (4.8)	20 (95.2)
Others[2]	4 (7.5)	49 (92.5)	3 (7.1)	39 (92.9)	1 (2.6)	38 (97.4)	0	21 (100)

[1]Yes implies produce either sold or purchased; No implies produce neither sold nor purchased
[2]Refers to offal and tissues other than meat

Respondents placed little emphasis on hygiene when it came to making purchasing choices. Among the commercial cold store operators (the key intermediaries for the distribution of frozen meat, fish and meat products), only 5.5%, 10.4% and 3.5% considered hygiene in their selection of supplier for chicken, fish and sausage, respectively. Other key factors influencing source selection were lack of adequate storage facilities as well as financial constriants to support bulk purchases. As a result, some cold store operators (about 20%) were limited to a few suppliers who were willing to sell smaller quantities of produce to them.

Similarly, consumers least considered hygiene during purchase of meat, fish and meat products with accessibility being the main criterion (56.7%), and followed by price (28.3%) (Figure 2). Rheinländer *et al.* (2008) and Asiegbu *et al.* (2016) reported that consumers in two urban cities mainly used affordability and accessibility of products as purchasing criteria but paid little attention to good hygienic practices.

Safety and hygienic practices

Vendors did not put any emphasis on self-protection and less than 50% of cold store

operators wore any protective clothing (Table 2). It was also clear from the study that formal education did not have a significant *(p > 0.05)* influence on the practices of the cold store operators except during the transportation of produce where those with formal education used cold vans (Table 3). More than half of the cold store operators wore gloves during vending for varied reasons which include personal protection and attracting customers (Table 3); the observation presents a good basis for future interventions to promote good hygienic practices among frozen meat and fish handlers.

Table 3: Influence[1] of education / sex on safety and hygienic practices during vending

Safety and hygienic practice	Sex[2]	Education	
	Cold store operators	Cold store operators	Table-top vendors
Means of transporting meat /fish/meat products to cold store or point of sale	7.93 (0.07)*	23.48 (0.00)***	3.53 (0.76)
Handling of meat products on arrival	1.88 (0.62)	9.26 (0.37)	
Wearing of personal protective equipment (PPE) during sales			
Wearing of gloves	2.74 (0.19)	5.09 (0.16)	4.83 (0.06)*
Wearing of aprons	7.82 (0.00)***	1.82 (0.63)	0
Wearing of overalls	0.01 (1.00)	1.36 (0.78)	0.73 (1.00)
Personal hygiene practices			
Washing of hands	3.12 (0.14)	1.83 (0.63)	0.99 (0.80)
Use of hand sanitizers	1.87 (0.35)	2.32 (0.49)	N/A
Inconveniences associated with wearing PPEs	0.03 (1.00)	11.15 (0.006)***	0.93 (0.72)
Cleaning practises in place at cold store			
Sweeping	0.98 (1.00)	4.18 (0.49)	N/A
Scrubbing with water	1.00 (0.61)	0.85 (1.00)	N/A
Scrubbing with water and detergent	2.84 (0.16)	1.92 (0.66)	N/A
Cleaning of tools and cutting platforms	24.48 (0.09)*	76.81 (0.88)	1.31 (1.00)
Cleaning the tools and cutting platforms in between products	3.05 (1.34)	2.01 (0.61)	1.30 (0.63)
Storage of cutting tools when not in use during vending	33.66 (0.05)*	102.77 (0.58)	5.74 (0.38)
Storage of cutting tools after close of work	23.10 (0.02)**	60.66 (0.71)	33.14 (0.32)

[1]Fisher's Exact Test (p-value)

[2]Not applicable to table-top vendors as they were all females

,, and *** denote statistical significance at 10%, 5% and 1% respectively*

The trend was same for the table-top vendors with the impact of education weakly reflecting (p=0.06) in the use of gloves during vending. A similar situation was found among butchers in Accra, Ghana (Sulleyman *et al.*, 2018) and Mekelle, Ethiopia (Haileselassie *et al.*, 2013). There is therefore an urgent need for safety/ hygienic training and awareness creation for meat and fish product handlers. The table-top vendors were more likely to wear overalls than aprons because of the fact that the overalls were basically worn to protect themselves from stains but not necessarily for food safety reasons. Thus, most respondents (85.7%) did not remove their overalls when leaving the point of sale to attend to other activities including nature's call. They

generally considered removing the overalls as a nuisance.

With respect to meat and fish handling practices, over 75% of both cold store operators and table-top vendors left cutting tools uncovered during vending and the tools were not thoroughly cleaned in between use and after daily sales; those who cleaned (<6%), did so without detergent or disinfectant. This practice poses a higher risk of food borne disease as most consumers (71.67%) preferred their meat and fish to be cut into convenient pieces during purchase. The findings suggest a high risk of contamination from tools used and corroborate earlier studies on hygienic practices of butchers in Accra which revealed cutting tools as a potential source of cross-contamination for food-borne pathogens (Sulleyman *et al.*, 2018). From the results, there was no clear distinction between how the two categories of vendors handled meat, fish and their products. The same cutting tools and platforms were used for all products and there was no stringent cleaning routine in place for the cutting equipment in-between the sale of different products. This further increases the risk for cross contamination.

Washing and disinfection of hands during vending was also poorly practiced among both categories of vendors. The finding was not unexpected for the table-top vendors because of the lack of requisite infrastructure at their disposal. However, most cold store operators have adequate infrastructure to support such required practices. Thus, their unwillingness to do so or lack of practice could possibly be attributed to the absence of, or lack of enforcement of regulations. Kunadu *et al.* (2016) showed that in institutions where rules were enforced, food handlers practiced a high level of hygiene.

Daily cleaning schedule of cold stores was mainly focused on sweeping the point of sale. Only 7.5% had stringent daily cleaning procedures that involved the use of detergents.

Handling practices of frozen meat and fish

The worst offenders were table-top vendors (90.5%) who sold products directly from open cartons under ambient temperature for long hours and stored products in same cartons after each day's sales. Additionally, cartons not yet displayed for sale are mostly placed on platforms that are less than 5cm above the ground in dusty environments under ambient temperatures. It is noteworthy that the table-top vendors are the major retail source for most consumers (Figure 2) due to their easy accessibility and affordability especially in terms of their willingness to sell smaller portions of meat and fish.

Frozen meat and fish product safety awareness

Cold store operators and table-top vendors

Awareness on the safety measures of frozen meat, fish and meat products was generally low among cold store operators; 77.3% of respondents had no knowledge of pathogens that contaminate frozen meat and fish while 35.8% of respondents (28.3 Males; 7.5 Females) cleaned fridges only when products were sold out or fridge looked dirty. The finding is similar to the observation from earlier studies on institutional food handling and street food vending which indicated that most respondents had limited knowledge of food borne pathogens (Akabanda *et al.*, 2017; Samapundo *et al.*, 2015). Rarely did respondents separate different product types during storage and those who did (39.6%) were mostly operators who used cold rooms but not freezers. Knowledge on sources of contamination was also skewed to physical contaminants such as dust and rusted knives with an appreciable number of respondents associating inconsistent power supply to contamination. The apparent lack of adequate knowledge on the sources of contamination had earlier been observed and reported on among street-food vendors (Rheinlander *et al.*, 2008).

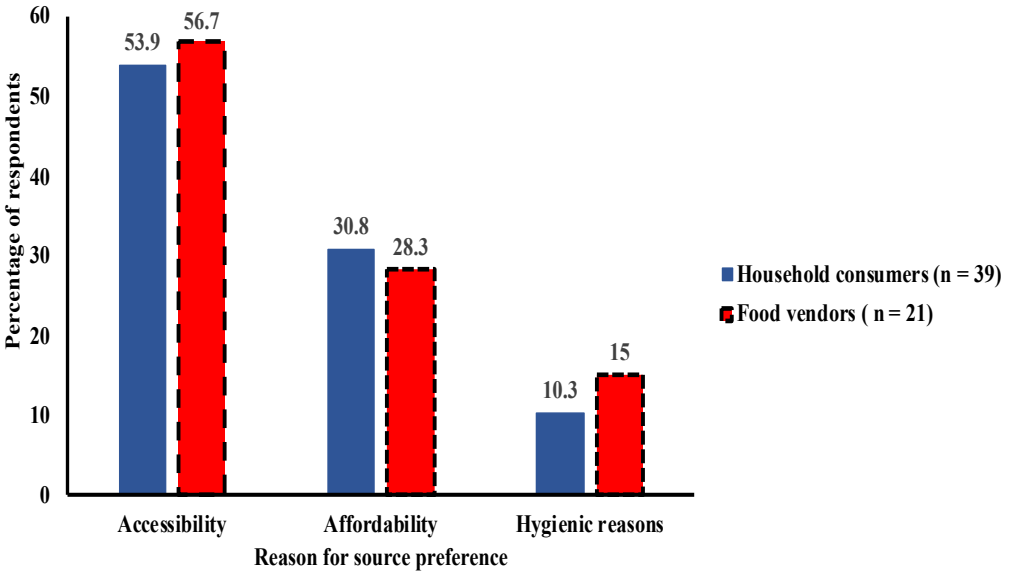

Figure 2. Frozen meat and fish purchasing criteria of consumers

Exacerbating this challenge of poor knowledge on safety was the fact that of the 79.2% respondents who did not share freezers/ cold rooms with other vendors, only 9.5% refused to do so due to hygienic and safety reasons whereas the majority was to avoid disputes among friends and relations.

A further analysis on safety measures (Table 4) showed no significant relationship ($p>0.10$) with educational background of respondents except for knowledge of pathogens which also deviated from the expected (Ababio & Lovatt, 2015). This is however contrary to the findings from institutional food handlers that showed a significant positive effect of education on knowledge of safety measures (Akabanda *et al.*, 2017). In the present study, only 6 respondents with tertiary education representing 11.3% of total respondents (Table 5) had knowledge about the pathogens that contaminate frozen meat and fish. The remaining 7 respondents with tertiary education indicated no knowledge of pathogens. Of the 26 respondents who had secondary education, only 5 persons representing 9.4% of respondents had knowledge of pathogens that contaminate frozen meat and fish. This information further situates the need for refresher training and awareness creation of operators to upgrade their knowledge on recommended safety practices for optimal food safety.

Table 4: Relationship† between education / sex and respondents' awareness of safety measures

	Cold store operators		Consumers		
			Sex‡	Education	
Awareness of safety measures	Sex	Education	Household consumers	Household consumers	Food vendors
How different meat and fish products are stored	1.57 (0.80)	8.37 (0.56)	N/A	N/A	N/A
Frequency of washing and cleaning of freezers / cold room	7.24 (0.06)*	29.31 (0.74)	N/A	N/A	N/A
Source of frozen meats contaminants	28.87 (0.61)	105.25 (0.56)	0.67 (1.00)	5.20 (0.08)*	1.87 (0.86)
Knowledge of pathogens that can contaminate frozen meat and /or fish products	3.90 (0.07)*	7.62 (0.04)**	0.07 (1.00)	4.24 (0.10)	6.83 (0.06)*
Co-sharing of cold store / cold room with others	1.38 (0.31)	6.02 (0.08)	N/A	N/A	N/A

[1]Fisher's Exact Test (p-value)

[2]Not applicable to food vendors as they were all females

** and ** denote statistical significance at 10% and 5% respectively*

Table 5: Cold store operators' knowledge of pathogenic contaminates of frozen meat, fish and meat products

	Frequency (%)	
	Yes	No
Sex		
Female	10 (18.9)	17 (32.0)
Male	2 (3.8)	24 (45.3)
Total	12 (22.7)	41 (77.3)
Educational level		
Basic	0	11 (20.8)
Secondary	5(9.4)	21 (39.6)
Tertiary	6 (11.3)	7(13.2)
No formal education	1(1.9)	2 (3.8)
Total	12 (22.7)	41 (77.3)

A similar trend was observed for the relationship between sex and knowledge of safety measures for frozen meat and fish products. No significant ($p > 0.10$) relationship existed between sex and the key attributes tested except for frequency of cleaning of freezers or cold room and knowledge of pathogens that contaminate frozen meat and fish. Female operators (22.7%) had a more frequent routine for cleaning freezers or cold rooms. Most of their male counterparts (28.3%) however, cleaned only when products were sold out or freezers were considered dirty. This gives an alarming 35.8% of respondents who had no scheduled cleaning routines. The present information signifies the potential risks of the frozen meat and fish industry to consumers' health.

Additionally, of the 22.7% of respondents who had knowledge of the potential pathogens that contaminate frozen meat/fish products, 18.9% were females. This confirms an earlier report that females generally had more knowledge of food safety issues than males (Odeyemi *et al.*, 2019). However, it is noteworthy that the number of vendors that had no knowledge was high; 77.3% with 45.3% being males. This further indicates the need for serious interventions to rectify the situation. The

low levels of knowledge could have arisen from the notion among many indigenes that the possibility for contamination during cold storage is almost zero (Kunadu *et al.*, 2016; 2018) thus making people apathetic to seek related information/ knowledge. This finding is key and should be taken into cognizance by policy framers and in the implementation of corrective measures for improved food safety.

Consumers (household and food vendors)

Household consumers and food vendors are the main end users of frozen meat and fish products. Thus, it is paramount that they are made aware of recommended safety measures to safeguard against food-related ill health. As expected, there were more females than males among the household consumers interviewed and no male among the food vendors. This further supports earlier reports of women being the key food handlers in most African cultures (Baluka *et al.*, 2016; Soares *et al.*, 2012). Irrespective of this, there was no significant ($p > 0.10$) relationship between sex and the two key safety measures assessed: source of frozen meat contaminants and knowledge of pathogens that contaminate frozen meat and fish products.

Education on the other hand, indicated a significant ($p = 0.08$) positive relationship with household consumers' awareness of the sources of contaminants for frozen meat and fish products (Table 4). This is similar to earlier report by Akabanda *et al.* (2017) but contrary to the obtained information for the cold store operators (Table 5) where education did not have a positive influence. The authors could not ascribe plausible reasons from the present data for this variation. However, there was also a significant (but negative) relationship between education and food vendors' knowledge of pathogens similar to the data for cold store operators (Table 4). When asked if consumers were comfortable with the handling of meat and fish by cold store operators and table-top sellers, few responses were obtained for dislikes (6.7%) but centered on how meat and fish products were left in the open for long hours. The remaining 93.3% shared no reservations on handling practices by vendors.

The obtained information further supports the above discourse on the apparent lack of knowledge on meat/ fish safety awareness and the challenges this pose to consumer health in an era where animal protein consumption is promoted particularly, among children.

Safety Measures: Proposals to enhance the vending industry for frozen fish and meat

The importance of ensuring safety measures along the value chain for uniform quality products at point of consumption cannot be overemphasized. A critical step in this chain is vending as it is the immediate step prior to final consumption. Thus, it is imperative to recommend feasible guidelines towards enhancing the vending activities and ultimate safety of frozen meat and fish. To achieve a culture of safety in the industry, there is the need for mindset and attitudinal changes towards recommended practices for safe meat and fish products. We propose a framework employing an integrated approach involving all stakeholders (Figure 3) to expedite the process.

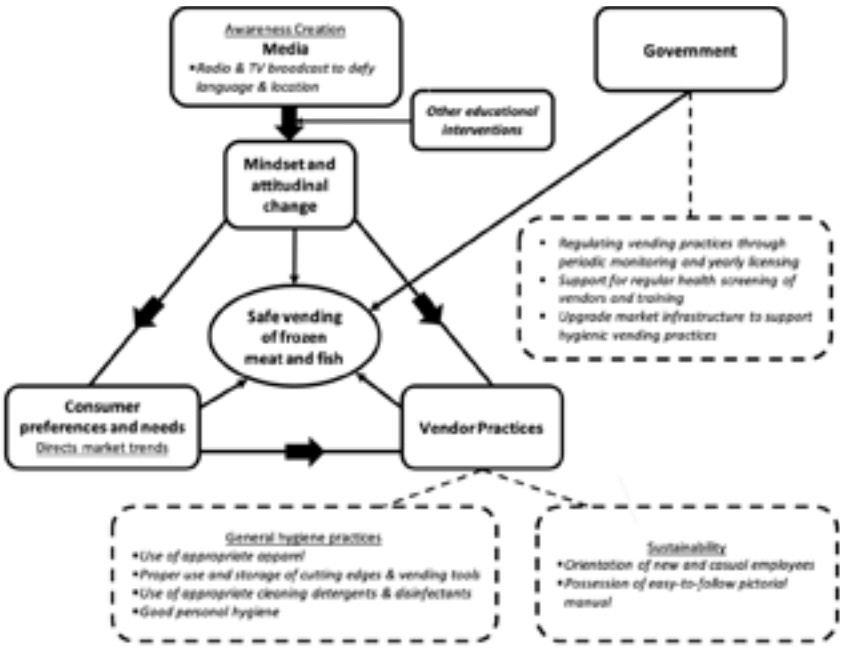

Figure 3. Conceptual framework to enhance safe vending of frozen meat, fish and meat products.

Solid boxes indicate direct factors that influence safe vending practices.
Dashed boxes give a further explanation of the activities by actors in the solid box they are aligned with.
Arrows indicate the directional flow of parameters.

The media would be instrumental in this quest. Radio and television are popular channels for disseminating information across all classes of people as a result of broadcast dynamism that defies language and geographical location. This platform is needed to create awareness on safety (and health-related) issues associated with the handling practices of frozen meat and fish. Blending the findings in this study with photographic scenes could be a good tool for the media-directed educational intervention.

Another important driver for this change is the consumer. The universally accepted notion that the consumer is always right has a strong influence in directing market trends (Rosenberg & Czepiel, 1984). The consumer being the best practices could dictate the needed positive changes in the vending industry for frozen meat and fish. A thorough education of the public on appropriate vending measures will enable them request for service based on right practices and procedures.

The key stakeholder that cannot be overlooked in the frozen meat and fish industry is the vendor. Local governments such as Municipal/ Metropolitan Chief Executives and regulatory bodies could employ a participatory approach that would include discussions with workers: focus groups and key informant interviews to deliberate on feasible recommendations and regulations for improved quality in their service delivery. Prominent among these would include regular health screening and treatment, appropriate apparel; proper use, cleaning and storage of cutting edges; use

of appropriate tool cleaning detergents and general good hygienic practices.

Refresher trainings to upgrade standards in vending spearheaded by local authorities could be done regularly. For efficient implementation and sustainability, these refresher trainings should be carried out alongside annual institutional requirements for health certification. Furthermore, an easy-to -follow pictorial manual should also be made handy to all vendors. Owners of larger cold stores could use the manual to orient new or casual employees to further ensure continuity of safe practices. Above all relevant government institutions could show commitment and be the leaders of change by providing the necessary amenities and upgrading infrastructure of markets that would support hygienic vending practices.

CONCLUSIONS

Frozen meat and fish are key sources of animal protein in developing countries. It was observed that formal education had little impact on the knowledge and practice of vendors but the primary indices for operational procedures were convenience and affordability. The same was true for consumers who used price and accessibility as buying indices while disregarding hygiene. The use of gloves, aprons and overalls among vendors were basically worn for personal cleanliness but not for safe handling of meat, fish and meat products.

Possible cross contamination was also a key issue. There was no measure in place for the cleaning of equipment in-between use for the different products. General cleanliness was also poor with most vendors not having scheduled cleaning routines for cold rooms and freezers. The use of food grade detergents and disinfectant was mostly non-existent. There was a general lack of knowledge on the awareness of food safety measures among both vendors and consumers. The findings suggest the urgent need for a proactive integrated approach involving all stakeholders but more especially vendors, to reorient them in essential safety practices.

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CONFLICT OF INTEREST

The authors declare that they do not have any conflict of interest.

REFERENCES

Ababio, P. F., & Lovatt, P. (2015). A review on food safety and food hygiene studies in Ghana. Food Control, 47: 92–97. https://doi.org/10.1016/j.foodcont.2014.06.041

Akabanda, F., Hlortsi, E. H., & Owusu-Kwarteng, J. (2017). Food safety knowledge, attitudes and practices of institutional food-handlers in Ghana. BMC Public Health, 17(1): 1–9. https://doi.org/10.1186/s12889-016-3986-9

Antwi-Agyei, P., & Maalekuu, B. K. (2014). Determination of microbial contamination in meat and fish products sold in the Kumasi metropolis (A Case Study of Kumasi central market and the Bantama market). Merit Research Journals, 2(3): 38–46.

Asiegbu, C. V., Lebelo, S. L., & Tabit, F. T. (2016). The food safety knowledge and microbial hazards awareness of consumers of ready-to-eat street-vended food. Food Control, 60:22–429. https://doi.org/10.1016/J.FOODCONT.2015.08.021

Baluka, S. A., Miller, R., & Kaneene, John, B. (2016). Hygiene practices and food contamination in managed food service facilities in Uganda. African Journal of Food Science, 9(1): 31–42. https://doi.org/10.5897/ajfs2014.1170

Cobbinah, P. B., & Niminga-Beka, R. (2017). Urbanisation in Ghana: Residential land use under siege in Kumasi central. Cities, 60: 388–401. https://doi.org/10.1016/j.cities.2016.10.011

Delgado, C. L. (2003). Rising Consumption of Meat and Milk in Developing Countries. Journal of Nutrition, 133, 3965s-3971s.

GSS, (Ghana Statistical Services). (2012). 2010 population and housing census: summary report of final results. Accessed 19th August, 2020.

Haileselassie, M., Taddele, H., Adhana, K., & Kalayou, S. (2013). Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekelle City, Ethiopia. Asian Pacific Journal of Tropical Biomedicine, 3(5): 407–412. https://doi.org/10.1016/S2221-1691(13)60085-4

Johnson, M. C. (2009). Why did the Chicken Cross the Road? An Investigation of Government Responses to Import Surges in Cameroon, Senegal and Ghana. APSA 2009 Toronto Meeting Paper. https://doi.org/10.1353/pbm.1997.0075

Kunadu, A. P., Amoako, D. B., Tano-debrah, K., Parry-Hanson Kunadu, A., Brian Amoako, D., & Tano-debrah, K. (2018). The microbiological quality of imported frozen chicken drumsticks from retail meat shops in Accra , Ghana. Science and Development, 2(1): 12–18.

Kusi, L., Agbeblewu, S., Anim, I., & Nyarku, K. (2015). The Challenges and Prospects of the Commercial Poultry Industry in Ghana: A Synthesis of Literature. International Journal of Management Sciences, 5(6): 476–489.

Levin, C. E., Ruel, M. T., Morris, S. S., Maxwell, D. G., Armar-Klemesu, M., & Ahiadeke, C. (1999). Working women in an urban setting: Traders, vendors and food security in Accra. World Development, 27(11): 1977–1991. https://doi.org/10.1016/S0305-750X(99)00096-0

Luo, X., Xu, X., Chen, H., Bai, R., Zhang, Y., Hou, X., Zhang, F., Zhang, Y., Sharma, M., Zeng, H., & Zhao, Y. (2019). Food safety related knowledge, attitudes, and practices (KAP) among the students from nursing, education and medical college in Chongqing, China. Food Control, 95: 181–188. https://doi.org/10.1016/j.foodcont.2018.07.042

Morales, L. E., & Higuchi, A. (2018). Is fish worth more than meat? – How consumers' beliefs about health and nutrition affect their willingness to pay more for fish than meat. Food Quality and Preference, 65: 101–109. https://doi.org/10.1016/j.foodqual.2017.11.004

Mutegi, C., Wagacha, M., Kimani, J., Otieno, G., Wanyama, R., Hell, K., & Christie, M. E. (2013). Incidence of aflatoxin in peanuts (Arachis hypogaea Linnaeus) from markets in Western, Nyanza and Nairobi Provinces of Kenya and related market traits. Journal of Stored Products Research, 52: 118–127. https://doi.org/10.1016/j.jspr.2012.10.002

Neumann, C., Harris, D. M., & Rogers, L. M. (2002). Contribution of animal source foods in improving diet quality and function in children in the developing world. Nutrition Research, 22(1–2): 193–220. https://doi.org/10.1016/S0271-5317(01)00374-8

Nikmaram, N., Budaraju, S., Barba, F. J., Lorenzo, J. M., Cox, R. B., Mallikarjunan, K., & Roohinejad, S. (2018). Application of plant extracts to improve the shelf-life,

nutritional and health-related properties of ready-to-eat meat products. Meat Science, 145: 245–255. https://doi.org/10.1016/j.meatsci.2018.06.031

Nkegbe, E., Assuming-Bediako, N., Aikins-Wilson, S., & Hagan, B. . (2013). Meat Consumption Trends in Some Selected Households in Accra Ghana. Asian Journal of Agriculture and Food Sciences, 1(4): 151–157.

Odeyemi, O. A., & Bamidele, F. A. (2016). Harnessing the potentials of predictive microbiology in microbial food safety and quality research in Nigeria. Future Science OA, 2(1). https://doi.org/10.4155/fso.15.91

Odeyemi, O. A., Sani, N. A., Obadina, A. O., Saba, C. K. S., Bamidele, F. A., Abughoush, M., Asghar, A., Dongmo, F. F. D., Macer, D., & Aberoumand, A. (2019). Food safety knowledge, attitudes and practices among consumers in developing countries: An international survey. Food Research International, 116: 1386–1390. https://doi.org/10.1016/j.foodres.2018.10.030

Onyeneho, S. N., & Hedberg, C. W. (2013). An assessment of food safety needs of restaurants in Owerri, Imo State, Nigeria. International Journal of Environmental Research and Public Health, 10(8): 3296–3309. https://doi.org/10.3390/ijerph10083296

Osei, S. A. (2010). The influx of imported animal product onto the Ghanaian market and the impact on animal production, processing and marketing: The case of poultry meat. Ghanaian Journal of Animal Science, 5: 1–9.

Parry-Hanson Kunadu, A., Ofosu, D. B., Aboagye, E., & Tano-Debrah, K. (2016). Food safety knowledge, attitudes and self-reported practices of food handlers in institutional foodservice in Accra, Ghana. Food Control, 69: 324–330. https://doi.org/10.1016/j.foodcont.2016.05.011

Pesewu, G. A., Quaynor, E. B., Olu-Taiwo, M. A., Anim-Baidoo, I., & Asmah, R. H. (2018). Bacterial contaminants of raw broiler meat sold at Korle-Gonno, Accra, Ghana. International Food Research Journal, 25(4): 1758–1762.

Rani, Z. T., Hugo, A., Hugo, C. J., Vimiso, P., & Muchenje, V. (2017). Effect of post-slaughter handling during distribution on microbiological quality and safety of meat in the formal and informal sectors of South Africa: A review. South African Journal of Animal Science, 47(3): 255. https://doi.org/10.4314/sajas.v47i3.2

Rheinländer, T., Olsen, M., Bakang, J. A., Takyi, H., Konradsen, F., & Samuelsen, H. (2008). Keeping up appearances: Perceptions of street food safety in urban Kumasi, Ghana. Journal of Urban Health, 85(6): 952–964. https://doi.org/10.1007/s11524-008-9318-3

Rosenberg, L. J., & Czepiel, J. A. (1984). A marketing approach for customer retention. Journal of Consumer Marketing, 1(2): 45–51. https://doi.org/10.1108/eb008094

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. https://doi.org/10.1016/j.foodcont.2014.09.010

Semba, R. D. (2016). The rise and fall of protein malnutrition in global health. Annals of Nutrition and Metabolism, 69(2): 79–88. https://doi.org/10.1159/000449175

Soares, L. S., Almeida, R. C. C., Cerqueira, E. S., Carvalho, J. S., & Nunes, I. L. (2012). Knowledge, attitudes and practices in food safety and the presence of coagulase-positive staphylococci on hands of food handlers in the schools of Camaçari, Brazil.

Food Control, 27(1): 206–213. https://doi.org/10.1016/j.foodcont.2012.03.016

Sofos, J. N. (2008). Challenges to meat safety in the 21st century. Meat Science, 78(1–2): 3–13. https://doi.org/10.1016/j.meatsci.2007.07.027

Sulleyman, K. W., Adzitey, F., & Frimpong Boateng, E. (2018). Knowledge and Practices of Meat Safety by Meat Sellers in the Accra. International Journal of Veterinary Science, 7(3): 167–171. www.ijvets.com

Tambi, N. E. (2001). Analysis of household attitudes toward the purchase of livestock products and fish in Cameroon. Agricultural Economics, 26(2): 135–147. https://doi.org/10.1016/S0169-5150(00)00120-1

Thow, A. M., Annan, R., Mensah, L., & Chowdhury, S. N. (2014). Development, implementation and outcome of standards to restrict fatty meat in the food supply and prevent NCDs: Learning from an innovative trade/food policy in Ghana. BMC Public Health, 14(1): 1–9. https://doi.org/10.1186/1471-2458-14-249

Walker, P., Rhubart-Berg, P., McKenzie, S., Kelling, K., & Lawrence, R. S. (2005). Public health implications of meat production and consumption. Public Health Nutrition, 8(4): 348–356. https://doi.org/10.1079/phn2005727