# Assessment of Knowledge, Attitude, and Practice of Meat Hygiene among Meat Handlers in Lagos State, Nigeria

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# Abstract

**Background:** Food-borne disease remains a major global health challenge in developing countries. Cross-contamination from raw meat due to poor handling as a result of poor knowledge and practices of meat handlers is a major contributing factor for meat-borne diseases. Adequate knowledge and preventive practices of meat handlers are important in limiting the outbreak of food-borne disease and contamination of raw meat. This study assessed the knowledge, attitude, and practice of meat hygiene and the associated factors among meat handlers in abattoirs and slaughter houses in Lagos State, Nigeria. **Materials and Methods:** A descriptive, cross-sectional survey was carried out among 318 meat handlers in Lagos, Nigeria, who were selected using a multistage sampling technique. A structured questionnaire was used to collect the data concerning their knowledge, attitude, and practice of meat hygiene, and data analysis was done using EpiInfo 7.2.2.16<sup>TM</sup> for Windows. Chi-square statistics was used to test the association between the variables at the level of significance of 5%. **Results:** The mean age was 39.07 years  $\pm 12.7$  standard deviation. Majority had good knowledge (71.1%), attitude (53.1%), and practice (66.6%) of meat hygiene. Significant association between knowledge and age (P < 0.001), tribe (P = 0.0174), level of education (P = 0.0029), work experience (P < 0.001). and religion (P = 0.0194). There was statistically significant association also between knowledge and practice of meat hygiene (> 20.001), tribe (P = 0.00174), level of education (P = 0.0029), work experience (P < 0.001). Older meat handlers with more years of work experience (> 20 years) had better knowledge and practice of meat hygiene compared to their younger colleagues. **Conclusions:** Public health education, policy formulation, and regular training and retraining of the meat handlers on safe meat handlers as well as general and personal hygiene are strongly recommended.

Keywords: Abattoirs, food-borne diseases, Lagos, meat handlers, meat hygiene, knowledge, practices

# INTRODUCTION

Food-borne diseases have been recognized as a major human health problem occurring commonly in both developed and underdeveloped countries, particularly in African countries, because of unhygienic handling of food and poor sanitation practices. Lack of adequate food safety laws, weak regulatory systems, insufficient financial resources to invest in safer equipment, and lack of education for food handlers are also major contributors to this problem.<sup>[1]</sup> It is a problem that is often underestimated due to unavailable or inadequate data that could assist in estimating the actual disease burden. This is because only a fraction of the people who become sick due to food-borne illnesses seek medical care.<sup>[2]</sup> Food-borne disease is a global issue affecting all individuals in all societies, ranging from various diarrheal diseases to various forms of cancer and, sometimes, even death.<sup>[2]</sup>

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Of the foods intended for human consumption, those of animal origin tend to be most hazardous, unless the principles of food hygiene are employed. Meat has been viewed as a vehicle for a significant proportion of human food-borne diseases. Although the spectrum of meat-borne diseases of public health importance has changed with changing production and processing systems, continuation of the problem has been well illustrated in recent years by human surveillance studies of specific meat-borne pathogens, such as *Escherichia coli* 

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Submitted: 15-May-2020 Accepted: 24-Jun-2020 Revised: 10-Jun-2020 Published: 07-Aug-2020 O157:H7, *Salmonella* spp., *Campylobacter* spp., and *Yersinia enterocolitica*.<sup>[3]</sup> Despite all these problems, there is very little information concerning the true level of exposure of specific populations to potential hazards, especially in the case of bacterial diseases that are transmitted by the consumption of meat and meat products.<sup>[4]</sup>

While the World Health Organization-Food and Agricultural Organization (WHO-FAO), through the Codex Alimentarius Commission (CAC), is making efforts by issuing several guidelines to member nations to improve food safety and hygiene, not much has been achieved.<sup>[5]</sup> Consequently, to raise awareness on the importance of food safety and hygiene, for better implementation of its guidelines, the WHO-FAO adopted a resolution on December 3, 2018, through the General Assembly, proclaiming every June 7 as the World Food Safety Day starting from 2019.<sup>[6]</sup> The theme for the maiden edition was, "Food Safety, Everyone's Business."<sup>[6]</sup>

The WHO estimates of the global burden of food-borne diseases as of 2015 show that 1 in 10 people falls ill every year with 420,000 deaths. Children under-5 are at high risk with 125,000 of them dying yearly due to food-borne diseases, with Africa and Southeast Asia having the highest burden. Diarrheal diseases are responsible for more than half of the global burden of food-borne diseases, causing 550 million people to fall ill and 230,000 deaths annually. Children are at particular risk of foodborne diarrheal diseases, with 220 million falling ill and 96,000 dying yearly.<sup>[5]</sup>

Apart from personal illness, unsafe food impedes socioeconomic development, overloads healthcare systems, and damages economies owing to unhealthy or sick workforce. Foreign trade and tourism in all countries are jeopardized. Economic opportunities of the international food market are lost to countries not able to meet the international food safety standards, thereby hampering sustainable development. Despite the impact of unsafe food on people and economies, and despite the commitments made by the Member States at the Second International Conference on Nutrition, food safety has received very little attention by policy makers.<sup>[7]</sup> Meat is such a highly perishable food material and the abattoir is such a labor-intensive working environment, so the knowledge and level of training of the meat handlers regarding personal and general hygiene are of particular importance to ensure improvement in the health and safety of the consumer.[8]

In Nigeria, several cases of food poisoning, which led to mortality and morbidity, have been reported.<sup>[9]</sup> According to the WHO, there are two million reported cases of food poisoning, with estimated deaths of 200,000 people from food poisoning and 20,000 deaths from exposure to food pesticides annually, children inclusive. *Salmonella* and *E. coli* were the pathogens mostly found to be responsible for these deaths.<sup>[9]</sup> Harmful bacteria, viruses, parasites, or chemical substances have also been linked to more than 200 diseases, ranging from diarrheal diseases to cancers.<sup>[9]</sup>

Due to paucity of data on knowledge, attitude, and practice of meat hygiene among meat handlers in the abattoirs,<sup>[7]</sup> there is a need for this assessment among meat handlers in Lagos, Nigeria. Most studies conducted were based on food handlers in restaurants and processed food establishments, whereas cases of food poisoning due to contaminated meat have been on the rise in recent years.<sup>[10,11]</sup> Information from this study will enable policymakers formulate appropriate policies that will result in better meat hygiene and healthier population. In spite of the provision of guidelines to member countries about safe handling procedures, such as Hazard Analysis and Critical Control Point and Good Manufacturing Practices, the knowledge and perceptions of meat handlers on safe food handling in most developing countries, particularly Nigeria, remain largely unknown.

This study is also important because there is a growing trend in the consumption of animal products such as meat, especially due to a growing population, urbanization, and rising incomes globally and in Nigeria.<sup>[7]</sup> The objective of this study was to assess the sociodemographic characteristics of the meat handlers in relation to their knowledge, attitude, and practice of meat hygiene in Lagos State, Nigeria.

# MATERIALS AND METHODS

### **Study area**

Lagos State, (6.5244° N, 3.3792° E) located in southwestern Nigeria, is the most populous state in Nigeria. The capital city, Lagos, is the fastest growing city in Africa and the seventh fastest growing city in the world. It is Nigeria's economic hub generating a significant portion of her Gross Domestic Product. It has a population which is estimated to be about 21 million people.<sup>[12]</sup> Lagos has a modern grade A slaughtering facility within the abattoir at the Oko-Oba Agege, although most of the animals are slaughtered at the grade C section of the abattoir in the State. A grade "A" abattoir is a factory-type abattoir which is established for purely commercial purpose. The abattoir should meet the standard for meat exportation to overseas countries. Slaughter operation takes place in hanging position, and the carcasses are handled by overhead rails. On the other hand, a grade "C" abattoir is meant for the slaughtering of animals for local consumption, and it is the lowest grade of abattoir that can be licensed under the Meat Inspection Law. This is also referred to as a slaughter slab. Artificial light of adequate intensity is a requirement in grade "C" abattoir as in all aspects of slaughtering carried out in both A and C types of abattoir. Therefore, most of the animals are slaughtered at the Oko-Oba abattoir.<sup>[13]</sup> There are also other grade C-approved smaller abattoirs distributed within the State where animals are slaughtered and transported to various markets in the State.<sup>[13]</sup>

These slaughtering facilities are government owned but managed by concessionaires appointed by the government under the private–public partnership arrangement. Each of these abattoirs typically has similar operations with few variations in the proportion or quantity of animals slaughtered and processed. The basic butchering processes in these abattoirs are sticking, flaying, evisceration, and splitting.

# Study design

A descriptive cross-sectional study design was used.

### Study population

The study population comprised meat handlers within the abattoirs in Lagos State, Nigeria. They were meat handlers from the point of sticking to the loading bay point from where the carcass is loaded into the meat vans, away from the abattoirs. The meat handler must be licensed and must have worked as a meat handler for at least 6 months.

#### Sample size calculation

Cochran's formula  $(n = z^2 [pq/d^2])^{[14]}$  was used to calculate the minimum sample size with reference to a previously published article, where the proportion of meat handlers working in government-owned abattoirs in Ibadan, Southwest Nigeria, with good knowledge of meat hygiene was 51.1%.<sup>[15]</sup>

Where n = the sample size, z = is the selected critical value of desired confidence level, p = the estimated proportion of an attribute that is present in the population, q = 1 - p, d = the desired level of precision.

Taking p = 0.511, q = 0.499, z = 1.645, and d = 0.05, and nonresponse rate of 10%, the minimum sample size was calculated to be 308.

### Sampling technique

Respondents were selected using a multistage sampling method from 11 abattoirs distributed all over Lagos State. Oko-Oba abattoir was purposively selected (due to its uniqueness as the largest abattoir which slaughters about 60% of the animals),<sup>[13]</sup> while seven abattoirs were selected from the other 10 small abattoirs using simple random sampling method (balloting). Using proportional allocation, proportions were distributed to the selected abattoirs according to the size considering the minimum sample size calculated. Respondents were selected using systematic sampling technique from each of the selected abattoir; a sampling interval of five was calculated for Oko-Oba abattoir, while a sampling interval of three was calculated for the other abattoirs. At Oko-Oba abattoir, the first respondent was selected using simple random sampling technique (balloting) from the first five eligible respondents, and subsequently, every fifth respondent was selected. At other abattoirs, the first respondent was selected using simple random sampling technique (balloting) from the first three eligible respondents, and subsequently, every third respondent was selected. Respondents were chosen among those involved in the business of slaughtering and processing the meat from the point of sticking to the point of loading into the meat vans. Those with <6 months' experience were excluded from the study to ensure that the actual and qualified meat handlers were interviewed and not the apprentices nor beginners.

### **Data collection**

A semi-structured, interviewer-administered questionnaire was used. The questions contained in the data collection tool

focused on sociodemographic characteristics as well as on knowledge, attitude, and practice of meat hygiene, which were adapted from previous studies.[15-21] The questionnaire was divided into four sections. Section A covered the sociodemographic characteristics of respondents such as age, gender, level of education, marital status, religion, tribe, and years of experience on the job. Section B consisted of ten questions which assessed knowledge of meat hygiene which focused on workplace meat hygiene, sources of contamination, and personal hygiene. Section C with ten statements and responses on Likert scale assessed attitudes to meat hygiene. Section D with eight questions assessed the practice of meat hygiene among the respondents. The questionnaire was pretested among meat handlers in another abattoir different from the ones used in this study for clarity of language. Data were collected with the assistance of six trained research assistants. They were deployed to these abattoirs after 1-day training on the purpose of the study, field protocol, questionnaire administration, harmonization of responses from respondents, and research ethics. The data collection was carried out within the period of 4 weeks.

#### Data management

### Scoring and grading

There were ten questions on knowledge of meat hygiene. Each correct answer was scored 1 mark while a wrong answer was scored zero. A total score >5 was considered as good knowledge, while total score  $\leq$ 5 was considered as poor knowledge.

Ten positive statements on opinion/attitude of meat handlers on meat hygiene were stated. The rating scale was measured as follows: positive statement with strongly agree, agree, indifferent, disagree, and strongly disagree was scored 5, 4, 3, 2, and 1, respectively. The scores ranged from 10 to 50. Each score was summed up and means of each calculated. Overall mean score was found to be  $40.5 \pm 4.36$ STD. This was classified into three namely:  $\geq$  mean score = good attitude (40–50), 1 STD < mean score = fair attitude (39–36) and poor attitude (10–35).

Eight questions on workplace practice of meat hygiene were asked. Each correct answer was scored 1 mark while a wrong answer scored 0. A total score >5 was considered as good practice, while total score  $\leq$ 5 was considered as poor practice.

### **Data analysis**

Data were entered and analyzed using EpiInfo 7.2.2.16<sup>TM</sup> for Windows which is the software developed by the Centers for Disease Control and Prevention in Atlanta, Georgia.<sup>[22]</sup> Descriptive statistics were computed for all variables. Frequency distribution table and charts were also used. For continuous variables, means and standard deviation (SD) were calculated. Cross-tabulations were generated for comparison of categorical data using Chi-square and *t*-test for continuous variables. The level of significance was set at P < 0.05. Variables significant at 0.05 level of significance were entered into multivariate logistic regression model to

determine the predictors of knowledge, attitude, and practice of meat hygiene.

### **Ethical consideration**

Ethical approval to conduct the study was obtained from the Human Research and Ethics Committee (HREC) of the Lagos University Teaching Hospital before the commencement of the study (Ethical Approval No.: ADM/DCST/HREC//APP/2959). Permission to conduct this study was obtained from the Lagos State Ministry of Agriculture. Written informed consent was obtained from the respondents. The purpose and objectives of the study, voluntary participation, and confidentiality issues were explained to all respondents.

# RESULTS

A total of 338 meat handlers were invited out of which 318 participated in this study giving a response rate of 94.1%. The demographic characteristics of the respondents are summarized in Table 1. The mean age of the respondents was 39.07 years  $\pm$  12.17 SD. Most respondents were within the age group of 36–45 years (31.5%). Majority of the respondents were male (84.5%) and of Yoruba tribe (71.7%). Most of the respondents (86.8%) had at least primary level of education.

The distribution of meat handlers from different abattoirs in Lagos who participated in this study is shown in Figure 1. Majority of the meat handlers were from Oko-Oba Abatoir which is the biggest abattoir in Lagos, Nigeria.

# Knowledge on meat hygiene

Assessment of respondent's knowledge and their responses is summarized in Table 2. Majority of the respondents (95.3%) knew that regular hand washing reduces the risk of meat contamination. About 78.9% of the respondents knew that clean and dirty parts of the meat should be processed separately, while only 30.9% of the respondents knew the sources of meat contamination.

# **Overall knowledge score**

Figure 2 shows the overall knowledge score among the respondents. Majority of the meat handlers (71.7%) had good



Figure 1: Distribution of the respondents by abattoir

knowledge, while 28.3% of them had poor knowledge of meat hygiene.

# Attitude toward meat hygiene practices

Table 3 summarizes respondents' attitude to meat hygiene. Majority agreed that professional training could improve good practices in food industry (94%) and that training provided useful information for the work (93.1%). Majority also agreed that it is important to use clean water for cleaning work surfaces and instruments (95.9%), and while 62.5% of the respondents agreed that rubbing of meat with fresh blood to make it look fresh should be discouraged as it reduces good hygiene in meat processing.

### Overall attitude to meat hygiene

Figure 3 shows the overall attitude of respondent to meat hygiene. About half of the respondents (53.1%) had good

Table 1: Sociodemographic	characteristics of respondents
Variable	Frequency ( <i>n</i> =318), <i>n</i> (%)
Age (years)	
≤25	45 (14.15)
26-35	94 (29.56)
36-45	100 (31.45)
46-55	45 (14.15)
>55	34 (10.69)
Mean±SD	39.09±12.17
Range	18-75
Marital status	
Single	82 (25.79)
Married	226 (71.07)
Widowed	5 (1.57)
Divorced	5 (1.57)
Gender	
Male	275 (84.48)
Female	43 (13.52)
Years of experience	
≤10	116 (36.71)
11-20	97 (30.70)
21-30	61 (19.30)
>30	42 (13.29)
Mean±SD	17.44±11.41
Range	1-50
Tribe	
Hausa	82 (25.79)
Igbo	6 (1.89)
Yoruba	228 (71.70)
Others	2 (0.63)
Religion	
Christianity	59 (18.55)
Islam	257 (80.82)
Traditional	2 (0.63)
Educational level	
No formal education	42 (13.21)
Primary	114 (35.85)
Secondary	137 (43.08)
Tertiary	25 (7.06)
SD: Standard deviation	

VariablesFrequency $(n=318), n$ (%)Regular washing of hands reduces the risk of meat contamination303 (95.28)No8 (2.52)I don't know7 (2.20)Using appropriate gloves reduces contaminationYesYes236 (74.21)No40 (12.58)I don't know42 (13.21)Meat inspection to rule out infection is importantYesYes251 (78.93)No15 (4.72)I don't know52 (16.35)Refrigeration of meat is important for preservationYesYes207 (65.09)No40 (12.58)I don't know71 (22.33)Cleanliness of the facility is important for meat processing facility9191 (60.06)No15 (4.72)Vashing of live animals is important before slaughterYesYes15 (4.72)Carcass can be contaminated in dirty environment95 (29.87)Yes15 (4.72)Carcass can be contaminated in dirty environmentYesYes251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sources251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of foodborne illness130 (30.88)No188 (69.12)Knowledge of cause of foodborne illness253 (79.56)	Table 2: Respondents' knowledge assessment				
Regular washing of hands reduces the risk of meat contamination     303 (95.28)       Yes     303 (95.28)       No     8 (2.52)       I don't know     7 (2.20)       Using appropriate gloves reduces contamination     Yes       Yes     236 (74.21)       No     40 (12.58)       I don't know     42 (13.21)       Meat inspection to rule out infection is important     Yes       Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Refrigeration of meat is important for preservation     Yes       Yes     207 (65.09)       No     40 (12.58)       I don't know     71 (22.33)       Cleanliness of the facility is important for meat processing facility     Yes       Yes     191 (60.06)       No     127 (39.94)       Washing of live animals is important before slaughter     Yes       Yes     135 (42.45)       No     16 (5.03)       I don't know     15 (4.72)       Carcass can be contaminated in dirty environment     Yes       Yes     251 (78.93) </th <th>Variables</th> <th>Frequency (<i>n</i>=318), <i>n</i> (%)</th>	Variables	Frequency ( <i>n</i> =318), <i>n</i> (%)			
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Meat inspection to rule out infection is importantYes $251 (78.93)$ No $15 (4.72)$ I don't know $52 (16.35)$ Refrigeration of meat is important for preservationYesYes $207 (65.09)$ No $40 (12.58)$ I don't know $71 (22.33)$ Cleanliness of the facility is important for meat processing facility191 (60.06)No $127 (39.94)$ Washing of live animals is important before slaughterYesYes $287 (90.25)$ No $16 (5.03)$ I don't know $15 (4.72)$ Carcass can be contaminated in dirty environmentYesYes $135 (42.45)$ No $88 (27.67)$ I don't know $95 (29.87)$ The clean and dirty part of meat should be processed separately $52 (16.35)$ Proper knowledge of potential contamination sources $Yes$ Yes $130 (30.88)$ No $188 (69.12)$ Knowledge of cause of foodborne illness $1233 (79.56)$	I don't know	42 (13.21)			
Yes   251 (78.93)     No   15 (4.72)     I don't know   52 (16.35)     Refrigeration of meat is important for preservation   Yes     Yes   207 (65.09)     No   40 (12.58)     I don't know   71 (22.33)     Cleanliness of the facility is important for meat processing facility   Yes     Yes   191 (60.06)     No   127 (39.94)     Washing of live animals is important before slaughter   Yes     Yes   287 (90.25)     No   16 (5.03)     I don't know   15 (4.72)     Carcass can be contaminated in dirty environment   Yes     Yes   135 (42.45)     No   88 (27.67)     I don't know   95 (29.87)     The clean and dirty part of meat should be processed separately   Yes     Yes   251 (78.93)     No   15 (4.72)     I don't know   52 (16.35)     Proper knowledge of potential contamination sources   Yes     Yes   130 (30.88)     No   188 (69.12)     Knowledge of cause of foodborne illness   Yes (253 (79.56)	Meat inspection to rule out infection is important				
No     15 (4.72)       I don't know     52 (16.35)       Refrigeration of meat is important for preservation     Yes       Yes     207 (65.09)       No     40 (12.58)       I don't know     71 (22.33)       Cleanliness of the facility is important for meat processing facility     Yes       Yes     191 (60.06)       No     127 (39.94)       Washing of live animals is important before slaughter     Yes       Yes     287 (90.25)       No     16 (5.03)       I don't know     15 (4.72)       Carcass can be contaminated in dirty environment     Yes       Yes     135 (42.45)       No     88 (27.67)       I don't know     95 (29.87)       The clean and dirty part of meat should be processed separately     Yes       Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Proper knowledge of potential contamination sources     Yes       Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     Yes <td>Yes</td> <td>251 (78.93)</td>	Yes	251 (78.93)			
I don't know     52 (16.35)       Refrigeration of meat is important for preservation     Yes       Yes     207 (65.09)       No     40 (12.58)       I don't know     71 (22.33)       Cleanliness of the facility is important for meat processing facility     Yes       Yes     191 (60.06)       No     127 (39.94)       Washing of live animals is important before slaughter     Yes       Yes     287 (90.25)       No     16 (5.03)       I don't know     15 (4.72)       Carcass can be contaminated in dirty environment     Yes       Yes     135 (42.45)       No     88 (27.67)       I don't know     95 (29.87)       The clean and dirty part of meat should be processed separately     Yes       Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Proper knowledge of potential contamination sources     Yes       Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     Yes       Yes     253 (79.56) <	No	15 (4.72)			
Refrigeration of meat is important for preservationYes207 (65.09)No40 (12.58)I don't know71 (22.33)Cleanliness of the facility is important for meat processing facility71 (22.33)Yes191 (60.06)No127 (39.94)Washing of live animals is important before slaughterYesYes287 (90.25)No16 (5.03)I don't know15 (4.72)Carcass can be contaminated in dirty environmentYesYes135 (42.45)No88 (27.67)I don't know95 (29.87)The clean and dirty part of meat should be processed separately52 (16.35)Proper knowledge of potential contamination sourcesYesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illness253 (79.56)	I don't know	52 (16.35)			
Yes   207 (65.09)     No   40 (12.58)     I don't know   71 (22.33)     Cleanliness of the facility is important for meat processing facility   71 (22.33)     Yes   191 (60.06)     No   127 (39.94)     Washing of live animals is important before slaughter   Yes     Yes   287 (90.25)     No   16 (5.03)     I don't know   15 (4.72)     Carcass can be contaminated in dirty environment   Yes     Yes   135 (42.45)     No   88 (27.67)     I don't know   95 (29.87)     The clean and dirty part of meat should be processed separately   Yes     Yes   251 (78.93)     No   15 (4.72)     I don't know   52 (16.35)     Proper knowledge of potential contamination sources   Yes     Yes   130 (30.88)     No   188 (69.12)     Knowledge of cause of foodborne illness   Yes	Refrigeration of meat is important for preservation				
No     40 (12.58)       I don't know     71 (22.33)       Cleanliness of the facility is important for meat processing facility     71 (22.33)       Yes     191 (60.06)       No     127 (39.94)       Washing of live animals is important before slaughter     Yes       Yes     287 (90.25)       No     16 (5.03)       I don't know     15 (4.72)       Carcass can be contaminated in dirty environment     Yes       Yes     135 (42.45)       No     88 (27.67)       I don't know     95 (29.87)       The clean and dirty part of meat should be processed separately     Yes       Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Proper knowledge of potential contamination sources     Yes       Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     Yes	Yes	207 (65.09)			
I don't know71 (22.33)Cleanliness of the facility is important for meat processing facility191 (60.06)No127 (39.94)Washing of live animals is important before slaughter287 (90.25)No16 (5.03)I don't know15 (4.72)Carcass can be contaminated in dirty environmentYesYes135 (42.45)No88 (27.67)I don't know95 (29.87)The clean and dirty part of meat should be processed separately52 (178.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sources Yes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illness Yes253 (79.56)	No	40 (12.58)			
Cleanliness of the facility is important for meat processing facilityYes191 (60.06)No127 (39.94)Washing of live animals is important before slaughterYes287 (90.25)No16 (5.03)I don't know15 (4.72)Carcass can be contaminated in dirty environmentYes135 (42.45)No88 (27.67)I don't know95 (29.87)The clean and dirty part of meat should be processed separatelyYes251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sourcesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illnessYes253 (79.56)	I don't know	71 (22.33)			
Yes   191 (60.06)     No   127 (39.94)     Washing of live animals is important before slaughter   287 (90.25)     Yes   287 (90.25)     No   16 (5.03)     I don't know   15 (4.72)     Carcass can be contaminated in dirty environment   Yes     Yes   135 (42.45)     No   88 (27.67)     I don't know   95 (29.87)     The clean and dirty part of meat should be   95 (29.87)     processed separately   Yes     Yes   251 (78.93)     No   15 (4.72)     I don't know   52 (16.35)     Proper knowledge of potential contamination sources   Yes     Yes   130 (30.88)     No   188 (69.12)     Knowledge of cause of foodborne illness   Yes     Yes   253 (79.56)	Cleanliness of the facility is important for meat processing facility				
No     127 (39.94)       Washing of live animals is important before slaughter     287 (90.25)       No     16 (5.03)       I don't know     15 (4.72)       Carcass can be contaminated in dirty environment     Yes       Yes     135 (42.45)       No     88 (27.67)       I don't know     95 (29.87)       I don't know     95 (29.87)       The clean and dirty part of meat should be processed separately     Yes       Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Proper knowledge of potential contamination sources     Yes       Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     Yes	Yes	191 (60.06)			
Washing of live animals is important before slaughterYes $287 (90.25)$ No $16 (5.03)$ I don't know $15 (4.72)$ Carcass can be contaminated in dirty environmentYesYes $135 (42.45)$ No $88 (27.67)$ I don't know $95 (29.87)$ The clean and dirty part of meat should be processed separatelyYesYes $251 (78.93)$ No $15 (4.72)$ I don't know $52 (16.35)$ Proper knowledge of potential contamination sourcesYesYes $130 (30.88)$ No $188 (69.12)$ Knowledge of cause of foodborne illnessYesYes $253 (79.56)$	No	127 (39.94)			
Yes   287 (90.25)     No   16 (5.03)     I don't know   15 (4.72)     Carcass can be contaminated in dirty environment   Yes     Yes   135 (42.45)     No   88 (27.67)     I don't know   95 (29.87)     The clean and dirty part of meat should be processed separately   Yes     Yes   251 (78.93)     No   15 (4.72)     I don't know   52 (16.35)     Proper knowledge of potential contamination sources   Yes     Yes   130 (30.88)     No   188 (69.12)     Knowledge of cause of foodborne illness   Yes     Yes   253 (79.56)	Washing of live animals is important before slaughter				
No     16 (5.03)       I don't know     15 (4.72)       Carcass can be contaminated in dirty environment     Yes       Yes     135 (42.45)       No     88 (27.67)       I don't know     95 (29.87)       The clean and dirty part of meat should be processed separately     Yes       Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Proper knowledge of potential contamination sources     Yes       Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     Yes       Yes     253 (79.56)	Yes	287 (90.25)			
I don't know15 (4.72)Carcass can be contaminated in dirty environment135 (42.45)Yes135 (42.45)No88 (27.67)I don't know95 (29.87)The clean and dirty part of meat should be processed separately95 (29.87)Yes251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sourcesYesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illnessYesYes253 (79.56)	No	16 (5.03)			
Carcass can be contaminated in dirty environmentYes135 (42.45)No88 (27.67)I don't know95 (29.87)The clean and dirty part of meat should be processed separately95 (29.87)Yes251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sourcesYesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illnessYesYes253 (79.56)	I don't know	15 (4.72)			
Yes   135 (42.45)     No   88 (27.67)     I don't know   95 (29.87)     The clean and dirty part of meat should be processed separately   95 (29.87)     Yes   251 (78.93)     No   15 (4.72)     I don't know   52 (16.35)     Proper knowledge of potential contamination sources   Yes     Yes   130 (30.88)     No   188 (69.12)     Knowledge of cause of foodborne illness   Yes     Yes   253 (79.56)	Carcass can be contaminated in dirty environment				
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I don't know95 (29.87)The clean and dirty part of meat should be processed separately251 (78.93)Yes251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sourcesYesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illnessYesYes253 (79.56)	No	88 (27.67)			
The clean and dirty part of meat should be processed separately251 (78.93)Yes251 (78.93)No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sourcesYesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illnessYesYes253 (79.56)	I don't know	95 (29.87)			
Yes     251 (78.93)       No     15 (4.72)       I don't know     52 (16.35)       Proper knowledge of potential contamination sources     Yes       Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     Yes       Yes     253 (79.56)	The clean and dirty part of meat should be processed separately				
No15 (4.72)I don't know52 (16.35)Proper knowledge of potential contamination sources52 (16.35)Yes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illness188 (69.12)Yes253 (79.56)	Yes	251 (78.93)			
I don't know52 (16.35)Proper knowledge of potential contamination sources52 (16.35)Yes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illness188 (69.12)Yes253 (79.56)	No	15 (4.72)			
Proper knowledge of potential contamination sourcesYes130 (30.88)No188 (69.12)Knowledge of cause of foodborne illnessYesYes253 (79.56)	I don't know	52 (16.35)			
Yes     130 (30.88)       No     188 (69.12)       Knowledge of cause of foodborne illness     253 (79.56)	Proper knowledge of potential contamination sources				
No188 (69.12)Knowledge of cause of foodborne illnessYes253 (79.56)	Yes	130 (30.88)			
Knowledge of cause of foodborne illness Yes 253 (79.56)	No	188 (69.12)			
Yes 253 (79.56)	Knowledge of cause of foodborne illness	× /			
	Yes	253 (79.56)			
No 65 (20.44)	No	65 (20.44)			

attitude to meat hygiene, while 36.5% had fair attitude and 10.4% of the respondents had poor attitude to meat hygiene.

### Practice of meat hygiene

Table 4 shows the practices of meat hygiene by meat handlers. Best practices were reported in the use of clean water for meat processing (98.7%), regular hand washing while at work (95.91), personal hygiene by washing of clothes daily (94.3%), and inspection of meat before slaughtering (88.1%). However, bad practices were reported on rubbing of meat with blood to make it look fresh (38.1%), processing of meat and offal together (56.6%), and nonrefrigeration of meat (41.8%).



Figure 2: Knowledge of meat hygiene



Figure 3: Overall attitude of the respondents to meat hygiene



Figure 4: Overall meat hygiene practice

#### **Overall practice of meat hygiene**

Overall practice of meat hygiene by respondents is shown in Figure 4. It shows that 33.33% of the respondents had poor practice of meat hygiene, while 66.67% of them had good practice of meat hygiene.

# Factors associated with knowledge, attitude, and practice of meat hygiene among meat handlers

Table 5 shows the association of respondents' sociodemographic characteristics with their knowledge, attitude, and practice of meat hygiene. Using Chi-square statistics, a statistically significant association was found between the knowledge of

Perception statements	Response to statements			
	Agree, <i>n</i> (%)	Indifferent, <i>n</i> (%)	Disagree, n (%)	
I think training provides useful information for the work	296 (93.08)	7 (2.20)	15 (4.72)	
I think wearing of clean protective overall at work improves meat hygiene	301 (94.65)	7 (2.20)	10 (3.14)	
I think eating and drinking in the slaughter area should be disallowed	232 (72.96)	32 (10.06)	54 (16.98)	
Antemortem and postmortem meat inspection is essential to hygienic meat production	293 (92.14)	18 (5.66)	7 (2.20)	
Professional training could help improve good practices in food industry	299 (94.03)	17 (5.35)	2 (0.63)	
It is important to use clean water to wash working surfaces and instrument after disinfection	305 (95.91)	10 (3.14)	3 (0.94)	
Meat handlers can contaminate meat when they are ill with contagious diseases	250 (78.62)	27 (8.49)	41 (12.89)	
Rubbing of meat with fresh blood to make it look good should be discouraged as it reduces good hygiene in meat processing	199 (62.58)	33 (10.38)	86 (27.04)	
There is need to change or sterilize your knives after each processing	295 (92.77)	19 (5.97)	4 (1.25)	
Slaughtering and processing of meat on clean slaughter floor is comparable to that of the slaughter line	219 (68.87)	50 (15.72)	49 (15.41)	

Table 4: Respondents' practice assessment	
Practice questions	Frequency ( <i>n</i> =318), <i>n</i> (%)
Do you wash your clothes daily after work?	
Yes	300 (94.34)
No	18 (5.66)
Do you process carcass and offal/intestine together in the same place?	
Yes	180 (56.60)
No	138 (43.40)
Do you wash your hands regularly during a work day?	
At the beginning only	4 (1.26)
At the beginning, in between, and at the end	305 (95.91)
At the end only	9 (2.83)
Do you use enough clean water to process your meat?	
Yes	314 (98.74)
No	4 (1.26)
Do you wash the animals before slaughtering?	
Yes	300 (94.34)
No	18 (5.66)
Do you rub meat with blood after processing to make it look fresh?	
Yes	121 (38.05)
No	197 (61.95)
Do you refrigerate your meat after processing?	
Yes	133 (41.82)
No	185 (58.18)
Do you inspect your animals before slaughtering?	
Yes	280 (88.05)
No	35 (11.95)

meat hygiene and tribe (P < 0.001), religion (P = 0.0172), and marital status (P = 0.0001). However, there was no statistically significant association between their attitude to meat hygiene and any of the sociodemographic characteristics. There was also statistically significant association between the practice of meat hygiene and tribe (P = 0.0074), level of education (P = 0.0029), marital status (P = 0.015), and religion (P = 0.019). Furthermore, using *t*-test and analysis of variance, the mean ages and years of experience of the respondents were compared. Those with good knowledge have a mean age of  $41.2 \pm 11.84$  compared to those with poor knowledge with a mean age of  $33.8 \pm 11.42$  (P < 0.001). The mean year of experience for those with good knowledge was  $19.43 \pm 11.26$ , while the mean year of experience for those with poor knowledge was  $12.38 \pm 10.19$  (P < 0.001). This shows that older meat handlers with more work experience have better knowledge of meat hygiene than their younger counterparts with less years of experience. However, there was no statistically significant difference in the mean ages and years of experience of those with poor, fair, and good attitude to meat hygiene.

Those with good practice have a mean age of  $41.43 \pm 12.8$  compared to those with poor practice with a mean age  $34.41 \pm 9.19$  (P < 0.001). The mean year of experience for those with good practice was  $20.33 \pm 11.64$  while the mean year of experience for those with poor practice was  $11.65 \pm 8.36$  (P < 0.001). This shows that older meat handlers with more work experience have good practice of meat hygiene than their younger counterparts with less years of experience.

The association between the practice of meat hygiene by the meat handlers and their knowledge and attitude to meat hygiene is shown in Table 6. There was a statistically significant association between knowledge and practice of meat hygiene by meat handlers. A higher proportion of the respondents with good knowledge (74.6%) had good practice of meat hygiene (P < 0.0001). However, there is no statistically significant association between their attitude and practice of meat hygiene (P = 0.080).

### DISCUSSION

The sociodemographic characteristics of the respondents in this study are similar to the study among meat handlers in the abattoir and retail market in Jigjiga town, Ethiopia,<sup>[23]</sup> where the profession is predominated by males and of Islamic religion. This confirms that males are mostly involved in the

Variables	Knowledge		Attitude			Practice		
	Good ( <i>n</i> =228), <i>n</i> (%)	Poor ( <i>n</i> =90), <i>n</i> (%)	Good ( <i>n</i> =169), <i>n</i> (%)	Fair ( <i>n</i> =116), <i>n</i> (%)	Poor ( <i>n</i> =33), <i>n</i> (%)	Good ( <i>n</i> =212), <i>n</i> (%)	Poor ( <i>n</i> =106), <i>n</i> (%)	
Gender								
Male	197 (71.64)	78 (28.36)	141 (51.27)	102 (37.09)	32 (11.64)	181 (65.82)	94 (34.18)	
Female	31 (72.09)	12 (27.91)	28 (65.12)	14 (32.56)	1 (2.33)	32 (74.42)	11 (25.58)	
-	$\chi^2 = 0.04, P$	=1.0000*		$\chi^2$ =4.7, <i>P</i> =0.0975		$\chi^2 = 1.35$ ,	P=0.298*	
Tribe								
Hausa	35 (42.68)	47 (57.32)	49 (59.76)	23 (28.05)	10 (12.20)	44 (53.66)	38 (46.34)	
Igbo	5 (62.50)	3 (37.50)	6 (75.00)	1 (12.50)	1 (12.50)	7 (87.50)	1 (12.50)	
Yoruba	188 (82.46)	40 (17.54)	114 (50.00)	92 (40.35)	22 (9.65)	162 (71.05)	66 (2.95)	
-	$\chi^2 = 47.4, P$	e<0.0001ª		$\chi^2 = 6.0, P = 0.1972$		$\chi^2 = 9.81$ ,	P=0.0074ª	
Religion								
Christianity	48 (81.36)	11 (18.64)	39 (66.10)	14 (23.73)	6 (10.17)	46 (77.97)	13 (22.03)	
Islam	180 (70.04)	77 (29.96)	129 (50.19)	101 (39.30)	27 (10.51)	166 (64.59)	91 (35.41)	
Traditional	0 (0.00)	2 (100.00)	1 (50.00)	1 (50.00)	0 (0.00)	0 (0.00)	2 (100.00)	
-	$\chi^2 = 8.13, P$	₽=0.0172ª		$\chi^2 = 5.8, P = 0.2152$		$\chi^2 = 7.89$ ,	$\gamma^2 = 7.89, P = 0.0194^a$	
Level of education								
No formal Education	25 (59.52)	17 (40.48)	17 (40.48)	21 (50.00)	4 (9.52)	37 (88.10)	5 (11.90)	
Primary	817 (71.05)	23 (28.95)	61 (53.51)	44 (38.60)	9 (7.89)	77 (67.54)	37 (32.46)	
Secondary	103 (75.18)	34 (24.82)	74 (54.01)	46 (33.58)	17 (12.41)	80 (58.39)	57 (41.61)	
Tertiary	19 (76.00)	6 (24.00)	17 (68.00)	5 (20.00)	3 (12.00)	19 (76.00)	6 (24.00)	
-	χ2=4.14, Ι	P=0.2469		$\chi^2 = 8.1, P = 0.2333$		$\chi^2 = 14.0,$	P=0.0029ª	
Marital status								
Married	I76 (77.88)	50 (22.12)	I26 (55.75)	76 (33.63)	24 (10.62)	I61 (71.24)	65 (28.76)	
Single	43 (52.44)	39 (47.56)	40 (48.78)	34 (41.46)	8 (9.76)	43 (52.44)	39 (47.56)	
Widowed	5 (100.00)	0 (0.00)	1 (20.00)	3 (60.00)	1 (20.00)	4 (80.00)	1 (20.00)	
Divorced	4 (80.00)	1 (20.00)	2 (40.00)	3 (60.00)	0 (0.00)	4 (80.00)	1 (20.00)	
-	$\chi^2 = 21.4, P$	≥<0.0001ª		$\chi^2 = 5.4, P = 0.4978$		$\chi^2 = 10.4$ ,	P=0.0155ª	
Age (years)								
Mean±SD	41.2±11.84	33.8±11.42	38.96±11.43	39.48±13.09	38.36±12.81	41.43±12.8	34.41±9.19	
Minimum	20	18	19	18	20	18	20	
Maximum	75	70	75	70	68	75	68	
-	T=5.1, P<	<0.0001ª	1	7=0.128, <i>P</i> =0.8796		<i>T</i> =5.0, <i>I</i>	P<0.001ª	
Years of experience								
Mean±SD	19.43±11.26	12.38±10.19	17.6±11.02	17.55±11.84	16.21±12.09	20.33±11.64	11.65±8.36	
Minimum	1	1	1	1	2	1	1	
Maximum	50	45	50	45	42	50	40	
-	<i>T</i> =9.7, <i>P</i> <	<0.0001ª	1	F=0.212, P=0.8092		T=6.8, I	P<0.0001ª	

Table 5: Association between respondent's socio-demographic characteristics and their knowledge, attitude, and practice of meat hygiene

\*Fisher's exact test, "Significant P<0.05. T: t-test, F: F-test, SD: Standard deviation, -: Statistics

Table 6: Association between respondent's knowledge, attitude, and practice of meat hygiene						
Variables	Good practice ( $n=212$ ), $n$ (%)	Poor practice ( <i>n</i> =106), <i>n</i> (%)	Total ( <i>n</i> =318), <i>n</i> (%)	Statistics ( $\chi^2$ )	Р	
Knowledge						
Good ( <i>n</i> =228)	170 (74.56)	58 (25.44)	228 (71.7)	21.36	<0.0001ª	
Poor ( <i>n</i> =90)	42 (46.67)	48 (53.33)	90 (28.3)			
Attitude						
Poor ( <i>n</i> =33)	17 (51.52)	16 (48.48)	33 (10.4)	5.05	0.0800	
Fair ( <i>n</i> =116)	75 (64.6600)	41 (35.34)	116 (36.5)			
Good ( <i>n</i> =169)	120 (71.01)	49 (28.99)	169 (53.1)			
*Figher's exect tog	t *Statistical significant P<0.05					

\*Fisher's exact test, a Statistical significant P<0.05

butchery or meat handling business unlike other food business predominated by females. A similar survey in Southwest Nigeria, Ibadan,<sup>[15]</sup> also reflected this male dominance. This might be partly due to the rigorous and risky nature of the butchery business and also partly due to religious consideration. The proportion of the respondents with basic primary education in this study is similar to the findings of the study from Ibadan<sup>[15]</sup> and Jigjiga,<sup>[23]</sup> where 36.8% and 52.7% of the respondents, respectively, had at least basic primary education. Another study conducted among meat handlers in Kano in Northern Nigeria reported similar level of education where 43% and 32% of the respondents attended secondary and primary school, respectively.

This similarity in the level of education might be due to the metropolitan nature and high population density of Lagos and Kano States in Nigeria. Although the level of education of the respondents in this study was lower than that observed in Kano,<sup>[24]</sup> it was much lower compared to the studies by Tegegne and Phyo,<sup>[23]</sup> Akabanda et al.,<sup>[25]</sup> Jianu and Golet,<sup>[26]</sup> and Siau.<sup>[27]</sup> In previous studies from Ghana<sup>[25]</sup> and Ethiopia,<sup>[23]</sup> it was reported that in spite of the level of education, the knowledge of food safety was unacceptably low which could trigger public health crisis if not checked.<sup>[25]</sup> This report was further strengthened by this study which demonstrated a statistically significant association between knowledge and practice of meat hygiene among the respondents in this study. The mean age of the respondents in this study (39.09 years  $\pm$  12.17 SD) is higher than the findings of Tegegne and Phyo<sup>[23]</sup> and Farahat et al.<sup>[28]</sup> but lower than that in the study conducted by Soares et al.,[17] Akabanda et al.,<sup>[25]</sup> and Sharif and Al-Malki.<sup>[29]</sup>

Overall, majority of the respondents (71.70%) had good knowledge of meat hygiene. Hand washing practices of the respondents (95.28%) are similar with the findings of the study conducted by Haapala and Probart.<sup>[30]</sup> The majority (91%) of the meat handlers in Jigjiga abattoir and retail meat shop in Ethiopia knew that regular washing of hands before and during meat processing reduces risk of contamination.[23] Similar findings reported in the study conducted by Sani and Siow also show that 92% of the respondents had good knowledge of hand washing before handling or processing food.[31] This is important since hand washing plays a vital role in altering the channel or route of disease transmission via food or meat contamination. Meat handlers should maintain this habit and also improve on other important hygienic procedures to avoid meat contamination.<sup>[16]</sup> Another issue of concern from this study is the poor knowledge on sources of meat contamination by respondents. This may probably be due to the inadequate regular and consistent training for the meat handler as majority of the respondents in this study were of the opinion that professional training could help improve good practices in food industry. It is important to put in place certain interventions such as regular update training to close the knowledge gap.

Age was found to be statistically significantly associated with knowledge of meat hygiene, where the older meat handlers have better knowledge of meat hygiene than their younger colleagues. This is similar to the findings of a study by Olumakaiye and Bakare, who found out that older food handlers had better knowledge and practice of food hygiene compared to their younger colleagues,<sup>[32]</sup> but contrary to the findings of a study in Ibadan, Southwest Nigeria, where the younger meat handlers had more knowledge of food hygiene as they are likely more willing to learn than the older ones.<sup>[15]</sup>

A statistically significant difference was also found between their years of experience as meat handlers and the respondents' knowledge of meat hygiene. Respondents who had spent longer time on the job as meat handlers with a mean length of 19.43 years  $\pm$  11.26 SD had better knowledge of meat hygiene than those whose years of experience was 12.38 years  $\pm$  10.19 SD. Length of experience as meat handlers was found to improve knowledge of meat hygiene and safety, so experienced meat handlers can train the beginners with few years of experience on meat hygiene.

Overall attitude to meat hygiene in this study was considerably good. The respondents showed positive attitude for cleanliness and hand and personal hygiene while at work. They also showed good attitude toward proper washing and disinfecting of instruments used for butchering and meat processing. However, their attitude toward floor slaughtering is of concern as majority of the respondents felt that there was no difference between floor and mechanized slaughtering; they are probably not prepared for the switch over to mechanized or semi-mechanized slaughtering and processing of carcasses being proposed by the present government. The attitude of respondents toward meat handling when they are ill was also not satisfactory. According to the CAC, improper food handling and poor hygiene are the main risk factors in the occurrence of food contamination that leads to food-borne diseases. According to the Codex, meat handlers with open skin injuries, gastroenteritis, ear or throat diseases, and any other similar infectious diseases should not handle or process meat in any form.<sup>[3]</sup> In the study conducted by Tegegne and Phyo, similar attitude was also expressed as 56% of the respondents handled meat while they were sick or having wound or cuts.[23] This portends risk of food contamination and spread of such diseases by these sick meat handlers. The respondents also showed poor attitude toward meat hygiene as some of the respondents disagreed that rubbing of meat with blood to make it appear fresh should be discouraged.

In this study, it was observed that more than half (58.18%) of the respondents do not refrigerate the processed meat. Improper temperature in meat processing and storage allows for growth and rapid proliferation of microorganisms which cause food-borne diseases.<sup>[33]</sup> The study conducted by Bas *et al.* also agrees with poor usage of refrigerator for food preservation due to lack of knowledge of correct refrigerating temperature.<sup>[34]</sup> Although the respondents in this study showed reasonable knowledge (65.09%) of refrigeration being a means of preventing microbial growth and spoilage of meat, their poor implementation may be due to the quantity being processed at the abattoir for sale since the eventual preservation of the meat has been transferred to the end consumer or whoever buys

the meat from them. The proportion of them that reflected in the use of refrigeration is likely to be the meat handlers who process reasonable quantity that exceeds daily sales which has to be stored before eventual stock is sold. Lack of adequate cold room or refrigerating facilities could also be the cause for this poor practice. Respondents who are older and had spent longer time on the job as meat handlers had good practice of meat hygiene than those who were younger and had spent shorter time on the job. Since age and length of experience as meat handlers were found to improve the practice of meat hygiene and safety, older and experienced meat handlers can train the younger ones with few years of experience on meat hygiene. Respondents' knowledge of meat hygiene is also associated with their practice of meat hygiene.

# CONCLUSION

This study provides a framework for future policy formulation on food safety improvement that would cascade or transcend to better public health. The study shows that there is reasonably good knowledge, which reflected in the good practices of meat hygiene. The attitude of the respondents, however, is not associated with these knowledge and practice, as revealed by the study. In general, the meat handlers displayed a reasonable knowledge and practice of meat hygiene although there is still need for improvement on the hygiene practices in the abattoirs. The study further reveals that the older people, meat handlers who are married, and meat handlers who have spent longer years on the job have better knowledge and practice of meat hygiene than the younger ones. Generally, the knowledge, attitude, and practice of meat hygiene is good, but these would require sustained improvement through training and capacity building on meat hygiene, consistent stakeholders engagement, mentorship of younger meat handlers by the older ones, and regular public health and meat hygiene education by the veterinary public health practitioners.

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### **Conflicts of interest**

There are no conflicts of interest.

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