Research Article

Sanitation and Hygiene Practices of Meat Sellers in Markets in Abia State, Nigeria

Uchechukwu Olive Iwuagwu[1], Agwu Nkwa Amadi [1], Blessed Okwuchi Nworuh[1], Chimezie Christian Iwuala[1], David Chinaecherem Innocent[1]*, Michael Okwudiri Ikeanumba[2] and Mary Onyinyechi Okorie[1]

[1]Department of Public Health, Federal University of Technology, Owerri, Imo State, Nigeria

[2]Department of Biology, Alvan Ikoku Federal University of Education, Owerri, Imo State, Nigeria

*Corresponding Author
David Chinaecherem Innocent, Department of Public Health, Federal University of Technology, Owerri, Imo State, Nigeria.

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Abstract

Background: *Globally in recently increased attention has been directed toward the critical role played by meat handlers and sellers in maintaining food safety standards, particularly in the context of low- and middle-income countries. The handling, processing, and sale of meat products are integral components of the food industry, and the practices employed in this sector have profound implications for the health and well-being of consumers. This study was carried out to determine the sanitation and hygiene practices of meat sellers in markets in Abia State, Nigeria.*

Methods: *This research involved the use of a Hazard Analysis Critical Control Point (HACCP) checklist to investigate the sanitation and hygiene practices of meat sellers. A total of 425 meat samples collected from 425 meat sellers from some randomly selected markets in Abia State were used for the study. The multistage simple random sampling technique through balloting was employed to determine communities/markets for the study. Statistical Package for social Sciences (SPSS) version 23.0 was used for the analysis.*

Results: *The sanitation and hygiene practices of the meat sellers were poor and fall below the HACCP Good Hygiene Practise standards. Only a percentage of (16.70%) reported wearing proper clothing, such as aprons and hair restraints, which are essential for preventing contamination of meat. Similarly, a low percentage (12.47%) of meat handlers reported wearing hand gloves. The majority (83.29%) reported not wearing proper clothing. Similarly, a large proportion (87.52%) of meat sellers reported not wearing hand gloves, and (81.88%) reported not having access to wash-handing basins with running water, both of which are critical measures for maintaining hand hygiene during meat handling.*

Conclusion: *The study revealed that the meat handlers in the study areas did not comply with HACCP standards of operations checklists. The observed failure of meat sellers and handlers to meet the required Process Hygiene Criteria during critical stages like slaughter, dressing, and other production processes at the time of sampling raises concerns regarding the potential for contamination and cross-contamination of meat offered for sale. It is recommended that meat sellers undergo proper training and regularly update their knowledge of meat safety.*

Keywords: Sanitation, Hygiene, Meat Hygiene, Hygiene Practices, Abattoir, Meat Sellers

1. Introduction

Food safety is a global concern of paramount importance, with the integrity of our food supply chain directly impacting public health, socioeconomic development, and overall quality of life [1-4]. In recent years, increased attention has been directed toward the critical role played by meat handlers and sellers in maintaining food safety standards, particularly in the context of low- and middle-income countries. The handling, processing, and sale of meat products are integral components of the food industry, and the practices employed in this sector have profound implications for the health and well-being of consumers [5, 6, 7]. Within the African continent, where vibrant markets and a rich culinary tradition rely heavily on meat products, ensuring the safety and hygiene of meat sold in local markets is a pressing concern [8]. In this context, we turn our focus to Abia State, Nigeria, a region characterized by a thriving meat market sector and a significant reliance on meat as a dietary staple. Understanding the sanitation and hygiene practices of meat sellers in Abia State is not only essential for safeguarding public health but also for addressing broader issues of foodborne

diseases, economic development, and social well-being.

Despite the global recognition of the importance of food safety, the literature indicates that meat handling practices in many African settings fall short of international standards [5, 9]. This deficiency is particularly concerning given the widespread prevalence of foodborne illnesses on the continent, with diarrhea, a common manifestation of such diseases, causing significant morbidity and mortality [2]. Contaminated meat and food products are known contributors to these health challenges, straining healthcare systems, reducing productivity, and imposing financial burdens on affected individuals and communities.

While there is a growing body of research addressing food safety concerns in Africa, specific investigations into the sanitation and hygiene practices of meat sellers in Abia State, Nigeria, are limited. Hence, this study aims to bridge this critical gap by comprehensively assessing the practices employed by meat sellers in local markets. Our objective was to determine the sanitation and hygiene practices of meat sellers in Abia State, Nigeria, and to provide evidence-based recommendations for improving food safety within this vital sector. By shedding light on the current state of meat handling practices in the region, we aim to contribute to the development of targeted interventions and policy measures that can enhance food safety, protect public health, and foster economic growth in Abia State, Nigeria.
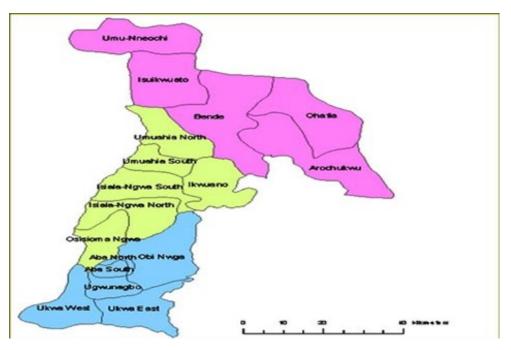
2. Methods
2.1 Study Design
This research design was a descriptive cross-sectional involving the use of questionnaires. Questionnaires was used in the interviewing of meat sellers; while observational sanitary inspection was used to help to detect any environmental nuisances in the slaughter/markets.

2.2 Study Setting
Abia state was created from part of Imo state in 27th August 1991. The geographical coordinates of Abia state is 5.4309°N 7.5247°E. As at the 2006 census, the population of Abia state was put at 2,833,999. Its capital city is Umuahia and the major commercial city is Aba. English is widely spoken and serves as the official language in governance and business. Christianity is the predominant religion of Abia people. Abia state has 3 senatorial zones with 17 Local Government Areas (LGAs). The senatorial zones are Abia Central, Abia North and Abia South. The LGAs include: Aba North, Aba South, Arochukwu, Bende, Ikwuano, Isiala Ngwa North, Isiala Ngwa South, Isuikwuato, Obi Ngwa, Ohafia, Osisioma Ngwa, Ugwunagbo, Ukwa East, Ukwa West, Umuahia North, Umuahia South and Umu Nneochi. Figure 3.1 shows the 3 senatorial zones and the LGAs in each zone of Abia state.

Figure 1: Geographyical Map of the Study Area- Abia State showing the three (3)Senatorial Zones and LGAs
(Source: Nigerian Muse, 2010)

2.3 Study Population
Meat handlers include meat handlers in abattoirs/ slaughter houses; meat handlers in the markers (meat sellers) and meat handlers in transit from abattoirs to markets.

The study population here is meat (red and white) sellers in markets in Abia State, Nigeria. According to the information from the meat sellers Associations in Abia State, there are about three thousand one hundred (3100) meat sellers across the various markets in Abia State. Ten (10) Local Government Areas (LGAs) out of the Seventeen (17) LGAs from the three Senatorial Zones in Abia State were randomly through balloting selected for this study.

2.4 Sample Size and Sampling Technique
2.4.1 Sample Size
The sample size calculation of the population of meat sellers in the markets for this study was determined using Taro Yamane (1967) formula :

$N = N/1+N(e)^2$

Where n=sample size; N=Population size; e=Level of precision (5%)

n= $3100/1+3100$ x $(0.05)^2$
 = $3100/1+3100$ x .0025
=$4250/1 + 7.75$
=$3100/8.75$
= 354.28 approximately 354

Adding 20% to account for attrition, then the 20% of 354 = 0.20 x 354 = 70.85 approximately 71

Therefore, the total sample size for this study is 354 + 71 = **425 meat sellers**

2.4.2 Sampling Technique
A Multi stage simple random sampling technique was adopted for this study.

2.4.2.1 Selection of LGAs, Markets
A simple random sampling using balloting was used for the selection of ten (10) out of the seventeen (17) Local Government Areas (LGAs) in Abia State for the study thereby giving every LGA in Abia State an equal chance of selection by the researcher. Thereafter, through balloting, markets were selected from enumerated major markets in the selected LGAs and communities for sampling.

2.4.2.2 Selection of Respondents
A total of 425 samples of meat and meat sellers were randomly selected from markets in ten (10) LGAs in Abia State, Nigeria was used for the study.

The sampled markets in Aba, Umuahia and Ohafia Senatorial Zones have a total number of 340, 250 and 100 meat sellers respectively out of which 200, 160 and 65 randomly selected meat sellers were drawn/participated in this study from the three senatorial zones respectively.

Table 1.0 below shows the distribution of participating meat sellers in the sampled markets according to the Senatorial Zones in Abia State

Study Area	Frequency	Percentage	Cumulative Percent
Aba Senatorial Zone	200 (R = 120; W=80)	47.06	47.06
Umuahia Senatorial Zone	160 (R = 62; W=98)	37.64	84.7
Ohafia Senatorial Zone	65 (R = 42; W=23)	15.30	100
Total	425 (R = 224; W=201)	100	

R= Red Meat (Beef), W = White Meat (Chicken)

Table 1: Distribution of participating meat sellers/ meat samples in the sampled markets according to the Senatorial Zones in Abia State

2.5 Inclusion and Exclusion Criteria
All meat sellers in the markets (both male and females from the ages of 18 years and above) who practice their trade in Abia State; and gave their consent for the study were part of this research work. Meat sellers/handlers who did not give an informed consent to be part of the study were excluded.

2.6 Instrument for Data Collection
The instrument for data collection were questionnaire and an observational sanitary checklist used for inspection of the selected markets was also done for deduction of environmental nuisances around the markets. The Questionnaire as an instrument of data collection was used to obtain information on the sanitation and hygiene practices of meat sellers in markets at Abia State; and other relevant information on the socio demographic characteristics of the meat sellers. Physical observations were also made from the observational sanitary survey.

The questionnaire has 17 research questions with an introductory cover note. Four hundred and twenty five (425) copies of the questionnaires were administered to participants face to face. English Language was the main language used, however, local dialects – Igbo Language was used to verbally explain the contents of the questionnaire to some respondents.

The questionnaire comprised of sections on the demographic profile of the meat sellers; information on the personal hygiene practices of the meat sellers; information on the cleaning and sanitation practices of the meat sellers and finally on the field report. The questions were prepared in line with the research objectives. The hygiene and sanitation of the meat handlers were also assessed by direct observation using the questionnaire/ checklist.

2.7 Validity and Reliability of the questionnaire:
The face and content validity of the questionnaire was established by the project supervisors and two other experts (in the environmental/public health discipline) after critical and constructive modification in line the research objectives. Also, a pilot study with 30 participants was carried out to pre-test the questionnaire and ascertain its reliability for use in a study of larger sample size. The questionnaire was test and retested on a small group of meat sellers and the scores of the pilot studies at both times were found to be highly correlated, >0.60, thus indicating the reliability of the questionnaire. (SS, 2023)

2.8 Method of Data Analysis

The data from this research work was collated manually by the Researcher; and then entered into the computer by a statistician. The Statistical Package for the Social Sciences (SPSS) software (version 20) was used in the analysis of the data. Results were expressed in percentages, frequencies, tables. One-way ANOVA and the independent sample T-test was used to test the hypotheses at 95% confidence interval and 0.05 Level of significance.

2.9 Ethical clearance/ Informed Consent

An informed consent was gotten from all meat handlers who participated in the study. The purpose of the research was explained to each respondent and verbal informed consent obtained from them before inclusion into the study. Also, anonymity of the respondents was assured and ensured.

3. Results

A total of four hundred and twenty-five (425) meat samples comprising 224 red meat- beef (120 from Aba zone, 62 from Umuahia zone and 42 from Ohafia zone) and 201 white meat- chicken (80 from Aba zone, 98 from Umuahia zone and 23 from Ohafia zone) collected from four hundred and twenty-five (425) meat sellers from markets in Abia State were used for this study. There were also twenty (20) water samples, twenty-two (22) samples from table surfaces, twenty-two (22) samples from knife surfaces and fourteen (14) samples from transport vehicles. The results of Data collected and analyized are presented in the tables below.

3.1 Socio-Demographic Characteristics of meat sellers

The result of data collected on the socio-demographic information of the meat sellers are presented in the table 2.0 below.

Table 2.0 showed the socio-demographic information of the meat sellers; the age distribution of the meat sellers was as follows: 18-20 had 24(5.62%), 21– 30 had 48 (11.30%); 31 – 40 were 105 (24.71%); 41 – 50 had 73 (17.18%); 51 – 60 had 121 (28.46%); above 60 had 54 (12.71%). Concerning the sex; male recorded 348(81.8%) compared to female with 77(18.2%). Among the meat sellers; no record for non-formal education; 218 (51.29%) meat sellers had primary school education; 172 (40.47%) had secondary school education while 35 (8.24%) had tertiary school education as their highest level of education. The marital status of the meat sellers was as follows: single recorded 140 (32.94%); married had 187 (44.00%); divorced had 28 (6.59%); separated had 24 (5.65%); widow/widower had 46 (10.82%). Religion aspect; Christianity highest 304(71.5%), Islam was 45(10.6%) and Traditional worship had 76(17.9%). The years of experience among the meat sellers were recorded as follows: with 1 – 5 years of experience had 40 (9.41%); 6 – 10 years of experience had 47 (11.06%); 11 – 15 years of experience had 78 (18.35%); 16 – 20 years of experience had 113 (26.59%); Above 20 years of experience had 147 (34.59%).

Variables		Selected LGAs in Abia State	
		n =425	
		Frequency (n)	Percentage (%)
Age of Respondents	18–20 years	24	5.62
	21–30years	48	11.30
	31-40years	105	24.71
	41-50years	73	17.18
	51-60years	121	28.46
	60+years	54	12.71
Gender of Respondents	Male	348	81.8
	Female	77	18.2
Educational level	No Formal Education	0	0.00
	Primary Education	218	51.29
	Secondary Education	172	40.47
	Tertiary Education.	35	8.24
Marital Status	Single	140	32.94
	Married	187	44.00
	Divorced	28	6.59
	Separated	24	5.65
	Widow/Widower	46	10.82
Religion of respondents	Christianity	304	71.5
	Islam	45	10.6
	Traditional Worship	76	17.9

Years of Experience	1 – 5 years	40	9.41
	6 – 10 years	47	11.06
	11 – 15 years	78	18.35
	16 – 20 years	113	26.59
	Above 20 years	147	34.59

Table 2: Overall Socio-Demographic Information

3.2 Response on personal Hygiene by meat sellers in Abia State

The result of data collected on the response on personal hygiene by meat sellers are presented in the table 3.0 below.

Table 3.0 below showed that 71(16.70%) meat sellers responded "yes" to wearing proper clothing; 152 (35.76%) to Jewellery limited to wrist watches and plain rings; 53(12.47%) to wearing hand gloves; 77 (18.12%) to wash-hand basins and running water being available; 59 (13.88%) to routine washing of hands with soap and water; 135 (31.76%) to being free from skin infection/ open cuts. Whereas, 354 (83.29%) meat sellers responded "No" to wearing proper clothing; 273 (64.23%) to Jewellery limited to wrist watch and plain rings; 372 (87.52%) to wearing hand gloves; 348 (81.88%) to wash-hand basins and running water being available; 366 (86.11%) to routine washing of hands with soap and water; 290 (68.23%) to being free from skin infection/ open cuts.

Criteria for Personal Hygiene	YES		NO	
	n	%	n	%
Meat handlers wear proper clothing – apron, hair restraints	71	16.70	354	83.29
Jewellery is limited to wristwatches and plain rings.	152	35.76	273	64.23
Wearing hand gloves	53	12.47	372	87.52
Wash-hand basins with soap and running water available	77	18.12	348	81.88
Hands are washed routinely with soap and water	59	13.88	366	86.11
Meat handlers are free from skin infection/open cuts	135	31.76	290	68.23

Table 3: Response on personal hygiene by meat sellers in Abia State

3.3 Comparison of response on personal Hygiene by meat sellers in the three Senatorial Zones in Abia State

The result of the comparison of response on personal hygiene by meat sellers in the three Senatorial Zones in Abia State is presented in the table 4.0 below.

Table 4.0 showed that 25 (15.58%) meat sellers responded "yes" to wearing proper clothing in Umuahia, 30(14.81%) in Aba, and 8 (12.96%) in Ohafia; 55 (34.42%) to Jewellery limited to wrist watch and plain ring in Umuahia, 70 (35.19%) in Aba and 19 (29.63%) in Ohafia; 18 (11.04%) to wearing of hand gloves in Umuahia, 26 (12.96%) in Aba and 7 (11.11%) in Ohafia; 27 (16.88%) to wash-hand basins and running water being available in Umuahia, 33 (16.67%) in Aba and 12 (18.52%) in Ohafia; 20 (12.34%) to routine washing of hands with soap and water in Umuahia, 37(18.52%) in Aba and 11(16.67%) in Ohafia; 49 (30.52%) to being free from skin infection/open cuts in Umuahia, 63 (31.48%) in Aba and 18 (27.78%) in Ohafia.

Whereas, 135(84.42%) meat sellers responded "No" to wearing proper clothing in Umuahia, 170(85.19%) in Aba and 57(87.04%) in Ohafia; 105(65.58%) to Jewellery limited to a wristwatch and plain ring in Umuahia, 130(64.81%) in Aba and 46(70.37%) in Ohafia; 142(88.96%) to wearing of hand gloves in Umuahia, 174(87.04%) in Aba and 58(88.89%) in Ohafia; 133(83.12%) to wash-hand basins and running water being available in Umuahia, 167(83.33%) in Aba and 53(81.48%) in Ohafia; 140(87.66%) to routine washing of hands with soap and water in Umuahia, 163(81.48%) in Aba and 54(83.33%) in Ohafia; 111(69.48%) to be free from skin infection/open cuts in Umuahia, 137(68.52%) in Aba and 47(72.22%) in Ohafia.

The chi-square test was conducted to assess the association between personal hygiene criteria and their corresponding "Yes" and "No" responses across the locations (Umuahia, Aba, Ohafia). The results revealed that there is no statistically significant association for any of the variables. The p-values for each criterion were as follows: for "Meat seller wear proper clothing," the p= 0.733; for "Jewellery is limited to wristwatch and plain ring," the p= 0.175; for "Wearing of hand gloves," the p= 0.442; for "Wash-hand basins with soap and running water available," the p= 0.495; for "Hands are washed routinely with soap and water," the p= 0.220; and for "Meat sellers are free from skin infection/open cuts," the p= 0.331.

These p-values, all greater than the common significance level of 0.05, suggest that the observed differences in the percentages of "Yes" and "No" responses for each criterion in the different locations are likely due to random chance rather than meaningful differences. A one-way ANOVA gave a P value of 0.781 showing that there was no significant difference (P>0.05) in the response of meat sellers on personal hygiene in the three Senatorial Zones of Abia state.

Criteria for Personal Hygiene	Umuahia		Aba		Ohafia		X²	P-value	Decision
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)			
Meat handler wear proper clothing	25(15.58)	135(84.42)	30(14.81)	170(85.19)	8(12.96)	57(87.04)	0.62	0.733	NS
Jewellery is limited to wristwatch and plain ring.	55(34.42)	105(65.58)	70(35.19)	130(64.81)	19(29.63)	46(70.37)	6.30	0.175	NS
Wearing of hand gloves	18(11.04)	142(88.96)	26(12.96)	174(87.04)	7(11.11)	58(88.89)	1.63	0.442	NS
Wash-hand basins with soap and running water available	27(16.88)	133(83.12)	33(16.67)	167(83.33)	12(18.52)	53(81.48)	1.41	0.495	NS
Hands are washed routinely with soap and water	20(12.34)	140(87.66)	37(18.52)	163(81.48)	11(16.67)	54(83.33)	3.03	0.220	NS
Meat handlers are free from skin illnesses/ open cuts	49(30.52)	111(69.48)	63(31.48)	137(68.52)	18(27.78)	47(72.22)	2.21	0.331	NS

One-way ANOVA P value = 0.781
NS*- Not Significant; S*- Significant

Table 4: Comparison of response on personal hygiene by meat sellers in the 3 Senatorial Zones in Abia State

3.4 Response on Sanitation by meat sellers in Abia State

The result of data collected on the response on sanitation by meat sellers are presented in the table 5.0 below.

Table 5.0 showed that 23 (5.50%) meat sellers responded "yes" to worktables being clean (washed and sanitized between operations); 59 (13.88%) to cleaning and sanitizing of equipment and utensils; 82 (19.38%) to storing cleaning chemicals away in the store; 29 (6.94%) to washing of mops after use; and 25 (5.98%) to cleaning of buckets after use.

Whereas, that 402 (94.50%) meat sellers responded "No" to worktables being clean(washed and sanitized between operations); 366 (86.12%) to cleaning and sanitizing equipment and utensils; 343 (80.62%) to storing cleaning chemicals away in the store; 396 (93.06%) to washing of mops after use; and 400 (94.02%) to cleaning of buckets after use.

Criteria for Sanitation	YES		NO	
	n	%	n	%
Worktables and work surfaces are clean (washed and sanitized between operation)	23	5.50	402	94.50
Small equipment and utensils including cutting boards, knives, etc. are thoroughly cleaned and sanitized between use	59	13.88	366	86.12
Cleaning chemicals and equipment are stored properly away in the store	82	19.38	343	80.62
Mops are washed after use and stored head up	29	6.94	396	93.06
Buckets are cleaned after use and inverted to drain	25	5.98	400	94.02

Table 5: Response on sanitation by meat sellers in Abia State

3.5 Comparison of response on sanitation by meat sellers in the three Senatorial Zones in Abia State

The result of the comparison of response on sanitation by meat sellers in the three Senatorial Zones in Abia State is presented in the table 6.0 below.

Table 6.0 showed that 15 (9.62%) meat handlers responded "yes" to worktables being clean(washed and sanitized between operations) in Umuahia, 15(7.41%) in Aba and 7(10.00%) in

Ohafia; 28 (17.31%) to cleaning of equipment and utensils in Umuahia, 30 (14.82%) in Aba and 9 (14.00%) in Ohafia; 37 (23.08%) to storing cleaning chemicals away in the store in Unuahia, 37(18.52%) in Aba and 13 (20.00%) in Ohafia; 31 (19.23%) to washing of mops after use Umuahia, 33 (16.67%) in Aba and 12 (18.00%) in Ohafia; 34 (21.15%) to cleaning of buckets after use in Umuahia, 37 (18.52%) in Aba and 10 (16.00%) in Ohafia.

Whereas, 145(90.38%) meat handlers responded "No" to worktables being clean(washed and sanitized between operations) in Umuahia, 185(92.59%) in Aba, and 58(90.00%) in Ohafia; 132(82.69%) to cleaning of equipment and utensils in Umuahia, 170(85.18%) in Aba and 56(86.00%) in Ohafia; 123(76.92%) to storing cleaning chemicals away in the store in Umuahia, 163(81.48%) in Aba and 52 (80.00%) in Ohafia; 129(80.77%)

to washing of mops after use Umuahia, 167(83.33%) in Aba and 53(82.00%) in Ohafia; 126(78.85%) to cleaning of buckets after use in Umuahia, 163(81.48%) in Aba and 55(84.00%) in Ohafia.

SPSS analysis using the Chi-square showed no significant difference in the criteria for sanitation among the three cities mentioned. 'Worktables and work surfaces are clean (washed and sanitized between operations)'; (p= 0.395), 'small equipment and utensils including cutting boards, knives, etc. are thoroughly cleaned'; (p= 0.168), 'cleaning chemicals and equipment are stored properly away in the store'; (p= 0.541), 'mops are washed after use and stored head up'; (p= 0.541) and 'buckets are cleaned after use and inverted to drain'; (p = 0.779). A one-way ANOVA gave a P value of 0.722 showing that there was no significant difference (P>0.05) in the response of meat handlers on sanitation in the three Senatorial Zones of Abia state.

Criteria for Sanitation	Umuahia		Aba		Ohafia		X^2	P-value	Decision
	Yes (%)	No (%)	Yes (%)	No (%)	Yes (%)	No (%)			
Worktables and work surfaces are clean(washed and sanitized between operations)	15(9.62)	145(90.38)	15(7.41)	185(92.59)	7(10.00)	58(90.00)	1.86	0.395	NS
Small equipment and utensils including cutting boards, knives, etc. are thoroughly cleaned and santized	28(17.31)	132(82.69)	30(14.82)	170(85.18)	9(14.00)	56(86.00)	3.58	0.168	NS
Cleaning chemicals and equipment are stored properly away in the store	37(23.08)	123(76.92)	37(18.52)	163(81.48)	13(20.00)	52(80.00)	1.23	0.541	NS
Mops are washed after use and stored head up	31(19.23)	129(80.77)	33(16.67)	167(83.33)	12(18.00)	53(82.00)	1.23	0.541	NS
Buckets are cleaned after use and inverted to drain	34(21.15)	126(78.85)	37(18.52)	163(81.48)	10(16.00)	55(84.00)	0.50	0.779	NS

One way Anova P value = 0.722
NS*- Not Significant; S*- Significant

Table 6: Comparison of response on sanitation by meat sellers in the 3 Senatorial Zones in Abia State

4. Discussion

The assessment of the bacteriological qualities of meat and contact surfaces in markets is a crucial aspect of ensuring food safety and public health. In Nigeria, particularly in Abia State, the consumption of meat is a significant part of the daily diet for many individuals. However, the handling and storage of meat in marketplaces can pose potential risks of bacterial contamination,

leading to foodborne illnesses. This study aims to investigate and analyze the bacteriological quality of meat and contact surfaces in markets in Abia State, Nigeria. Through examining samples of meat being sold in the markets in Abia State together with samples collected from the meat contact surfaces; and evaluating the hygiene and sanitation practices of the meat sellers, this research seeks to identify the bacteriological qualities of the

meat being sold to the public, potential sources of contamination and recommend measures for improved meat safety standards. The findings of this study will provide valuable insights into the existing practices and enable policymakers, regulatory bodies, and meat vendors to implement effective interventions that ensure the safety and quality of meat/meat products, and thus, ultimately protecting the health of the public.

Findings on the personal hygiene practices of meat handlers in the study indicated that a significant proportion of meat handlers did not adhere to basic standards of personal hygiene while handling meat. Only a small percentage (16.70%) reported wearing proper clothing, such as aprons and hair restraints, which are essential for preventing contamination of meat. Similarly, a low percentage (12.47%) of meat handlers reported wearing hand gloves, which can act as a barrier to prevent direct contact between hands and meat, thus, reducing the risk of bacterial transfer. Additionally, a relatively low number (18.12%) of meat sellers reported having access to wash-hand basins with running water, which is crucial for maintaining hand hygiene during meat handling. Routine hand washing with soap and water is a fundamental practice to minimize the risk of bacterial being transferred to meat, yet only 13.88% of meat sellers reported this practice. Moreover, a relatively low percentage (31.76%) of meat sellers reported being free from skin infections or open cuts, which can be potential sources of bacterial contamination. Conversely, a considerable majority of meat handlers responded negatively to most of the personal hygiene practices assessed in the study. The majority (83.29%) reported not wearing proper clothing. Similarly, a large proportion (87.52%) of meat sellers reported not wearing hand gloves, and (81.88%) reported not having access to wash-handing basins with running water, both of which are critical measures for maintaining hand hygiene during meat handling. Routine hand washing with soap and water, another important practice, was reported to be neglected by a significant majority (86.11%) of meat sellers. Moreover, a considerable percentage (68.23%) of the meat sellers reported having skin infections or open cuts, which can serve as reservoirs for bacteria and pose serious risks to meat safety. These findings are in line with previous studies which reported poor sellers' personal hygiene practices in various regions by Gutema et al., Adzitey et al., Azuamah et al., Azuamah et al., and Tegegne, [1,3,9-11].

Information on the personal hygiene practices of meat sellers in the markets in the three sanatorial zones of Abia State, Nigeria, namely Umuahia, Aba, and Ohafia showed that the majority of meat handlers across all locations responded negatively to several personal hygiene criteria, indicating potential lapses in hygiene practices during meat handling. Firstly, regarding the use of proper clothing, only a small percentage of meat handlers responded affirmatively, with Umuahia having the highest response (15.58%), followed by Aba (14.81%) and Ohafia (12.96%). Similarly, the use of hand gloves was reported by a limited number of meat handlers, and the availability of wash-hand basins with running water was also reported by only a fraction of respondents in all three zones. Furthermore, the study did not find any significant association/relationship between

personal hygiene criteria and their corresponding responses across the three senatorial zones. The p-values for all the criteria were above the common significance level of 0.05, indicating that any observed differences in responses are likely due to random chance rather than meaningful disparities. These findings raised concerns about the overall personal hygiene practices among meat sellers in the studied locations. Such poor personal hygiene practices in meat handling among meat sellers/handlers can lead to the transfer of harmful microorganisms to the meat and have been identified as contributing factors to bacterial contamination of meat and the occurrences of foodborne diseases when consumed by the public in line with the reports of Gutema et al., and Oloruntoba et al., [9,12].

These findings (The low compliance with essential hygiene practices, such as wearing proper clothing, using hand gloves, and washing hands with soap and water etc) underscore the need for regular training and awareness programs for meat sellers/ handlers in the markets to improve their knowledge of personal hygiene practices. Also, regulatory authorities and market managers should collaborate to ensure that regular monitoring and supervision of the meat sellers by the relevant authorities are sustained; as well as the provision of necessary facilities, such as wash-hand basins with running water and incentives like aprons, gloves etc. to ensure the safety and wholesomeness of meat/meat products sold to the public.

Insights into the sanitation practices of the meat handlers in Abia State revealed concerning trends, as the majority of meat sellers/ handlers in all sampled markets demonstrated poor compliance with essential sanitation criteria during meat handling. The results highlighted the limited adherence to sanitation practices, with only a small percentage of meat sellers responding positively to criteria such as worktables being clean (5.50%), cleaning and sanitizing of equipment and utensils (13.88%), storing cleaning chemicals away in the store (19.38%), washing of mops after use (6.94%), and cleaning of buckets after use (5.98%). On the other hands, the majority of meat sellers responded negatively to these criteria, indicating potential lapses in sanitation practices across all markets. There were variations in responses across the three sanatorial zones of the State, with Umuahia, Aba, and Ohafia showing different levels of compliance with sanitation criteria. However, the Chi-square test indicated no statistically significant difference in sanitation practices among the three cities, as evidenced by the p-values for each criterion (p > 0.05).

These findings of inadequate hygiene and sanitation practices, potentially leading to the contamination of meat products with harmful microorganisms and the subsequent attendeant risk of foodborne illnesses are consistent/in line with previous studies such as Adzitey et al [3]. Who reported no provision of facilities for thorough cleaning and sanitization of equipment and utensils in meat handling to prevent the transmission of pathogens; and Gutema et al [9]. who reported poor hygiene and sanitation practices among meat handlers in slaughter houses and markets in Bishoft town, Ethiopia. Hot water is essential and needed for effective washing and sanitization of hands and equipment (knives) to remove potential surface contaminants and thus

prevent further cross contamination of meat from contact surfaces.

The lack of significant differences among the meat sellers/handlers in the markets in the three sanetorial zones suggests that sanitation practices among meat sellers in Abia State require immediate attention and improvement. The low compliance with proper sanitation measures also, highlights the need for targeted interventions, including comprehensive training, enlightenment and educational programs for meat sellers/handlers. Thus, it is crucial to emphasize the importance of keeping work surfaces clean, regularly sanitizing equipment and utensils (with hot water), and appropriately storing cleaning chemicals. Additionally, proper hygiene practices, such as washing mops after use and cleaning buckets, are essential to prevent cross-contamination and ensure food safety in line with the previous works of Azuamah et al., Tesson et al., and others [11,13].

Also, the meat handlers in the study areas did not comply with HACCP standards of operations checklists. Plates 4.01 to 4.07 showed that the immediate environment of the slaughterhouses/meat markets and the standard practices therein fall below international standards for meat handling and processing. Animals were slaughtered on dirty slaughter slabs and those slaughtering the animals stepped into the slaughtering slabs bare-footed on dirty legs, dehidding and esciveration were done in such a way that exposes the meat carcass to possible cross-contamination from the microbial contents of the animal skins and the guts/wastes in agreement with previous studies of Gutema et al. [9] who identified the major possible sources of carcass contamination at the slaughter house to include feces during evisceration, the hides, slaughter slabs, handlers' hands and knifes amongst others.

Additionally, there was a lack of sufficient potable water supply, posing challenges for proper cleaning and handwashing. Another alarming observation was the open display of meat on tables, leading to the attraction of flies, which could potentially contaminate the meat with harmful microorganisms. Moreover, prospective buyers freely examine the displayed meat without proper hygiene measures further adds to the risk of bacterial contamination. Furthermore, the transportation of meat from the slaughter areas to the market using inadequate vehicles such as wheelbarrows, motorcycles, and car boots instead of covered containers with appropriate temperature control devices violates standard protocols, potentially compromising the quality and safety of the meat. These unhygienic practices are as observed in the markets and slaughter houses are in line with previous studies of Amadi et al [14]. which associated such conditions with the presence of bacterial pathogens like Staphylococcus aureus and Escherichia coli. To address these issues, urgent interventions are required. Market authorities should implement proper waste management practices in the markets and in the animal slaughter areas; ensure the provision and access to potable water, and enforce regulations on the proper handling and display of meat. It is essential to educate meat sellers/handlers and prospective buyers on proper hygiene practices, including the use of aprons and gloves, and discouraging the handling of displayed meat

without appropriate precautions. Additionally, strict monitoring and enforcement of regulations on the transportation of meat using covered containers with temperature control mechanisms are crucial to ensure temperature control and meat safety and protect public health. By improving hygiene and sanitation practices in the meat markets, the risk of foodborne illnesses and bacterial contamination could be significantly reduced, safeguarding the health and well-being of consumers.

5. Conclusion and Recommendations

The assessment of sanitation and hygiene practices among meat sellers in markets across Abia State, Nigeria, has revealed distressing deficiencies in the bacteriological quality of both meat products and the associated contact surfaces. This inadequacy is underscored by the detection of indicator bacteria such as Salmonella sp. and Escherichia coli, among others, in the meat samples and contact surface specimens examined. The observed failure of meat sellers and handlers to meet the required Process Hygiene Criteria during critical stages like slaughter, dressing, and other production processes at the time of sampling raises concerns regarding the potential for contamination and cross-contamination of meat offered for sale. This contamination is likely originating from external sources, including unsanitary contact surfaces, soil, as well as animal body discharges and excreta. Such findings strongly suggest that poor personal hygiene and sanitation practices are prevalent among meat sellers and handlers in Abia State, as highlighted in this study. To address these alarming issues and mitigate public health risks, urgent measures are imperative, including comprehensive educational initiatives aimed at enlightening meat sellers and handlers about proper meat handling procedures and the significance of maintaining strict hygiene standards within the meat industry in Abia State.

It is recommended that the public should be enlightened on the dangers of meat safety to make informed decisions on where to purchase their meat for consumption. Laboratories in Universities and other research organizations should be properly funded and equipped with state-of-the-art facilities to encourage research on meat safety. Also the government and other professional Agencies should ensure proper supervision and enforcement of existing regulations on meat safety and hygiene in the country.

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Supplementary Materials
APPENDIX A: Questionnaire
Informed Consent
Sanitation And Hygiene Practices Of Meat Sellers In Markets In Abia State, Nigeria

Dear Respondent,

We are conducting a research on the topic: ***Sanitation And Hygiene Practices Of Meat Sellers In Markets In Abia State, Nigeria.*** It is believed that Poor meat handling practices including non-adherence to internationally recommended standards such as the Codex Alimentarius Commission CAC - Good Hygiene Practices (GHPs) and Hazard Analysis Critical Control Point (HACCP) -based Standard Operating Procedures (SOPs) as seen in : lack of basic knowledge of hygiene practices to be observed by meat handlers; poor sanitation at the abattoirs and butchers' shops; non maintenance of cool chain, poor storage infrastructures, lack of safety awareness, poor waste disposal etc could be responsible for meat contamination by microorganisms and high bacterial loads in meat samples. Contaminated meat have been implicated in food poisoning and food borne illnesses with symptoms including nausea, vomiting, diarrhea, abdominal cramps/pains, headaches, fever and dehydration etc.

Contaminated food is important cause of illness, disability and death globally; and food borne diseases impede socioeconomic development by straining health care systems, harming national economies, tourism and trade.

Food borne illness poses a significant public health challenges as it is a serious threat to the health and well being of millions globally, contributing to decrease in workers' productivity; loss in school days; reduce family income as huge sum of money are spend on medical bills and legal fees; causing pains, suffering and early death.

The information generated from this study will be use to determine the meat management practices in your locality with the view to ascertaining the level of compliance of meat handlers to international standards and the bacteriological quality of meat. This will help in recommending and articulating appropriate public health interventions.

This research is not a tool for assessing taxation.

All information provided will be kept confidential and used only for academic purposes.

Kindly provide honest and accurate answers to the questions below.
Thanks for your co-operation.
Yours Faithfully

Department of Public Health
School of Health Technology, FUTO

Please tick in the box provided which category of options best fits you.
SECTION 1: GENERAL INFORMATION

A. DEMOGRAPHIC CHARACTERISTICS
Location: LGA ☐   ZONE ☐
1. Sex: Male ☐   Female ☐
2. Age …………………………years/ (18-20; 21-30; 31-40; 41-50; 51-60; 60 above)
3. Marital Status: Single/Never Married
Widowed   ☐   Married   ☐
Separated   ☐   Divorced   ☐
4. For how many years have you been selling meat? /Years of Experience as meat seller?
1 – 5 /below 5 years   ☐   6 – 10   ☐
11 – 15   ☐   16 – 20
Above 20   ☐
5. Religion of Respondents: Christianity ☐ Islam ☐ Traditional worship ☐ None ☐
6. What is your highest level of education?
None/No formal education   ☐   Primary School   ☐
Secondary School   ☐   Tertiary Institution ☐
Post graduate   ☐

SECTION 2: HACCP CHECKLIST

S/No	Criteria for Control	YES	NO
1	**Personal Hygiene practices**		
1.1	Meat handler wear proper clothing – clean uniforms/aprons and hair restraints.		
1.2	Jewellery is limited to wristwatch and plain ring.		
1.3	Wearing of hand gloves where appropriate and changed at necessary intervals.		
1.4	Wash-handing basins with soap, running water are available		
1.5	Hands are washed routinely with soap and clean water		
1.6	Meat handlers are free from skin infections/open sores, cuts, or wounds		
2	**Sanitation practices**		
2.1	Worktables and work surfaces are clean to sight and touch and washed and sanitized between operations.		
2.2	Small equipment and utensils including cutting boards, knives, etc. are thoroughly cleaned between uses and sanitized.		
2.3	Cleaning chemicals and equipment are stored properly away in the store.		
2.4	Mops are washed after use and stored head up.		
2.5	Buckets are cleaned after use and inverted to drain.		
	Total Score		