ASSESSMENT OF HYGIENE PRACTICES AND DETERMINANTS OF FOOD SAFETY COMPLIANCE IN BUTCHERIES ACROSS COUNTIES IN EASTERN KENYA

Orwa Joy Deborah1, Jakin Njagi Nanua1, Moses Mahugu Muraya2
1Department of Food Science and Technology, Chuka University, Kenya.
2Department of Plant Science, Chuka University, Kenya
Corresponding author: jorwa@chuka.ac.ke, moses.muraya@chuka.ac.ke, jnanua@chuka.ac.ke

ABSTRACT

Poor hygiene in meat handling and distribution contributes significantly to contamination and foodborne disease outbreaks. Although Kenya has established meat safety regulations, compliance among butcheries remains poorly documented. This study assessed hygiene practices, storage conditions, and demographic predictors of food safety behaviour in butcheries across Embu, Meru, and Tharaka-Nithi counties. Random sampling was applied in a cross-sectional survey of 26 butcheries in Tharaka-Nithi, 51 in Meru and 32 in Embu counties bringing the total sample size to 109. A structured questionnaire was developed based on WHO's Essential Food Safety Requirements. Data was analysed using R software (version 4.5.0), employing descriptive and logistic regression analysis. Results showed that 71% of butcheries kept meat on-site for over 48 hours, and 77% refrigerated meat overnight. Refrigeration varied by county, with Embu recording the highest usage (51.7%). Only 12.8% of butcheries practiced species separation during storage, and sterilization of equipment or premises was inconsistently applied, 43% in Embu, with lower rates elsewhere. Although all personnel had food handler certificates, less than half had undergone medical check-ups within the recommended three-month interval. Only 40% of butcheries used a separate cashier, indicating widespread concurrent handling of meat and money. Logistic regression revealed that age and education significantly influenced hygiene practices. Personnel with secondary education had over ten times higher odds of practicing species separation (OR = 10.17, $p < 0.001$), while those with primary education also showed increased odds (OR = 5.15, $p = 0.005$). Individuals aged above 50 were less likely to separate meat species (OR = 0.14, $p = 0.016$). Sterilization was more likely among those aged 31–40 (OR = 3.94, $p = 0.044$) and 41–50 (OR = 6.68, $p = 0.007$). The study concludes that significant gaps persist in hygiene compliance, with demographic characteristics influencing key practices. Targeted training and stricter enforcement of regulations are recommended to enhance meat safety in butcheries.

Key words: Food safety, Butchery hygiene, Meat handling, Meat contamination, Public health

INTRODUCTION

Poor Hygiene handling of foods of animal origin is the leading contributor to contamination with pathogenic diarrheagenic microbes with sub Saharan Africa bearing the largest burden of these diseases (Khan et al., 2022). In Kenya, 100 deaths are reported daily and Eastern Kenya has been reported to be leading in positive cases in the country (Ogumbo et al., 2024). The main route to human contamination is through ingestion of contaminated food and water as a result of poor hygiene practices. Food of animal sources such as meat are the most contaminated with pathogens which naturally inhabit the animals' gut. Contamination occurs mainly through slaughter and may persist along the value chain under substandard hygiene practices.

Food-producing animals are the most preferred sources of proteins due to their high biological value (Mallhi et al., 2019). The demand for meat is rising due to increased population, urbanization and higher purchasing power especially in low and middle -income countries (LMiCs) (Kunyanga et al., 2021). In Kenya the meat value chain is an important economic activity. It provides nutrition and employment to the agricultural sector by contributing about 40-50% to the agricultural Gross Domestic Product (FAOSTAT, 2022).

Unfortunately, foods from animal sources have been implicated as the leading contributors to food borne diseases by 70% (WHO, 2023). Foodborne diseases (FDB) remain a major global public health challenge, with significant socio-economic and health implications, particularly in LMICs. These include; morbidity, loss of productivity and strain in health care facilities. Centre for disease control and prevention (CDC) has reported that approximately 600 million illnesses occur worldwide due to food borne diseases with children under the age of five being the most affected (CDC, 2019). The burden of FDB is made up of mostly LMICs economies which are disproportionately struggling with poor access to health facilities, non-structured food value chains and minimal regulations (Onyeaka et al., 2023). The prevalence of food borne diseases in Africa remains high with gastrointestinal diseases especially cholera and diarrhoea being the most prevalent (WHO, 2023).

In Kenya, the meat retail sector plays a pivotal role in the food supply chain. However, this sector is fraught with hygiene and sanitation challenges that heighten the risk of transmission of FDB agents (CDC, 2019). Urbanization, changing consumer lifestyles, and the growing demand for convenient and affordable protein sources have increased the consumption of meat, particularly beef and poultry meat (Bett et al., 2012; Cornelson et al., 2016). These dynamics, coupled with weak enforcement of food safety regulations and limited awareness of proper hygiene practices, make butcheries which are the main urban meat retail outlets, potential hotspots for foodborne disease outbreaks. In Kenya meat value chain actors have been documented to fail to adhere to Good manufacturing practices (GMP) in handling meat and meat products (Aduah *et al.,* 2021; Mwove *et al.,* 2021). Majority lack basic sanitation facilities such as running water sinks, refrigeration and proper waste disposal systems (Siluma *et al.,* 2023).

Although there exist meat hygiene and handling requirements for butcheries in Kenya (GOK, 2023), adherence to this requirement by most butcheries is low (Chepkemoi *et al.,* 2016; Wambui *et al.,* 2017) and food borne diseases are still being reported in Kenyan counties (Ogumbo *et al.,* 2024). Despite Eastern Kenya leading in diarrheal diseases, little is known on the role the butcheries play as the main retail outlets of meat to the urban population. This study therefore, aims to identify the relationship between demographic characteristics of butcheries' personnel hygiene handling practices as per the Essential Food safety Requirement by the WHO which is categorized into; personnel Hygiene, Food storage and design of premises with some modifications such as sanitation water and environment plus government involvement and their role in food safety practices in the region (WHO, 2018).

MATERIALS AND METHODS

Study Site

This study was conducted in Embu (0°8′–0° 50′S, 37°3′–37°9′E), Meru (0°6′N–0°1′S, 37°–38°E), and Tharaka-Nithi (0°07′–0°26′ S, 37°19′–37°46′E) counties in Eastern Kenya. Two transit towns per county along the Meru-Nairobi highway were purposively selected due to their urban growth and active involvement in meat handling and distribution.

Data Collection and Survey Instrument

A structured survey method was used to collect data through semi-structured questionnaires adapted from WHO's Essential Food Safety Requirements (2018), and contextualized using Kenyan (KS EAS 1190:2023), Ugandan (US 736:2019), and EU (VPN 15) standards. The tool was validated and tested for reliability. The questionnaire captured demographic data (gender, age, education, experience) and five thematic areas: meat sourcing (from certified slaughterhouses), storage practices (e.g., refrigeration, species separation), cleaning and sterilization frequency, environmental hygiene (water source, waste disposal and toilets), personnel hygiene (protective clothing, handwashing, money handling), and government oversight (inspection frequency, food handler certification, medical check-ups). Before commencing data collection, ethical approval was provided by the National Commission of Science Technology and Innovation by the government of Kenya (NACOSTI License Number; NACOSTI/P/24/34614) and Chuka University Ethical Review Committee.

Three major counties participated and one major town was targeted per county. The counties were Embu, Meru and Tharaka-Nithi, while the major towns selected were Embu, Meru and Chuka town, respectively, with a total of 151 butcheries (Table 1). The population of butcheries from which the sample size was collected were obtained from the county offices ministry of public health for each county. The sample size determination was done according to Krejcie and Morgan's (1970),

$$n = \frac{X^2 \times N \times P(1-P)}{(d^2 \times (N-1)) + (X^2 \times P \times (1-P))}$$

where, n = desired sample size

X^2 = Chi square value of 3.841 for 95% CI

N = Population size = 151

d = degrees of accuracy set at 0.05 for 95% CI

P = Population proportion (0.5)

$$n = \frac{3.841 \times 151 \times 0.5(0.5)}{[(0.05^2 \times (151-1)) + (3.841 \times 0.5 \times (0.5)]}$$

$$n = \frac{(134.435)}{(0.3725) + 0.96025)} = 109$$

$$n = 109$$

A total of 109 establishment were randomly surveyed with distributions as shown in Table 1.

Table 1: Distribution of registered butcheries and sample samples from major towns in selected

County	Major town	Registered butcheries in CBD	Sample size (n)
Tharaka-Nithi	Chuka	36	26
Meru	Meru	71	51
Embu	Embu	44	32
Total		151	109

Where CBD is Central Business District

Data analysis

Data collected from the field were coded and analysed using R software version 4.5.0. Descriptive statistics were used to summarize demographic characteristics and hygiene-related practices. Chi-square tests were conducted to assess associations between categorical variables across counties. To identify key predictors of critical hygiene practices, binary logistic regression was performed using demographic variables, age, gender, education level and work experience as independent variables and species separation during storage and equipment/premise sterilization as dependent variables. The level of statistical significance was set at $\alpha = 0.05$. "Data were preprocessed and reshaped using the reshape2 package in R to organize the distribution of meat types across counties into a matrix format. A heatmap was then generated to visualize the relative frequencies of each meat type using a colour gradient, where darker shades represent higher values.

RESULTS

Demographic Characteristics of Butchery Personnel

Key variables of demographic characteristics reported included gender, age, education level, and work experience (Table 2). The majority of respondents were male (94%), with female respondents accounting for only 6.4%. Meru had the highest proportion of male participants (98%), while Embu had the highest proportion of females (13%). Regarding age, the most represented group was 31–40 years (39%), followed by those aged 21–30 years (29%). Only 8.3% of the respondents were over 50 years old, and none were below 20. In terms of education, most participants had attained secondary level education (49%), while 37% had post-secondary education. A small number reported primary (13%) or non-formal education (2%). For experience, the most common category was 3–5 years (47%), followed by 1–3 years (28%) and less than 1 year (25%).

Table 2: Demographic characteristics of personnel working in butcheries

	Characteristic	Tharaka-Nithi n = 26	Embu n = 32	Meru n = 51	Overall n = 109
Gender	Male	24 (92%)	28 (88%)	50 (98%)	102 (94%)
	Female	2 (8%)	4 (13%)	1 (2%)	7 (6%)
Age	21-30	8 (31%)	13 (41%)	11 (22%)	32 (29%)
	31-40	10 (38%)	10 (31%)	22 (43%)	42 (39%)
	41-50	5 (19%)	5 (16%)	16 (31%)	26 (24%)
	Above 50	3 (12%)	4 (13%)	2 (4%)	9 (8%)
Education	Non-Formal	0 (0%)	1 (3.1%)	1 (2.0%)	2 (1.8%)
level	Primary level	4 (15%)	4 (13%)	6 (12%)	14 (13%)
	Secondary level	13 (50%)	13 (41%)	27 (53%)	53 (49%)
	Post-secondary	9 (35%)	14 (44%)	17 (33%)	40 (37%)
Experience	Less than 1 year	5 (19%)	5 (16%)	17 (33%)	27 (25%)
	1 <3 years	7 (27%)	13 (41%)	11 (22%)	31 (28%)
	3 – 5 years	14 (54%)	14 (44%)	23 (45%)	51 (47%)

Types and Distribution of Meat Sold in Butcheries

The study primarily focused on beef and poultry, which are the most commonly consumed sources of meat in the study area. However, there was also an interest in mapping the distribution of other meat types available in butcheries across the urban population centres. The finding of the study showed that beef was the most widely retailed, followed closely by poultry (Fig. 1). Butcheries that stocked poultry often did not sell it as a standalone product; rather, poultry was used to compliment beef which was the primary meat offering. In addition to beef and poultry, other animal species such as goat and pork were also stocked, though in much

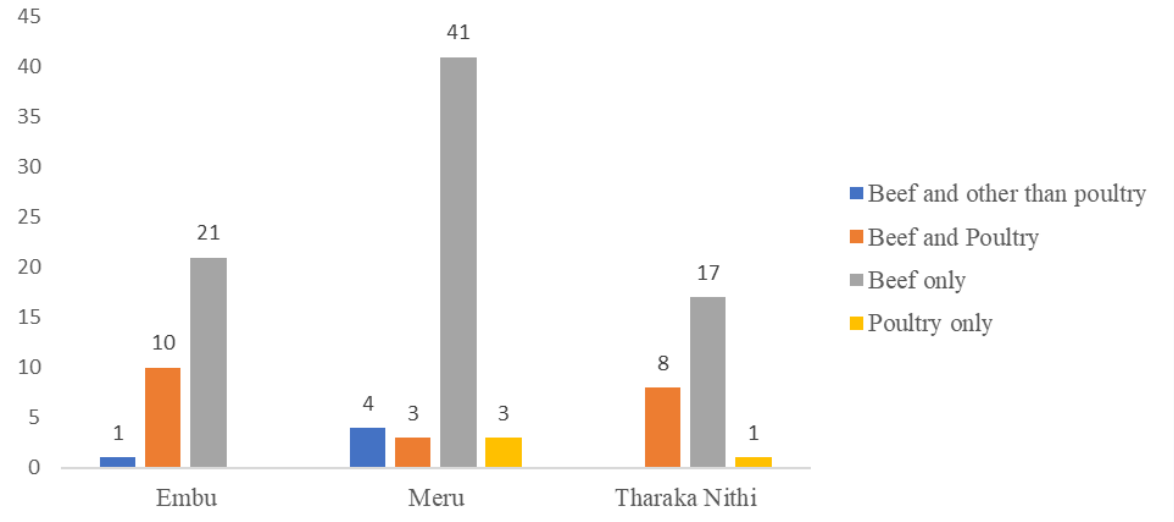
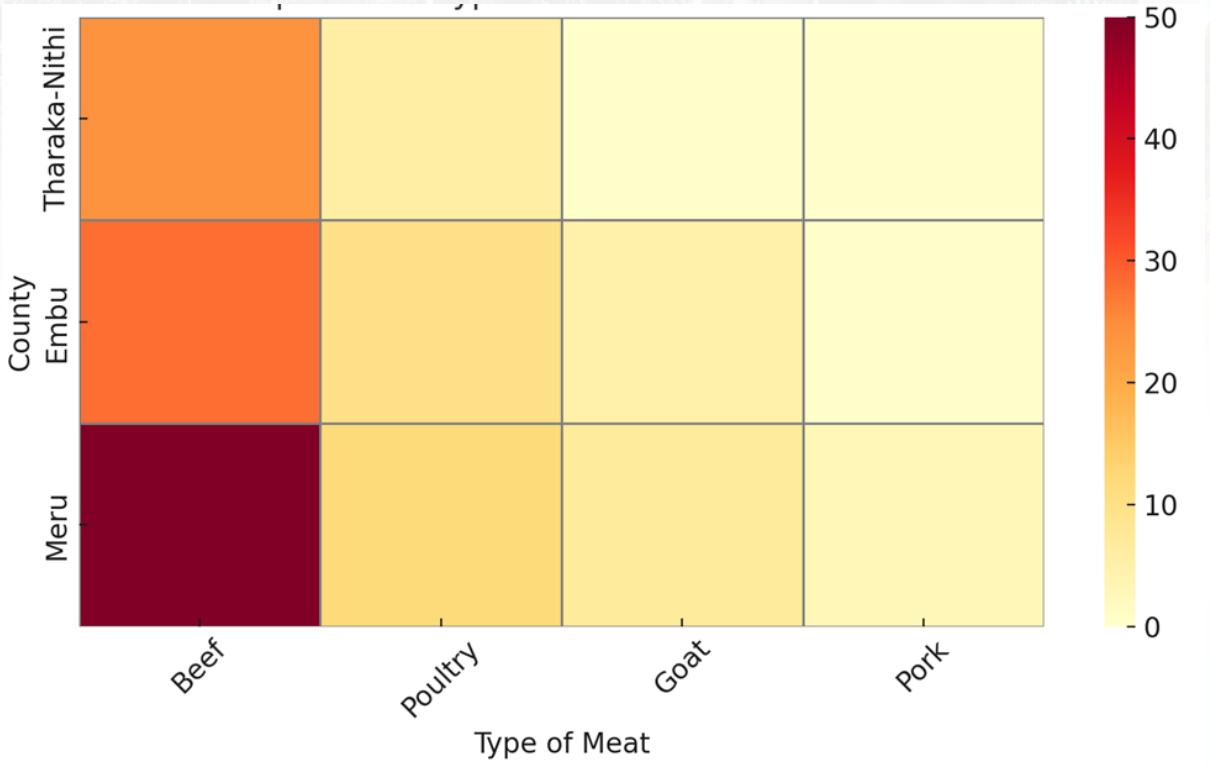


Figure 1: The distribution of beef, poultry and other meat types sold in Eastern Kenya Butcheries

Figure 2 presents a heatmap showing the distribution intensity of different meat types retailed across butcheries in Embu, Meru and Tharaka-Nithi, counties. The visual intensity reflects relative frequency, with darker shades indicating higher availability. Beef was the dominant meat type across all three counties, with Meru County exhibiting the highest frequency. Poultry was also widely sold, though in combination with beef, rather than as a stand-alone offering. Goat meat was present in Embu and Meru counties, while completely absent in Tharaka-Nithi County. Pork was least common, recorded only in Meru County. These patterns suggest a regional variation in meat preference and supply, with beef maintaining a central role in urban meat consumption, while other meats like pork and goat are more localized or secondary in distribution.



The colour gradient reflects the relative frequency of each meat type per county, where darker shades represent higher values

Figure 2: Heatmap showing the distribution of meat types sold across counties

Sources of Beef and Poultry Meat Retailed in Butcheries by Counties

Majority of beef retailers bought their meat from licensed slaughterhouses. In some cases, particularly in Meru County, retailers procured live animals directly from farmers in Isiolo town. However, even in such cases, the animals were still taken to official slaughterhouses for inspection and certification by veterinary officers prior to slaughter and distribution to butcheries. .

There were no significant differences observed in the sources of beef across the three counties, indicating that slaughterhouses remain the primary source of beef regardless of location.

In contrast, the sourcing of poultry meat was notably more diverse. Unlike beef, poultry marketing and slaughter often bypass formal health inspection systems, with no mandatory requirement for certification prior to sale. Statistical analysis revealed a significant difference (χ^2 = 24.712, p = 0.0004) in poultry sourcing practices across the counties (Table 3). The majority of poultry retailers, especially in Tharaka-Nithi County, preferred to buy directly from farmers, while others sourced chicken from local markets.

Table 3: Sources of beef and poultry for raw meat retailers in Embu, Meru, and Tharaka-Nithi counties

County	Response	Frequency	Percent	Total	X^2, p -value
Embu	Directly from farmers	7	17.9	13	24.712, 0.0004
	Market	6	15.4	(33.4%)	
Meru	Directly from farmers	10	25.6	16	
	Market	6	15.4	(41%)	
Tharaka- Nithi	Directly from farmers	9	23.5	10	
	Market	1	2.1	(25.6%)	

n = 39

Meat Turnover Rates and Associated Storage Safety Risks in Butcheries

The duration between the reception of meat into the butchery and its complete sale was assessed to understand turnover and potential public health risks. In this study, the time to complete sale ranged from less than 24 hours to up to three days. The study revealed that the majority of meat was sold within 36 to 48 hours of arrival (Fig. 3). Only a small proportion of butcheries had meat remaining for sale beyond the third day, suggesting relatively fast turnover. However, this also raises concerns about storage conditions, particularly in facilities lacking refrigeration or proper hygiene practices. Meat is highly perishable commodity due to its rich nutrient profile and high moisture content, which creates a favourable environment for microbial growth, particularly under warm storage conditions. Monitoring the duration of meat storage is essential for ensuring food safety, especially in informal retail environments where cold chain infrastructure may be inadequate or absent.

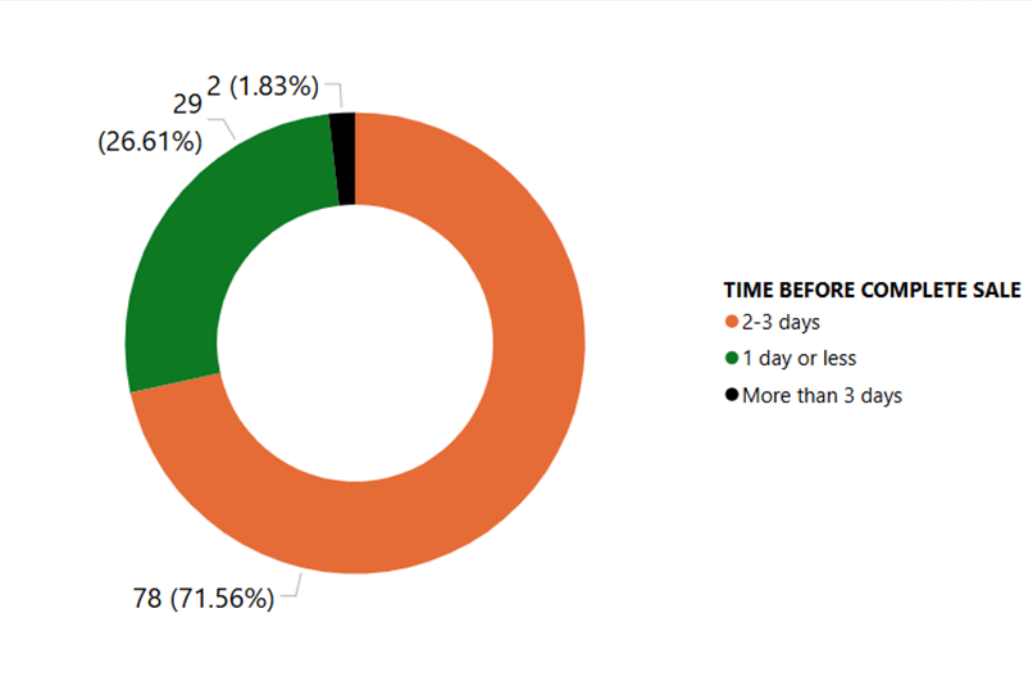


Figure 3: Distribution of time taken to completely sell meat in butcheries, showing the proportion sold within 1 day or less, 2–3 days, and more than 3 days after arrival.

Overnight Meat Storage Practices and Species Separation in Butcheries

To assess food safety practices in butcheries, the study examined overnight storage methods of meat, with a focus on temperature control and species separation. The results showed that a greater proportion of butcheries stored meat at room temperature in all counties, typically by hanging it on hooks, rather than under refrigeration (Table 4). There were statistically significant differences across counties in the use of refrigeration systems (χ^2 = 16.175, p = 0.0003). Butcheries in Embu County were significantly more likely to employ refrigeration for meat storage, whereas those in Meru and Tharaka-Nithi predominantly stored meat at ambient temperatures overnight. In terms of species separation during storage, only 12.8% of retailers reported separating different types of meat, while a striking 87.2% did not. This practice raises public health concerns, especially regarding cross-contamination risks and meat quality degradation.

Table 4: Overnight storage methods by county and their association with refrigeration use

Counties		Frequency	Percent	Total N (%)	X^2, p -value
Embu	Refrigerate	17	15.5	32	16.175, 0.0003
	Room temperature (Hanging on hook)	17	15.5	31%	
Meru	Refrigerate	7	6.2	51	
	Room temperature (Hanging on hook)	44	40.2	46.4%	
Tharaka-Nithi	Refrigerate	1	3.1	26	
	Room temperature (Hanging on hook)	22	20.6	22.7%	

n = 109

Predictors of Species Separation Practices in Butcheries

To determine the factors influencing whether species separation was practiced in butcheries, a binary logistic regression analysis was conducted. The dependent variable was species separation (1 = Yes, 0 = No), while predictor variables included gender, age, education level, and work experience. Age and level of education were statistically significant ($p < 0.05$) predictors of species separation (e.g., poultry and beef) during storage (Table 5). Specifically, individuals aged above 50 were significantly less likely to practice species separation compared to those aged 20–30 (OR = 0.14, p = 0.016), suggesting a potential association between age and heightened concern for food hygiene or compliance.

In terms of education, personnel with primary education had 5.15 times higher odds of practicing species separation compared to those with non-formal education (p = 0.005). Interestingly, those with secondary education had even greater odds (OR = 10.17, $p < 0.001$), indicating a strong and significant positive relationship between educational attainment and the adoption of proper meat handling practices. However, gender and experience were not statistically significant ($p > 0.05$) predictors in this model. These findings suggest that age and education play a key role in promoting safer meat handling practices. The overall model had a Tjur's $R^2 = 0.75$, suggesting a good level of explanatory power. Generally, experience and level of education had positive influence on specie separation.

Table 5: Logistic regression of factors influencing species separation during meat storage

Characteristics	Predictors	Odds Ratios	Std. Error	95 % CI for Odds Ratio	Z-value	p-value
Constant	(Intercept)	244.96	319.76	0.11–1.25	0.01	0.990
'Female'	Gender [Male]	0.00	0.00	0.01–1.91	-0.01	0.989
Reference	Age31- 40	0.40	0.29	0.09–1.57	-1.27	0.202
'Age 20- 30'	Age 41-50	1.17	0.85	0.27–4.82	0.22	0.829
	Age [Above 50]	0.14	0.11	0.03–0.65	-2.42	0.016
Reference 'Less	Experience1-3 Years	0.64	0.35	0.22–1.85	-0.81	0.419
than 1 year'	Experience3-5 Years	1.32	0.85	0.38–4.83	0.44	0.661
Reference 'Non-formal education'	Education [Primary]	5.15	2.99	1.71–16.97	2.82	0.005
	Education [Secondary]	10.17	6.44	3.15-38.68	3.66	<0.001
Observations = 109						
R^2 Tour = 0.75						

Hygiene Practices in Meat Retail Establishments on Cleaning and Sterilization of Equipment, Storage Facilities and Premises

Cleaning Frequency of Meat Handling Equipment, Storage Facilities and Butcheries Premises

The study assessed hygiene practices in butcheries by examining the cleaning frequency of three key areas: meat handling equipment (e.g., knives, cutting boards), meat storage equipment (e.g., hooks, refrigerators) and the butchery premises themselves (Table 6). The cleaning frequency of meat handling equipment was generally high across all counties, with Embu County reporting the highest rate of multiple daily cleanings (62.5%). However, the differences across counties were not statistically significant.

In contrast, the cleaning of meat storage equipment showed more variation. A significantly larger proportion of respondents in TNC and Meru reported daily cleaning (70.0% and 67.5% respectively) compared to Embu (43.5%). This difference was statistically significant (χ^2 = 19.485, p = 0.0006).

Regarding butchery premise cleaning, both Meru (58.8%) and TNC (65.4%) had a high proportion of respondents who cleaned their premises once daily, while Embu (46.9%) had more who cleaned twice daily. Nevertheless, the differences in cleaning patterns were statistically significant across counties (χ^2 = 16.865, p = 0.0021), highlighting variability in hygiene routines. These findings suggest that while basic hygiene is practiced across all counties, there are important differences in rigor and consistency, particularly in storage and premise cleaning, with potential implications for meat safety.

Table 6: Cleaning frequency of meat handling equipment, storage facilities and butchery premises by county

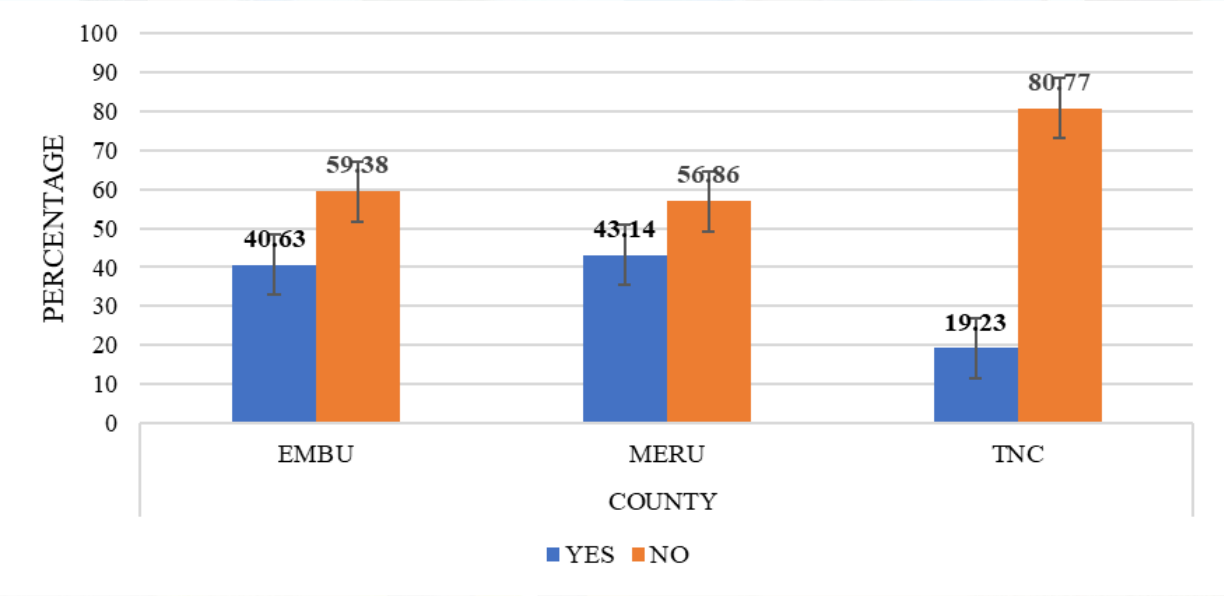
		Counties			X^2, p -value
Hygiene Practice		Embu	Meru	Tharaka-Nithi	
Meat handling equipment cleaning frequency (%)					
	Once daily	37.5	47.06	53.9	1.598, 0.450
	More than Once	62.5	52.94	46.15	
Meat storage equipment cleaning frequency (%)					
	Daily	43.5	67.5	70.0	19.485, 0.0006
	Weekly	47.8	20.0	20.0	
	Cannot tell	8.7	12.5	10.0	
Butchery/Premise cleaning frequency (%)					
	Once daily	18.7	58.8	65.4	16.865, 0.0021
	Twice daily	46.9	21.6	23.1	
	When dirty	34.4	19.6	11.5	

n = 109

Sterilization Frequency of Meat Handling Equipment, Storage Facilities and Butcheries Premises

Sanitation plays a vital role in maintaining hygiene in meat retail establishments. In this study, the practice of sterilizing meat handling equipment and butchery premises was assessed both in terms of its prevalence and the influence of key predictor variables. The highest proportion sterilization was reported in TNC, where 80.77% of respondents indicated they sterilize equipment and premises (Figure 4). In contrast Meru County had the lowest proportion, with only 43.14% reporting sterilization. The study also dissected the predictor variables to find if there was any which significantly contributed to sanitation practices in the establishments (Table 7).

Gender, experience and level of education had no statistically significant contribution sterilization as a practice. Individuals who were aged between 31 -40 and those above 50 were more likely to sterilize the equipment and premise compared to other categories of age. These differences were also statistically significant at CI 95%.



Where Yes = sterilize and No = do not sterilize

Figure 4: Proportion of butcheries practicing equipment and premise sterilization

To further understand the factors influencing this practice, a binary logistic regression analysis was conducted (Table 7). The model examined the impact of gender, age, experience, and education level on the likelihood of sterilization. The analysis revealed that age was the only statistically significant predictor of sterilization practices in butcheries. Specifically, individuals aged 31–40 years had nearly four times higher odds of practicing sterilization compared to those aged 21–30, with an odds ratio (OR) of 3.94 and a p-value of 0.044. Moreover, those in the 41–50 years age group were even more likely to engage in sterilization, with an OR of 6.68 and a p-value of 0.007, indicating a strong and statistically significant relationship. In contrast, gender, experience, and level of education were not significantly associated with sterilization practices. While individuals with 3–5 years of experience demonstrated relatively high odds of sterilization (OR = 4.05), this finding was not statistically significant (p = 0.064), suggesting only a borderline effect. Overall, the logistic regression model had a Tjur's R^2 value of 0.214, indicating a modest level of explanatory power in predicting sterilization behaviour based on the included demographic variables.

Table 7: Binary logistic regression analysis of predictors of sterilisation practices in butcheries

	Use of Sterilizer					
Characteristics	Predictors	Odds Ratios	Std. Error	95% CI for Odds Ratio	Z-value	p-value
Reference 'Female'	(Intercept)	2.91	4.13	(0.23–83.93)	0.75	0.452
	Gender [Male]	0.42	0.53	(0.02–3.75)	0.69	0.492
Reference Age '21 – 30'	Age 31-40	3.94	2.69	(1.07–15.87)	2.01	0.044
	Age 41-50	6.68	4.74	(1.73–28.88)	2.68	0.007
	Age [Above 50]	0.70	0.48	(0.18–2.69)	-0.52	0.603
Reference Experience 'Less than 1 year'	Expirience1-3 Years	0.74	0.39	(0.26–2.11)	-0.56	0.575
	Experience 3-5 years	4.05	3.05	(1.02–21.21)	1.85	0.064
	Education [Primary]	0.45	0.27	(0.13–1.46)	1.31	0.191
	Education [Secondary]	0.75	0.46	(0.23–2.47)	0.47	0.641
Observations = 109						
R^2 Tjur = 0.214						

Environment, Water and Sanitation Facilities in Meat Retail Outlets

This study assessed the availability and source of water, sanitation facilities, and waste disposal systems across butcheries in the three counties. the source of water varied significantly across counties ($\chi^2 = 17.408$, $p = 0.00016$; Table 8). The majority of butcheries in all three counties relied on treated municipal water, with the highest proportion reported in Meru County (88.2%). However, river water use was reported exclusively in Meru (11.8%) and Tharaka-Nithi (7.7%), while water vendors were a more common source in Embu (18.8%) and TNC (7.7%).

Regarding in-premise facilities, over 50% of establishments in each county had sinks within the butchery premises, with Meru (78%) having the highest proportion. The differences across counties were not statistically significant ($p = 0.229$). The presence of toilets near the butcheries was highest in Embu (75%), followed closely by Meru (69%) and TNC (65%) but the differences were not statistically significant either.

In terms of waste disposal or drainage systems, Tharaka-Nithi County (62%) had the highest reported availability of waste disposal sites within the vicinity (approximately 100 meters) of the butcheries, while Embu had the lowest (53%) but the differences were not significant.

Table 8: Distribution of water sources, sanitation facilities, and waste disposal systems by county

Environment, water and sanitation factors		Embu (%(n))	Meru (% (n))	Tharaka-Nithi (%(n))	X^2, p - Value
Water source	Municipal	81.3 (26)	88.2(45)	84.6(22)	17.408,
	Vendors	18.8(6)	0(0)	7.7(2)	0.00016
	River	0(0)	11.8(6)	7.7(2)	
Sink within Premise	Yes	53(17)	78(40)	69(18)	2.946,
	No	47(15)	22(12)	31(8)	0.229
Toilet in vicinity	Yes	75(24)	69(35)	65(17)	0.683,
	No	25(8)	31(17)	35(9)	0.717
Waste disposal/drainage in vicinity	Yes	53(17)	59(30)	62(25)	0.4576, 0.7955
	No	47(15)	41(22)	38(1)	

n = 109

Compliance of Butchery Personnel with Government Food Safety and Hygiene Regulations

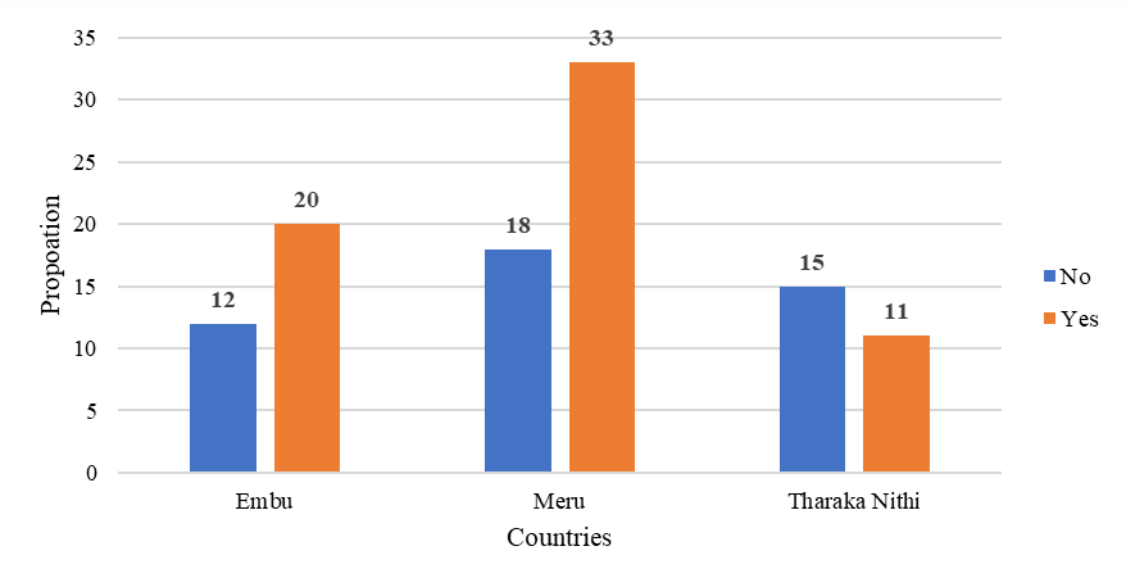
The enforcement of food safety and hygiene standards in Kenya falls under the mandate of the Ministry of Public Health, operating through county governments. Among its key roles is ensuring that food handlers obtain mandatory medical check-ups and are issued food handler's certificates, as stipulated by the Public Health Act (Government of Kenya, 2016). This study assessed compliance with these regulations across the three counties. The findings of the study showed that 100% of raw meat handler's in the surveyed butcheries had valid food handler's certificates, indicating full compliance with this requirement (Table 9). However, adherence to the recommended three-month interval for medical check-ups was less consistent. In Embu County, only 50% of personnel had undergone medical check-up in the last three months, while in Meru and TNC, the figures were 40% and 38%, respectively. The rest had check-ups ranging from three to six months prior, and a small number reported having medical assessments more than six months ago. Although these differences were not statistically significant, they suggest potential gaps in routine health monitoring.

In terms of government hygiene inspections, most respondents indicated that visits by public health officers occurred once a month, with 91% in Embu, 86% in Meru, and 88% in TNC reporting this frequency. Weekly inspections were rare across all counties. Training of butchery personnel was also explored as part of hygiene enforcement and skill development. The majority of workers in all counties had received some form of training, either formal or informal/apprenticeship (Figure 5). The training mainly focused on meat cutting techniques, sanitation and personal hygiene practices within the premises.

Table 9: Compliance with medical check-ups, food handler certification and government hygiene inspection by County

	Response	Embu % (n)	Meru % (n)	TNC % (n)	X^2, p-value
Food handler's medical check-up	Yes	100 (32)	100 (52)	100 (26)	3.0806, 0.0143
	No	0 (0)	0 (0)	0 (0)	
Last medical check-up	Less than 3 months	50 (16)	40 (20)	38 (10)	4.0734, 0.6667
	3-6 Months	41(13)	44 (22)	50 (13)	
	More than 6 months	9 (6)	12 (6)	12 (3)	
	Once only	0 (0)	2 (4)	0 (0)	
Govt inspection frequency	Weekly	9 (3)	14 (7)	31(3)	11.1846, 0.6715
	Once a month	91 (29)	86 (45)	88 (23)	

n = 109



Where Yes = Trained and No = Not trained

Figure 5: Proportion of personnel trained in food safety handling practices per county

Personnel Hygiene and Money Handling Practices Within Butcheries

Personnel hygiene and financial transaction practices in meat handling environments play a critical role in maintaining food safety standards. One potential contamination route is handling money while simultaneously managing raw meat, which increases the risk of microbial transfer. This study assessed payment methods, the presence of separate cashiers, and the use of protective clothing by meat handlers in Embu, Meru, and Tharaka-Nithi counties. The majority of butcheries in all three counties accepted both cash and mobile money payments, 97% in Meru, 94% in TNC, and 96% in Embu (Table 10). Use of only cash or only mobile money was uncommon. These differences in payment methods were not statistically significant.

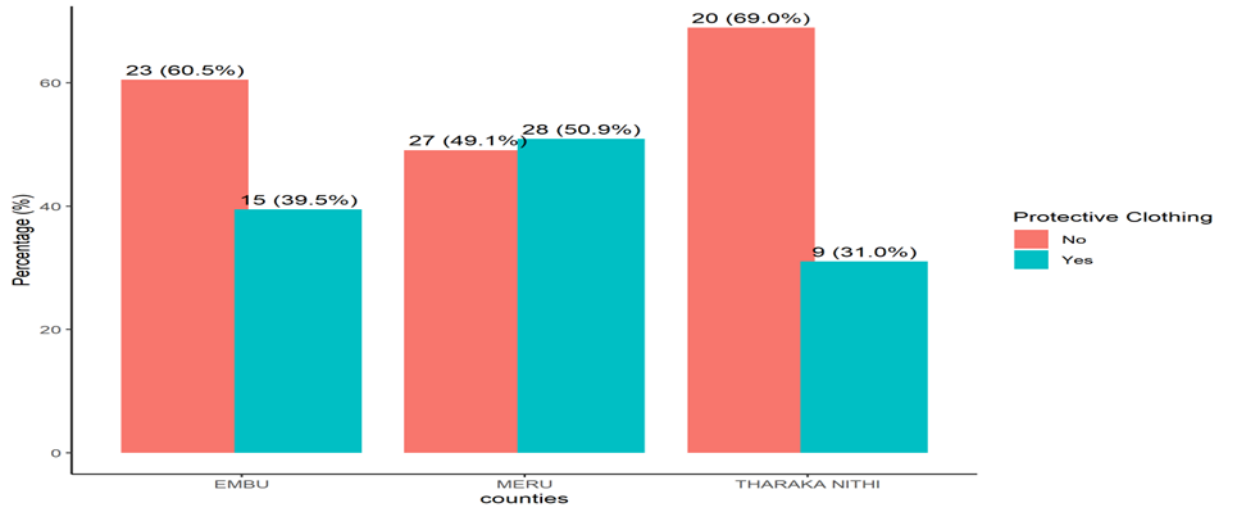
In Meru, 56% of butcheries reported having a designated cashier, compared to 33% in Embu and 35% in TNC (Table 10). However, this difference was also not statistically significant, although it suggests a potential area for improvement in hygiene protocol enforcement.

Table 10: Payment methods and presence of designated cashiers in butcheries by county

		Embu % (n)	Embu % (n)	Tharaka-Nithi % (n)	X^2, p - value
Payment Method	Cash only	3 (1)	4 (2)	0 (0)	3.301, 0.5088
	Mobile Money only	0 (0)	2 (1)	4 (1)	
	Both	97 (31)	94 (49)	96 (25)	
Separate Cashier	Yes	56 (18)	33 (17)	35 (9)	4.759, 0.0926
	No	44 (14)	67 (35)	65 (17)	

n = 109

In terms of personnel protective clothing, Figure 6 highlights that their use (i.e. aprons, gloves, water resistant shoes or hairnets) was not consistently practiced across the counties. Meru County had the highest proportion of individuals wearing protective clothing (50%), while TNC had the lowest at 31%. Wearing protective clothing is crucial not only for the safety of meat handlers but also for preventing cross-contamination of meat products from the personnel.



Where Yes = Have protective clothing and No = Does not have protective clothing
Figure 6: Proportion of butchery personnel wearing protective clothing

DISCUSSIONS

This study found that the meat retail industry is highly male-dominated, with 94% of respondents being men. This aligns with findings by Koech *et al*. (2024) and Chepkemoi *et al.* (2016). Similar gender patterns were reported in Ghana, Ethiopia, South Africa, and Uganda (Asati *et al.,* 2024; Siluma *et al.,* 2023; Nabwire *et al.,* 2023; Kanko *et al.,* 2023). These results suggest persistent gender roles and socio-cultural norms that limit women's participation in the sector. Addressing this gap requires targeted interventions to support gender equity through skills training and inclusive policy frameworks.

The age group of raw meat sellers was in this study reported to be between 30 - 40 that is 39%. Other studies in Kenya also reported that age wise, most raw meat handlers were above 35 years of age and below 50 years (Chepkemoi *et al.,* 2016, Kunyanga *et al.,* 2021, Koech *et al.,* 2024). This means that the industry is energy demanding and is therefore attracts men of middle age compared to a youthful population. Education plays a major role in transferring information. In this study the most educated individuals were more likely to carry out better hygiene practices than the non-educated. These results have also been replicated in Uganda and Nigeria (Kehinde *et al.,* 2020, Grace, 2022). Regular trainings can therefore be used to target food safety enhancement programs at these establishment.

From the study, the most common red meat was beef (Figure 1). On the other hand, the main source of white meat was chicken which was mainly sold within the butcheries as well. In this study beef sold alone was highest in all butcheries. This was followed by beef together with chicken and finally beef with meat from other species such as goats and sheep. However the sale

of chicken meat alone was very rare (less than 5%) in all three counties. The chicken meat value chain was not structured between the farmer to the butchery. This was unlike beef where the cattle had to be slaughtered at slaughterhouses before distribution to butcheries. Chicken meat value chain is non-structured and could be a source of contamination to the meat value chain. There is lack of veterinary inspection during slaughter unlike in beef where the cattle are slaughtered in designated slaughterhouses with supervision from veterinary officers. This was noted as big gap which should be looked into in the spread and contamination of chicken meat by sickly birds which is a rapidly growing industry (Gulati *et al.,* 2022)

Meat is a highly perishable protein source and has a very short lifespan, especially when not refrigerated (Johansson *et al.,* 2020). From the current study it is evident that meat could actually take more than three days in a butchery (Figure 3). For most of the establishment the meat was sold within 36 to48 hours. In another study in Uganda, only 10% of meat in butcheries was sold within 1 day (Nabwiire *et al.,* 2023) According to the Kenyan Standards (KS EAS 1190: 2023), the regulation states that slaughterhouse products should be frozen or refrigerated. It is evident that regulations are set by the government but very little compliance is observed within the butcheries. There is a need to have strict follow ups and possible fines to those who do not comply with these regulations.

Without refrigeration, microbial multiplication could rise above the levels set by KEBS and other standards which is set at 316 CFU/g for coliforms (Commission regulation 2005; NDVQPH, 2010). With only 25% of butcheries installed with refrigerators, the risk is very high. Some studies have reported that refrigerators in butcheries available are not more than 11% in Nairobi and 39% in Isiolo (Chepkemoi *et al.,* 2016). In Uganda, refrigeration systems were recorded in 26% (Nabwiire *et al.,* 2023) of butcheries while in Nigeria 42% of butcheries reported to refrigerate meat (Kehinde *et al.,* 2020). This trend is alarming and could be a possible hotspot for foodborne diseases outbreaks. Microorganisms are temperature specific (McMeekin *et al.,* 2018), and therefore refrigeration is among the first steps in controlling microbial multiplication and possible outbreak of foodborne diseases.

Separation of species and different types of meat play a major role in controlling cross-contamination. Therefore, having beef and chicken meat in close proximity with each other will cause contamination of all types of meat with a wide range of microorganism. This is because the different sources of the animals are also accompanied by different types of microbes. Separation of species is therefore an important step in controlling possible zoonotic bacteria between species.

In the current study, separation was only done in 12.8 % of the butcheries. Separation of species was explained by age, where individuals 41 to 50 years were more likely to separate the species. And also, more educated personnel were likely to separate species compared to those with lesser level of education. This different was significant (p =0.001).

At the butchery the equipment used in handling and storing meat such as knives, sharpening tools, refrigerators, hooks and cutting boards (Kunyanga *et al.,* 2019) were considered as those likely to breed microorganisms due to their frequency of contact with meat. Their cleaning frequency is critical since sales occur at unprecedented intervals between one customer and another. The Meat Control Act, Cap 356 under the meat control regulations of 1973, state that meat handling equipment should be washed with soap and water and undergo sterilization with hot water (Meat Control Act cap 356). One of the methods in controlling microorganisms is through physical removal by cleaning. Cleaning removes most microorganisms and should be followed by sterilization for microbial safety (Urban-Chmiel *et al.,* 2025). This was not the case in this study and should be a recommendation during cleaning to the local butcheries. This is because Meat contact surfaces have had pathogenic microorganisms (*E. coli, Staphylococcus aureus and Salmonella*) isolated from them (Hiko *et al.,* 2025, Kenaw *et al.,* 2024, Kanko *et al.,* 2023).

When it comes to premises, the regulations are that the floor and walls should be cleaned at least once daily followed by sterilization (US 736: 2019 Section 7.5). Premise where food is being sold as a major factor in food safety. Hiko and others (2025) have isolated pathogenic microorganisms from the butchery floors. The cleaning frequency was different in all study sites while daily cleaning was common in TNC while twice -daily cleaning was common in Embu County. Overall, it can be concluded that cleaning practiced was a well-established practice among butcheries in the study area with 100% of the respondents doing daily cleaning and sometimes twice per day. Previous studies in Kenya generalized cleaning practice with no differentiation between the equipment and the premise, (Chepkemoi *et al.,* 2016, Kunyanga *et al.,* 2019). In all the above studies, cleaning was done daily in 100% of the butcheries. Since the results show that the younger individuals are likely to carry out sterilization, it is recommended that this population should be hired or contracted to carry out the hygiene practices within the butcheries.

The Kenyan Standard (KS EAS 1190: 2023) state that water used for cleaning of meat and equipment should be portable. The water provided by the government for domestic use is always treated and portable. The certainty of water quality from vendors could not be determined and river water carries with it a lot of environmental pathogens which is a possible source of contamination

(Berhanu *et al.,* 2024, Njuguna *et al.,* 2020, Mbui *et al.,* 2016). A significant number of butcheries draw water from municipal sources (Over 80%) per county. This practice could be among the steps encouraged towards improvement of hygiene in the establishments. Potable water will enhance even personnel hygiene practices like hand washing and hand washing sinks in the premise which is already at over 50% according to this study.

Waste disposal sites and toilets are useful in managing environmental and human waste. In this study, the proximity of toilets to a point where they could become sources of contamination was considered. Open waste disposals within vicinity could act as sources of cross contamination especially with flies. We reported that not less than 60% establishments had toilets within the vicinity while more than 50% had waste disposal sites/ and draining facilities too close to the butchery. The toilets could act as sources of contamination if not well maintained, the same goes to waste disposal sites. These need to be well regulated since none is mentioned in the meat control act CAP 456 of Kenya.

The government is responsible for ensuring that the set-out regulations are belong followed to the latter by the raw meat handlers. This is usually done by Public health officers who are mandated by frequent inspection of these premises. This study reported that all butcheries (100%) had at one point been visited by a public health officer. It is also a requirement that food handlers are tested and given food handlers certificate if they pass the test. In this study all (100%) the participating butcheries personnel had food handlers' certificate in all three counties. Medical certificates should be reviewed after every 3 months and not later than 6 months (Government of Kenya, 2016). In our study we report that majority of the certificates were reviewed in the last 3- 6 months in all three counties, however, some food handlers had not done a medical check-up for a period exceeding six months (33%) while others never reviewed after getting the first food handlers' certificate (4% in Meru county only). These results indicate a disconnect between legal information and implementation from the government side.

Training of food safety during handling of meats is essential to maintain a hygienic environment and reduce cross contamination (Government of Kenya, 2016). Training both formal and informal were considered crucial in the current study and there was a positive trend. Training has a positive impact on personnel practices such as wearing of protective clothing (hair nets, water proof gumboots, gloves, nose masks and bright aprons) which scored poorly in the current study. Money handling could be a possible source of contamination when personnel do not wash hands between meat

handling and money. Although this is not a recommendation in the Kenyan standard, it should be included in the legislation. However, with the increase in mobile money transfer in Kenya (Ngugi *et al.,* 2010) money contact is expected to be low. On the downside, the personnel might need to check payment messages in the phone, and therefore the phone might become the next source of meat contaminant. Either way this study, recommends separate cashiers per establishment.

CONCLUSION AND RECOMMENDATION

Meat is major protein source to the entire population and its sale is increasing with urbanization and population rise. The meat value chain a likely contributor to outbreak of food borne diseases and therefore it needs a lot of attention in control of microbial contamination and growth. From this study, it evident that there are inadequate hygienic practices which still occur among significant amount of butcheries. Despite regular government inspection, most butcheries do not comply with basic regulatory requirements. The study therefore recommends regular training of personnel on meat hygiene and safety in handling, processing and storage. Development of a standardized HACCP system is missing in butcheries and therefore each establishment is designed different from each other. The developed HACCP plan and system can be used as a standard by the inspecting public health officers and also in training the butchery owners and workers.

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