FOOD SAFETY KNOWLEDGE, ATTITUDES AND PRACTICES AMONG READY-TO-EAT MEAT RETAILERS IN MERU, EMBU AND THARAKA-NITHI COUNTIES, KENYA

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Abstract
In Kenya, weak enforcement of food safety regulations and limited awareness among meat value chain actors heighten outbreak risks, but limited data exists about the knowledge, attitudes and practices of RTE meat retailers outside Nairobi posing a possible foodborne disease outbreak. The main objective of this study was to assess the knowledge, attitudes, and practices of RTE meat retailers in Meru, Embu and Tharaka-Nithi counties and determine their association with demographic characteristics. A cross-sectional survey was conducted among 107 randomly selected RTE meat retailers, using a structured and pre-tested KAP questionnaire administered in hotels and retail outlets between May and August 2025. Data were analyzed using descriptive statistics, Kruskal–Wallis, and Mann–Whitney U tests in STATA version 18 to examine associations between demographic characteristics and KAP scores. Results showed that males constituted 53.3% (57) of retailers, with secondary education being the most common level attained (41.1%, 44). Overall, food safety knowledge was satisfactory in hygiene (mean score 23.1 ± 8.0), while attitudes (51.0 ± 7.6) and practices (22.3 ± 3.2) were rated as neutral in hygiene. Education level, food safety training, and possession of a valid food handling certificate were significantly associated with significant KAP scores ($p < 0.05$), whereas gender, age, and work experience showed no significant effects. Across counties, Meru recorded the highest (Mean = 25.4) knowledge scores, while Embu had the highest attitude (54.1) and practice scores (23.6). Food safety training consistently emerged as the strongest predictor of improved KAP. Although most RTE meat retailers demonstrated satisfactory food safety knowledge, gaps in attitudes and practices remain, posing a potential public health risk. Regular, practical, food safety training and strict enforcement of certification requirements are recommended to enhance safe RTE meat handling.

Keywords: Food safety, Knowledge, Attitudes, Practices (KAP) Ready-to-eat meat, Handlers, Hygiene.

Introduction
The World Health Organization has highlighted food safety as a pressing international issue, outlining five core practices: ensuring cleanliness, keeping raw and ready-to-eat items separate, thorough cooking, maintaining appropriate temperatures, and careful inspection of raw ingredients (Haddad *et al.,* 2020; WHO, 2018). Foodborne illnesses persist as a major hazard, frequently resulting from poor handling procedures within food establishments and along the supply chain. Such outbreaks can affect extensive populations at once, thereby presenting a serious public health challenge (Islam *et al.,* 2023; Grace, 2015). The consequences of these diseases are particularly severe in low- and middle-income nations, particularly across Africa and sub-Saharan regions. In addition to immediate health implications, weak food safety standards hinder progress toward sustainable development goals aimed at reducing hunger and poverty, while also fostering public health and overall wellbeing (Hoffmann *et al.,* 2019; Morse *et al.,* 2018). In Africa, food contamination of microbial and chemical origin leads to about 91 million cases of acute illness and 137,000 deaths each year, accounting for 1,200 Disability-Adjusted Life Years (DALYs) per 100,000 individuals in Eastern and Southern regions (World Health Organization, 2016). In Kenya 100 deaths are reported daily from diarrheal diseases linked to contaminated foods (Ogumbo *et al.,* 2024).

Kenya and other low- and middle-income countries (LMICs), urbanization and changing consumer lifestyles have increased the demand for affordable protein sources, particularly RTE meat (McAfee *et al.,* 2010). However, weak enforcement of food safety regulations, inadequate infrastructure, and limited awareness of hygiene practices make urban retail outlets potential hotspots for foodborne disease outbreaks Studies report that food handlers contribute up to 50% of microbial contamination, with even higher risks expected in informal markets of LMICs like Kenya (Mwove *et al.,* 2020, Catherine *et al.,* 2021; Mwove *et al.,* 2025).

Food safety measures are essential in safeguarding individuals from diseases linked to contaminated food. These measures consist of a series of guidelines that food establishments must implement to guarantee safe consumption (Abegaz, 2022; Hassauer & Roosen, 2020). A fundamental component of food safety is correct handling, which covers the entire process of receiving, preparing, storing, and serving food until it is eaten. Each stage, from initial production to final consumption, demands strict attention to minimize the risk of harmful contamination (Holban & Grumezescu, 2018).

Assessment of KAP is anchored on the theory of planned behavior (Nickell & Hinsz, 2023). This theory speculates that the best predictor of an individual's behavior is the intention to perform the behavior (Divianjella *et al.,* 2020). This is grounded on three antecedents: subjective norms, attitudes, and perceived behavioral control (PBC) (Tao-Ing, 2022). Attitude, on the other hand, determines the level at which individuals have favorable or unfavorable assessment of a behaviour in question (Vamvaka *et al.,* 2020). This is influenced by beliefs individuals hold regarding such behavior and expectations from subjective norms. KAPs are critical determinants of safe food behaviors (Teferi, 2022). Adequate knowledge and skills, coupled with supportive infrastructure and training, can promote proper hygiene, while poor attitudes and misconceptions increase risks (Mulat *et al.,* 2024). Evidence further shows that factors such as formal education, training, and work experience positively influence hygiene practices (Zenbaba *et al.,* 2022). Yet, in Africa, many RTE meat retailers operate in informal environments with minimal infrastructure and limited food safety awareness. Despite the growing consumption of RTE meat in Kenya, few studies have examined the KAP of meat retailers outside Nairobi. Empirical evidence on the food safety KAP of RTE meat retailers in Kenya's regional towns remains scarce. This study therefore aimed to; assess the levels of food safety knowledge, attitudes, and practices, and examine factors associated with these KAP domains among RTE meat retailers in Meru, Embu, and Tharaka-Nithi counties. The findings will provide insights for strengthening training and regulatory interventions aimed at reducing foodborne disease risks.

Materials and Methods
Study Area and Sample Size Determination
A purposive selection of towns with high consumer traffic was made, followed by random selection of RTE meat retailers within each town. An individual from the premise that volunteered to participate in the study was interviewed. 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. The population of ready-to- eat meat retailers from which the sample size was collected were obtained from the county offices ministry of public health for each county. The total number of registerd butcheries (148) was used to calculate the sample size (107) using the Krejcie and Morgan formula. The individual samples per county was determined as a proportion from the registered butcheries as shown in table 1. Written informed consent was obtained from all participants. Ethical approval was obtained from the Chuka University Ethical Review Committee (Approval No. NACOSTI/NBC/AC-0812) and a research permit was issued by the National Commission for Science, Technology and Innovation (License No. 989690).

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

where, n = desired sample size
X^2 = Chi square value of 3.841 for 95% CI
N = Population size = 148
d = degrees of accuracy set at 0.05 for 95% CI
P = Population proportion (0.5)

$$n = \frac{3.841 \times 148 \times 0.5(1-0.5)}{\left[(0.05^2 \times (148-1)) + (3.841 \times 0.5 \times (0.5))\right]}$$

$$n = \frac{(142.117)}{(0.3675) + 0.96025}$$

$$n = \frac{142.117}{1.32775}$$

$$n = 107$$

Table 1: Distribution of samples among towns representing each county

County	Major Town	Registered Butcheries Around the Bus Stand	Sample size (n)
Tharaka-Nithi	Chuka	47	34
Meru	Meru	51	37
Embu	Embu	50	36
Total		148	107

CBD (Central Business District)

Data collection
The questionnaire had four sections namely; demographic characteristics of the retailers, food safety knowledge questions (16 questions), food safety attitude questions (14) and food safety practices questions (13). The level of knowledge of the food handlers was determined by scoring.
For each correct answer- Yes- 2 points, for wrong ones -No- 0 point, and for Unsure - 1 point. Based on the response to 16 knowledge questions, the scores could vary from 0 to 32. The range of 0 to 32 was determined and divided by three to give an approximate number used in creating the categories. The three categories were: scores between 0 to 11 were classified as poor, 12 to 22 as neutral, and 23 to 32 as satisfactory. For 14 attitude questions, the answers were pointed from 1 to 5 where 1 referred to strongly disagree and 5 strongly agree. Total scores could differ from 14 to 70: The categories created were 14 -32 for negative, 33 – 51 neutral and 52– 70 satisfactory. For 13 practice questions, the answers were; Yes (2) and No (1). The scores for practice could range from 13 to 26. The categories developed were; negative (13 -17), neutral (18-22) and satisfactory (23 -26). For all negatively phrased questions, reversed scoring was applied.

The questions were adopted from previous KAP studies and WHO recommendations for essential food safety requirement with modifications to fit the study (ul Haq *et al.,* 2018; Fariba *et al.,* 2018, Wangmo *et al.,* 2021; WHO, 2018). The scoring criteria is as shown in the table 2.

Table 2: Scoring criteria for assessing knowledge, attitude and practices of ready-to-eat meat Retailers

Food Safety Section	Number of Questions	Range	Criteria	Interpretation
Knowledge	16	0 -32	0-11	Poor
			12 -22	Neutral
			23 -32	Satisfactory
Attitude	14	14 - 70	14 -32	Poor
			33-51	Neutral
			52 -70	Satisfactory
Practices	13	13 -26	13 -17	Poor
			18 -22	Neutral
			23 -26	Satisfactory

Data analysis

The data was first coded for ease of analysis and analyzed using STATA version 18.0. The analysis included; percentages and frequencies. The questionnaire was pre-tested on 10 RTE meat retailers in a neighboring town to assess clarity and reliability. Cronbach's alpha coefficients for knowledge, attitude, and practice sections were 0.78, 0.81, and 0.74, respectively. Mean and standard deviation was calculated to determine the scores and their categories (Poor, neutral, and satisfactory). Data was tested for normality using Kruskal – Wallis test and Mann Whitney U-test and found to be non-normal, justifying non-parametric analysis. The significance threshold used was $p < 0.05$.

Results

Demographic Characteristics of Ready-to-Eat Meat Retailers

Across the three counties males constituted a slightly higher proportion (53.3%) than females (46.7%) (Table 3). The highest proportion of males was recorded in Tharaka-Nithi County (55.5%), while the lowest was in Embu County (52.9%). Age distribution showed that the 21–30 age group was most represented overall (24.3%), with the highest proportions in Tharaka-Nithi (27.8%) and Meru County (27.0%). The least represented age category was those above 50 years (15.0%), particularly low in Tharaka-Nithi (8.3%). The youngest group (18–20 years) was least represented in Meru (8.1%) but relatively high in Tharaka-Nithi (25%).

In terms of work experience, retailers with less than one year of experience formed the largest group (38.3%), with Tharaka-Nithi recording the highest proportion (41.7%). Those with over five years' experience were the least common overall (25.3%). Education levels were dominated by secondary education (41.1%), most prevalent in Tharaka-Nithi (47.2%). College education was the second most common (34.6%) and was relatively consistent across counties. Primary education was least common overall (13.1%), highest in Embu (17.7%) and lowest in Meru (8.1%). University education accounted for only 11.2% of retailers, with Tharaka-Nithi having the lowest representation (5.6%).

Regarding food safety training, 41.1% of retailers reported having received formal training, with Tharaka-Nithi recording the highest proportion (47.2%) and Embu the lowest (17.7%). Similarly, 44.6% of retailers held a valid food handlers' certificate, with Tharaka-Nithi again recording the highest proportion (69.4%) and Meru the lowest (40.5%).

Over half of retailers (54.2%) also reported selling raw meat alongside RTE meat products. This practice was most common in Embu (55.9%) and least common in Meru (37.8%).

Table 3: Socio-demographic characteristics of retailers of ready-to-eat beef and chicken Meat

Demographic Characteristics	Category	N (%) Total	Meru	TNC	Embu
Gender	Male	57 (53.3)	19 (51.4)	18 (52.9)	20 (55.5)
	Female	50 (46.7)	18 (48.6)	16 (47.1)	16 (44.5)
AGE	18-20	19 (17.8)	3 (8.2)	7 (20.6)	9 (25)
	21 -30	26 (24.3)	10 (27.0)	6 (17.6)	10 (27.8)
	31 -40	25 (23.4)	7 (18.9)	10 (29.4)	8 (22.2)
	41 -50	21 (19.4)	9 (24.3)	6 (17.6)	6 (16.7)
	Above 50	16 (15.1)	8 (21.6)	5 (14.8)	3 (8.3)
Experience	<1 Year	41 (38.3)	13 (35.1)	13 (38.2)	15 (41.7)
	1 - 5 Years	39 (36.4)	14 (37.9)	12 (35.3)	13 (36.1)
	> 5 Years	27 (25.3)	10 (27.0)	9 (26.5)	8 (22.2)
Education	Primary	14 (13.1)	3 (8.1)	6 (17.6)	5 (13.9)
	Secondary	44 (41.1)	16 (43.2)	11 (32.4)	17 (47.2)
	College	37 (34.6)	14 (37.8)	11 (32.4)	12 (33.3)
	University	12 (11.2)	4 (10.8)	6 (17.6)	2 (5.6)
Training	Yes	44 (41.1)	18 (48.6)	28 (82.4)	17 (47.2)
	No	63 (58.9)	19 (51.4)	6 (17.6)	19 (52.8)
Food Handlers Certificate	Yes	48 (44.9)	15 (40.5)	19 (55.9)	25 (69.4)
	No	59 (55.1)	22 (59.5)	15 (44.1)	11 (30.6)
Also sells Raw Meat	Yes	58 (54.2)	14 (37.8)	19 (55.9)	16 (44.4)
	No	49 (45.8)	23 (62.2)	15 (44.1)	20 (55.6)

TNC = Tharaka Nithi County

Food Safety Knowledge Attitude and Practices of Ready-to-Eat Meat Retailers
On knowledge of food safety, most participants (77.5%) knew what foodborne diseases are, while only 8 (7.5%) did not, and 16 (15.0%) were unsure (Table 4). Similarly, 66.4% were aware of how these diseases could be transmitted, though 11.2% lacked awareness and 22.4% were unsure. A large majority (79.4%) recognized that raw meat quality affects ready-to-eat meat quality, with 5 (4.7%) disagreeing and 15.9% unsure. Knowledge of spoilage signs in meat or poultry was high, with 86 (80.4%) affirming awareness, 7 (6.5%) denying it, and 13.1% unsure. About two-thirds (72, 67.3%) understood that cooked meat can be contaminated by surfaces previously used for raw meat, though 28.0% were unsure. Hand hygiene knowledge varied where only 47 (43.9%) believed hand sanitizers are effective as part of cleaning after handling raw meat. Ninety-four retailers (87.9%) recognized that unhygienic food handling can cause contamination, with only 3.7% disagreeing. Knowledge of safe storage practices was mixed: 53 (49.5%) knew cooked meat should be stored at specific temperatures, while 45 (42.1%) were unsure.

Table 4: Food safety knowledge of Ready-to-eat beef and chicken meat retailers

Knowledge Questions	Yes	No	Unsure
		N (%)	
Do you know what food borne diseases are?	83 (77.5)	8 (7.5)	16 (15.0)
Are you aware of how foodborne diseases can be transmitted?	71 (66.4)	12 (11.2)	24 (22.4)
Do you know that the quality of your raw meat affects the quality of ready-to-eat meat?	85 (79.4)	5 (4.7)	17 (15.9)
Do you know of any signs accompanied by spoiled meat or poultry?	86 (80.4)	7 (6.5)	14 (13.1)
Can cooked meat be contaminated by surfaces previously used for raw meat e.g. cutting boards?	72 (67.3)	5 (4.7)	30 (28.0)
Are hand sanitizers effective in killing most germs after handling raw meat?	47 (43.9)	20 (18.7)	40 (37.4)
When you handle food unhygienically can it cause food contamination with pathogenic microorganisms?	94 (87.9)	4 (3.7)	9 (8.4)
Is there a specific temperature at which cooked meat should be stored at?	53 (49.5)	9 (8.4)	45 (42.1)
Do you know how long cooked meat can safely remain unrefrigerated?	45 (42.1)	20 (18.7)	42 (39.2)
Can ready-to-eat meat be infected by flies and rodents?	94 (87.9)	2 (1.9)	11 (10.2)
Can improperly reheated cooked meat cause foodborne illness?	71 (66.4)	14 (13.0)	22 (20.6)
Do you know if meat can become contaminated even after thorough cooking?	70 (65.4)	18 (16.8)	19 (17.8)
Are you aware of the diseases commonly caused by contaminated beef or poultry (e.g., *Salmonella, E. coli*)?	58 (54.2)	21 (19.6)	28 (26.2)
Can using untreated water to wash meat or utensils cause contamination?	74 (69.3)	9 (8.4)	24 (22.3)
Do you know the importance of using clean gloves or tongs when serving meat?	83 (77.6)	5 (4.7)	19 (17.8)
Do you know of any government guidelines on handling ready-to-eat meat?	59 (55.1)	25 (23.4)	23 (21.5)

A large proportion (87.9%) acknowledged that ready-to-eat meat could be contaminated by flies and rodents, with just 2 (1.9%) disagreeing. Additionally, 66.4% recognized the risk from improperly reheated meat. About 65% of retailers acknowledged that contamination can still occur after thorough cooking from other sources like utensils and non-portable water among other environmental factors. Over half of the RTE meat retailers (54.2%) were aware of diseases caused by contaminated meat such as *Salmonella* and *E. coli*, though 26.2% were unsure. Most retailers (69.2%) understood that untreated water could contaminate meat or utensils, and 83 (77.6%) knew the importance of clean gloves or tongs. Finally, knowledge of government guidelines on ready-to-eat meat handling was generally moderate (55.1%). Generally, the highest awareness was on hygiene-related risks (over 80% for several questions), while the lowest knowledge was on safe storage duration, use of hand sanitizers, and food borne disease pathogen awareness.

On food safety attitudes, a majority of retailers valued core hygiene practices. For instance, 30.8% agreed and 0.5% strongly agreed that washing hands before handling ready-to-eat meat is an important practice (Table 5). Wearing protective clothing was rated as important by 33.6% (36) of retailers who agreed and 41.1% who strongly agreed, with only 2 (1.9%) strongly disagreeing. The importance of following public health officers' recommendations was also high, with 42.1% agreeing and 44.9% (48) strongly agreeing. Hand hygiene was supported by over 50% agreeing and strongly agreeing that using soap and clean water each time is necessary. On meat safety practices, 46.7% (50) agreed and 39 (36.5%) strongly agreed that covering food prevents contamination. Additionally, 40 (37.3%) agreed and 52 (48.6%) strongly agreed that spoiled meat should be disposed of rather than sold at a discount the following day (Table 5).

Training was positively perceived by 34 (31.9%) agreeing and 48.6% strongly agreeing that they would attend free food safety training, only 2% disagreed. The necessity to get regular training received neutral responses where 42% neutral on the practice with only 18% strongly agreeing to it. The responsibility of ensuring food safety should be a shared responsibility between the seller and the consumer of the RTE meat but only 41.1% that it is a shared responsibility. Some (24%) retailers shifted the blame to the consumer to be fully responsible for food safety without them being involved. Confidence in personal hygiene practices was not high, with 35.5% agreed while 19 % were neutral on the effectiveness of their practices in ensuring food safety.

Table 5: Food safety attitudes of RTE beef and chicken meat retailers

Attitude Questions	Responses N (%)				
	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I believe washing hands before handling ready-to-eat meat is very important.	5 (4.7)	4 (3.7)	11 (10.3)	33 (30.8)	55 (50.5)
Maintaining a clean selling environment helps prevent diseases.	54 (50.5)	16 (15.0)	13 (12.1)	12 (11.2)	12 (11.2)
It is acceptable to reheat cooked meat only when a customer asks.	1 (0.9)	2 (1.9)	8 (7.5)	49 (45.8)	47 (43.9)
I feel that regular training on food hygiene is necessary.	11 (10.3)	12 (11.2)	45 (42.1)	19 (17.8)	20 (18.7)
Wearing protective clothing (e.g., aprons, gloves) while handling meat is important.	2 (1.9)	4 (3.7)	21 (19.6)	36 (33.6)	44 (41.1)
I am confident that my current hygiene practices are enough to prevent foodborne illnesses.	3 (2.8)	11 (10.3)	21 (19.6)	38 (35.5)	34 (31.8)
Selling meat in open-air conditions significantly affect its safety.	12 (11.2)	10 (9.4)	27 (25.2)	37 (34.4)	21 (19.6)
Using soap and clean water every time I wash my hands is always necessary.	11 (10.3)	15 (14.0)	12 (11.2)	18 (16.8)	51 (47.7)

It is important to follow public health officers' recommendations about meat hygiene.	1 (0.9)	2 (1.9)	11 (10.3)	45 (42.1)	48 (44.9)
Food safety is a shared responsibility between the seller and the customer.	1 (0.9)	7 (6.5)	16 (15.0)	44 (41.1)	39 (36.5)
Covering food is a good way to prevent contamination.	1 (0.9)	3 (2.0)	14 (13.1)	50 (46.7)	39 (36.5)
I would attend food safety training if offered for free.	1 (0.9)	1 (0.9)	19 (17.8)	34 (31.9)	52 (48.6)
Disposing of spoiled meat is better than selling it at a discount.	8 (7.5)	1 (0.9)	6 (5.6)	40 (37.3)	52 (48.6)
It is the customer's job to ensure meat is safe before eating.	1 (0.9)	9 (8.4)	35 (32.7)	26 (24.3)	36 (33.6)

These results show that most ready-to-eat meat retailers reported good hygiene practices in certain areas (Table 6). High compliance was observed in key hand hygiene measures. Almost all retailers (91.6%) washed their hands with soap before handling meat, and an even larger proportion (98.1%) washed hands after using the toilet before returning to food handling. Covering meat to protect it from dust and flies was also widely practiced (92.5%). Hygiene practices such as using safe, treated water for cleaning (87; 81.3%), daily cleaning of storage or display equipment (73.8%), and washing/sterilizing equipment and utensils (77; 71.9%) were highly practiced. Similarly, 72.0% reheated meat kept for over two hours before sale, and 71.0% stored unsold cooked meat in under refrigeration.

Moderate compliance was noted for glove use during meat handling where only 58.9% were involved in the practice. The act of discarding leftover meat at day's end of business day was carried out by 58.9% only posing a public health risk by the remaining 42% who keep the leftovers for sale the next day. Food safety risk was evident in equipment separation and temperature control. Only 56 (52.3%) used separate knives and boards for raw and cooked meat, while 46.7% monitored the temperature of stored cooked meat.

Table 6: Food safety hygiene practices of RTE beef and chicken meat retailers

Practice Questions	Yes N (%)	No N (%)
Do you wash your hands with soap before handling meat	98 (91.6)	9 (8.4)
Do you wash your hands after using the toilet before handling food again	105 (98.1)	2 (1.9)
Do you sanitize your hands at any moment	59 (55.1)	48 (44.9)
Do you use separate equipment (knives, boards) for raw and cooked meat	56 (52.3)	51 (47.7)
Do you wash and sterilize your equipment and utensils	77 (71.9)	30 (28.1)
Do you store unsold cooked meat in a refrigerator or cooler	76 (71.0)	31 (29.0)
Do you check the temperature of stored cooked meat	50 (46.7)	57 (53.3)
Do you cover meat to protect it from dust and flies	99 (92.5)	7 (6.5)
Do you clean your storage or display equipment daily	79 (73.8)	28 (26.2)
Do you ensure the water used for cleaning is safe and treated	87 (81.3)	20 (18.7)
Do you wear gloves when handling ready-to-eat meat	63 (58.9)	44 (41.1)
Do you reheat meat before sale when it has been kept for more than 2 hours	77 (72.0)	30 (28.0)
Do you discard leftover meat at the end of the day	63 (58.9)	44 (41.1)

Relationship between Socio-Demographic Characteristics and Food Safety Knowledge, Attitude and Practices

The analysis exploring associations between socio-demographic characteristics with KAP scores on food safety had several statistically significant relationships ($p < 0.05$) as shown in table 7. Education level was strongly associated with food safety knowledge ($p = 0.0001$). Mean scores increased progressively from primary education (13.9 ± 9.2) to university (28.3 ± 6.2). Possession of a food handling certificate ($p = 0.0116$) and attendance at food handling training ($p < 0.0001$) were also linked to higher knowledge scores; trained retailers scored (25.6 ± 7.6) versus (19.5 ± 7.4) untrained. Retailers who also sold raw meat had higher knowledge (25.5 ± 7.0) than those who did not sell both (22.1 ± 8.4; $p = 0.0016$). Town-level differences were significant ($p = 0.0282$), with Nkubu recording the highest mean score in knowledge (27.5 ± 4.1) and Chuka the lowest (19.1 ± 5.7).

Significant associations were found with food handling training ($p = 0.0080$), county ($p = 0.003$), and town ($p = 0.0001$). Training improved attitudes (52.5 ± 8.8) compared to no training (48.9 ± 4.7). Embu County had the highest mean rank (68.6), while Meru had the lowest (44.3). At town level, Embu town recorded the highest score (54.9 ± 13.7), while Chuka had the lowest (47.3 ± 3.1). Education level was significantly related to food safety practices ($p = 0.0006$), with university-educated retailers scoring highest (24.3 ± 2.1) and those with primary education lowest (20.1 ± 2.8). Training had a strong effect ($p < 0.0001$), as trained retailers reported better practices (23.6 ± 2.6) than untrained (20.4 ± 3.0). Selling raw meat alongside RTE products was linked to better practice scores ($p = 0.0042$). County differences were significant ($p = 0.0053$), with Embu having the highest practice score (23.6 ± 3.2) and TNC the lowest (21.1 ± 3.1). Town-level variations ($p = 0.0001$) showed Embu town leading (24.0 ± 3.3) and Chuka trailing (19.0 ± 2.2). Gender, age, and experience were not significantly associated with any of the KAP domains ($p > 0.05$), although younger groups (18–20 years) tended to have slightly better knowledge and attitude mean ranks. The most consistent predictor of KAP scores was participation in food handling training, which significantly improved KAP.

Table 7: Relationship between socio-demographic characteristics and RTE meat retailers' knowledge, attitude, and practice (KAP) scores regarding Food safety in handling and processing

		Food Safety Knowledge			Food Safety Attitude		
		Mean ± SD	Mean Rank	p-value	Mean ± SD	Mean Rank	p -value
Gender	Female	23.4 ± 7.6	55.0	0.7549	52.5 ± 7.1	58.7	0.1440
	Male	22.9 ± 8.6	53.1		49.8 ± 7.8	49.9	
Age	18 -20	25.2 ± 5.8	60.7	0.6379	53.1 ± 5.7	65.6	0.0524
	21- 30	23.8 ± 8.6	58.0		50.0 ± 4.4	50.0	
	31 - 40	22.6 ± 7.9	50.8		53.7 ± 7.3	63.1	
	41- 50	22.6 ± 8.1	52.5		48.8 ± 6.5	40.8	
	Above 50	21 ± 9.8	46.6		49.0 ± 12.6	49.8	
Experience	< 1 year	23.1 ± 7.7	52.9	0.7164	51.3 ± 6.5	56.2	0.8455
	1 - 5 years	22.3 ± 9.1	52.2		51.0 ± 6.2	52.5	
	> 5 years	24.3 ± 7.0	58.2		50.6 ± 0.6	52.9	

Education Level	Primary	13.9 ± 9.2	23.5	0.0001	50.2 ±6.2	56.6	0.5163
	Secondary	23.1 ± 6.1	50.4		50.9 ± 6.4	51.6	
	College	24.9 ± 7.6	61.6		51.2 ± 6.7	52.0	
	University	28.3 ± 6.2	79.3		51.8 ± 14	65.9	
Food Handling Certifi-cate	Yes	24.9 ± 7.0	60.8	0.0116	51.3 ± 8.1	56.4	0.3771
	No	20.9 ± 8.7	45.6		50.6 ± 7.0	51.1	
Food Handling training	Yes	25.6 ± 7.6	66.0	0.0000	52.5 ± 8.8	60.7	0.0080
	No	19.5 ± 7.4	36.8		48.9 ± 4.7	44.5	
Also sells raw Meat	Yes	25.5 ±7.0	58.6	0.0016	52.3 ± 9.5	59.8	0.0768
	No	22.1 ± 8.4	45.3		49.9 ± 5.3	49.1	
County	Meru	25.4 ± 5.0	58.6	0.1978	49.9 ± 5.4	44.3	0.003
	Embu	22.1 ± 11	57.0		49.2 ± 2.8	68.6	
	TNC	21.8 ± 7.0	46.5		54.1 ± 1.7	50.2	
Towns	Meru	25.1 ± 4.5	56.2	0.0282	48.7 ± 2.6	40.8	0.0001
	Nkubu	27.5 ± 4.1	69.6		50.6 ± 2.9	54.8	
	Embu	21.5 ± 2.1	57.7		54.9 ±13.7	70.3	
	Runyenjes	23.4 ± 8.0	55.3		52.2 ± 3.4	64.4	
	Chuka	19.1 ± 5.7	33.3		47.3 ± 3.1	31.8	
	Ndagani	24.4 ± 7.7	24.4		53.1 ± 4.5	70.7	

Continuation of Table 7

		Food Safety Practices		
		Mean	Mean Rank	p -value
Gender	Female	22.1 ± 2.8	49.2	0.2990
	Male	22.6 ± 3.5	55.4	
Age	18 -20	23.1 ± 2.4	23.1	0.7934
	21- 30	22.7 ± 2.8	22.7	
	31 - 40	22.0 ± 3.2	22.4	
	41- 50	22.2 ±3.7	22.2	
	Above 50	21.5 ± 4.0	21.5	
Experience	< 1 year	21.5 ± 3.0	44.4	0.0974
	1 - 5 years	22.9 ±3.1	57.6	
	> 5 years	22.8 ± 3.4	57.5	

Education Level	Primary	20.1 ± 2.8	32.4	0.0006
	Secondary	21.7 ± 3.1	45.3	
	College	23.4 ±3.0	63.0	
	University	24.3 ± 2.1	70.8	
Food Handling Certificate	Yes	22.7 ± 3.2	55.9	0.2110
	No	22.0 ± 3.1	48.4	
Food Handling training	Yes	23.6 ± 2.6	64.0	<0.0001
	No	20.4 ± 3.0	34.9	
Also sells raw Meat	Yes	23.4 ± 2.7	61.6	0.0042
	No	21.5 ± 3.3	44.7	
County	Meru	22.4 ± 2.9	53.4	0.0053
	Embu	23.6 ± 3.2	63.9	
	TNC	21.1 ± 3.1	40.2	
Towns	Meru	22.4 ± 2.8	53.8	0.0001
	Nkubu	23.2 ± 2.4	57.7	
	Embu	24.0 ± 3.3	68.6	
	Runyenjes	22.6 ± 2.7	52.5	
	Chuka	19.0 ± 2.2	22.2	
	Ndagani	23.0 ± 2,7	57.1	

Scores of Knowledge Attitude and Practices of RTE Beef and Chicken Meat Retailers in Different Counties

The findings of this study reveal notable variations in food safety knowledge, attitudes, and practices among RTE beef and chicken meat handlers in Tharaka Nithi, Meru, and Embu Counties (Table 8). For **knowledge,** Meru recorded the highest mean score (25.4 ± 5.1), interpreted as *satisfactory*, while Tharaka Nithi (21.8 ± 6.9) and Embu (22.1 ± 11.0) both showed *neutral* knowledge levels. Notably, Embu had the widest score range (0 – 32).

In terms of **attitude,** Embu scored the highest mean (54.1 ± 11.7) with a *satisfactory* interpretation. Tharaka Nithi also demonstrated a *satisfactory* attitude (50.0 ± 4.8), whereas Meru, despite relatively high scores (49.1 ± 2.8), was interpreted as *neutral*. For **practices,** Embu again led with the highest mean (23.6 ± 3.2), achieving a *satisfactory* interpretation. Meru (22.4 ± 2.9) and Tharaka Nithi (20.9 ± 3.1) both fell into the *neutral* category.

Table 8: Mean scores of Ready-to-eat meat retailers' food safety knowledge, attitude and practices in Embu Meru and Tharaka-Nithi Counties

	County	Mean	SD	Minimum Score	Maximum Score	Interpretation (Based on Mean)
Knowledge	TN	21.8	6.9	8	31	Neutral
	Meru	25.4	5.1	11	32	Satisfactory
	Embu	22.1	11.0	0	32	Neutral
Attitude	TNC	50.0	4.8	40	58	Satisfactory
	Meru	49.1	2.8	44	57	Neutral
	Embu	54.1	11.7	14	70	Satisfactory
Practices	TN	20.9	3.1	15	26	Neutral
	Meru	22.4	2.9	16	26	Neutral
	Embu	23.6	3.2	15	26	Satisfactory

SD = Standard deviation

The overall assessment of food safety among RTE meat handlers across the three counties shows mixed performance (Table 9). Knowledge recorded a mean score of 23.1 ± 8.0, with scores ranging from 0 to 32, interpreted as satisfactory, indicating a generally acceptable understanding of food safety concepts despite some retailers scoring very low. Attitude towards food safety had a mean score of 51.0 ± 7.6 (range 14–70), interpreted as neutral. Practices scored a mean of 22.3 ± 3.2, ranging from 15 to 26, also interpreted as neutral.

Table 9: Overall comparison on level of food safety knowledge attitude and practices in the three counties

	Mean	SD	Minimum Score	Maximum score	Interpretation
Knowledge	23.1	8.0	0	32	Satisfactory
Attitude	51.0	7.6	14	70	Neutral
Practices	22.3	3.2	15	26	Neutral

Generally, Embu was more satisfactory at food safety attitude and practices than Meru or Tharaka Nithi. This may reflect differences in local regulatory enforcement, health inspections, and public health outreach by the local county governments. Neutral attitude scores suggest that while handlers may appreciate food safety, they might lack strong conviction about its importance. This could stem from limited perceptions of risk—if foodborne illness is not commonly experienced or tied to their practice, motivation may remain uncertain to the RTE meat retailers. The neutral practice scores, particularly in temperature control, cross-contamination prevention, and reheating, would accelerate the risk of foodborne disease outbreaks, especially *Escherichia coli* (most common pathogen in meat) infections. *E. coli* (particularly pathotypes) can be transmitted via contaminated beef, causing symptoms ranging from diarrhoea to haemolytic uremic syndrome.

DISCUSSION

The study having more men than women (53%) is contrary to the cultural practice that women are more conversant with the kitchen and thus more should be in RTE establishment where a lot of cooking and serving occurs (Letuka *et al.,* 2021). These results are similar to those of Mwove, (2025), who reported that men were the majority gender in street vended foods in Meru Town. A study in Ethiopia reported even higher proportion of males at 97.2% involvement in the trade (Abunna *et al.,* 2022). These results are contrary to those of Gichunge *et al.,* (2023) where female were the majority participants in RTE establishments around a campus environment in Kenya. This shows that men are actively taking up roles that were traditionally left for women in order to benefit economically. Secondary level education attainment was very common among the participants (41.1%) which was different to studies in Ethiopia where most retailers of RTE foods had primary level of education (Abunna *et al.,* 2022; Gemeda *et al.,* 2025). Other Kenyan studies have given similar results of secondary education personnel being the majority in Meru (Mwove, 2025) and Nairobi (Obinda *et al.,* 2021). This could be affected by the economic milestones which are different from one country to another. Similarly, those with university level of education were very few probably due to minimal option of job opportunities to those with lower level of education hence uptake of short term small and medium enterprise employment in RTE establishments.

Work experience in terms of years varied with most having a less than one year on job experience (38.3%). These results are similar to those reported by Mwove *et al.,* (2020) in Thika and Obinda *et al.,* 2021) in Nairobi. The results are also different from those of Obinda *et al* (2021) who reported that the majority of personnel in RTE businesses had been working for 1- 5 years in Nairobi. Nairobi being the capital city could have a stable cash flow compared to towns like Meru, Embu and Chuka which have lower economic activities compared to Nairobi City. The age group of many people working in RTE establishment were people below 50 years old and majority were between 21- 30 at 26% and 31 – 40, 25% giving an accumulative of 51% for the age group between 21- 40. The industry is labor intensive and would be attractive to the youthful population compared to the older individuals. This could be explained by the fact that RTE establishment could be a short-term employment space.

Untrained personnel were the majority in the study (58.9%) posing a public health risk. The report is similar to that of Gemeda *et al.,* (2025) who reported a higher percentage of non-trained personnel involvement in Ethiopia. However, this was different from a study done in Nairobi which found out that a high percentage (78%) had some form of training in food safety handing practices (Obinda *et al.,* 2022). The Kenyan bylaw expect individuals involved in food trade to have some form of food safety training, however this is not a consideration to the business people in the sector. It is mandatory for all food handlers to have medical certificates which should be renewed every 3 months (GOK, 2016). Medical certificates were only with 48% of the retailers. Most towns (Embu and Meru) also scored low in medical certificate (49% and 47%). It is only Chuka where the medical certificate was highly reported at 82.4%. This could be due to the instability in employment retention among the personnel since the majority were only employed for less than a year, this could include months below three. Training is an important aspect in food safety and public health issues within food distribution (Soon *et al.,* 2020).

One of the five world health recommendations towards ensuring food safety is the separation of raw and ready-to-eat food and associated utensils (WHO, 2018). This study reported that over 50% of RTE meat establishment also sold raw meat. The same scenario was reported in Nairobi where butcheries were reported to also prepare RTE meat for sale (Koech *et al.,* 2024). This is a public health hazard especially when the level of food safety practices is low as reported. The mix in raw

and RTE meat establishment is rising since entrepreneurs would like to control most of the value chain (raw and RTE). This setup is likely to cause cross contamination of pathogenic microbes from the carcass to the RTE if proper hygiene measures are missing.

The current findings showed that only 49.5% identified correct storage temperatures. Other research on food safety knowledge had almost similar results. In Ghana, Asati *et al.* (2024) found that while 89% of meat sellers were aware that unhygienic handling could transmit pathogens, fewer than half understood the role of temperature in microbial growth. In Ethiopia, Abunna *et al.* (2022) reported that although 94% of meat handlers had positive attitudes, 83.7% practiced unsafe handling due to poor knowledge of detailed hygiene protocols. In developed countries, studies show higher baseline knowledge but still reveal deficiencies in specific domains. A review by Insfrán-Rivarola (2020) reported that food handlers in Europe and North America generally scored above 80% on awareness of foodborne disease transmission, yet only 55 – 65% correctly identified safe cooking and storage parameters. Similarly, a UK study noted that while most handlers understood cross-contamination risks, fewer than half adhered to correct refrigeration practices (Soon *et al.,* 2020). Compared with the present data, handlers in developed settings display more technical knowledge, reflecting stronger regulatory oversight and mandatory training systems. Nonetheless, gaps in practice remain universal.

The current study's finding that 71% refrigerated unsold meat echoes national results, but the low proportion monitoring storage temperatures (46.7%) highlights persistent gaps in operational food safety. In Kenya, comparable practice patterns have been reported. Mathenge *et al.* (2017) observed that while over 85% of Nairobi meat handlers adhered to routine handwashing, fewer than half regularly monitored storage conditions or separated raw from cooked products. Similarly, Kimindu *et al.,* (2024) in Kajiado found that although 90% of workers maintained personal hygiene, only 49% adhered to safe meat storage and tem-

perature control. These parallels confirm that Kenyan handlers excel in visible hygiene but fall short in critical practices requiring equipment, monitoring, or resources. Other African studies report similar discrepancies. In Ethiopia, Abunna *et al.* (2022) found that although 94% of meat handlers had positive attitudes toward safety, only 43% practiced correct separation of raw and cooked meat, and temperature monitoring was rarely done. In Ghana, Asati *et al.* (2024) also documented high compliance with handwashing and covering meat, yet only about half discarded leftovers at the end of the day. These findings align with the present data, that while African handlers are diligent in basic hygiene, resource-intensive or knowledge-intensive practices (e.g., refrigeration monitoring, cross-contamination prevention) remain weak points.

Current results show that handlers had comparatively higher knowledge (25.4) and moderate practices (23.6). On the other hand, some studies outside Africa present a stronger correlation between knowledge, attitudes, and practice than these findings. In Bangladesh, only 20% and 16.3% of meat handlers had good knowledge and practices, respectively, with training and longer working hours strongly predictive of both (Ai *et al.,* 2021). The difference may be as a result of varied baseline education levels in Kenya versus Bangladesh, or differing training outreach programs. A study in Ethiopia reported that most meat handlers exhibited good attitudes but still had poor practices (Abunna *et al.,* 2022) which is similar to this study where practices scored lower than knowledge and attitude. It suggests that negative or partial attitudes might still fail to drive safe behaviours possibly due to systemic barriers like inadequate infrastructure or oversight.

This study revealed satisfactory food safety knowledge but only neutral attitudes and practices among RTE meat handlers. Similar findings have been reported in Kenyan, where food handlers who attended training scored significantly higher on KAP measures than their untrained counterparts (Mwove, 2025).

The findings of this study corroborate this, showing that trained and certified handlers, particularly in Meru, demonstrated better practices. Likewise, Tohonon *et al.,* (2025) identified education, certification, and training as significant predictors of knowledge and practice. However, evidence from Ghana shows that even certified handlers may exhibit unsafe behaviours, such as handling meat and money with bare hands (Asati *et al.,* 2024). This is consistent with the findings of this study in Embu and Meru counties, suggesting that knowledge alone does not guarantee behaviour change. Broader barriers, including weak enforcement, limited resources, and entrenched habits, may undermine translation of knowledge into safe practices. This underscores the need for integrated interventions that combine training with stronger institutional support and behaviour-focused strategies.

While handlers with secondary education or training scored better in knowledge and practice, many may lack regular courses or practical training emphasizing hands-on behavioural change. Other studies have reported satisfactory attitude and knowledge but inadequate practices just as in this study (Abunna *et al.,* 2022; Gemeda *et al.,* 2025). Economic constraints may outweigh safety considerations even with awareness (Soon *et al.,* 2020). This means that training may cover theoretical aspects but lack competence in real-world scenarios like temperature control or causes of cross-contamination. Handlers may know the ideal practices but lack access to refrigeration, food grade sanitization equipment, calibrated thermometers, or clean storage spaces. In the practices data, temperature checks and equipment separation were among the main drivers in poor food safety practices. Retailers may face pressure to minimize spoilage and maximize profit, leading to cutting corners such as delayed reheating, extended storage without refrigeration, or dual handling of raw and cooked meat. Since most of the retailers were small and medium enterprises, the cash flow could likely be a hindrance to acquiring equipment required to monitor food safety procedures such as refrigerators and thermometers.

Discrepancies across counties and towns (i.e., Embu more satisfactory at attitude and practices than Meru or Tharaka Nithi) may reflect differences in local regulatory enforcement, health inspections, and public health outreach by the local county governments. The neutral practice scores, particularly in temperature control, cross-contamination prevention, and reheating, would accelerate the risk of foodborne disease outbreaks, especially *E coli* (most common pathogen in meat) infections (Tohonon *et al.,* 2025). Neutral attitude scores suggest that while handlers may appreciate food safety, they might lack strong conviction about its importance. This could stem from limited perceptions of risk, if foodborne illness is not commonly experienced or tied to their practice, motivation may remain uncertain. *Escherichia coli* (particularly pathotypes) can be transmitted via contaminated beef, causing symptoms ranging from diarrhoea to haemolytic uremic syndrome. It thrives when meat is undercooked or improperly stored between 4 °C and 60 °C the "danger zone." Without adequate monitoring, meat may remain for long. In unsafe temperature ranges conducive proliferation of pathogenic microorganisms.

Conclusion
The findings clearly demonstrate that education level and, more importantly, food safety training are central determinants of food handlers' knowledge, attitudes, and practices in relation to ready-to-eat meat. The need to integrate food safety education into licensing requirements and promoting routine refresher courses can help bridge knowledge disparities observed across counties. Collaborative efforts between regulatory agencies, local governments, and industry players are essential to sustain compliance and strengthen public health protection and policy development.

Recommendation

To address the identified knowledge to practice gap, several evidence-based interventions are recommended. There should be an enforcement of certification laws by the local government. Access of resources for maintaining and monitoring temperatures together with training modules should be enhanced among the industry personnel. Frequent health inspections could also re-enforce hygiene practices and create accountability among the retailers.

Limitations of the study

The study was limited by a mixed population of RTE retailers also selling raw meat. In future studies, these two populations could be separated since raw meat could be a close microbial contaminant to RTE meat.

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Conflict of interest

The authors declare that they have no conflict of interest.

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