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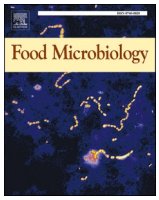

Review

Prevalence of *Escherichia coli*, *Campylobacter* spp. and *Salmonella* spp. in the East African Community: a systematic literature review and meta-analysis

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ABSTRACT

Pathogenic *Escherichia coli*, *Salmonella* spp. and *Campylobacter* spp. are bacteria associated with foodborne diseases. This systematic review and meta-analysis investigates the prevalence of these pathogens in foods sold across seven East African Community (EAC) countries and identifies key risk factors for contamination. A comprehensive search for peer-reviewed papers and grey literature was conducted in six databases (PubMed, CAB Direct, African Journals Online, Google Scholar, ScienceDirect, and Web of Science), as well as 12 online repositories. The review encompassed studies published in English and French between January 2000 and June 2022, adhering to the 2020 guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. Eligible studies employed probabilistic sampling and reported the proportion of contaminated samples. Out of 4134 initial records, 53 studies met the inclusion criteria. Most were conducted in Kenya (n = 22) and Tanzania (n = 21), with no eligible studies found for Burundi and South Sudan. *E. coli* and *Salmonella* spp. were the most frequently studied pathogens, while *Campylobacter* spp. was less represented. Using a random-effects model in Stata®, pooled prevalence estimates were 41 % for *E. coli* (95 % CI: 34–52 %), 12 % for *Salmonella* spp. (95 % CI: 12–27 %), and 9 % for *Campylobacter* spp. (95 % CI: 7–32 %). Significant heterogeneity was observed and further explored through meta-regression and subgroup analyses. Contamination levels varied by food type, processing status, sample size, and country. Meat, especially poultry, showed the highest prevalence of bacterial contamination across all pathogens. Alarmingly, beverages were also highly contaminated, with *E. coli* detected in 66.3 % (95 % CI: 31–89 %) and *Salmonella* spp. in 11.8 % (95 % CI: 1–55 %) of samples. Key risk factors included poor hygiene practices, inadequate sanitation, high storage temperatures, and a lack of food safety training. These findings underscore the urgent need for improved food safety measures in the EAC region for improved public health and support trade advancement. The study also highlights critical gaps in surveillance, particularly for *Campylobacter* spp., pathogenic *E. coli*, and data from some EAC countries.

1. Introduction

Foodborne hazards are harmful microbiological, chemical, or physical agents that contaminate food. Consumption of these hazardous agents in food poses health risks ranging from mild illnesses to life-threatening or fatal events (Grace, 2017). Globally, 31 important food hazards, mainly microbiological, were found to cause at least 600 million illnesses and 420,000 deaths in 2010 (Havelaar et al., 2015). Among chemical hazards, four foodborne metals; lead, methylmercury, arsenic, and cadmium, were estimated to cause over one million illnesses and more than 56,000 deaths globally in a year (Gibb et al., 2019).The greatest disease burden is attributed to diarrheal disease agents (Havelaar et al., 2015). Among these, *Campylobacter* spp., non-typhoidal *Salmonella* spp. and pathogenic *E. coli* (enteropathogenic and enterotoxigenic *E. coli),* are recognised as leading causes of diarrheal diseases (WHO, 2015). Together with *Taenia solium* and *Vibrio cholerae*, these hazards are considered major contributors to the FBD burden in Africa (Dewaal et al., 2010; Havelaar et al., 2015).

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According to the World Health Organisation, (WHO, 2015), the burden of foodborne disease (FBD) varies significantly across global subregions. The African regions bear the highest per capita burden of foodborne diseases (FBD), accounting for 75 % of FBD-related deaths and 53 % of illnesses (Jaffee et al., 2019). However, national estimates of FBD in specific African countries are largely based on expert opinion, due to underreporting of FBD and a lack of empirical evidence (Lake et al., 2015; Sapp et al., 2022). This lack of robust surveillance data poses a major challenge for policy development and the implementation of effective food safety interventions.

Several factors make FBD-related surveillance difficult in low- and middle-income countries. One is the dominance of informal markets, which supply over 80 % of fresh food (Blackmore et al., 2020; Ferris et al., 2014). These markets, common across Africa, are characterised as non-modern, unregistered sale points for fresh and perishable food products, mainly animal-source foods (ASF), fruits, and vegetables (Global Alliance for Improved Nutrition, 2020). While these foods are rich in nutrients, they carry a higher risk of FBD (Grace, 2017).

Although there are challenges related to hygiene, sanitation, and infrastructure in informal markets, they also play a crucial role in supporting the livelihoods of many people by providing ready access to markets for smallholder farmers, particularly women and youth, and offering affordable and nutritious food options to low-income consumers (Ferris et al., 2014; Global Alliance for Improved Nutrition, 2020; Grace et al., 2018).

The East African Community (EAC) is expanding and currently comprises eight member countries, with growing commercial activities among partner states, particularly in food trade (East African Community, 2002). Additionally, efforts to enhance trade have intensified under the African Continental Free Trade Area (AfCFTA) and the recently established Africa Food Safety Agency (AFSA) (African Union, 2025). As trade and the movement of goods and people increase within regional blocs and across the African continent, there is a need for a better understanding of food safety and the implementation of measures that protect public health while facilitating trade.

Despite these developments, few studies have investigated the prevalence of pathogens in food within the EAC, which is essential for risk assessment and management, as well as trade facilitation. Previous reviews have examined *Campylobacter* spp., *Salmonella* spp., and *E. coli* in foods, but none have collectively covered the EAC. Thomas et al. (2020) studied *Salmonella* and *Campylobacter* spp. across the African continent, including four studies from Tanzania, three from Kenya, and one each from Uganda and Rwanda, focusing on both animals and animal-source foods. Another study examined *Campylobacter* spp. in food products in Kenya (Mwangi et al., 2025). A few reviews have been conducted in Ethiopia and Burkina Faso (Belina et al., 2021; Gazu et al., 2021), and a rapid review focusing on the occurrence of hazards, but not including hazard levels, was conducted in the EAC (Mutua et al., 2021).

This current review provides comprehensive evidence on the levels of *Campylobacter* spp., *Salmonella* spp., and *E. coli*, and risk factors associated with their prevalence in foods sold in domestic markets in the EAC countries. Our study contributes to knowledge aimed at improving food safety in informal markets within the EAC region. The findings inform current gaps with regard to the pathogens studied and define future research and intervention strategies for improving food safety.

2. Materials and methods

2.1. Scope of EAC

The EAC (as of 2025) comprises eight partner states: Burundi, the Democratic Republic of Congo (DRC), Kenya, Rwanda, South Sudan, Somalia, Tanzania, and Uganda. Except for the Republic of Somalia, which had not been admitted into the EAC at the time the study was commenced, all other countries were considered.

2.2. PRISMA guidelines

A Systematic Literature Review (SLR) was conducted following Cochrane Review principles and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines for reporting (Higgins and Thomas, 2024; Page et al., 2021). The systematic procedures, including the search strategy, syntax and number of references from each database, are presented in Annexe 1 in the supplementary material.

2.3. Research questions

The study addressed the following research questions.

- What is the prevalence of *E. coli*, *Campylobacter* spp. and *Salmonella* spp. in foods retailed in domestic markets in EAC?
- What food value chains are affected by these hazards?
- What factors have been associated with contamination?
- Are there any temporal or seasonal trends observed in occurrence of the hazards?

2.4. Search strategy and study selection

A comprehensive search for peer-reviewed papers, reports and grey literature was made in six databases namely; PubMed, CAB-Direct, African Journals Online, Google scholar, Science Direct and Web of Science. Online searches in 12 East African University repositories were also done.Keywords used were: food, food safety, foodborne, disease, disease burden, illness, infection, outbreak, hazard, risk, health, toxin, pathogen bacteria, *E. coli*, Campylobacter spp. and Salmonella spp., Kenya, Uganda, Tanzania, Burundi, Rwanda, South Sudan, East Africa. These were combined using Boolean operators to form a basic search syntax as given below (refer to Annex 1 for additional information).

> Food AND (Salmonell* OR *Campylobacter** OR "*E. coli*" OR "*Escherichia coli*") AND (Burundi OR DRC OR "Democratic Republic of Congo" OR "East Africa*" OR Kenya OR Tanzania OR Rwanda OR "South Sudan" OR Uganda) AND (safety OR "food safety" OR foodborne OR "food-borne" OR "food borne" OR risk OR disease OR illness OR infection OR outbreak OR toxi* OR health OR symptom* OR outbreak OR microb* OR metabolite OR intoxic* OR "food hygiene" OR hazard OR pathogen OR bacteria OR prevalence OR proportion OR frequency OR fraction OR distribution OR percentage OR magnitude).

Articles were downloaded into Mendeley (https://www.mendeley.com/) and screened for any duplicates. The resultant list was loaded into Rayyan® QCR tool (https://new.rayyan.ai/) for two-level screening by two independent reviewers. A third reviewer resolved conflicts.

2.5. Inclusion and exclusion criteria

The inclusion criteria were; studies published between January 2000 and June 2022, studies that used a probabilistic sampling approach and reported the prevalence of *Campylobacter* spp., *Salmonella* spp. or *E. coli* in foods. The search was done in English and French. Only sampling at the retail node was considered; however, for studies on milk, we considered the farm gate since this is an important retail outlet (Kiambi et al., 2018; Njehu and Omore, 2014).

Studies outside the EAC region, published outside the established time frame and not covering one or more of the pathogens in focus were excluded. Fig. 1 summarises the systematic process of identification and review screening of eligible studies. The initial search yielded 4134 studies after the removal of duplicate records. During the screening of article titles and abstracts, 3876 studies were excluded for several reasons: some were conducted outside the geographical scope, some did not fall within the publication year range, and others did not focus on the

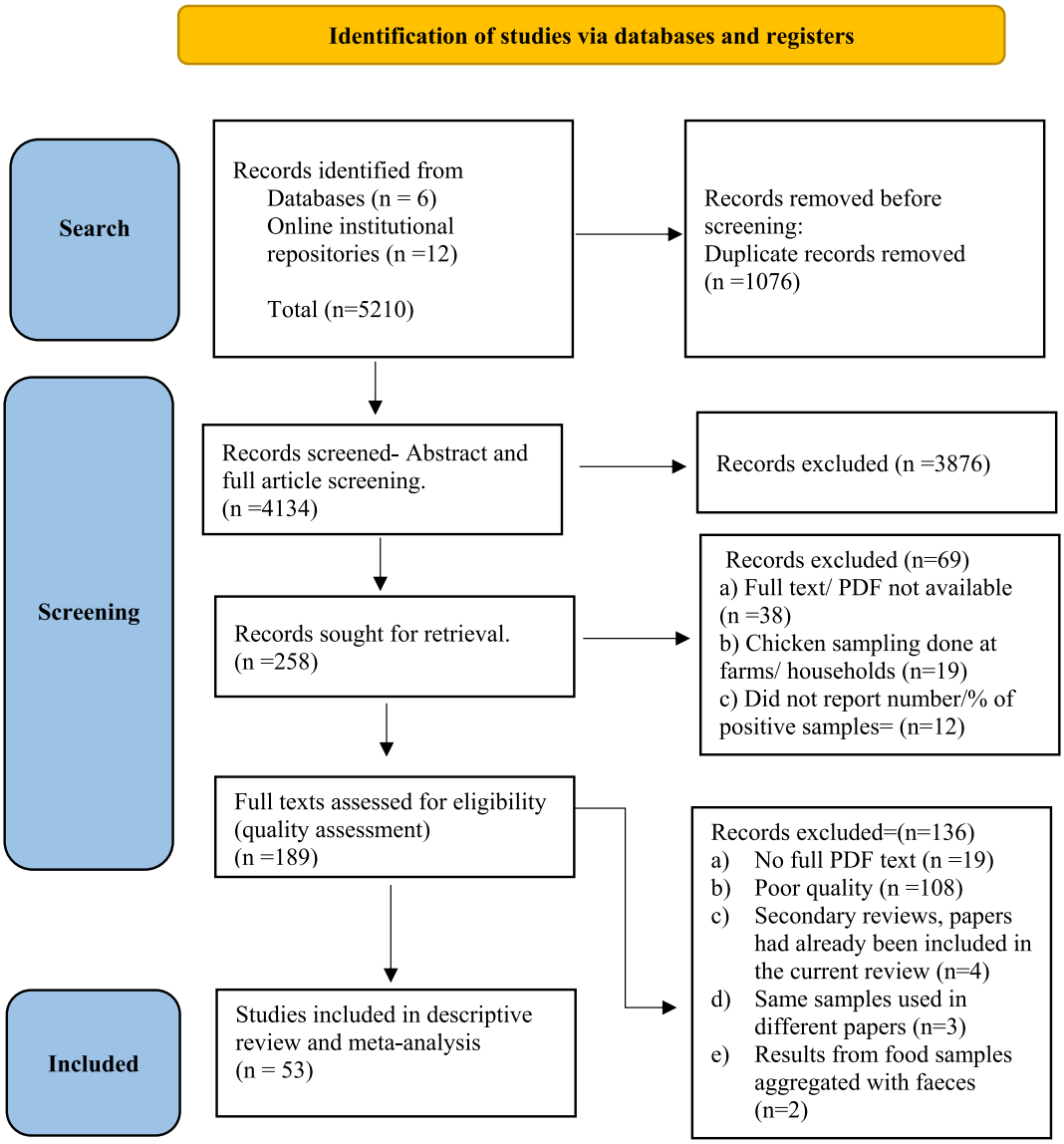

Fig. 1. PRISMA 2020 (Page et al., 2021) flow diagram for systematic review and meta-analysis of foodborne pathogens in EAC countries, January 2000 and June 2022.

three targeted pathogens. Additionally, 69 studies were excluded due to the unavailability of full-text articles or because the sampling was conducted outside the market (see Fig. 1).

2.6. Quality analysis

The resulting 189 studies were assessed for quality using five criteria: absence of bias in the selection of subjects, how appropriate the data analysis method was to the data, use of scientifically sound methods, accurate method description, and accuracy and completeness of reported results. Quality of the papers was rated as "good", "moderate" or "poor". Articles considered adequate for two or fewer of the five quality criteria were classified as "poor", those considered adequate for three or four responses were classified as "moderate", and those considered adequate for all five quality criteria were assigned as "good"(Kwoba et al., 2023). As a result, an additional 136 papers were excluded during this process, resulting in 53 studies (of "good" and "moderate" quality) that were included for data extraction (see Fig. 1).

The data extracted included: year of authorship, year when data was collected, sampling site (country and region), sampling size, sample population, sampling technique used, pathogen studied, microbiological assay method used, proportion of positive samples analysed, and measures of Disability Adjusted Life Years (DALYs), if given.

2.7. Meta-analysis

Descriptive data and frequencies were summarized using graphs and tables. Meta-analysis was carried out in STATA® statistical analysis software, version 19.5 (https://www.stata.com/) by running *metapreg* and *meta set* commands. The estimate was calculated as the proportion of samples testing positive for each of the three hazards studied. To account for the binomial distribution of prevalence data and high between-study heterogeneity, we used *metapreg* to fit a logistic-normal random-effects model and estimate pooled prevalence with Wilson 95 % confidence intervals. This model accounts for within-study binomial error and between-study heterogeneity without requiring continuity corrections or transformation. *Meta set* command uses logit-transformed inverse-variance meta-analysis. The former offers more robust modeling for sparse data; the latter enables subgroup comparisons. Estimates were similar across methods.

Random effects model (restricted maximum likelihood (REML)) was used to estimate heterogeneity (Tau squared or τ^2), assuming overall

variation that is due to study observation and random variation ($T_i = \theta + \mu_i + \varepsilon_i$; where T_i is the effect measure from study i, μ_i is the random effect for study i and ε_i is the error term for study i). Higgin's I^2 statistic was used to express variation not attributed to chance or sampling errors. Cochran's Q statistic was used to express the statistical significance of heterogeneity and differences between the subgroups. Meta-regression was done by applying *mixed* command for mixed-effects regression model. Individual studies were considered as random effects variables, while predictors such as processing state, country of origin, year of publication and sample size were modelled as fixed effect variables. The model and predictors were considered significant at p-value <0.05.

Pooled data were used for each hazard. Where the number of total samples and positive samples were given, this was transformed into percentages and vice versa. To enable subgroup analysis, foods were categorised into respective value-chains (Table 1). All red meat types (pork, beef, goat meat, rabbit meat and wild meat were categorised as meat. Poultry was categorised separately because of a higher risk noted in literature. Other subgroups are as given in Table 1. Where there was only one study in a value chain, this was categorised together with other single studies and designated as "other" for subgroup analysis. In overall meta-analyses, the model and predictors were considered significant at p-value <0.05.

Separate forest plots were generated for each pathogen and used to graphically represent the level of contamination of foods. We used the JBI Critical Appraisal Checklist (Moola et al., 2020), to assess bias and identify the studies to include. After meta-analysis, we checked for small-study effects and publication bias using funnel plots, Egger's test and trim-and-fill method.

Table 1
Food products sampled from domestic markets in the EAC countries, between January 2000 and June 2022, categorised by value chain.

Food category	Food products studied	[a]Number of studies (n)
Beverages	Fruit juice, mixed fruit juice, mango juice, passion juice, tamarind juice, juice, fermented and unfermented cereal beverage, infant porridge, drinking water.	7
Chicken meat	Chicken carcass, raw chicken meat and its products, cooked chicken meat products, roast chicken.	5
Cooked ready-to-eat foods	Mixed dishes, including cereal and cereal products, vegetables, legumes, meat and meat products, starchy roots	2
Grain and flours	Sorghum flour, millet flour, cassava flour, cooked grains and uncooked grains	3
Fish	Freshwater fish, marine fish, fresh and dried silver cyprinid/sardines, Nile perch,	5
Meat	Cattle carcass, cattle meat, roast beef, beef stew, goat carcass, goat meat, rabbit meat, pork carcass, pork meat cuts, offal, wild meat (from *Syncerus caffer* (African buffalo), *Phacochoerus aethiopicus* (desert warthog), *Sylicapra grimmia* (duiker))	14
Milk	Raw milk, pasteurised milk, cow milk, camel milk, goat milk, packaged long-life milk, packaged fresh milk, and unpackaged milk, unpasteurised yoghurt, milk-containing infant foods, milk products.	22
Raw produce	Fresh vegetable salads (mainly sliced tomatoes, onions and cabbage), *Kachumbar*i (mainly onions, tomatoes, green capsicum, chillies, coriander, cabbage, carrots and lettuce (to a lesser extent)), kale, chinese cabbage, tomatoes, raw produce, amaranth, fruit salad.	7

[a] Some studies considered multiple sample types; thus, the number of records here is greater than the overall number of studies included in the review.

3. Results

3.1. Description of studies

Fig. 2 shows EAC countries included in this review. Out of the 53 included studies, the majority were carried out in Kenya (n = 22) and Tanzania (n = 21). Other articles retrieved described studies in Uganda (n = 7) and Rwanda (n = 2), and only one study was conducted in the Democratic Republic of Congo (DRC). No studies retrieved on Burundi or South Sudan.

Fig. 3 is the distribution of studies included in this review by year. The number of studies per year increased during the period studied, with a few declines, the biggest being in 2019 and 2021. In the initial search, most studies (49.3 %) were obtained from the Science Direct database (https://www.sciencedirect.com/) with institutional repositories contributing 11 unique papers to the final list, mainly student theses. The search in French yielded no results. Annex 1 in the supplementary material presents the study protocol and results of the search.

Table 1 gives a summary of value chains, the type of samples and the number of studies included in the review. Most food products included raw, minimally processed, and traditionally processed products (boiled or sun-dried), sampled from different informal and semi-formal retail outlets. Milk was the most studied value chain across the countries (n = 22), followed by meat (n = 13).

Raw produce, fish, and beverages were commonly studied across countries. Only one study was conducted on meat from wild animals (in the DRC) (Mpalang et al., 2013). Grains, flours, eggs and cooked ready-to-eat (RTE) foods were also less studied (Byakika et al., 2019; Gacheru et al., 2016; John, 2016; Tsai et al., 2022). There were no studies on offal.

The supplementary material (annex 2) gives a comprehensive description of the studies included in the review, value chain involved, the point of sampling as well as the food hazard investigated.

3.2. Risk factors associated with pathogen contamination in food

Three studies reported risk factors for contamination using logistic regression models (Table 2). High storage temperature of food products, poor sanitation, low personal hygiene and bad handling practices were reported as risk factors. Some studies reported risk factors without regression analysis. Simforian et al. (2015) compared juice contamination across different vending sites and found that products sold by the roadside, bus stations and restaurants had higher contamination than those sold in food shops and markets (p-value <0.05). In addition, juice stored in cooler boxes were less contaminated than that stored at room temperature (p-value <0.05). Byakika et al. (2019) assessed the microbiological quality of cereal products in relation to food safety knowledge, attitude and practice among vendors. However, no correlation could be established.

3.3. Meta-analyses of the proportion of pathogens in foods

Fifty-three studies were included in the meta-analysis. Fewer records were found for *Campylobacter* spp. (n = 12) than *Salmonella* spp. (n = 26) or *E. coli* (n = 44) in all countries (some studies investigated a combination of the pathogens).

In the analysis, observations on chicken meat were separated from other types of meat, considering the known difference in contamination levels, especially for the hazards studied.

3.3.1. Analysis of Campylobacter spp. in foods

The forest plot for *Campylobacter* spp. in foods was based on a pooled sample of 3,884, as shown in Fig. 4. The samples included milk (n = 1993), meat (n = 1344), chicken meat (n = 323), and "other" category, consisting of fish (n = 185) and raw produce (n = 39). The overall pooled prevalence of *Campylobacter* spp. in food was found to be 9 % (95

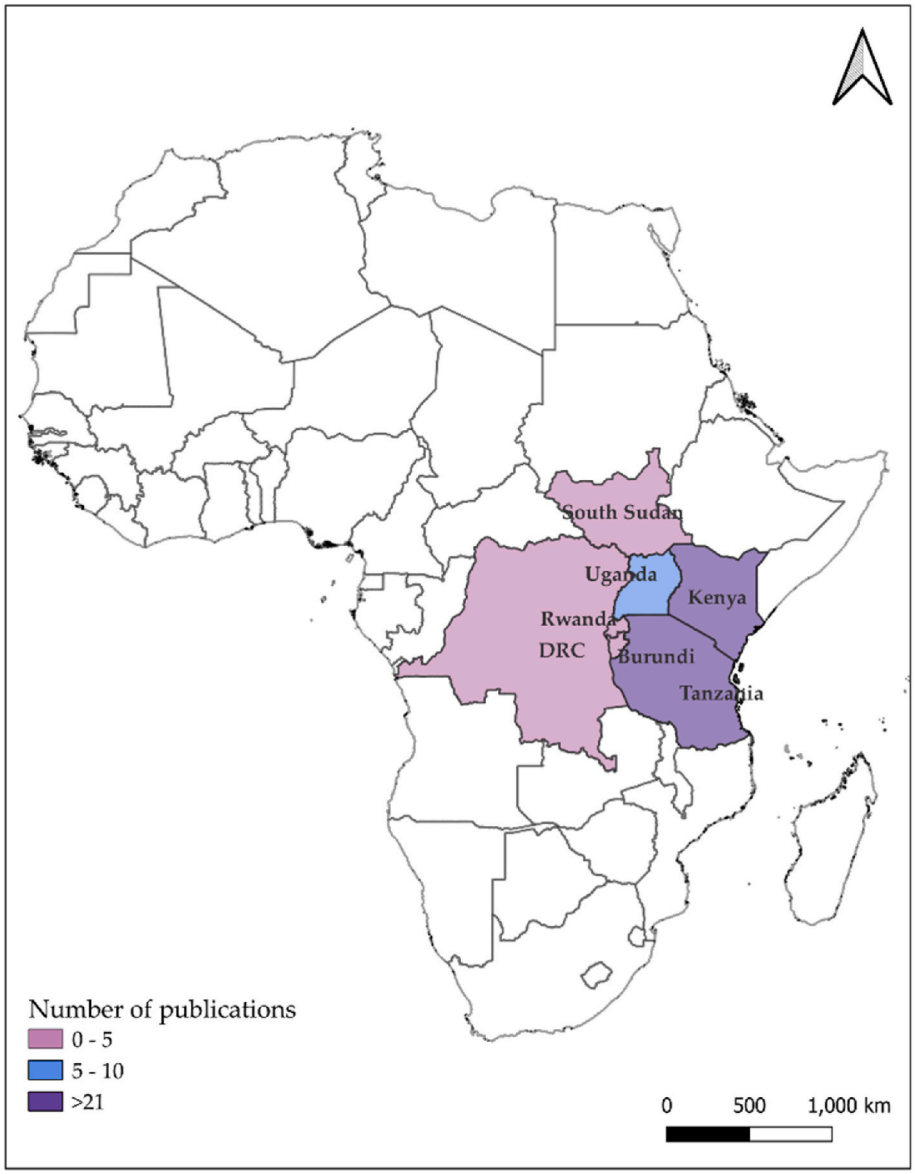

Fig. 2. Map of EAC countries within Africa, and distribution of studies found in the review, between January 2000 and June 2022.

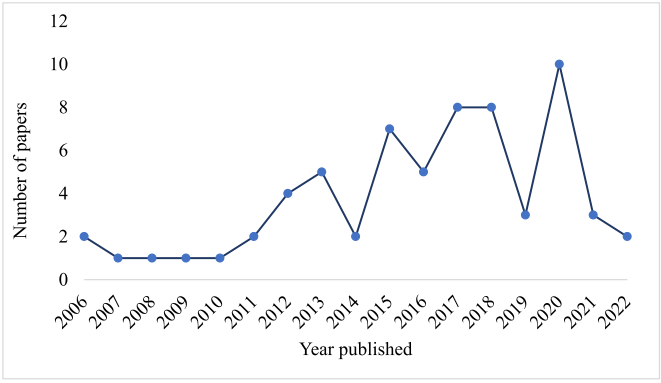

Fig. 3. *Distribution of studies on Campylobacter* spp.*, E. coli and Salmonella* spp. *in EAC countries between January 2000 and June 2022.*

% CI = 7–30 %). The prevalence of *Campylobacter* spp. was highest in chicken meat, at 25.9 % (95 % CI = 6.4–45.5 %); in comparison to other types of meat, at only 5.2 % (95 % CI = 3.1–7.3 %). Subgroup analysis indicated borderline significance (p-value = 0.05) in the prevalence of *Campylobacter* spp. across the different food types. *Campylobacter jejuni* was analysed in 1441 samples, revealing a prevalence of 4.5 % (95 % CI = 0.0242–0.0892), whereas *Campylobacter coli* was analysed in 902 samples, with a prevalence of 4 % (95 % CI = 2 %–18 %). Figs. 5 and 6 present forest plots for *C.* coli and *C.* jejuni in various foods, respectively. Table 3 provides a summary of subgroup analysis, including the pooled sample size and pathogen prevalence for the different food products.

3.3.2. Analysis of *E. coli* in foods

E. coli was the most studied of the three bacteria with a pooled sample of 7208 across seven value chains: meat, chicken meat, fish, milk, beverages, raw produce and cooked foods. Most observations were related to milk (n = 3159) and the least to cooked foods (n = 155) and flour (n = 38), designated as "other" in subgroup analysis. Pooled prevalence was 41 % (95 % CI = 034–52 %), applying *metapreg* command and 42 % applying *meta set* command. Significantly high prevalences were observed in beverages 66.3 % (95 % CI = 41.9–90.6 %) and meat 65.2 % (95 % CI = 36.2–94.2 %). Subgroup "other" had the lowest prevalence at 11.6 % (95 % CI = 1.5–24.7 %). Subgroup analysis revealed a significant difference across value chains, p-value <0.01.

Table 2
Risk factors associated with food contamination in EAC countries, between January 2000 and June 2022.

Risk factor	Pathogen under study	Odds ratio (OR) estimate	p-value	Reference
Low-temperature storage of meat was associated with reduced contamination	*Salmonella* spp.	0.08	<0.05	Niyonzima et al. (2017)
Easy-to-clean and disinfect food-contact surfaces were associated with reduced contamination		0.01	<0.05	
Training of personnel on hygienic handling of food was associated with reduced contamination		0.17	<0.05	
Selling defrosted meat was associated with presence of pathogen	*Campylobacter* spp.	4.69	0.02	Carron et al. (2018)
Use of display surfaces that are not easy to clean was associated with presence of pathogen		7.86	0.03	
Sale of beef alongside chicken meat was associated with presence of pathogen		3.24	0.13	
Number of chicken carcasses sold per week (above 100 carcasses) was associated with presence of pathogen		1.36	0.15	
Using hot water in cleaning equipment was associated with presence of pathogen		4.93	0.09	
Access to running water was associated with reduced contamination	*Salmonella* spp. and *E. coli*	0.36	0.003	Kariuki (2018)
Hand washing before handling food items was associated with reduced contamination		0.02	<0.001	
Use of apron was associated with reduced contamination		0.09	0.02	
Type of toilet facility-use of modern toilet facilities was associated with increased contamination		0.02	0.01	

Fig. 7 is a forest plot of *E. coli* in foods, while Table 3 displays the summary of subgroup analysis.

Pathogenic *E. coli* was detected in various foods, alongside non-pathogenic strains. The pathotypes identified include Shiga toxin-producing *E. coli* (STEC), enterotoxigenic *E. coli* (ETEC), enteropathogenic *E. coli* (EPEC), enteroinvasive *E. coli* (EIEC), and enteroaggregative *E. coli* (EAEC). Non-O157 STEC strains identified in the studies were O45:H7, O9:H21 and ONT:H28 (Baniga et al., 2020). These were excluded from the meta-analysis because the number or percentage of positive samples was not provided; instead, they are listed in Table 4.

Fig. 8 illustrates STEC in 4336 samples, primarily consisting of meat, chicken meat, milk, raw produce and fresh fruit juices. All the records of STEC included in meta-analysis were identified as the O157 strain. The average prevalence of STEC in foods was 2.0 % (95 % CI = 1–10 %). Chicken meat exhibited the highest prevalence at 6.1 % (95 % CI = 3.0–15.2 %). Other types of meat and raw produce each had a prevalence of 3.9 %, while milk had the lowest prevalence at 0.4 % (95 % CI = 0.3–0.8 %).

3.3.3. Analysis of *Salmonella* spp. in foods

The meta-analysis of *Salmonella* spp. in foods included 5677 samples across six value-chains, mainly on meat (n = 2174), and the least on cooked food samples (n = 56). For subgroup analysis, single studies on eggs (n = 50) and cooked foods (n = 56) were categorised as subgroup "other".

Salmonella spp. prevalence across all foods was 12 % (95 % CI = 12–27 %). Subgroup analysis across different value chains indicated significant differences at p-value <0.01. Fig. 9 shows a forest plot of *Salmonella* spp. in foods, and Table 3 gives a summary of subgroup analysis on *Salmonella* spp.

The highest prevalence was found in chicken meat, at 24.4 % (95 % CI = 15.6–33.3 %). Fish and milk were also highly contaminated at 14.1 % (95 % CI = 8–20.3 %) and 13.3 % (95 % CI = 6.5–20.1 %), respectively. *Salmonella* spp. was not detected in cooked RTE foods, eggs, grains and flours (this was adjusted by a corrective factor) (Byakika et al., 2019; Gitahi et al., 2012; John, 2016; Kariuki, 2018; Tsai et al., 2022).

Table 5 summarises the *Salmonella* serotypes detected in food using PCR technology or biochemical tests. The most detected serotypes were *S.* Typhimurium and *S.* Enteritidis, particularly in ASF. Other serotypes identified in our review include S. Singapore, *S.* Typhi, *S.* Enterica, and non-typhoidal *Salmonella*.

3.3.4. Heterogeneity and publication bias across studies

Table 6 provides a summary of observations included in this review and statistics describing heterogeneity across the studies. Heterogeneity describes the measure of variation across studies that is actual differences and not to chance. In this study, the highest heterogeneity observed in *E. coli* studies was 88.5 %, indicating significant variability among individual studies. Other studies displayed moderate heterogeneity, ranging from 34 % to 43 %.

We used meta-regression to explore variation in prevalence. Geographical location of sampling, sample size, processing state (processed or raw) and year of publication were used as predictors. While there was no significant variation in *E. coli* prevalence between countries, levels in the DRC were found to be 60 % higher than in other countries. Processed products (including heated, fermented and sun-dried) were associated with approximately 17 % lower prevalence of *E. coli*. Additionally, larger sample sizes tended to show slightly lower prevalence, although this difference was not statistically significant. The year of publication did not account for any variation in *E. coli* prevalence.

Larger sample sizes were associated with a lower prevalence of *Salmonella* spp. Processed products were also associated with 8 % lower prevalence compared to raw products, while positive prevalence of *Salmonella* spp. was seen to increase with years. There was no significant variation between countries.

Processing was associated with 8 % reduction in prevalence of *Campylobacter* spp.; however this was not significant. Geographical location, sample size and year of publication did not explain variation in prevalence. However, samples from Tanzania showed higher positive rates of *Campylobacter* spp. Table 7 describes the association between

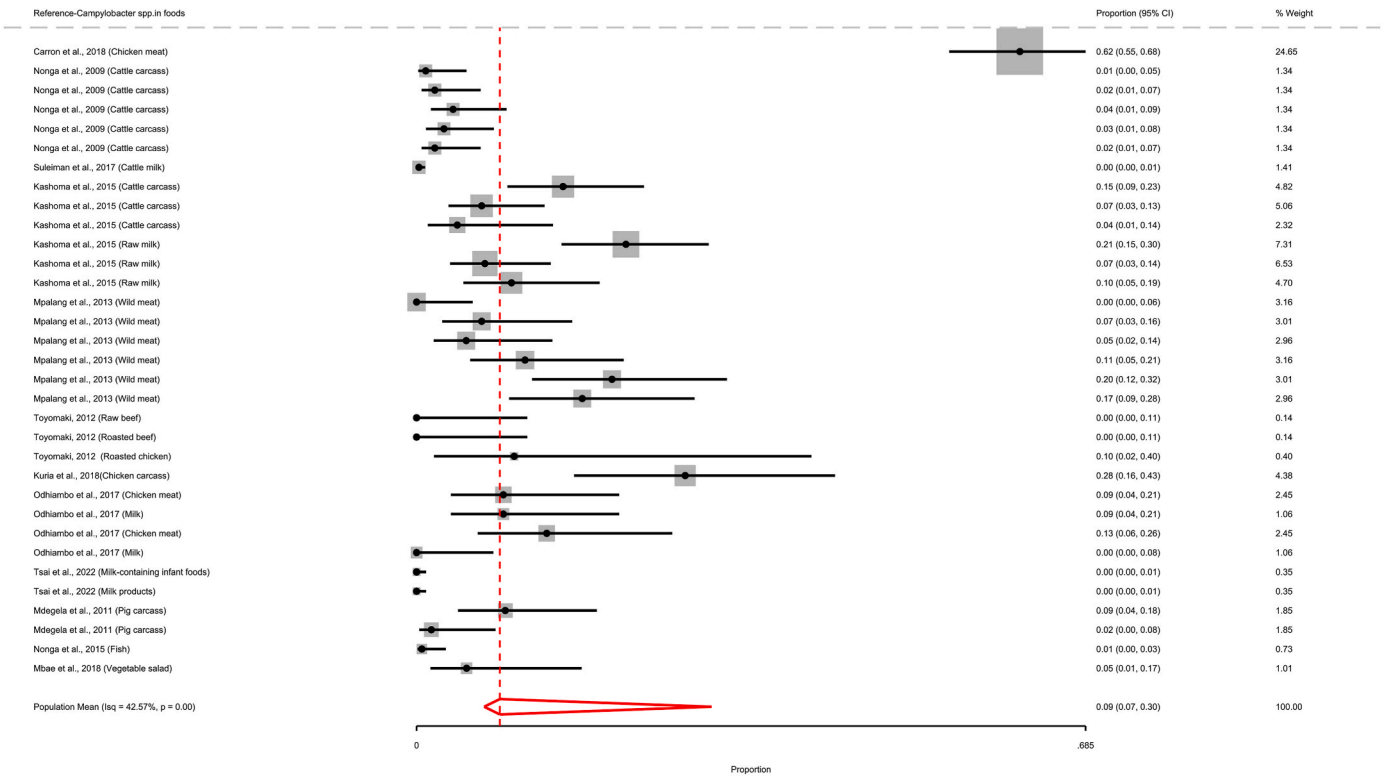

Fig. 4. Forest plot of *Campylobacter* spp. in foods in EAC countries, January 2000 to June 2022.

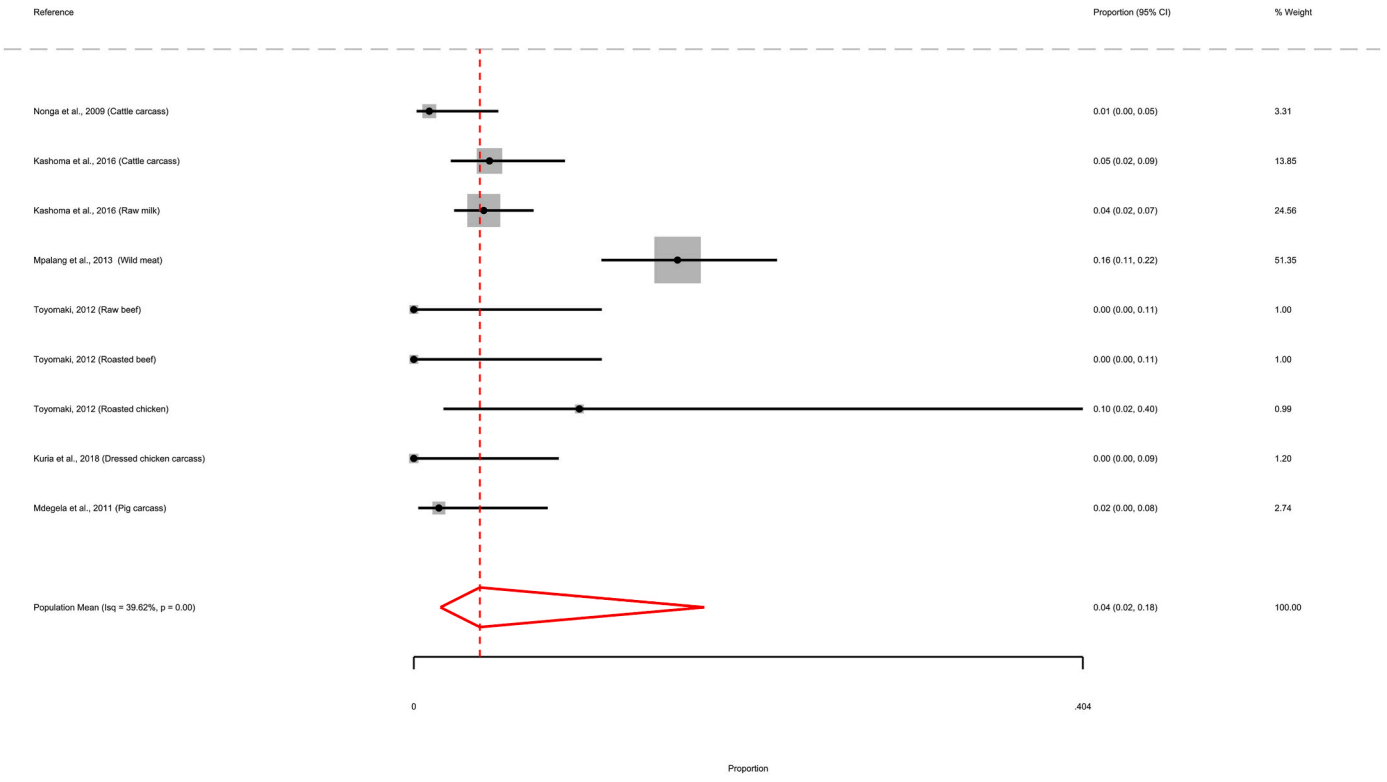

Fig. 5. Forest plot of *Campylobacter coli* in foods in EAC countries, January 2000 to June 2022.

pathogen prevalence and predictors.

Although funnel plot and Egger's test revealed evidence of publication bias (p-value <0.05) in studies on *Campylobacter* and *Salmonella* spp., trim and fill method confirmed symmetry, indicating no small-study bias, with the value of imputed studies being zero. Results on publication bias are presented in Tables 9–10 and Figs. 10–12 in the supplementary material.

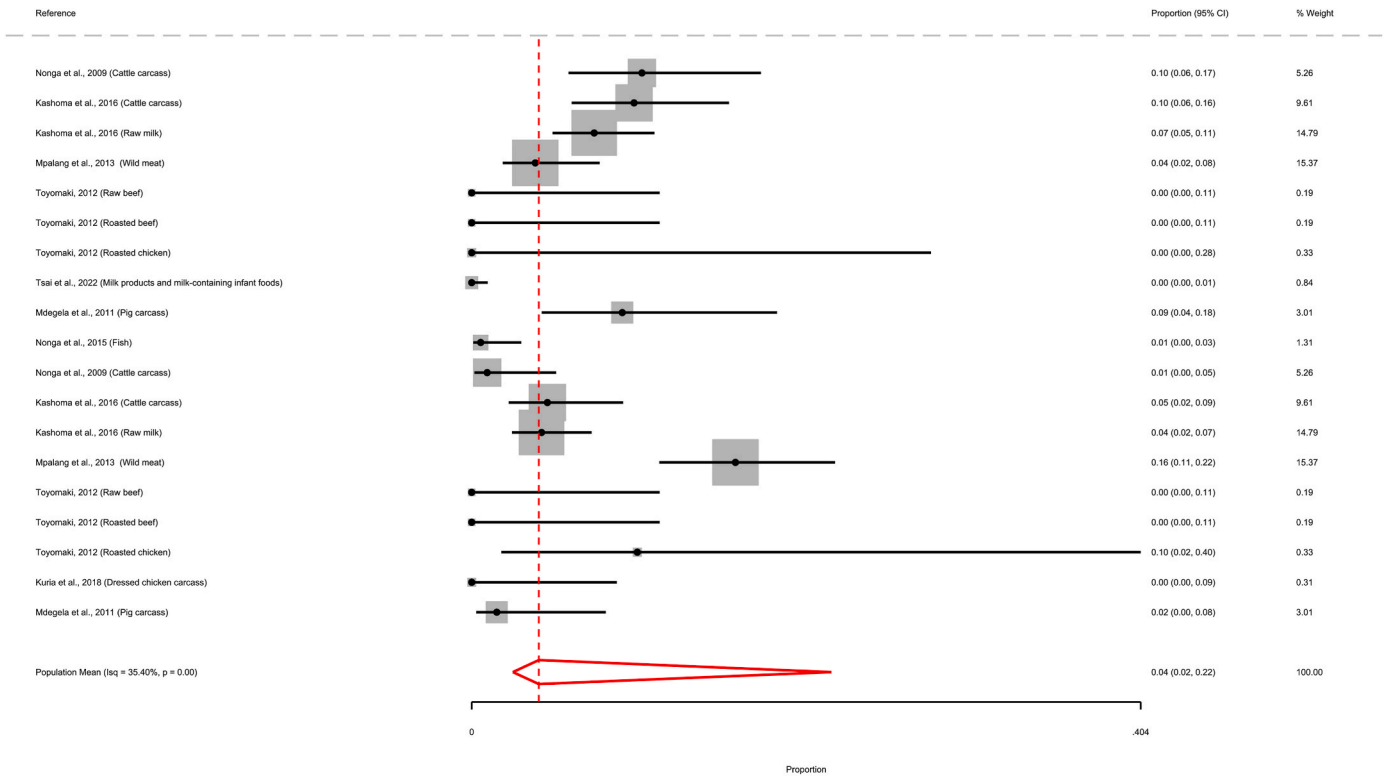

Fig. 6. Forest plot of *Campylobacter jejuni* in foods in EAC countries, January 2000 to June 2022.

4. Discussion

4.1. Inclusion and exclusion of studies

This review was conducted to determine the prevalence of *E. coli*, *Salmonella* spp. and *Campylobacter* spp. in foods consumed in the EAC and the risk factors associated with contamination.

There was a steady increase in the number of food safety studies in the EAC region over the years covered by this review, with a notable rise following the publication of the first WHO report on the global burden of foodborne diseases(WHO, 2015). This, along with funding opportunities, may have stimulated greater interest in the subject. There was also a decline after the COVID-19 pandemic, possibly indicating that research priorities shifted and there was limited capacity to conduct field research activities.

Most studies were conducted in Kenya and Tanzania, with a smaller but significant proportion carried out in Uganda. Gazu et al. (2023) observed that the presence of relevant research institutions can influence the concentration of studies in a particular region or country. No studies were retrieved for Burundi or South Sudan. In Burundi, available reports have been on food control systems (Niragira et al., 2020), milk quality (Iribagiza et al., 2024), and a few on zoonotic diseases (Hakizimana et al., 2020; Isabel et al., 2022; Minani et al., 2022). Most research has focused on food security and nutrition (Niragira et al., 2015; Nkurunziza et al., 2017; Rubyogo et al., 2021), with limited attention given to food safety and epidemiology of the three pathogens under our investigation. South Sudan, which gained independence in 2011 (African Development Bank (AfDB) Group, 2013), had no studies, probably because the available studies were those that had been conducted in Sudan (mainly Khartoum region, n = 7). The absence of studies from these countries highlights a research gap that should be addressed to provide evidence for decision-making and public policy on food safety and public health.

Many studies (n = 108) were excluded during the review process due to poor quality, primarily because non-probabilistic sampling methods were used. In addition, some studies did not adequately describe the microbiological methods or provide a complete description of the results. This may indicate a lack of scientific rigour in the application of methods, which can introduce bias and compromise the reliability of the SLR (Shaheen et al., 2023); therefore, these studies were excluded.

4.2. Value-chains studied

Our review extensively covered milk, meat, and raw-produce value chains, a focus that was also highlighted in a previous African study (Paudyal et al., 2017). Livestock value chains, in particular, have been identified as not only among the most risky in terms of FBD but also the most nutritious (Grace, 2017), and are especially important for vulnerable population groups with increased nutrient requirements (Leroy and Alonso, 2024). Raw-produce value chains, on the other hand, present a greater risk for FBD due to the absence of a pre-treatment step before consumption in many cultures. These factors may have warranted the attention of food safety research.

Food products from cattle, goats, chickens and pigs were commonly studied in our review. Except for pigs, these are also the most common species kept for food security and livelihoods in Africa (Malabo Montpellier Panel, 2020; Robinson et al., 2014). One study in our review specifically focused on rabbit meat (Niyonzima et al., 2017) and another on wild meat (Mpalang et al., 2013). Reports have highlighted the growing significance of unconventional meat sources, such as wild animals, in providing nutrition in Africa (Golden et al., 2011; Grace et al., 2024; Ickowitz et al., 2024; Nasi and Fa, 2015). However, consumption of meat from such species is predominantly localised in rural areas, with only a few points of sale in urban settings. (Staal et al., 2021). In addition, wildlife hunting is illegal or highly regulated in most EAC countries (Lindsey et al., 2015). Thus, market surveys may not explicitly reflect the actual evidence of consumption of unconventional meat sources in East Africa.

Most sampling was conducted in informal and semi-formal outlets including open-air markets, kiosks, slaughter slabs, shops and farm-gate

Table 3
Summary of subgroup analysis showing prevalence and confidence intervals (CI) for pathogen levels in foods in EAC countries, a meta-analysis of studies published between January 2000 to June 2022.

	Subgroup	Pooled sample size	Prevalence	95 % CI interval Lower	Upper
Salmonella spp.	Chicken meat	126	0.25	0.18	0.33
	Fish	675	0.14	0.05	0.55
	Milk	1623	0.15	0.09	0.35
	Ready-to-drink beverages	272	0.09	0.01	0.55
	Raw produce	640	0.10	0.03	0.58
	Meat	2174	0.10	0.07	0.26
	Grains and flours	61	0.01	0.00	0.03
	Others (eggs and cooked foods)	106	0.01	0.00	0.03
	Overall	**5677**	**0.12**	**0.12**	**0.27**
Campylobacter spp.	Chicken meat	323	0.26	0.10	0.55
	Milk	1993	0.06	0.01	0.46
	Meat	1344	0.06	0.04	0.17
	Other (fish and vegetable salads)	224	0.01	0.00	0.04
	Overall	**3884**	**0.09**	**0.07**	**0.30**
E. coli	Ready-to-drink beverages	277	0.66	0.31	0.89
	Meat	2357	0.65	0.30	0.87
	Chicken meat	290	0.63	0.36	0.82
	Raw produce	299	0.46	0.29	0.66
	Milk	3159	0.34	0.26	0.51
	Fish	635	0.27	0.11	0.54
	Others (flours and cooked foods)	191	0.12	0.02	0.43
	Overall	**7208**	**0.41**	**0.34**	**0.52**
STEC[a]	Chicken meat	235	0.04	0.02	0.07
	Meat	2413	0.04	0.04	0.05
	Milk	1614	0.004	0.00	0.10
	Raw produce	74	0.03	0.01	0.09
	Overall	**4336**	**0.02**	**0.01**	**0.10**

[a] Shiga-toxin producing *E. coli*.

locations. Only a few formal sales points, such as retail supermarket chains, were sampled. This is because informal retail outlets remain dominant in low-and middle-income countries (LMICs), and are the preferred primary sources of food for the majority of the population (Blackmore et al., 2020). Consumer preference for informal markets is mainly due to the variety and freshness of foods, convenient locations, and low prices, which are particularly appreciated by low-income earners (Kuboka et al., 2024; Nordhagen et al., 2024). There is considerable debate on the relative safety of formal and informal systems, and the lack of studies on food from the formal systems often promoted on public health grounds is a gap.

4.3. Pathogen levels in food samples

There were fewer studies on *Campylobacter* spp. in foods compared to *E. coli* and *Salmonella* spp., despite this pathogen being known to be prevalent in foods and one of the leading causes of FBD. This may be due to the fact that isolating *Campylobacter* spp. requires specific culture media and incubation conditions. Conventional culture methods are often inefficient because the growth of competing microorganisms can mask *Campylobacter* spp., reducing detection sensitivity. As a result, the prevalence of *Campylobacter* spp. may be underestimated, particularly due to challenges associated with sample transport and culture conditions. However, recovery of *Campylobacter* spp. can be optimised using selective enrichment media and advanced diagnostic techniques (Soto-Beltrán et al., 2023).

The pooled prevalence of *Campylobacter* spp. in our study was 9 % overall, with 26 % in chicken and 5 % in other types of meat. In an SLR by Thomas et al. (2020), prevalence of 21.5 % for *Campylobacter* spp. in poultry and 6.7 % in beef carcasses was observed, which is similar to what we observed in our study. However, a higher prevalence of 36 % was reported in retail chicken meat in India, and up to 63 % in Colombia (Khan et al., 2018; Ortiz et al., 2024). *C. jejuni* was more commonly detected than *C. coli*, which aligns with literature indicating that *C. jejuni* is the most common of *Campylobacter* spp. (WOAH, 2024). *Campylobacter* is a zoonotic pathogen associated with poultry, which serves as its main reservoir. During slaughtering and processing of chickens, carcasses can become contaminated, contributing to the higher prevalence in chicken meat (WOAH, 2024). Cross-contamination of food with livestock faeces can result in *Campylobacter* infections, particularly in children, and these infections can be identified in stool samples (Kiarie et al., 2023; Worku et al., 2024).

In a pooled sample (all food types) of 5677, *Salmonella* spp. was detected with a pooled prevalence of 12 %. This is similar to the 13 % pooled prevalence observed in Burkina Faso (Dinede et al., 2023), although lower rates of up to 3.5 % have been detected in meat in Nigeria (Dagah. et al., 2024; Tafida et al., 2013). Higher prevalences of *Salmonella* spp. have been reported in South-East Asia. In Vietnam, the prevalence ranged between 26 % and 80 %, and a meta-analysis established a pooled prevalence ranging between 30 % and 41 % in meat products (Dang-Xuan et al., 2019; Ngo et al., 2021; Nhung et al., 2024). In Cambodia, one study established a prevalence of 42 % in chicken meat and 45 % in pork (Rortana et al., 2021).

Beverages such as fruit juices, drinking water, and cereal-based drinks, often consumed by infants and children, were also found to be highly contaminated with *Salmonella* spp. at 11.8 %. Our findings are similar to those reported in Ethiopia, where *E. coli* and *Salmonella* spp. were frequently reported in beverages (GAIN, 2022). Higher levels of *Salmonella* spp. were detected in borehole water in Nigeria, with a pooled prevalence of 20% (Oduori et al., 2022). This water is sometimes used in cooking.

Salmonellosis is among the leading causes of hospitalisations and deaths from FBD, even in developed countries (EFSA and ECDC, 2021; Jackson et al., 2013). *S.* Enteritidis and *S.* Typhimurium are the most important serotypes implicated in FBD outbreaks and human infections worldwide (Jackson et al., 2013; EFSA and ECDC, 2021; He et al., 2023). In this review, only a few studies (n = 8) reported specific serotypes, with *S.* Enteritidis and *S.* Typhimurium being the most common. The lack of information on specific serotypes associated with FBD may hinder efforts to accurately determine source attribution and estimate the disease burden in African countries.

Other serotypes reported in our review included *S.* Hivingtoss, which was responsible for FBD outbreak in Australia in 2017 (Smith et al., 2020); *S.* Newport, which was linked to a *Salmonella* outbreak caused by raw cheese in France (Robinson et al., 2020); and *S.* Seftenberg, which was linked to 75 confirmed clinical cases in multiple countries in the EU (ECDC and EFSA, 2023).

Of the 53 included studies in our review, 41 (77.4 %) examined *E. coli* in foods. The predominance of *E. coli* studies is a common finding in many FBD-related reviews (GAIN, 2022; Gazu et al., 2021; Paudyal et al., 2017). Pooled prevalence for *E. coli* in our study was 41 %, comparable to what was found in foods in West Africa (40 %), South-East Asia (21.8 %–48.1 %) and different African countries (35.4–37.6 %) (Dinede et al., 2023; Desiree et al., 2021; Paudyal et al., 2017). However, some studies have reported prevalences exceeding 50 % with levels above the national allowable maximum limits (Kagambèga et al., 2013; Koech et al., 2024).

E. coli is a commensal microorganism, naturally found in the gastrointestinal tract of humans and animals. Due to poor hygiene and faecal-contamination, food and beverages can become contaminated (Feng et al., 2020). Most *E. coli* strains are non-pathogenic and have no adverse effects in humans. However, some strains, such as O157:H7, produce toxins that can lead to adverse effects in humans, including kidney failure, as seen in the case of haemolytic uremic syndrome (Tserenpuntsag et al., 2005; WOAH, 2004). In addition, some *E. coli*

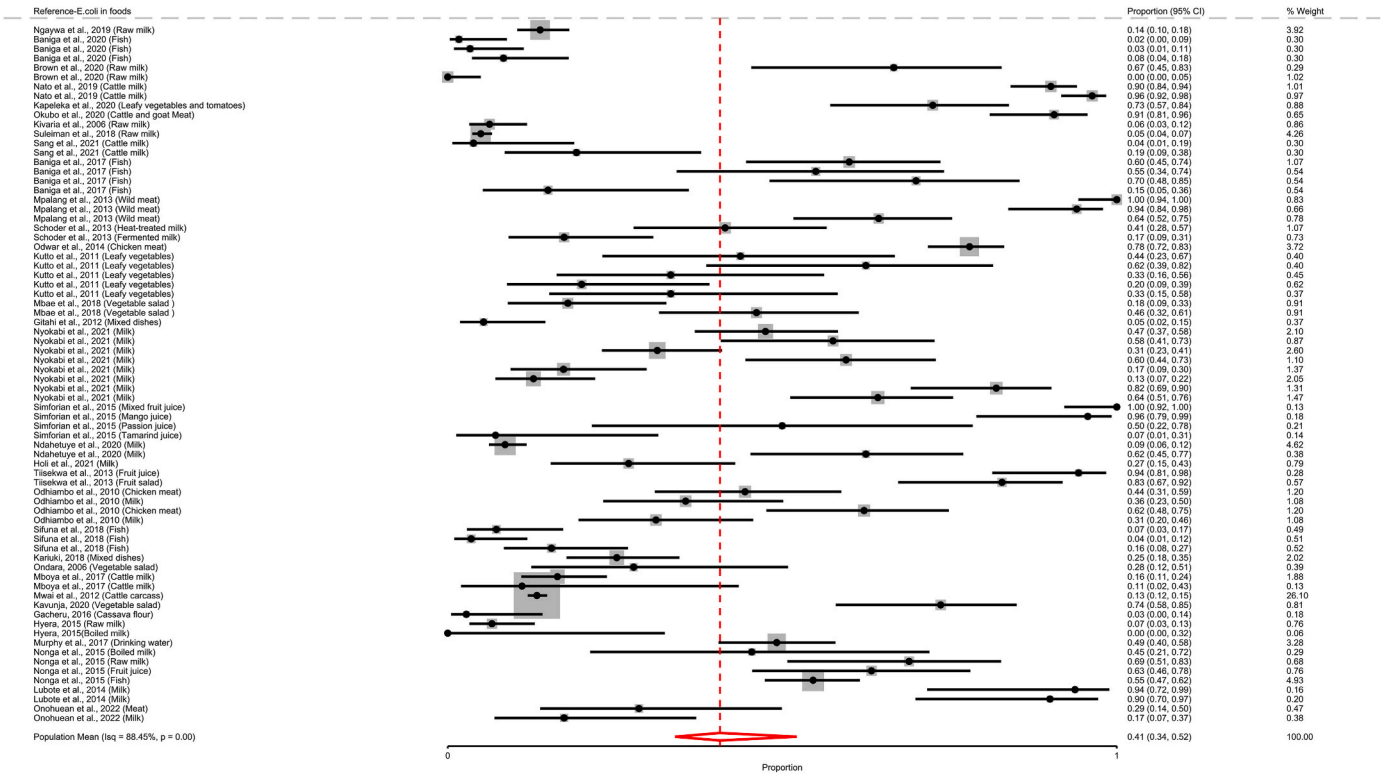

Fig. 7. Forest plot of *E. coli* in foods in EAC countries, January 2000 to June 2022.

Table 4
Pathogenic *E. coli* detected in foods from retail sale points in EAC countries, between January 2000 to June 2022.

Reference	Pathotypes identified	Method of detection	Point of sampling	Specific food	Country
Odwar et al. (2014)	EPEC, ETEC, EIEC, EAEC	Microbial culture, biochemical test and PCR	Butcheries and supermarkets	Chicken meat	Tanzania
Tsai et al. (2022)	EAEC, EPEC, ETEC	Microbial culture and qPCR	Market	Milk products and milk containing infant foods	Kenya
Baniga et al. (2020)	Non-O157 STEC (09:H21) (045: H7) (ONT:H28)	Microbial culture, API system and whole-genome sequencing	Fishing ground, landing sites and markets	Fish	Tanzania

PCR = polymerase chain reaction.
qPCR = quantitative polymerase chain reaction.

strains produce extended-spectrum β-lactamases, which render them resistant to antibiotics (Brolund, 2014; Koech et al., 2024), making this bacterium an important concern in public health.

In our review, the O157 STEC strain was detected mostly in ASF with a pooled prevalence of 2 %. In Ethiopia, STEC was found in beef carcasses at a prevalence of 4.5 % (Beyi et al., 2017), while in Burkina Faso, the prevalence in chicken carcasses was 4 % (Kagambèga et al., 2013). Higher prevalences of up to 9.7 % have been observed in meat in Vietnam (Duc et al., 2024). Non-O157 STEC strains such as O45:H7 and O9: H21which also harbour virulence genes, were reported in this review (Baniga et al., 2020). These have also been associated with foodborne diseases (Bertoldi et al., 2013; Mellmann et al., 2009). In addition, other pathogenic strains observed in our review, such as ETEC, EPEC, EIEC and EAEC, have been implicated in diarrheal diseases (Bii et al., 2005; Okumu et al., 2023; Schlosserová et al., 2024).

4.4. Risk factors associated with contamination

Storage temperature and proper hygiene remain important factors in food contamination and were identified as significant risk factors in our review. Similarly, Ngo et al. (2021) found that increasing the temperature by one degree and selling mixed types of meat increased the likelihood of *Salmonella* contamination in Vietnam. Refrigerated storage and frequent sanitisation were associated with reduced contamination of pork carcasses with *Campylobacter* spp. in Nepal (Ghimire et al., 2014). Additionally, decreased frequency of cleaning and sanitation, as well as proximity to other meat carcasses, were associated with the incidence of *Campylobacter* spp. in chicken meat in Colombia (Ortiz et al., 2024).

One study in our review found a link between food safety training and decreased contamination levels (Niyonzima et al., 2017). Although few studies are available, research among food handlers and dairy farmers in Kenya and Ethiopia has shown that training on food safety and hygiene improved microbial quality in food and on food-contact surfaces (Beyene et al., 2025; Malavi et al., 2021).

Other risk factors identified in different studies include the effect of seasonal variation on contamination levels (Desiree et al., 2021; Rortana et al., 2021). However, this was not observed in this review.

4.5. Application of standards and public health implications of pathogens

In 2025, the African Union, through its member states, agreed to establish the African Union Food Safety Agency, which will serve as a focal point for harmonising food policies and regulations. Standards will

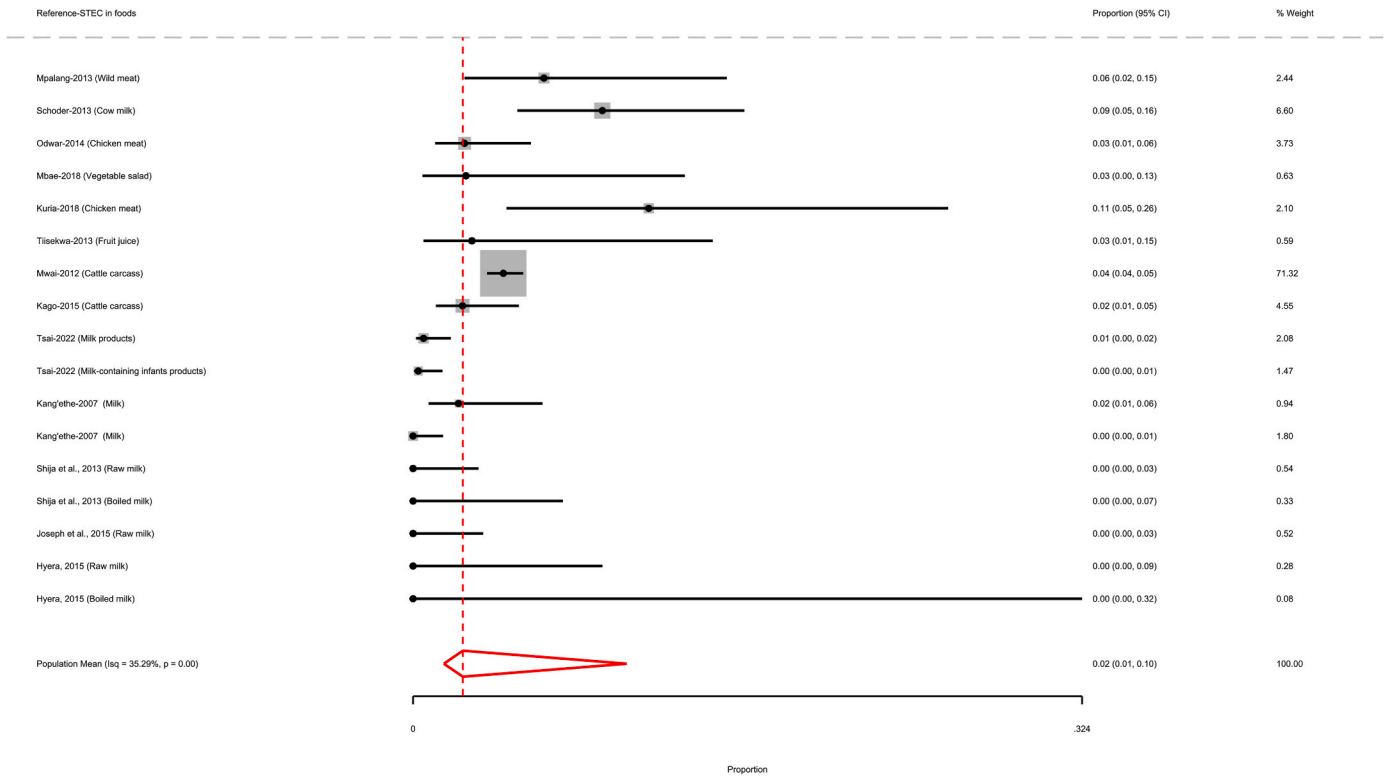

Fig. 8. Forest plot of STEC in foods in EAC countries, January 2000 to June 2022.

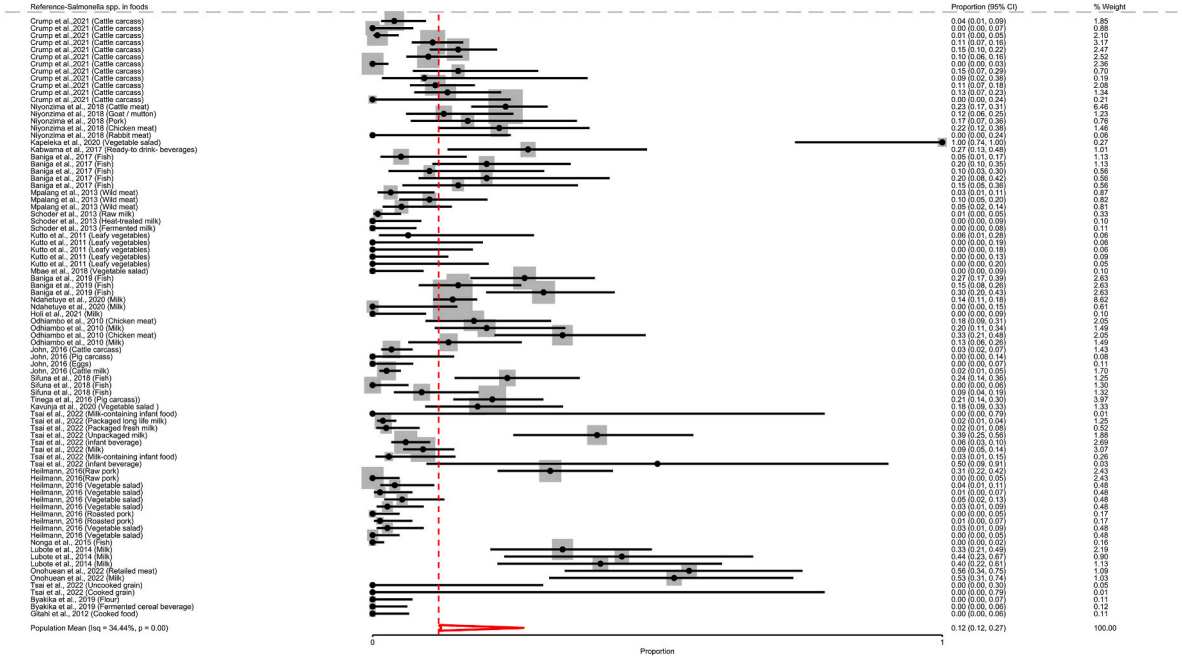

Fig. 9. Forest plot of *Salmonella* spp. in foods in EAC countries, January 2000 to June 2022.

be applied uniformly, thereby promoting food trade under the AfCFTA agreement, while safeguarding public health (African Union, 2025). Meanwhile, standards established by regional bodies such as the EAC, as well as the Codex Alimentarius Commission (CAC), are applied across countries, providing guidelines on food safety.

According to EAC standards, *E. coli* and *Salmonella* spp. must be absent in pasteurised milk and beverage products (Codex Alimentarius Commission, 1981, Draft Kenya Standard Water - based fruit flavoured drinks, 2024, East African Standard, 2006, KEBS, 2024), while a limit of 10^2 cfu/g is set for *E. coli* in meat (East African Standard, 2022). Detection of *Salmonella* spp. and pathogenic *E. coli* in foods, especially RTE categories, indicates a high risk of foodborne illness in humans. Poor or nonexistent hygiene facilities, combined with a lack of understanding among food handlers in cottage industries and food establishments, are possible causes of high contamination in food (Simforian et al., 2015; Tiisekwa, 2013). Stringent hygiene measures are required,

Table 5
Salmonella enterica serotypes reported in foods in EAC countries between January 2000 to June 2022.

Reference	*Salmonella* serotype	Method of detection	Point of sampling	Sample type	Country
Crump et al. (2021)	*S.* Enteritidis *S.* Orion *S.* Typhimurium *S.* Saintpaul II 42:r:	Microbial culture, biochemical test and PCR	Meat slaughter and butcher facilities	Goat and cattle carcass and meat	Tanzania
Kabwama et al. (2017)	Non-typhoidal	Microbial culture, biochemical test	Street vendors	Drinking water	Uganda
Baniga et al. (2017)	*S.* Typhimurium	Microbial culture and PCR	Landing sites, markets and fish vendors (fishermen and processors)	Fish	Tanzania
Baniga et al. (2019)	*S.* Waycross *S.* Hvittinfoss *S.* Typhimurium *S.* Singapore *S.* Enterica *S.* Senftenberg *S.* Newport *S.* enterica subsp. salamae 42:r:	Microbial culture, agglutination tests and PCR	Fishing ground, landing site and markets	Fish	Tanzania
Sifuna and Onyango (2018)	*S. enterica - Group E*	Microbial culture, biochemical tests and API	Landing sites and markets	Fish	Kenya
Tsai et al. (2022)	*S.* enterica	Microbial culture and PCR	Market	Milk products, milk-containing infant foods	Kenya
Heilmann et al. (2016)	*S.* Enteritidis *S.* Offa *S.* Arechavaleta *S.* Gallinarum	Microbial culture, biochemical test and PCR	Pork butcheries	Pork, vegetable salads	Uganda
Odhiambo et al. (2017)	*S.* Typhimurium *S.* Enteritidis *S.* Typhi	Microbial culture, gram-staining and biochemical tests	Commercial food kiosks	Fish	Kenya

Table 6
Summary statistics and level of heterogeneity in meta-analyses of studies in EAC countries, *between January 2000 to June 2022*.

Pathogen	Number of observations	Chi-square statistic	P-value	Tau^2	I^2
Campylobacter spp.	33	611.45	<0.001	4.63	42.57
C. jejuni	19	51.52	<0.001	2.40	35.40
C. coli	9	27.22	<0.001	1.17	39.62
E. coli	74	2455.30	<0.001	3.39	88.45
STEC	17	45.30	<0.001	1.45	35.29
Salmonella spp.	84	396.90	<0.001	3.96	34.44

including testing the water used to prevent the introduction of bacteria into the product. Although our analysis showed a low prevalence of some pathogens, such as STEC, the risk to human health remains significant, particularly through consumption of raw meat, milk, fruit and vegetable products.

In our analyses, there was a significant association between food processing and the prevalence of *Salmonella* spp. and *E. coli*; however, this connection was borderline for *Campylobacter* spp. (p-value = 0.05). Traditional processing of food products, including fermentation, cooking and smoking, is a risk reduction strategy employed by informal actors and households in Africa (Ibnouf, 2012). These strategies reduce the bioavailable moisture and nutrients necessary for microbial growth,

Table 7
Summary of multivariable regression model for predictors of pathogen levels in foods in EAC countries, between January 2000 to June 2022.

Pathogen	Co-variates	Co-efficient	Standard error	P-value	95 % confidence interval Upper limit	Lower limit
Campylobacter spp.	Intercept**	0.20	0.05	0.00	0.10	0.30
	Sample size	−0.00	0.00	0.49	−0.00	0.00
	Processing state	−0.09	0.05	0.05*	−0.18	0.00
	Country					
	Kenya	Baseline	Baseline	Baseline	Baseline	Baseline
	Tanzania	−0.12	0.06	0.04*	−0.24	−0.00
	DRC	−0.01	0.12	0.92	−0.26	0.23
Salmonella spp.	Intercept**	0.18	0.03	0.00	0.13	−0.23
	Sample size	−0.001	0.00	0.03*	−0.00	−0.00
	Processing state	−0.09	0.04	0.02 *	−0.16	−0.01
	Year	0.01	0.01	0.04*	0.00	0.03
E. coli	Intercept**	0.41–0.00	0.07	0.00	0.28	0.54
	Sample size	−0.17	0.00	0.06	−0.00	0.00
	Processing state		0.08	0.04*	−0.33	−0.01
	Country					
	Kenya	Baseline	Baseline	Baseline	Baseline	Baseline
	Tanzania	0.08	0.09	0.35	−0.09	0.25
	Uganda	0.09	0.16	0.58	−0.22	0.40
	Rwanda	0.03	0.26	0.90	−0.55	0.48
	DRC	0.60	0.26	0.02*	0.09	1.11

Intercept** is the expected prevalence when the year is set at baseline and all predictors are zero.
P-value*-significant at 0.05.

thereby decreasing pathogen levels (Tapía et al., 2020). However, poor handling and insufficient processing can also result in microbial contamination (Dzikunoo et al., 2021). *Campylobacter* spp. is highly sensitive to heat and low moisture conditions. Proper heating to temperatures up to 70 °C is important and considered sufficient to destroy bacteria and some toxins that may have formed (Nguyen et al., 2006; Oosterom et al., 1983). Therefore, insufficient heating or post-process contamination of products may have led to equally high prevalence of *Campylobacter* spp. in processed products compared to raw food products.

Although there was no significant variation in prevalence among different countries, notably higher *E. coli* levels were observed in the DRC, while *Campylobacter* spp. was more prevalent in Tanzania. This may be because the studies focused on meat, especially wild meat in DRC, which is classified as a high-risk food. Higher prevalences are therefore expected, given the potential for poor production and hygiene practices, as well as interaction with environmental factors (Grace et al., 2024; Staal et al., 2021).

4.6. Limitations

Moderate to high heterogeneity was observed across the studies, which may limit the interpretation of our findings. However, by applying subgroup analyses to explore sources of heterogeneity (Higgins and Thompson, 2002), we confirmed significant differences in the prevalence of *E. coli* and *Salmonella* spp., which could be attributed to the different types of samples analysed. Heterogeneity was particularly high for studies on *E. coli* ($I^2 = 88.45$ %), which may limit confidence in precise point estimates. Nonetheless, our review provides pooled estimates that compare studies across countries and are weighted by sample size, offering regional policymakers broad magnitude estimates needed for AfCFTA food safety harmonisation efforts.

Meta-regression analyses were used to explore variation in prevalence. Notable variation was attributed to processing sample sizes, countries and year of publication, thus providing additional data on variation that may explain high heterogeneity in our study meta-analyses.

Methodologically, *meta* command has been widely used in meta-analysis of proportions; however, it was unsuitable in our study, where there were proportions with zero or 100 % positive samples. Application of *Metapreg* in STATA® allowed estimation of pooled prevalence using a logistic-normal random-effects model, with Wilson confidence interval. The key advantage of this command was that it handled zeros without the addition of a continuity correction factor (Nyaga and Arbyn, 2024).

While Egger's test showed evidence of small-study effects, the trim-and-fill method revealed no asymmetry, confirming no publication bias.

5. Conclusion and future directions

Our review reveals that some countries within the EAC, specifically, Burundi, the DRC and South Sudan, have been overlooked in food safety research. Investment in food safety research in these countries will help to understand and mitigate the burden of foodborne illnesses.

Our findings indicate that chicken meat was more contaminated than other types of meat, although there were fewer studies focused specifically on chicken. Similarly, unconventional meat sources, such as wild meat, had also been understudied. Ready-to-drink beverages frequently showed contamination with *E. coli* and *Salmonella* spp. While our study was focused on contamination levels in foods, risk assessment studies are needed to link exposure to these pathogens with the occurrence of foodborne illnesses.

Most studies were focused on *E. coli*, revealing high levels of contaminated food, which is an indication of poor hygiene and sanitation practices. However, fewer studies characterised *Salmonella* serotypes and *E. coli* pathotypes. Consistently, even fewer studies analysed *Campylobacter* spp. Modern diagnostic techniques for characterisation of pathogens can be expensive and are often unavailable in LMICs settings. Investing in laboratory infrastructure is crucial for improving the understanding of FBD burden.

Although pathogen levels in food were found to be considerably high, only a small number of studies reported associations between risk factors and contamination levels. Moreover, there were no studies that went beyond hazards to assess actual risk to human health, which is the most crucial information. By understanding risk factors, targeted interventions to counter contamination can be designed. Additionally, risk assessment studies will offer valuable evidence to inform policy direction on food safety and health.

With the increased calls for intra-African trade, there is a need for guidelines and stringent measures to protect food safety and public health. The establishment of the African Food Safety Agency is crucial and timely to safeguard public health while promoting livelihoods and trade.

CRediT authorship contribution statement

Maureen Kuboka: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ianetta Mutie:** Writing – review & editing, Software, Methodology, Investigation, Conceptualization. **Karin Artursson:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Johanna Lindahl:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Gunnar Carlsson:** Writing – review & editing, Supervision, Methodology, Conceptualization. **Florence Mutua:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Delia Grace:** Writing – review & editing, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial or personal interests that could have influenced the work reported in this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.fm.2025.105004.

Data availability

Data will be made available on request.

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