

The Prevalence of *Listeria* Species in Different Food Items of Animal and Plant Origin in Ethiopia: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Listeriosis is one of an important emerging zoonotic disease affecting human health following the consumption of contaminated foods of animal origin. It results in serious clinical complications in humans with a high case facility rate. Therefore, this systematic review and meta-analysis aimed to estimate the pooled prevalence of *Listeria* species in Ethiopia.

Methods: A systematic search was conducted on PubMed, Web of Science, EMBASE, Google Scholar and the Cochrane Library. All identified observational studies reporting the prevalence of *Listeria* species in different food items of animal and plant origin in Ethiopia were included. Three authors independently extracted data and analyzed them using STATA version 13 statistical software. A random effects model was computed to estimate the pooled prevalence of *Listeria* species in Ethiopia.

Results: After reviewing 122 studies, 5 studies fulfilled the inclusion criteria were included in the meta-analysis. The findings from the 5 studies revealed that the pooled prevalence of *Listeria* species in different food items of animal and plant origin in Ethiopia was 27% (95% CI: 25, 29). The highest prevalence of *Listeria* species was reported in beef meat followed by ice cream with prevalence rates of 62% (95% CI: 50, 75) and 43% (95% CI: 33, 53), respectively.

Conclusion: The presence of *Listeria* species in different food items of animal and plant origin in Ethiopia is an indicator of the presence of public health hazards to the consumer, particularly to the high-risk groups. Hence awareness creation on food safety and implementation of regulations is strongly recommended.

Keywords: *Listeria*; Prevalence; Milk products; Animal product; Ethiopia

INTRODUCTION

Listeriosis is an important emerging zoonotic disease affecting human health following the consumption of contaminated foods of animal origin [1]. Among the different species of the genus *Listeria* is the causative agent of listeriosis [2]. *Listeria* can persist for long periods in the environment or as an asymptomatic infection in adult animals and birds. Due to its psychrophilic nature, it can grow within a wide range of temperatures (1.5°C to 50°C) [3]. *Listeria* can persist for long periods in the environment and can easily contaminate agricultural products and ultimately livestock products [4].

Listeria is an important cause of diseases in both animals and humans. In the vast majority of human cases, infection is the result of consumption of contaminated food is a food-borne pathogen, and its incidence and growth in foods, contribute to outbreaks of

listeriosis [5]. Reports have indicated is most frequently prevalent in the milk-processing environment including steps, drains and floors [2]. In addition, different studies reported that a higher prevalence of *Listeria* species was also found in meat and meat product foods, and ice cream samples [6-8].

The occurrence of listeriosis among humans has received increasing attention as epidemic listeriosis has been recognized and reported in immunosuppressed populations [9]. This bacterium principally causes intrauterine infection, meningitis and septicemia. Listeriosis in pregnancy may be asymptomatic or manifest as severe systemic infection in the unborn or newly delivered infants. The microorganism causes fatal infections such as encephalitis, sepsis and meningitis in immune deficient patients and abortion in pregnant women [10]. The mortality rate is reported to be 20%-30% [11,12].

Currently, there is inadequate information regarding the prevalence

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of *Listeria* species in Ethiopia. Therefore, the present systematic review was undertaken to determine the pooled prevalence of *Listeria* species using a published article in Ethiopia.

METHODS

Study design

A systematic review and meta-analysis were conducted to estimate the magnitude of *Listeria* species in different food items of animal and plant origin in Ethiopia following the methodological framework suggested by Arksey and O'Malley.

Search strategies

All relevant articles were searched without date limits using the following databases: PubMed, Web Science, Embase, Google Scholar, Cochrane Library and Science Direct according to the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA). All searches were limited to articles written in English given that such language restriction does not alter the outcome of the systematic reviews and meta-analysis. The gray literature of observational studies was searched through the review of reference lists and input of content experts. The literature search was conducted from January 2009 to February 2015. All papers published until the end of 2015 and fulfilling inclusion criteria were considered. The search used the following keywords *Listeria*, prevalence, milk products, animal product, and Ethiopia. The search terms were used separately and in combination using Boolean operators such as OR or AND.

Eligibility criteria

Studies conducted only in Ethiopia and involving only humans were included in this study. All observational study designs reporting the prevalence in humans were eligible for this review. Only articles reported in the English language were considered. Articles, that were not fully accessible, after email contact with the primary authors and duplicate publications of the same study, were excluded.

Assessment of study quality

Studies selected for inclusion were assessed for methodological quality by all authors independently using the standard critical appraisal instruments of the Joanna Briggs Institute Meta-Analysis of Statistics Assessment for Review Instrument (JBI-MASTARI). Disagreements were resolved by consensus.

Outcome measure

The primary outcome variable of this study was the prevalence of *Listeria* species, while the secondary outcome was its comparison in different types of food, including cheese, raw beef, raw milk, fish meat, raw meat, ice cream, and cream cake.

Data extraction

Data were extracted using a standardized data extraction format, adapted from the Joanna Briggs Institute (JBI), by three authors (Kuma Diriba, Ephrem Awulachew, Kumsa Diriba and Behailu Taye) independently extracting all necessary data. Then the extracted data were merged for systematic analysis. Any disagreements during the data extraction were resolved through discussion and consensus. The main outcomes extracted from the study were: primary author, publication year, study method, study area, sample size and cases. Data on associated risk factors were also extracted by the authors.

Statistical analysis

Following data extraction, systematic review and meta-analysis were carried out using R software version 3.6.1 and STATA statistical software (version 13) with user contributed commands for meta-analyses, metaprop, metan, metafor, metabias, and metareg. The effect sizes and SEs of the studies were pooled using a random-effects model to calculate the pooled prevalence of *Listeria* species in different food items of animal and plant origin in Ethiopia. A meta-analysis was also planned to assess the association *Listeria* species in different food items of animal and plant origin collected during the study period.

The standard error for each original study was calculated using the binomial distribution formula. Evidence for statistical heterogeneity among reported prevalence was using the Cochrane Q-test and I² statistics. The pooled proportion was estimated by using the back-transform of the weighted mean of the transformed proportions for both the fixed-effects model and the random-effects model. A significance level of P<0.10 and I²>50% was interpreted as evidence of heterogeneity. A potential source of heterogeneity was investigated by subgroup analysis and meta-regression analysis. Where statistical pooling was not possible, the findings were presented in a narrative form including tables and figures to aid in data presentation where appropriate.

Sensitivity analyses were conducted to weigh up the relative influence of each individual study on the pooled effect size using a user-written function, metainf. The presence of publication bias was assessed informally by visual inspection of funnel plots. Point prevalence, as well as 95% confidence intervals, was presented in the forest plot format.

RESULTS

Study selection

Data base search identified a total of 122 articles reporting prevalence of *Listeria* species in different food items of animal and plant origin. From these initial articles, 40 articles were excluded due to duplication. From the remaining 82 articles, 51 articles were excluded after review of their titles and abstracts confirmed non-relevance to this review, 31 full-text articles were assessed with respect to their eligibility for inclusion, which resulted in the further exclusion of 26 articles primarily due to the study done in other countries, and 5 studies were included in the final systematic review and meta-analysis (Figure 1).

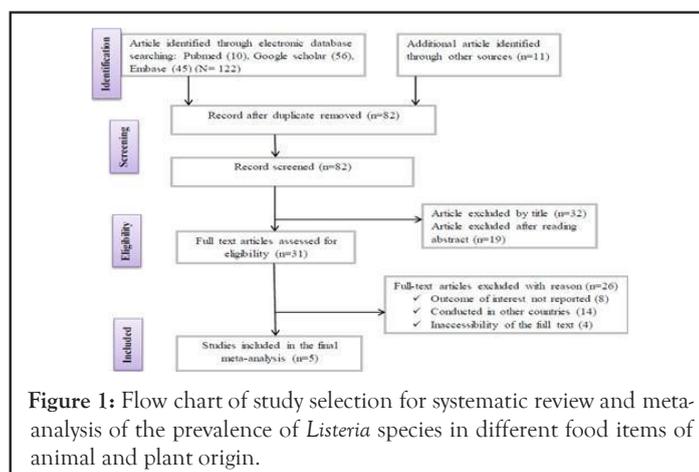


Figure 1: Flow chart of study selection for systematic review and meta-analysis of the prevalence of *Listeria* species in different food items of animal and plant origin.

Description of included studies

In this review, the 5 papers published between, 2009 to 2015 and reported prevalence of *Listeria* species in different food items of animal and plant origins was included. In this systematic review and meta-analysis, 2169 study participants were included to assess the pooled prevalence of *Listeria* species among food and animal products. Sample size of the included studies was ranged from 240 to 711. The prevalence of *Listeria* species in different area reported in this meta-analysis was near to each other with the lowest prevalence (25%) reported in Gondar town, Amhara and the highest prevalence (28%) in Addis Ababa. Three of the studies were from Addis Ababa, and two from Amhara.

Risk of bias

The risk of bias tool was used to assess the risk of bias for the included studies and almost greater than 80% of the studies had low risk of bias. The sample selection and temperature during transport and the amount of any individual sample tested were specified in some of the studies. *Listeria* specific enrichment media, biochemical test and supplement were used in majority of the studies. *Listeria* was incubated at 30°C for 24-48 hour in most of the studies.

The pooled prevalence of *Listeria* species in different food items of animal and plant origin in Ethiopia was 27% (95% CI: 25, 29). The heterogeneity observed across the included studies was zero ($I^2=0$, $p=0.84$). From this meta-analysis, the prevalence of each study was nearer to each other falling within the range of 25% and 28%.

DISCUSSION

Data on *Listeria* species in different food items of animal and plant origin in Ethiopia are limited and are not currently available in aggregate form. We conducted a systematic review and meta-analysis to provide the pooled prevalence of *Listeria* species in different food items of animal and plant origin. *Listeria* species are a leading cause of bacterial-derived foodborne disease worldwide with an estimated 400 million cases per year. The information from this study might be used by the policy makers in the prevention and control of the infection.

In the present study, the pooled prevalence of *Listeria* species in different food items of animal and plant origin obtained from this study was 27% that indicated significant public health hazard associated with consumption of contaminated foods of animal and plant origin. This indicates, in part, increased attention to the issues of microbial food safety in this region.

In the current study, both food items of animal and plant origin showed a significant level of contamination with *Listeria* species. In this study, cheese, raw beef, raw milk and liquid whole egg samples were collected and analyzed for the presence of *Listeria* species. Among the seven species of *Listeria* reported in different research article conducted in Ethiopia. In the present meta-analysis, raw beef was found to be the predominant food item contaminated with *Listeria* species, out of 369 food items of animal and plant origin examined, around one third (29.3%) raw beef meat were contaminated with *Listeria* species. The high contamination of the beef samples may be due to poor hygienic conditions during slaughtering, processing and selling. This indicates raw or undercooked beef meat was consumed traditionally throughout the country which aggravates the public health associated to *Listeria* species.

Limitations of the study

The collected article for this study was limited to English language. Study method (most of them were cross-sectional), which can affect the outcome variable by other confounding variables. Small sample size, which could affect the estimated pooled prevalence of *Listeria* species in different food items of animal and plant origin.

CONCLUSION

In this meta-analysis, there was high prevalence therefore, based on our findings, we recommend emphasis shall be given on health education about cooking of animal product before consumption, improved food safety through the implementation of hygienic measures at all levels from production to consumption with particular emphasis on personal hygiene as well as, proper disposal of wastes including excreta in integration with the existing national health extension program are recommended.

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Ethics approval

Ethical approval was not required because the analysis under consideration is from data that already publicly available in published studies.

Consent for publication

Not required.

Data availability statement

All data relevant to the study are included in the article.

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Authors' contributions

KD is the first and corresponding author. KD and EA conceived and designed the study. KD, EA and SB acquired the data. KD and EA analyzed the data and interpreted the results. EA and KD drafted the initial and final manuscripts. KD, EA and EG performed critical revisions of the manuscript. All authors approved the final version of the manuscript.

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