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Prevalence of Foodborne Pathogens in Fresh, Chilled and Smoked Fish in Ghana: A Systematic Review

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ADMINISTRATIVE INFORMATION**Support** - This systematic review received no specific grant from any funding agency in the public, commercial or not-for-profit sectors. The study is being conducted as part of academic research.**Review Stage at time of this submission** - Preliminary searches.**Conflicts of interest** - None declared.**INPLASY registration number:** INPLASY202620047**Amendments** - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 14 February 2026 and was last updated on 14 February 2026.**INTRODUCTION**

Review question / Objective What is the prevalence of food borne pathogens in fresh, chilled and smoked fish in Ghana and how does contamination vary by processing method and associated risk factors?. The objective of this systematic review is to identify food borne pathogens in fish intended for human consumption and also discover factors associated with microbial contamination along the fish value chain in Ghana.

Rationale Fish is a major source of animal protein in Ghana. However, its microbiological safety remains a significant public health concern. Fishes and fish products are highly susceptible to microbial contamination due to their biochemical composition, environmental and handling conditions within the fish value chain. Some primary studies (Dayie et al. 2024; Abarike et al. 2022) conducted in Ghana have reported microbial contamination in fresh, chilled and smoked fish.

However, the evidence remains fragmented, location-specific and methodologically heterogeneous, making it difficult to determine the national burden of contamination or compare risks across processing methods. This review therefore seeks to collate, appraise and synthesize existing empirical evidence on the prevalence and distribution of food borne pathogens in fishes in Ghana and to identify contamination risk factors across the value chain.

Condition being studied This review focuses on microbial contamination of fish intended for human consumption in Ghana. The condition of interest is the presence and prevalence of foodborne pathogens in the fishes, specifically bacterial pathogens and indicator microorganisms. The review examines contamination across fish processing methods that is fresh, chilled and smoked fish and factors contributing to pathogen occurrence, including handling practices,

processing conditions, storage, environmental hygiene and market infrastructure.

METHODS

Search strategy A comprehensive systematic search was conducted across multiple electronic databases to identify relevant studies. The databases searched included PubMed/MEDLINE, EBSCOhost, Scopus, ScienceDirect, Wiley Online Library, African Journals Online (AJOL), SpringerLink, Taylor & Francis Online, and Google Scholar.

The search strategy was developed in accordance with the PRISMA-S guideline. Key concepts informing the search included fish, microbial contamination, foodborne pathogens, and Ghana. Keywords, synonyms, and spelling variations were identified and combined using Boolean operators (AND, OR). Controlled vocabulary terms such as Medical Subject Headings (MeSH) were incorporated where applicable.

The initial search strategy was developed in PubMed and adapted to the syntax requirements of other databases. Truncation, phrase searching and field tags were applied where appropriate. Searches covered studies published from database inception to December 2025. The full search strategies were documented to ensure transparency and reproducibility.

Participant or population The population of interest includes fish intended for human consumption in Ghana. Eligible fish products include fresh, chilled and smoked fish obtained from aquaculture systems, marine and inland capture fisheries, landing sites, processing centers and retail markets.

Fish species investigated across studies include, but are not limited to, Nile tilapia (*Oreochromis niloticus*), African catfish (*Clarias gariepinus*), anchovies, sardines, and mixed species. No restrictions were placed on fish species, production system, or geographic location within Ghana.

Intervention The review evaluates microbial contamination of fish and fish products. This includes the detection and laboratory identification of foodborne pathogens such as bacterial species and contaminants present in fresh, chilled, and smoked fish.

Comparator Where applicable, comparisons will be made across fish processing methods, specifically fresh, chilled and smoked fish products, to assess differences in the prevalence and distribution of microbial contamination.

Study designs to be included Primary empirical studies reporting microbiological contamination of fish products will be included. Eligible designs include cross-sectional laboratory-based studies, surveillance studies, observational studies, and prevalence studies employing culture-based or molecular pathogen detection methods.

Eligibility criteria

Inclusion criteria:

Studies reporting primary empirical data on microbial or foodborne pathogens in fish intended for human consumption in Ghana; studies examining fresh, chilled, or smoked fish; laboratory-confirmed pathogen detection; peer-reviewed articles and accessible grey literature.

Exclusion criteria:

Studies conducted outside Ghana without disaggregated data; studies on chemical contaminants only; fish diseases unrelated to human consumption; reviews, editorials, commentaries, protocols; studies lacking extractable microbiological data; duplicates or inaccessible full texts.

Information sources Information sources include electronic bibliographic databases (PubMed/MEDLINE, Scopus, ScienceDirect, Wiley Online Library, EBSCOhost, SpringerLink, Taylor & Francis Online, African Journals Online) and Google Scholar.

Additional sources include reference list screening of included studies and grey literature where accessible. Study authors were considered for contact where clarification of data was required.

Main outcome(s) The primary outcome will be the prevalence of microbial contamination in fish and fish products intended for human consumption in Ghana. This will include the proportion of fish samples testing positive for specific foodborne pathogens, particularly bacterial organisms such as *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*, *Aeromonas* spp., and *Streptococcus agalactiae*. Outcomes will be measured as reported prevalence estimates based on laboratory detection methods within individual studies.

Additional outcome(s)

Secondary outcomes include:

- Distribution of pathogens by fish processing method (fresh, chilled, smoked)
- Types and diversity of microorganisms identified
- Indicator microorganisms (e.g., coliforms, heterotrophic bacteria)

• Factors associated with microbial contamination (handling, storage, processing conditions).

Data management All identified records were imported into Zotero reference management software for deduplication. Deduplicated records were exported to Rayyan for screening.

Two independent reviewers will conduct title/abstract and full-text screening. Data extraction will be performed independently using a standardized, piloted extraction form. Extracted data will include study characteristics, fish type, pathogens, laboratory methods, prevalence, and contamination factors. Discrepancies will be resolved through discussion or consultation with a third reviewer.

Quality assessment / Risk of bias analysis

Methodological quality of included studies will be assessed using the Joanna Briggs Institute (JBI) critical appraisal checklists for prevalence and analytical cross-sectional studies. Appraisal domains will include sampling methods, sample size adequacy, validity of laboratory detection techniques, outcome measurement, and statistical reporting. Quality assessment will be conducted independently by two reviewers, with disagreements resolved through consensus. Results will inform interpretation of findings but will not be used as exclusion criteria.

Strategy of data synthesis Because of the methodological heterogeneity in study designs, sampling approaches, laboratory techniques and reporting formats, a narrative synthesis approach will be employed. Extracted data will be summarized descriptively and organized by fish processing method and pathogen type. Occurrence estimates will be compared across studies to identify patterns in microbial contamination. Thematic synthesis will be used to summarize factors associated with contamination. Findings will be presented in tables and narrative format. Quantitative meta-analysis is not planned due to variability in prevalence reporting and absence of consistent effect measures.

Subgroup analysis Subgroup analyses will be conducted descriptively based on fish processing method (fresh, chilled, or smoked), fish species, geographic study location, and pathogen category. These subgroupings will help explore patterns in microbial contamination.

Sensitivity analysis Sensitivity analyses will be conducted narratively where feasible by comparing findings from higher-quality versus moderate-quality studies based on JBI appraisal scores. This

will help assess the robustness of contamination patterns reported across studies.

Language restriction No language restrictions will be applied.

Country(ies) involved Ghana.

Other relevant information The review will follow PRISMA 2020 reporting guidelines and PRISMA-P protocol standards. The protocol aims to enhance transparency, reduce duplication and provide an evidence base for food safety policy and research in Ghana's fisheries sector.

Keywords Foodborne pathogens; Microbial contamination; Fish; Ghana; Prevalence; Food safety; Smoked fish; Fresh fish.

Dissemination plans Findings from this systematic review will be disseminated through peer-reviewed journal publication, conference presentations, and policy briefs targeted at food safety regulators and public health stakeholders in Ghana. Results will also inform future research and risk-reduction interventions within the fish value chain.

Contributions of each author

Author 1 - Doreen Osei Frimpong - Conceptualization of the review, designing the methodology, conducting literature searches, study selection, data extraction, analysis, and drafting the systematic review protocol.

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Author 2 - Pearl Boamah Agyekum - Provide methodological supervision, contribute to protocol development, review eligibility criteria, and critically revise the manuscript.

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Author 3 - Herman Erick Lutterodt - Provide an academic oversight, validate the review design, resolve methodological issues and critically review the protocol.

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