

Foodborne Pathogens in Street-Vended Food in India: A Narrative Review of Prevalence, Risk Factors, and Public Health Implications

Satya Prakash Himanshu¹, Rahul Kumar², Muskan Kumari³, Abir Majumder⁴

¹Assistant Professor (H.O.D), Department of Allied & Healthcare, Jharkhand Rai University, Ranchi, India.

^{2,3,4} Assistant Professor, Department of Allied & Healthcare, Jharkhand Rai University, Ranchi, India.

Corresponding Author: Mr. Satya Prakash Himanshu, Assistant Professor (H.O.D), Department of Allied & Healthcare, Jharkhand Rai University, Ranchi, India.

(Received: 30 May 2026)

Revised: 20 June 2026

Accepted: 24 July 2026)

KEYWORDS

Street food; foodborne pathogens; food safety; India; Escherichia coli; Staphylococcus aureus; antimicrobial resistance; public health; vendor hygiene.

ABSTRACT:

Introduction: Street food is a major source of affordable nutrition and informal-sector employment in urban and semi-urban India, but the sector's largely unregulated water supply, storage, and hygiene infrastructure has repeatedly been linked to microbial contamination and foodborne illness.

Objectives: To synthesize the peer-reviewed and institutional evidence on the prevalence of key foodborne pathogens in Indian street-vended food, the vendor-level and environmental factors driving contamination, and the public health, economic and antimicrobial-resistance (AMR) implications, and to identify evidence-based directions for policy and future research.

Methods: A structured narrative review was conducted using Scopus, PubMed/MEDLINE, Web of Science and Google Scholar, supplemented by institutional sources (FSSAI, IDSP/NCDC, ICMR, WHO). Peer-reviewed studies, systematic reviews and government/WHO reports addressing street-vended food safety in India (or directly comparable South Asian contexts) published between 2014 and 2025 were screened for relevance and synthesized thematically.

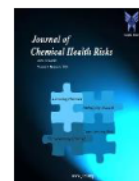
Results: Escherichia coli and Staphylococcus aureus are consistently the most frequently reported contaminants of Indian street food, with Salmonella spp., Shigella spp., Listeria monocytogenes, Bacillus cereus and Vibrio cholerae also documented in specific food categories and regions. Untreated water, poor hand hygiene, ambient-temperature storage of pre-cooked items, and low uptake of Food Safety and Standards Authority of India (FSSAI) licensing are recurring risk factors. Vendor knowledge-attitude-practice surveys show only partial translation of food-safety awareness into consistent hygienic behaviour, and national surveillance of street-food-linked outbreaks remains fragmented across agencies.

Conclusions: Addressing microbial contamination of Indian street food requires coordinated investment in water and sanitation infrastructure, mandatory vendor training and licensing, strengthened multi-agency surveillance, and further nationally representative, methodologically standardized research to close current evidence gaps.

1. Introduction

Street-vended food is a defining feature of urban and semi-urban life across India, providing inexpensive, culturally rooted, and readily accessible meals-such as pani puri, bhel puri, vada pav, samosas, chaats, and egg

rolls-to hundreds of millions of consumers daily. Beyond its dietary role, the sector is a significant source of livelihood for the urban informal workforce, and it forms an integral part of India's culinary and economic landscape [1,2].



Despite this socio-economic importance, street food vending in India typically operates with limited access to potable water, refrigeration, waste disposal, and sanitary preparation surfaces. These infrastructural constraints, combined with variable vendor knowledge of food-safety principles, create conditions favourable to the growth and transmission of foodborne pathogens, including *Escherichia coli*, *Salmonella* spp., *Staphylococcus aureus*, *Shigella* spp., *Listeria monocytogenes*, *Bacillus cereus*, *Clostridium perfringens*, and *Vibrio cholerae* [1,3,4].

Globally, foodborne disease disproportionately affects children, the elderly, and immunocompromised individuals, and the World Health Organization has identified strengthening food-safety systems as a priority under its Global Strategy for Food Safety 2022-2030 [5]. In India, national surveillance instruments such as the Integrated Disease Surveillance Programme (IDSP) and regulatory frameworks under the Food Safety and Standards Authority of India (FSSAI) exist, but a recent SWOT-based evaluation of the country's foodborne- and waterborne-disease surveillance architecture found persistent gaps in laboratory capacity, inter-agency data sharing, and real-time outbreak detection-gaps that are most acute in the informal food sector where street vending predominates [5].

Although a number of city- and region-specific microbiological and knowledge-attitude-practice (KAP) studies of Indian street food vendors have been published, the evidence remains scattered across disciplines (microbiology, public health, food science) and has not been consistently synthesised. This review consolidates the available peer-reviewed and institutional evidence on (i) the pathogens most frequently associated with Indian street food, (ii) the vendor-level and environmental risk factors that drive contamination, (iii) the public-health, economic and antimicrobial-resistance consequences, and (iv) the regulatory and surveillance landscape, in order to identify evidence-based priorities for intervention and further research.

2. Objectives

The primary objective of this review is to synthesize the available peer-reviewed literature and institutional evidence on the microbiological safety of street-vended foods in India. The review examines the prevalence of

major foodborne pathogens across different food categories and regions and evaluates vendor-level, food-handling, and environmental factors, including hygiene, water quality, sanitation, food storage, and regulatory compliance, that contribute to microbial contamination.

Furthermore, the review assesses the public health, economic, and antimicrobial resistance (AMR) implications of contaminated street-vended foods while identifying key research gaps and regional disparities in the existing evidence. Based on the findings, it provides evidence-based recommendations to strengthen food safety surveillance, improve vendor awareness and regulatory implementation, and guide future research for safer street food systems and better public health protection in India.

3. Review Methodology

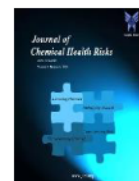
This is a structured narrative review rather than a formal systematic review or meta-analysis. Literature was identified through searches of Scopus, PubMed/MEDLINE, Web of Science and Google Scholar, using combinations of the terms 'street food', 'street-vended food', 'India', 'foodborne pathogen*', 'Escherichia coli', 'Salmonella', 'Staphylococcus aureus', 'Shigella', 'Listeria', 'Vibrio', 'food safety', 'hygiene', and 'antimicrobial resistance'. These were supplemented by direct searches of institutional sources, namely FSSAI, the National Centre for Disease Control (NCDC)/IDSP, the Indian Council of Medical Research (ICMR), and the WHO Global Environment Monitoring System for Food Contamination (GEMS/Food). The search and selection process is summarised in Figure 1.

Peer-reviewed journal articles, government reports, or WHO/FAO publications;

Focused on street-vended or informally sold ready-to-eat food, primarily in India (broader South Asian or international studies were retained only where they provided directly relevant comparative or methodological context);

Reporting pathogen prevalence, vendor knowledge/attitude/practice data, environmental risk factors, regulatory frameworks, or public-health burden;

Published between 2014 and 2025 to reflect the current regulatory era under the Food Safety and Standards Act,



2006, while allowing inclusion of a small number of frequently cited earlier foundational studies.

Findings were extracted and grouped thematically-pathogen prevalence, vendor and environmental risk factors, regional patterns, public health and economic implications, and regulatory/surveillance architecture-and are presented narratively with supporting tables and figures rather than pooled quantitatively, given the heterogeneity of sampling frames, laboratory methods, and outcome definitions across the underlying studies (see Section 9, Limitations).

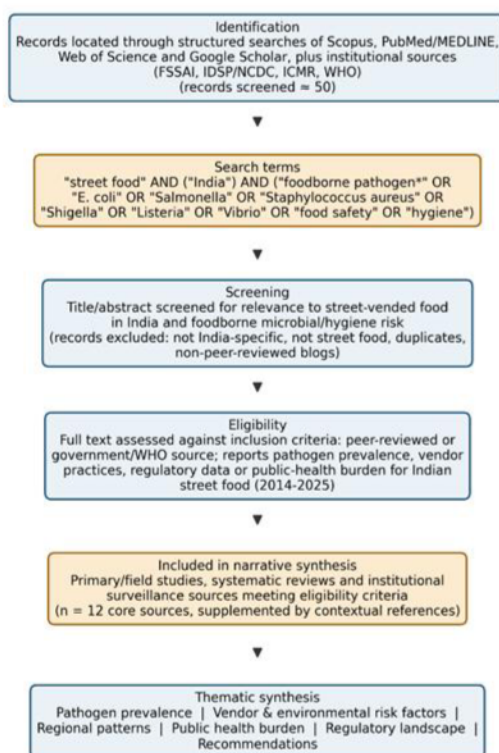


Figure 1. Literature search and study-selection flow for this narrative review.

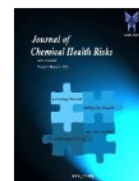
4. Results

Across the studies reviewed, a consistent core group of bacterial pathogens recurs in Indian street food, food-contact surfaces, and vendor hand/utensil swabs. *E. coli* and *S. aureus* are the most frequently reported organisms and are typically used as indicators of faecal contamination and poor hand hygiene, respectively [3,6]. *Salmonella* spp. and *Shigella* spp. are more commonly associated with contaminated water, raw vegetables, and meat-based items, while *Listeria monocytogenes* and

Bacillus cereus are more often isolated from dairy-based sweets and starchy, previously cooked items held at ambient temperature [1, 7]. *Vibrio cholerae*, though less frequently isolated, is a marker of grossly contaminated water sources used in food preparation [4]. Table 1 summarizes these organisms, their principal food vehicles, and the mechanisms most often implicated in their transmission via street food.

Table 1. Key foodborne pathogens reported in association with Indian street-vended food, their principal food vehicles, and transmission mechanisms.

Pathogen	Commonly Implicated Foods	Principal Transmission Mechanism
Escherichia coli	Water-based chutneys, golgappa/pani puri filling, cut fruit, salads	Faecal contamination of water and hands; inadequate handwashing
Staphylococcus aureus	Hand-prepared items, sandwiches, chaats	Direct hand-to-food contact by vendors with poor hand hygiene
Salmonella spp.	Meat-based snacks (kebabs, rolls, momos), improperly reheated food	Cross-contamination from raw meat; inadequate cooking/reheating
Shigella spp.	Raw/undercooked vegetables, puffed rice-based snacks	Contaminated water used for washing produce or mixing
Listeria monocytogenes	Dairy-based sweets (kulfi, shrikhand-type items)	Poor cold-chain management; extended ambient storage



Bacillus cereus	Rice- and starch-based dishes held at room temperature	Spore germination on slow cooling/ambient holding of cooked food
Vibrio cholerae	Beverages and chutneys mixed with untreated water	Use of contaminated municipal or stored water



Figure 2. Conceptual pathway from environmental and vendor-level risk factors to consumer exposure to foodborne pathogens in Indian street food.

Reported contamination patterns vary regionally, broadly tracking differences in climate, water quality, and predominant food categories rather than any single dominant national pattern. Studies from northern India have repeatedly implicated untreated water used in chutneys and juice preparation: a Delhi-based assessment of street-vended fruit juices, for example, found microbiological quality of the tested juices did not meet acceptable standards, attributing this primarily to the water used in preparation and to vendor hygiene and safety practices, and additionally documented antimicrobial resistance among the isolated *E. coli*, *Salmonella* and *Vibrio* strains [6]. A separate assessment of ready-to-eat panipuri and noodle samples from north Delhi similarly reported substantial bacterial and fungal loads together with antimicrobial-resistant isolates [8].

In eastern India, an early but still frequently cited study of ready-to-eat street food in Silchar, Assam, documented bacteriological quality below acceptable limits for a majority of tested samples [9], while a hygiene-practices assessment around medical colleges in Kolkata found that roughly half of the tested food samples-spanning items such as lassi, sugarcane juice, and street sweets-carried organisms including *E. coli*, *Shigella* spp. and *Staphylococcus* spp. [10]. In western India, a large public microbiological survey of Mumbai street food (sandwiches, vada pav, gravies and related items) reported that the great majority of samples tested were microbiologically unsafe, with cooked items generally showing lower contamination than items such as sandwiches that receive more hand-preparation after cooking [11].

These regionally distinct findings are consistent with the broader international literature: a 2023 systematic review of the socio-economic determinants of street food vending in developing countries found that microbiological quality is shaped less by the specific food items sold than by vendors' access to potable water, sanitation, refrigeration and formal training-conditions that vary considerably between Indian states and even between neighbourhoods of the same city [1].

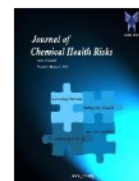
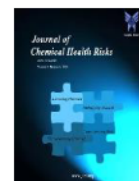


Table 2. Selected recent Indian studies illustrating vendor-level food-safety compliance and microbiological findings (non-exhaustive; heterogeneous methods-see Section 9).

Location	Study focus	Key finding	Source
Delhi (5 urban markets)	Microbiology of street-vended fruit juices	Sub-standard microbiological quality; AMR detected in <i>E. coli</i> , <i>Salmonella</i> and <i>Vibrio</i> isolates	Sharma et al., 2020 [6]
North Delhi	RTE panipuri and noodle samples	Substantial bacterial/fungal loads with antimicrobial-resistant isolates	Sultana et al., 2025 [8]
Silchar, Assam	RTE street food bacteriological quality	Majority of samples below acceptable bacteriological standards	Sharma & Mazumdar, 2014 [9]
Kolkata	Hygiene practices near medical colleges	~Half of food samples positive for <i>E. coli</i> , <i>Shigella</i> spp. or <i>Staphylococcus</i> spp.	Nandy et al. [10]
Mumbai	Citywide microbiological survey	Large majority of tested items microbiologically unsafe; hand-prepared	Metropolis Healthc are survey [11]

		items worst-affected	
Pune (urban slum)	Vendor conformance with BIS food-safety standard	64% of 100 vendors achieved satisfactory BIS conformance ; gaps in raw-material storage, waste disposal, pest control	Kaushal et al., 2025 [12]
Bhubaneswar, Odisha	Vendor knowledge-attitude-practice (KAP)	Only 22.2% good knowledge and 35.3% good practice despite 55.1% positive attitude (n = 214)	Gautam & Giri et al., 2025 [13]

Across the studies reviewed, a consistent set of modifiable risk factors recurs regardless of region or specific pathogen: (i) reliance on untreated or intermittently treated water for food preparation, ice, and utensil washing; (ii) inconsistent handwashing and low use of gloves; (iii) reuse of cleaning water and utensils across multiple preparation cycles; (iv) prolonged ambient-temperature holding of pre-cooked items, particularly chutneys, gravies, and rice-based dishes; and (v) low registration/licensing of vendors with FSSAI, which limits both formal training exposure and routine inspection [1,6,12,13]. The most recent Indian vendor-level surveys illustrate that awareness alone does not guarantee safe practice. In the Pune study, while 64% of surveyed vendors met overall Bureau of Indian Standards (BIS) conformance criteria, specific domains-reception,



transport and storage of raw materials, waste disposal, and pest control—showed markedly lower compliance [12]. In Bhubaneswar, although a majority of vendors expressed a positive attitude toward food safety (55.1%), only about one-fifth demonstrated good underlying knowledge (22.2%) and roughly one-third exhibited good practice (35.3%)—a knowledge-practice gap that the study authors attribute to structural barriers (lack of running water, storage, and waste facilities at vending sites) rather than to unwillingness among vendors [13]. These findings are illustrated in Figure 3.

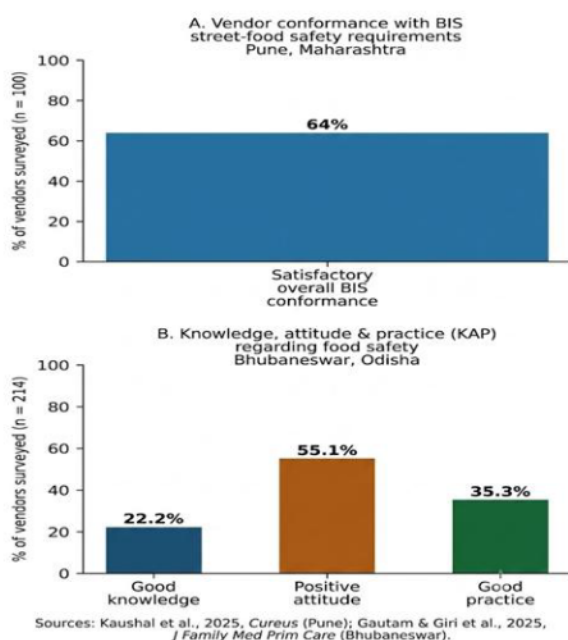


Figure 3. Vendor-level food-safety compliance and knowledge-attitude-practice (KAP) findings from two recent cross-sectional Indian studies.

This gap between attitude and practice underscores that vendor education campaigns alone are unlikely to substantially reduce contamination unless paired with infrastructural investment (potable water points, waste collection, cold storage) and enforceable licensing requirements—an argument also advanced in the international systematic review of street food vending in developing countries [1].

5. Discussion

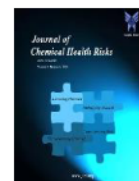
Foodborne pathogens associated with street food are established causes of acute gastroenteritis and diarrhoeal disease, with children, the elderly, pregnant women, and immunocompromised individuals at disproportionate

risk [5]. A 2024 evaluation of India's foodborne- and waterborne-disease surveillance landscape found that outbreaks linked to informal food vending are systematically underreported because of weak diagnostic and laboratory surveillance capacity, particularly outside major metropolitan centres, and recommended integrated, real-time laboratory-based surveillance as a priority [5].

Several of the studies reviewed identify antimicrobial resistance (AMR) as an emerging concern specific to street-food-associated pathogens. The Delhi fruit-juice study found resistance among *E. coli*, *Salmonella* and *Vibrio* isolates to commonly used antibiotics [6], and a global systematic review of antibiotic-resistant bacteria in street foods (which included Indian data) concluded that street food constitutes a plausible route for community transmission of both resistant organisms and resistance genes, warranting closer integration of food-safety and AMR surveillance [7]. This is consistent with the broader pattern in India of empirical, culture-unconfirmed antibiotic use for presumed foodborne illness, which is understood to accelerate resistance selection.

Beyond direct healthcare costs, foodborne illness linked to street food can reduce household productivity through missed work or school days, and outbreaks can damage vendor livelihoods and consumer trust in the informal food economy [1,5]. Because urban poor populations are disproportionately dependent on street food as an affordable primary food source and have comparatively limited access to safe alternatives or timely healthcare, the burden of these risks is not evenly distributed across the population.

India's food-safety governance for street vending operates through several, only partially integrated, mechanisms. The Food Safety and Standards Authority of India (FSSAI), established under the Food Safety and Standards Act, 2006, sets and enforces food-safety standards, including a specific Bureau of Indian Standards (BIS) requirement for street food vendors [12,14]. The Integrated Disease Surveillance Programme (IDSP), run by the NCDC under the Ministry of Health and Family Welfare, tracks outbreaks of epidemic-prone diseases, including foodborne illness, though largely through passive, facility-based reporting [3,5]. The Indian Council of Medical Research (ICMR) contributes AMR-



focused surveillance through its Antimicrobial Resistance Surveillance Network, and the WHO/FAO Global Environment Monitoring System for Food (GEMS/Food) provides an international data-sharing platform to which India contributes country-level summary data [15].

Table 3. Principal Indian and international bodies relevant to street-food safety governance.

Body	Primary Role	Relevance to Street Food
FSSAI	National food-safety standard-setting and licensing authority	Sets BIS-based hygiene requirements for street vendors; low registration uptake remains a barrier [12,14]
IDSP / NCDC	Epidemic-prone disease surveillance	Captures outbreak data, but underreporting is significant in the informal food sector [3,5]
ICMR	Medical research and AMR surveillance	AMR Surveillance Network tracks resistance trends relevant to foodborne isolates [7]
WHO / FAO GEMS-Food	International food-contaminant monitoring platform	Provides comparative, country-level contamination data [15]

A recurring theme across institutional and academic sources is fragmentation: data are collected by multiple agencies using different protocols and are not routinely integrated, which limits the ability to detect trends or respond rapidly to emerging outbreaks linked to street vending [5].

Infrastructure investment: Priorities potable water access, hand washing stations, and waste-disposal facilities at designated vending zones, particularly in high-footfall areas such as railway stations, bus stands, and markets.

Mandatory training tied to licensing: Link FSSAI registration to completion of a basic, practically oriented food-safety training module, addressing the knowledge-practice gap documented in recent KAP studies.

Risk-based inspection: Direct routine inspection resources toward food categories and preparation steps repeatedly implicated in contamination (water-based chutneys, hand-prepared chaats, ambient-held cooked items).

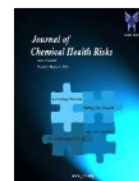
Integrated surveillance: Strengthen data-sharing between FSSAI, IDSP/NCDC, ICMR and state food-safety departments, including laboratory confirmation of suspected foodborne outbreaks, to enable earlier detection and AMR tracking.

Standardized research protocols: Encourage harmonized sampling frames, culture/PCR methods, and reporting standards across future Indian street-food studies to enable valid cross-study and cross-regional comparison and eventual meta-analysis.

Consumer engagement: Support public-facing hygiene-rating or certification schemes for vendors to create market incentives for compliance.

6. Limitations

This review has several limitations that also characterize the underlying literature. First, as a narrative rather than systematic review, the search-though structured-was not exhaustive, and formal risk-of-bias or quality appraisal (e.g., using validated tools) was not conducted; findings should be read as a synthesis of the identified literature rather than an exhaustive or quantitatively pooled estimate. Second, the underlying primary studies vary substantially in sample size, sampling frame (single city or even single neighborhood versus multi-city), laboratory methodology (culture-based versus molecular confirmation), and outcome definitions, which precludes direct numerical comparison or meta-analysis across studies—a limitation also noted in the international systematic review of street-food vending [1]. Third, nationally representative, standardized surveillance data on street-food-linked foodborne illness in India are not available; existing studies are geographically clustered in a limited number of cities, and rural and peri-urban vending remains comparatively understudied. Fourth, some claims that circulate informally in secondary or non-peer-reviewed sources about specific city-level



contamination percentages could not be independently verified against a traceable, citable primary publication during this review and have therefore been deliberately excluded; readers and authors extending this work are encouraged to verify all cited figures directly against primary sources before further use, consistent with standard practice for Scopus-indexed submission.

7. Conclusion

The literature synthesized in this review consistently identifies *Escherichia coli* and *Staphylococcus aureus* as the most frequently detected contaminants of Indian street-vended food, with *Salmonella* spp., *Shigella* spp., *Listeria monocytogenes*, *Bacillus cereus* and *Vibrio cholerae* implicated in specific food categories and settings. Contamination is driven less by any single factor than by the interaction of inadequate water and sanitation infrastructure, inconsistent vendor hygiene practice, ambient-temperature food storage, and limited regulatory reach into the informal sector. Recent vendor-level surveys further show that positive attitudes toward food safety do not reliably translate into safe practice without accompanying infrastructure and enforceable licensing. Given India's continued reliance on street food for both nutrition and livelihoods, closing these gaps-through targeted infrastructure investment, mandatory and practically oriented vendor training, integrated multi-agency surveillance, and methodologically standardized future research-represents a public-health priority with direct relevance to disease burden, antimicrobial resistance, and the economic sustainability of the informal food sector.

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