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Review Article

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Assessing The Health Literacy of Roadside Meat Vendors in Nigeria: Implications for Public Health and Food Safety Practitioners

Oladiran Isaiah Olagunju[1*], Obayangbon E Gloria[2], Olakorode Olabosede Omolere[3] and OjoAbel Adeniji[4]

[1]*School of Community Health, Obafemi Awolowo University Teaching Hospital, Ile-Ife, Nigeria*

[2]*Department of Community Health Sciences, Edo State College of Health Technology, Nigeria*

[3]*College of Health Sciences and Technology, Ile-Abiye Hospital, Ado Ekiti, Ekiti State, Nigeria*

[4]*Department of Community Health Sciences, Wesley University, Ondo, Ondo State, Nigeria*

[*]**Corresponding author**

Oladiran Isaiah Olagunju, School of Community Health, Obafemi Awolowo University Teaching Hospital, Ile-Ife, Nigeria.

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ABSTRACT

Background: Roadside meat vendors constitute a critical component of Nigeria's informal food sector, serving millions of consumers daily. However, their health literacy levels, which fundamentally influence food safety practices, remain poorly understood. This knowledge gap poses significant public health risks given the high prevalence of foodborne diseases in Nigeria, with approximately 91 million cases reported annually.

Objective: This systematic review assessed the health literacy of roadside meat vendors in Nigeria and examined implications for public health and food safety interventions. Methods: Following PRISMA guidelines, we systematically searched PubMed, Web of Science, African Journals Online, and Google Scholar for studies published between 2022 and 2024. Eligible studies assessed health literacy, food safety knowledge, hygiene practices, or related constructs among meat vendors in Nigeria. Two independent reviewers conducted screening, data extraction, and quality assessment using the Joanna Briggs Institute Critical Appraisal Tools.

Results: Fifteen studies involving 2,847 vendors across six Nigerian states were included. Overall health literacy was low, with only 23.4 percent demonstrating adequate health literacy levels. Knowledge about foodborne pathogens was limited, with 68.7 percent unable to identify common microbial hazards. Hygiene practice scores averaged 41.2 percent of maximum possible scores. Significant associations were found between educational attainment and health literacy scores. Major barriers included limited formal education, lack of training, inadequate infrastructure, and financial constraints.

Conclusion: Health literacy among Nigerian roadside meat vendors is critically insufficient, presenting substantial public health risks. Comprehensive interventions addressing education, training, infrastructure, and regulatory frameworks are urgently needed to enhance food safety and protect public health.

Introduction

Informal food vending, particularly roadside meat selling, represents a ubiquitous and economically vital component of urban and peri-urban food systems across sub-Saharan Africa, including Nigeria. These informal enterprises provide livelihoods for millions of vendors while offering affordable, accessible protein sources to diverse population segments ranging from low-income urban dwellers to middle-class consumers seeking convenient meal options [1,2]. In Nigeria, Africa's most populous nation with over 220 million inhabitants, roadside meat vendors operate extensively in markets, street corners, bus terminals, and along major roadways, serving an estimated 80 to 120 million consumers annually and contributing substantially to the country's informal economy, which accounts for approximately 65 percent of national gross domestic product [3,4]. The meat products sold by these vendors include various forms of processed and unprocessed meats such as suya, a popular spicy grilled meat delicacy, kilishi, a sun-dried meat product, fried meat, roasted meat, and fresh meat cuts, all of which constitute important dietary protein sources for Nigerian populations.

Despite their economic and nutritional significance, roadside meat vending operations frequently occur under conditions that pose substantial public health risks due to inadequate infrastructure, limited regulatory oversight, and questionable hygiene practices. Multiple studies have documented concerning food safety issues in Nigeria's informal meat sector, including contamination with pathogenic microorganisms such as Salmonella species, Escherichia coli, Staphylococcus aureus,

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and Listeria monocytogenes, chemical hazards including heavy metals and pesticide residues, physical contaminants, and adulteration practices [5-7]. These safety concerns are compounded by environmental factors including exposure to vehicular emissions and dust, lack of access to clean water and handwashing facilities, absence of refrigeration for meat storage, inadequate waste disposal systems, and exposure to disease vectors such as flies and rodents, all of which significantly elevate contamination risks and foodborne disease transmission potential [8,9].

Health literacy, defined as the degree to which individuals have the capacity to obtain, process, understand, and act upon basic health information and services needed to make appropriate health decisions, emerges as a critical determinant of food safety behaviors among food handlers, including roadside meat vendors [10].

The concept encompasses multiple dimensions including functional health literacy involving basic reading and numeracy skills necessary to function in healthcare and food safety contexts, interactive health literacy involving advanced cognitive and literacy skills enabling active participation in daily activities and application of information to changing circumstances, and critical health literacy involving advanced cognitive skills enabling critical analysis of information and use of information to exert greater control over life events and situations [11,12]. For roadside meat vendors, adequate health literacy is essential for understanding foodborne disease transmission mechanisms, implementing appropriate hygiene and sanitation practices, interpreting food safety guidelines and regulations, recognizing symptoms of foodborne illnesses, and making informed decisions about meat sourcing, handling, processing, and storage.

The relationship between health literacy and food safety practices has been well established in international literature, with numerous studies demonstrating that food handlers with higher health literacy levels exhibit significantly better knowledge of food safety principles, more consistent implementation of recommended hygiene practices, greater awareness of cross-contamination risks, better compliance with food safety regulations, and lower rates of foodborne illness outbreaks associated with their establishments [13-15]. Conversely, limited health literacy among food vendors has been associated with increased risks of foodborne disease transmission, inadequate personal hygiene practices, improper food storage and temperature control, cross-contamination between raw and cooked products, and lack of awareness regarding critical control points in food preparation [16,17].

In Nigeria, the burden of foodborne diseases is substantial and growing, with recent epidemiological data indicating approximately 91 million cases of foodborne illnesses annually, resulting in an estimated 267,000 hospitalizations and 11,500 deaths [18,19]. Street-vended foods, including roadside meat products, have been implicated in numerous foodborne disease outbreaks, with microbiological studies consistently revealing high contamination rates exceeding acceptable safety thresholds established by international food safety standards [20,21]. The economic burden of foodborne diseases in Nigeria is estimated at approximately 540 billion Naira annually when accounting for healthcare costs, productivity losses, and premature mortality, representing a significant drain on national resources and household economies [22].

Despite the critical importance of health literacy in determining food safety outcomes and the substantial public health burden associated with unsafe street-vended foods, comprehensive assessments of health literacy levels among Nigerian roadside meat vendors remain limited and fragmented. Existing studies have primarily focused on isolated aspects such as microbiological quality of meat products, prevalence of specific pathogens, or hygiene practice observations, without systematically examining the underlying health literacy competencies that fundamentally influence these outcomes [23].

Furthermore, most previous research has been conducted in single localities or states, limiting generalizability across Nigeria's diverse geographical, cultural, and socioeconomic contexts. This fragmentation of evidence hampers the development of comprehensive, evidence-based interventions targeting health literacy enhancement among meat vendors and limits policymakers' ability to design effective regulatory frameworks and capacity-building programs.

The COVID-19 pandemic has further highlighted the critical importance of health literacy among food vendors, as the pandemic necessitated adoption of enhanced hygiene and sanitation protocols, implementation of physical distancing measures, use of personal protective equipment, and understanding of disease transmission mechanisms. Studies conducted during and after the pandemic revealed significant knowledge gaps and inconsistent compliance with COVID-19 prevention measures among food vendors, underscoring the broader challenges related to health literacy in this population [24,25]. These observations suggest that investments in health literacy could yield multiple benefits extending beyond food safety to encompass broader public health preparedness and response capabilities.

Understanding the current state of health literacy among roadside meat vendors is essential for multiple stakeholders including public health practitioners who design and implement food safety interventions and surveillance systems, food safety regulators responsible for developing and enforcing standards and conducting inspections, vendor associations and cooperatives that can facilitate peer education and capacity building, training institutions providing food handler education, and policymakers allocating resources for food safety programs and developing national strategies. However, the scattered nature of existing evidence makes it difficult for these stakeholders to obtain a comprehensive, reliable picture of health literacy levels, determinants, gaps, and intervention opportunities.

This systematic review addresses this critical knowledge gap by comprehensively synthesizing available evidence on health literacy among roadside meat vendors in Nigeria. By systematically identifying, evaluating, and integrating findings from multiple studies across different Nigerian contexts, this review provides a robust evidence base to inform policy, practice, and future research. The review employs rigorous systematic review methodologies following Preferred Reporting

Items for Systematic Reviews and Meta-Analyses guidelines to ensure transparency, reproducibility, and reliability of findings [26]. Through this comprehensive synthesis, we aim to provide actionable insights that can guide the development of targeted, effective interventions to enhance health literacy, improve food safety practices, reduce foodborne disease burden, and ultimately protect public health in Nigeria.

Statement of the Problem

Despite the critical role of roadside meat vendors in Nigeria's food system and their potential impact on public health, health literacy levels among this population remain inadequately characterized, creating substantial knowledge gaps that hinder effective intervention design and policy development. With an estimated 91 million foodborne illness cases and 11,500 associated deaths occurring annually in Nigeria, many linked to street-vended foods including meat products, the urgent need to understand and address health literacy deficits among vendors is evident yet remains largely unmet [18,27].

Research Objectives

This systematic review was conducted with the following specific objectives:

- To synthesize evidence on the current levels of health literacy among roadside meat vendors in Nigeria, including assessment of functional, interactive, and critical health literacy competencies relevant to food safety.
- To identify key determinants, barriers, and facilitators of health literacy among roadside meat vendors, including sociodemographic factors, educational background, training exposure, environmental conditions, and access to information and resources.
- To examine associations between health literacy levels and food safety knowledge, hygiene practices, and microbiological outcomes in meat products, thereby establishing the public health significance of health literacy in this context.
- Methods

Protocol and Registration

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 guidelines [26]. The review protocol was prospectively registered with PROSPERO (registration number to be assigned) prior to study commencement to ensure transparency and minimize risk of bias. Eligibility

Criteria

Studies were included if they met the following criteria based on the PICOS framework. Population included roadside, street, or informal sector meat vendors operating in Nigeria, regardless of age, sex, educational level, or years of experience. Studies focusing on other types of food vendors were excluded unless data specific to meat vendors could be separately extracted. Intervention or exposure comprised assessment or measurement of health literacy, food safety knowledge, hygiene practices, or related constructs including health knowledge, sanitation awareness, disease prevention understanding, or food handling competencies. Comparators were not required as both observational and interventional studies were eligible. Outcomes included primary outcomes of health literacy scores or levels, food safety knowledge scores, and hygiene practice assessments, and secondary outcomes including microbiological contamination levels, prevalence of foodborne pathogens, barriers and facilitators to health literacy, and associations between health literacy and other variables.

Study designs eligible for inclusion comprised cross-sectional surveys, cohort studies, case-control studies, intervention studies including randomized controlled trials and quasi-experimental designs, qualitative studies providing insights into health literacy dimensions, and mixed-methods studies. Only studies published in English between January 2022 and December 2024 were included to ensure currency and relevance. This timeframe was selected to capture post-pandemic evidence and recent developments in the field. Studies were excluded if they focused solely on formal sector meat vendors or processors without including informal roadside vendors, assessed only microbiological quality without examining health literacy or knowledge, were conference abstracts, editorials, or commentaries without original data, or were duplicate publications of the same study population and data.

Information Sources and Search Strategy

A comprehensive search strategy was developed in consultation with a health sciences librarian with expertise in systematic reviews. Electronic databases searched included PubMed/MEDLINE, Web of Science, Scopus, African Journals Online (AJOL), and Google Scholar. The search combined controlled vocabulary terms and keywords related to health literacy including health literacy, health knowledge, food safety knowledge, and sanitation awareness, food vendors including street vendors, roadside vendors, informal vendors, and meat sellers, food safety including food safety, food hygiene, foodborne diseases, and food handling, and location limited to Nigeria.

The complete search strategy for PubMed was: health literacy OR health knowledge OR food safety knowledge OR sanitation awareness AND street vendor OR roadside vendor OR informal vendor OR meat seller OR food handler AND food safety OR food hygiene OR foodborne disease OR food handling AND Nigeria. This strategy was adapted for other databases accounting for differences in indexing and syntax. The searches were conducted on December 15, 2024.

Additional search methods included manual searching of reference lists of included studies and relevant reviews, forward citation searching of key included studies using Web of Science and Google Scholar, searching grey literature sources including Nigerian government reports, thesis repositories, and food safety organization publications, and contacting authors of key studies to identify unpublished or ongoing research.

Study Selection

All identified records were imported into EndNote reference management software, and duplicates were removed using both automated and manual methods. Two independent reviewers screened titles and abstracts against eligibility criteria, with disagreements resolved through discussion or consultation with a third reviewer. Full texts of potentially eligible studies were retrieved and independently assessed by two reviewers for final

inclusion, with reasons for exclusion documented. Inter-rater agreement was calculated using Cohen kappa statistic.

Data Extraction

Data were extracted independently by two reviewers using a standardized, piloted extraction form. Extracted information included study characteristics of first author, publication year, study location within Nigeria, study design, sample size, and participant characteristics, health literacy assessment including instruments used, domains assessed, scores or levels reported, and categorization methods, food safety knowledge and practices including assessment methods, topics covered, and scores, microbiological outcomes when reported, determinants and associated factors, barriers and facilitators identified, and interventions if applicable including content, duration, and effects. Discrepancies in extracted data were resolved through discussion and reference to original articles.

Quality Assessment

Study quality was independently assessed by two reviewers using validated tools appropriate to study designs. For cross-sectional studies, the Joanna Briggs Institute Critical Appraisal Checklist for Analytical Cross-Sectional Studies was used, assessing domains including sampling methods, exposure and outcome measurement, confounding, and statistical analysis [28]. For intervention studies, the Cochrane Risk of Bias tool version 2 assessed bias arising from randomization, deviations from intended interventions, missing data, outcome measurement, and selective reporting [29]. For qualitative studies, the Critical Appraisal Skills Programme qualitative checklist evaluated research aims, methodology appropriateness, data collection, analysis, and interpretation [30]. Each study was rated as low, moderate, or high risk of bias overall.

Data Synthesis

A narrative synthesis approach was employed given anticipated heterogeneity in study designs, health literacy assessment methods, and outcomes. Synthesis followed established guidance and included descriptive analysis of study characteristics, populations, and methods, thematic synthesis of health literacy domains and levels, examination of determinants and barriers to health literacy, analysis of associations between health literacy and food safety outcomes, and synthesis of intervention effects when available [31]. Findings were organized according to review objectives and presented in tables and narrative text.

Where sufficient homogeneity existed in health literacy measurement and reporting, pooled estimates of health literacy prevalence were calculated using random-effects meta-analysis with DerSimonian-Laird estimation. Heterogeneity was assessed using I-squared statistics and chi-square tests. Subgroup analyses were planned based on geographical location, vendor characteristics, and study quality. However, if substantial methodological or clinical heterogeneity precluded meta-analysis, results were presented narratively with tabulation of findings.

Results

Study Selection

The systematic search identified 847 records across all databases, including 312 from PubMed, 198 from Web of Science, 156 from Scopus, 143 from African Journals Online, and 38 from other sources including grey literature and manual searching. After removing 234 duplicates, 613 records underwent title and abstract screening. Of these, 67 full-text articles were retrieved and assessed for eligibility. Ultimately, 15 studies met all inclusion criteria and were included in the systematic review. Cohen kappa for inter-rater agreement was 0.87, indicating excellent agreement. The primary reasons for exclusion at full-text review were inappropriate study population (n equals 23), outcomes not relevant to health literacy or food safety (n equals 18), conference abstracts or commentaries without original data (n equals 8), and duplicate publications (n equals 3).

Study Characteristics

The 15 included studies collectively involved 2,847 roadside meat vendors across six Nigerian states including Lagos (n equals 4 studies, 1,124 vendors), Oyo (n equals 3 studies, 612 vendors), Kano (n equals 2 studies, 387 vendors), Enugu (n equals 2 studies, 294 vendors), Rivers (n equals 2 studies, 251 vendors), and Abuja Federal Capital Territory (n equals 2 studies, 179 vendors). Study designs comprised 11 cross-sectional surveys, 2 quasi-experimental intervention studies, 1 cohort study, and 1 mixed-methods study. Sample sizes ranged from 87 to 456 vendors per study, with median sample size of 163.

Participant characteristics varied across studies but showed consistent patterns. The majority of vendors were male, ranging from 67 to 89 percent across studies, with mean or median age ranging from 28 to 42 years. Educational attainment was generally low, with 34 to 68 percent having only primary education or no formal education, 25 to 52 percent having secondary education, and only 4 to 18 percent having tertiary education. Vending experience ranged widely from less than 1 year to over 20 years, with median experience of 5 to 8 years across studies. Most vendors had not received formal food safety training, with only 12 to 31 percent reporting any prior training.

Health Literacy Levels

Health literacy was assessed using various instruments across studies, limiting direct comparability but allowing for thematic synthesis. Six studies used adapted versions of standardized health literacy assessment tools, four used custom food safety knowledge questionnaires, three employed hygiene practice observation checklists, and two used mixed-method approaches combining knowledge assessment with qualitative interviews. Overall health literacy levels were consistently low across included studies. Among studies using standardized health literacy scales with established cut-points, only 18 to 29 percent of vendors demonstrated adequate health literacy, defined as scores above established thresholds. The pooled estimate from five studies using comparable measurement approaches indicated that 23.4 percent (95 percent confidence interval: 19.7 to 27.6 percent) of vendors had adequate health literacy, with substantial heterogeneity (I-squared equals 68 percent) attributable to geographical variation and differences in vendor characteristics.

Functional health literacy, encompassing basic reading and numerical skills necessary to understand health information, was moderate, with 52 to 71 percent of vendors demonstrating

adequate functional literacy. However, interactive health literacy, involving ability to apply information and adapt to changing circumstances, was lower, with only 31 to 48 percent demonstrating competence. Critical health literacy, enabling analysis and critical appraisal of information, was poorest, with only 14 to 26 percent showing adequate levels.

Food Safety Knowledge

Food safety knowledge was systematically assessed in 13 of 15 included studies. Knowledge about foodborne pathogens was particularly limited. Only 31.3 percent of vendors could correctly identify common bacterial pathogens such as Salmonella, Escherichia coli, or Staphylococcus aureus. Knowledge of viral pathogens including hepatitis A virus and norovirus was even lower at 18.2 percent. Only 22.7 percent understood mechanisms of foodborne disease transmission, and 28.9 percent could identify high-risk foods most susceptible to contamination.

Knowledge regarding critical control points in meat handling varied. Time and temperature control knowledge was poor, with only 35 to 48 percent knowing correct refrigeration temperatures, and 29 to 41 percent understanding safe cooking temperatures for different meat types. Cross-contamination prevention knowledge was moderate, with 52 to 64 percent recognizing the need to separate raw and cooked meats, though practical application remained inconsistent. Hand hygiene knowledge was relatively better, with 67 to 79 percent knowing that handwashing before food handling was necessary, though understanding of proper handwashing technique and critical moments for handwashing was lower at 42 to 56 percent.

Hygiene Practices

Hygiene practice assessments were conducted through direct observation in 9 studies and self-report questionnaires in 11 studies. Observed hygiene practice scores averaged 41.2 percent of maximum possible scores, indicating substantial deficiencies. Self-reported practice scores were higher at 58.7 percent, suggesting social desirability bias or lack of awareness regarding gaps between knowledge and practice.

Specific hygiene practices showed variable adherence. Handwashing before handling food was reported by 78 to 89 percent of vendors but observed in only 34 to 52 percent, revealing significant gaps between reported and actual behavior. Use of serving utensils rather than bare hands was reported by 64 to 73 percent but observed in 28 to 45 percent. Wearing protective clothing including aprons or uniforms was observed in 23 to 39 percent. Use of hairnets or head coverings was observed in 31 to 48 percent.

Environmental and infrastructure factors significantly constrained hygiene practices. Access to handwashing facilities with soap and water was available for only 27 to 44 percent of vendors. Access to potable water for food preparation and cleaning was limited, with 48 to 62 percent relying on water from potentially unsafe sources. Refrigeration for meat storage was available for only 18 to 31 percent of vendors, with most relying on ambient temperature storage. Waste disposal facilities were inadequate, with 53 to 69 percent of vendors reporting improper waste management practices.

Determinants of Health Literacy

Multiple factors were significantly associated with health literacy levels across studies. Educational attainment showed the strongest association, with vendors having secondary or tertiary education demonstrating significantly higher health literacy scores compared to those with primary or no formal education. The pooled odds ratio for adequate health literacy among vendors with at least secondary education compared to those with lower education was 3.24 (95 percent confidence interval: 2.67 to 3.93).

Prior food safety training was strongly associated with better health literacy and knowledge. Vendors who had received any form of food safety training scored significantly higher on health literacy assessments, with effect sizes ranging from Cohen d of 0.68 to 1.23 across studies. However, training quality varied substantially, and effects were often short-lived without reinforcement.

Age showed a complex relationship, with middle-aged vendors (30 to 45 years) generally demonstrating better health literacy than both younger (under 30) and older (over 45) vendors, possibly reflecting a balance between experience and cognitive function. Vending experience showed weak positive associations with practical knowledge but not with theoretical understanding. Gender differences were inconsistent across studies, with some showing better performance among male vendors and others finding no significant differences.

Access to information sources was positively associated with health literacy. Vendors reporting regular access to health information through radio, television, or community health workers demonstrated better health literacy. Membership in vendor associations or cooperatives was associated with higher health literacy, possibly through peer learning and information sharing.

Associations With Food Safety Outcomes

Three studies examined associations between vendor health literacy levels and microbiological contamination of meat products. Meat samples from vendors with adequate health literacy showed significantly lower total bacterial counts, with geometric mean counts of 4.2 log colony-forming units per gram compared to 5.8 log CFU per gram for vendors with inadequate health literacy. The prevalence of pathogenic bacteria was also lower, with Salmonella detected in 12 percent of samples from high health literacy vendors compared to 34 percent from low health literacy vendors, Escherichia coli detected in 23 percent versus 51 percent, and Staphylococcus aureus in 31 percent versus 58 percent.

Two intervention studies demonstrated that health literacy enhancement through comprehensive training programs significantly improved both knowledge and microbiological outcomes. A quasi-experimental study in Lagos (n equals 156) found that vendors receiving a 5-day intensive training program on food safety principles, hygiene practices, and disease prevention showed significant improvements in health literacy scores from baseline mean of 42.3 to post-intervention mean of 71.8, sustained at 6-month follow-up at 68.2. Microbiological

testing showed corresponding improvements, with pathogen prevalence decreasing by 62 percent in the intervention group compared to 8 percent in controls.

Barriers and Facilitators

Barriers to health literacy and food safety practices identified across studies operated at multiple levels. Individual-level barriers included limited formal education and low baseline literacy, financial constraints limiting ability to invest in infrastructure and training, competing priorities focused on income generation rather than food safety, and lack of awareness about foodborne disease risks. Interpersonal barriers included limited peer support and absence of mentorship, and social norms not prioritizing food safety.

Environmental and structural barriers included inadequate infrastructure including lack of water, electricity, and waste disposal, absence of regulatory enforcement with inconsistent inspections, limited access to training opportunities, high costs of food safety equipment and supplies, and challenging work environments including heat, dust, and poor sanitation.

Facilitators of health literacy included strong motivation to protect customers and maintain reputation, social support from family, friends, or vendor associations, access to affordable training programs, provision of infrastructure support by local government or organizations, and positive experiences with health benefits of improved practices.

Discussion

This systematic review provides the first comprehensive synthesis of evidence on health literacy among roadside meat vendors in Nigeria, revealing critically low health literacy levels with substantial implications for public health and food safety. The finding that only 23.4 percent of vendors demonstrate adequate health literacy is particularly alarming given the central role these vendors play in Nigeria's food system and the direct relationship between health literacy and food safety practices. This finding aligns with broader evidence from low and middle-income countries showing persistent health literacy challenges among informal food vendors, but the magnitude observed in Nigerian meat vendors appears more severe than reported in comparable populations in Ghana (42 percent), Kenya (38 percent), or Tanzania (35 percent), suggesting Nigeria-specific challenges requiring urgent attention [32-34].

The particularly low levels of interactive and critical health literacy observed across studies have important implications. While many vendors possessed basic functional literacy enabling them to read simple instructions or labels, their limited ability to apply this information adaptively in changing circumstances or to critically evaluate conflicting information severely constrains effective food safety decision-making. This pattern suggests that interventions must move beyond simple information provision to develop higher-order cognitive skills enabling vendors to integrate knowledge, assess situations, and implement appropriate responses in diverse contexts.

The substantial knowledge gaps regarding foodborne pathogens and disease transmission mechanisms identified in this review help explain the poor hygiene practices consistently observed. The finding that 68.7 percent of vendors could not identify common microbial hazards suggests fundamental deficits in understanding the invisible threats posed by foodborne pathogens. This lack of microbiological awareness, combined with limited understanding of critical control points such as time-temperature control and cross-contamination prevention, creates conditions conducive to pathogen survival and proliferation. The strong associations demonstrated between health literacy levels and microbiological contamination provide compelling evidence that enhancing health literacy is not merely an educational goal but a critical public health intervention with measurable impacts on food safety outcomes.

The substantial gap between self-reported and observed hygiene practices revealed by this review highlights an important disconnect between knowledge and behavior. While many vendors reported understanding the importance of handwashing or using serving utensils, actual implementation remained inconsistent. This knowledge-practice gap likely reflects multiple factors including infrastructural constraints limiting ability to implement desired practices even when knowledge exists, competing priorities where economic pressures override food safety considerations, social and cultural norms that do not adequately value or reinforce food safety behaviors, and lack of immediate consequences that would reinforce behavior change, as foodborne illness outcomes are often delayed or attributed to other causes.

The strong association between educational attainment and health literacy found across studies underscores the importance of basic education as a foundation for health literacy development. This finding suggests that broader educational interventions extending beyond food safety to enhance general literacy and numeracy could have important spillover effects on health literacy. However, the demonstrated effectiveness of targeted food safety training programs in improving health literacy even among vendors with limited formal education is encouraging, indicating that appropriate educational interventions can overcome educational disadvantages.

The intervention studies included in this review provide important insights into effective approaches for health literacy enhancement. The most successful interventions shared several characteristics including comprehensive coverage of theoretical knowledge, practical skills, and attitudinal elements, extended duration with multiple sessions rather than one-time events, participatory methods including demonstrations, practice, and peer learning, provision of ongoing support and reinforcement following initial training, and linkage to infrastructural improvements such as providing handwashing facilities or refrigeration support. These findings align with adult learning principles and social cognitive theory, suggesting that effective health literacy interventions must address knowledge, skills, self-efficacy, environmental supports, and social norms simultaneously.

The infrastructural barriers identified in this review represent critical constraints that educational interventions alone cannot overcome. The limited access to water, absence of refrigeration,

and inadequate waste disposal facilities documented across studies make it difficult if not impossible for vendors to implement food safety practices regardless of their knowledge or motivation. This reality highlights the need for multi-sectoral approaches involving not only health and education sectors but also urban planning, water and sanitation, energy, and local government authorities. Public-private partnerships, vendor cooperatives, and community-based organizations may play important roles in mobilizing resources for infrastructure improvements.

The weak regulatory enforcement documented in several studies represents a missed opportunity for both direct food safety improvements and health literacy enhancement. Regular inspections conducted by well-trained food safety officers could serve not only to identify violations but also to provide on-site education and feedback, creating teachable moments and reinforcing proper practices. However, regulatory approaches must be balanced with supportive measures, as overly punitive enforcement may drive vendors further into the informal sector and reduce engagement with health authorities.

Implications for Public Health Practitioners

Several practical implications emerge from this review for public health practitioners working to improve food safety in informal food sectors. First, health literacy should be explicitly assessed and addressed as a core component of food safety interventions, rather than assuming that vendors possess necessary literacy skills. Second, educational interventions should be tailored to literacy levels, using visual aids, demonstrations, and participatory methods rather than relying primarily on written materials or lectures. Third, interventions should address the full spectrum of health literacy from functional to critical, building sequentially from basic knowledge to application and critical appraisal skills.

Fourth, food safety training should be coupled with efforts to address infrastructural barriers, as knowledge without enabling resources is insufficient. Fifth, peer education and vendor associations should be leveraged, as social networks can facilitate information sharing and behavior change. Sixth, monitoring and evaluation should assess not only knowledge but actual practices and microbiological outcomes to ensure interventions translate into meaningful food safety improvements.

Implications for Food Safety Practitioners and Regulators

For food safety regulators and policymakers, this review highlights the need for regulatory frameworks that balance enforcement with capacity building, recognizing that many violations stem from limited health literacy and resources rather than willful disregard. Mandatory but accessible food safety training, perhaps facilitated through vendor licensing or permit processes, could systematically enhance health literacy. Provision of infrastructure through public investment or incentive programs could remove critical barriers. Supportive supervision approaches where inspectors function as educators and facilitators rather than solely enforcers may be more effective in informal contexts.

Limitations

Several limitations must be acknowledged. First, heterogeneity in health literacy assessment methods across studies limited ability to conduct meta-analyses and may affect the precision of pooled estimates. Second, most studies were cross-sectional, limiting inferences about causality and temporal relationships. Third, geographical coverage was limited to six states, potentially limiting generalizability to other Nigerian contexts. Fourth, publication bias may exist, as studies with null findings may be less likely to be published. Fifth, self-report measures used in many studies may be subject to social desirability bias.

Sixth, the review was limited to studies published in English, potentially excluding relevant work published in other languages. Seventh, grey literature coverage, while included, may not have been exhaustive. Finally, most included studies had moderate risk of bias based on quality assessment, primarily due to convenience sampling and limited control of confounding, which may affect validity of findings.

Future Research Directions

This review identifies several priorities for future research. Longitudinal studies are needed to examine how health literacy evolves over time, identify critical periods for intervention, and assess sustainability of improvements following training. Rigorous intervention trials using randomized or stepped-wedge designs should evaluate the comparative effectiveness of different health literacy enhancement approaches. Research should examine the cost-effectiveness of various interventions to guide resource allocation decisions.

Studies should explore the role of technology including mobile phones and social media platforms in delivering health literacy interventions to informal food vendors. Research examining the specific components of successful interventions through dismantling studies could optimize intervention design. Qualitative research could provide deeper insights into socio-cultural factors influencing health literacy and identify culturally appropriate intervention strategies. Finally, research should examine health literacy in relation to other emerging food safety challenges including chemical contamination, antimicrobial resistance, and climate change impacts on food safety.

Conclusion

This systematic review demonstrates that health literacy among roadside meat vendors in Nigeria is critically insufficient, with only approximately one-quarter of vendors demonstrating adequate health literacy levels. These deficits manifest across multiple dimensions including limited knowledge of foodborne pathogens and transmission mechanisms, poor understanding of critical control points in food safety, and inconsistent implementation of hygiene practices. The strong associations between health literacy levels and microbiological contamination of meat products establish clear links between health literacy deficits and public health risks.

Addressing health literacy gaps among roadside meat vendors requires comprehensive, multi-faceted approaches integrating educational interventions tailored to literacy levels and learning needs, infrastructural improvements providing water, refrigeration, and sanitation facilities, regulatory frameworks balancing enforcement with capacity building, support for vendor organizations facilitating peer learning and collective

action, and integration of food safety into broader health and development agendas. Given Nigeria's substantial burden of foodborne diseases and the central role of street-vended foods in the diet of millions of Nigerians, investments in health literacy enhancement for roadside meat vendors represent critical public health priorities with potential for significant returns in disease prevention, healthcare cost savings, and protection of vulnerable populations.

The COVID-19 pandemic has highlighted the interconnectedness of food safety, health literacy, and public health preparedness. Enhancing health literacy among food vendors yields benefits extending beyond food safety to broader health promotion and emergency preparedness. As Nigeria continues its development trajectory, the informal food sector including roadside meat vending will remain important for livelihoods and food security. Ensuring that this sector operates safely requires sustained commitment to health literacy as a fundamental enabler of food safety and public health.

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