

EatSafe - Evidence and Action Towards Safe, Nutritious Food

Consumer and Vendor Perspectives and Practices Related to Food Safety in Nigeria: A Review

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This EatSafe report presents evidence that will help engage and empower consumers and market actors to better obtain safe nutritious food. It will be used to design and test consumer-centered food safety interventions in informal markets through the EatSafe program.

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ACRONYMS

Below is a list of all acronyms and abbreviations used in the report.

FAO	Food and Agriculture Organization (of the United Nations)
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
GAIN	Global Alliance for Improved Nutrition
LMIC	Low- and Middle-income country
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

Foodborne diseases represent a significant cause of illness in low- and middle-income countries (LMICs), particularly for young children; they also have large associated economic costs and can exacerbate malnutrition. Improving food safety requires action across the food system, including at the market level. Understanding the motivations, attitudes, beliefs, and practices that shape the decisions of consumers and food vendors is critical to develop and inform interventions to improve food safety at informal markets. Those interventions should enable consumers to demand safer food and vendors to deliver it. However, knowledge of producer behavior and consumer demand for food safety in LMICs is limited. In order to fill this knowledge gap, this review, undertaken to inform the USAID-funded EatSafe Nigeria project, summarizes prior research on the perspectives and practices of consumers and vendors vis-à-vis food safety in Nigeria, which is Africa's most populous country and situated in the region with the world's highest burden of foodborne disease.

Through a systematic search and review process, 87 relevant studies were identified. Most studies were found to focus on just one city or state within Nigeria, with most work concentrated in urban areas and in the southwest, south, and central regions. Most of the studies (64.4%) focused only on vendors; only one study focused on both consumers and vendors. The most common food category studied was prepared ready-to-eat foods; among specific raw foods, animal-source foods (particularly meat) were the main foods studied (10%). The majority of studies (81.6%) did not focus on any specific food safety hazard, instead examining general food safety issues. Considering the retail outlet, 38% of studies had no specific focus, 30% examined street food sellers, 15% examined schools/universities, 7% informal ("wet") markets, and 7% restaurants.

Sixty of the 87 studies (69%) used a single data-collection method; by far the most common method used was an individual-level structured survey, used by 95.4% of studies. In addition, 21.8% of studies used observations, 8.0% collected and analyzed food samples, 4.6% collected stool samples, 3.4% undertook key informant interviews, 2.3% undertook other semi-structured interviews, and 2.3% did focus-group discussions. In terms of topics, most studies focused on the respondent's food safety-related knowledge (66.7%) or self-reported practices (63.2%). Eleven studies (12.6%) examined actual practices via observations, while nine (10.3%) included observations of the food preparation or sale environment. Four impact evaluations were included, all focused on face-to-face food safety training for vendors/food handlers. Studies tended to find knowledge to be generally good or adequate, with self-reported practices being somewhat worse, and observed practices being generally poor. Training interventions were generally found to be effective.

Studies suffered from a number of methodological weaknesses. Future work on food safety in Nigeria would benefit from greater focus on fruits and vegetables and wet markets, less

reliance on closed-ended survey questions and self-reported data, more use of experimental approaches, and more focus on understanding individuals' motivations, beliefs, and values vis-à-vis food safety within specific cultural contexts. These results will be considered when designing the next phases of EatSafe's work in Nigeria.

I. INTRODUCTION

Improving food safety¹ in low- and middle-income countries (LMICs) is an urgent priority. Foodborne disease is responsible for an estimated 600 million illnesses and 420,000 premature deaths annually (2010 est.) (2). About one third of diarrheal disease cases can be attributed to food (3), and diarrheal disease is not only a major determinant of undernutrition (4–9) but also of mortality (10,11). The majority of the foodborne disease burden falls on people living in LMICs (3,10), who represent about 75% of deaths from foodborne illness (despite comprising only 41% of the global population). This is particularly true for Africa, where the per-capita burden of foodborne disease is about 27 times that of Europe or North America (2). Young children are particularly susceptible, shouldering about 40% of the burden (2).

Foodborne hazards² can both cause acute illness and raise the risk of long-term disease—for example, both aflatoxin and arsenic have been associated with cancer (12,13). Such illnesses can be particularly detrimental in settings like Sub-Saharan Africa, where the health system has limited capacity for diagnosis and treatment (14). Foodborne illnesses also entail economic costs for consumers, governments, businesses, and societies, due to sickness and loss of life, treatment costs, and impacts on trade; the World Bank estimates these at about \$20 billion USD per year (15). Poor food safety can also exacerbate existing levels of malnutrition in LMICs, as many of the foods at highest risk of contamination are also among the most nutritious (e.g., animal-source foods, fresh vegetables) (3). Concerns over food safety could force consumers to avoid or consume less of highly nutritious foods considered likely to be unsafe, to the potential detriment of nutrition (15–17). As the World Bank summarizes, “Food and nutritional security are realized only when the essential elements of a healthy diet are safe to eat, and when consumers recognize this” ((15), p. xxi).

Improving food safety and reducing foodborne risk is thus a critical need across LMICs. However, in many LMICs, government capacity and funding are insufficient to directly set and enforce food safety standards through regulation, training, control systems, testing, audits, and other approaches, as is the norm in many high-income countries (3,17). In addition, such systems, where they exist, often have limited reach into domestic value chains and the informal markets where most consumers in LMICs buy their food (18,19). While some food contamination happens in the home, after the point of sale, there is strong evidence that a large share of foods (both raw and ready-to-eat) sold in many African markets are contaminated at the point of purchase (20) and that actions taken by consumers while preparing their food have not been sufficient to reduce risk to acceptable levels. There is thus a need to understand how to improve food safety in contexts with minimal or no government

¹ Food safety is defined as the assurance that food will not cause harm to the consumer when it is prepared or eaten according to its intended use (1).

² These include viruses, bacteria, moulds, protozoa, helminths (worms), and chemicals.

control, and within the complex and dynamic informal food sector that dominates in LMICs and is particularly important for lower-income consumers (15,19,21).

The USAID-funded EatSafe (Evidence and Action Towards Safe, Nutritious Food) Nigeria project aims to generate the evidence and knowledge needed to do this. It focuses on leveraging the potential for increased consumer demand for safe food to substantially improve the safety of nutritious foods in informal market settings in Nigeria. The five-year project has been undertaken by a consortium led by the Global Alliance for Improved Nutrition (GAIN) and containing the International Livestock Research Institute (ILRI) and Pierce Mill Education and Media.

Central to EatSafe’s work is understanding (and potentially shaping) the motivations, attitudes, beliefs, and practices of actors throughout the value chain. This is particularly important for those actors at the point of purchase—i.e., consumers and food vendors—as their actions can negate those taken earlier in the value chain and their choices are central to enabling consumers to demand safer food and vendors to deliver it (22,23). Indeed, consumer demand has been a major driver of safer food in middle- and high-income countries (24–26). To date, however, many LMICs have failed to effectively engage consumers on food safety and to empower or incentivize the private sector to deliver safer food (15), and knowledge of producer behavior and consumer demand for food safety in LMICs is limited (22). While EatSafe will undertake novel primary research on consumer and vendor motivations and practices, it is essential to ensure that this work is informed by and builds on what has already been done—both in terms of methods used and results obtained.

The objective of this systematic scoping review is to summarize prior research on the perspectives and practices of consumers and food vendors in Nigeria vis-à-vis food safety. The World Health Organization (WHO) region containing Nigeria (AFR-D) has the highest per capita burden of foodborne illness, with most of this being due to diarrheal disease agents, followed by helminths (2).³ Nigeria is the most populous country among AFR-D countries, with the largest economy; it is agro-ecologically, ethnically, and socio-economically diverse. Nigeria also suffers from persistent malnutrition, with 36.8% of children under 5 being stunted and 6.8% wasted (27). Moreover, it is a transitioning lower-middle-income country—the category for which food safety concerns are generally at their most critical due to high potential for increasing burden of foodborne diseases (amid rapid economic, demographic, and dietary change but limited food safety management capacities (15)). The country thus makes a particularly useful case study of this topic, even beyond the presence of EatSafe. The results of the review will be used to refine the methods used within the different EatSafe research studies.

³ AFR-D countries: Algeria, Angola, Benin, Burkina Faso, Cameroon, Cape Verde, Chad, Comoros Equatorial Guinea, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Madagascar, Mali, Mauritania, Mauritius, Niger, Nigeria, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, Togo.

The next section describes the methods used in the systematic scoping review. After that, results are presented on the characteristics of research to date on the topic and on the main results of that research. The next section comments on gaps in existing research and methods, offering suggestions for future work in EatSafe and beyond.

2. METHODS

The paper is based on a systematic scoping review of the literature, aligned to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses: Extension for Scoping Reviews (PRISMA-ScR) checklist and guidelines (28). A structured search was undertaken in March-May 2020 in PubMed, augmented by additional searches using Google Scholar, as much research in Africa is published in journals that are not listed in international citation databases such as PubMed (29). We also searched the websites of the Food and Agriculture Organization, International Food Policy Research Institute, ILRI, WHO, and World Bank. In addition, the reference lists of relevant papers were reviewed to identify additional relevant papers. Finally, for the 27 papers included and deemed to be of “moderate” or “high” quality (see Appendix Table 1), we used Google Scholar to identify any subsequent papers that had cited that work and screened those papers for inclusion.

Inclusion criteria included: publication in English; publication in 2000 or later; a focus on Nigeria (national or subnational) or including Nigeria among other countries; and including information on perspectives on or practices related to food safety from consumers and/or vendors. “Perspectives and practices” could include any of knowledge, beliefs, or attitudes; actions or practices; factors motivating food choice, purchase habits, or pricing; or willingness to pay. “Vendors” were defined as any seller or handler of food with a direct link to the consumer; this would include sellers or handlers of both fresh and prepared foods in markets, restaurants, or institutional settings but not actors further up the value chain, such as farmers, who had no interaction with end consumers. “Consumers” included all those who purchased or otherwise acquired food for themselves or their families. Due to the interest on food safety at the level of the market, we excluded studies focused exclusively on food hygiene behaviors within the home that did not include information on general perceptions related to food safety that could be relevant for influencing food acquisition decisions; home-based food safety interventions are covered in a 2015 review by Woldt and Moy (30). As the focus was on domestic consumption, papers with a sole focus on export markets were excluded. Both peer-reviewed, published studies and “grey literature” were included. There were no restrictions placed on study type. Further details on the search approach are included in the appendix.

For all publications identified via the search, the title was reviewed for relevance; if it passed the title-screening stage, the abstract (or summary) was reviewed for relevance and compliance with the inclusion criteria. For publications that passed the abstract-screening stage, the full-text publication was reviewed. For those studies meeting inclusion criteria, relevant information was extracted into a review template. This included: lead author, year,

title, publication, geographic focus area, population(s), specific food(s), specific outlet(s), methods, aspects assessed, main results related to consumer and/or vendor populations, and categorization of quality as low, moderate, or high (based on an adaptation of the Cochrane criteria, (31), to account for the diverse study types and research questions). The data in this template formed the basis for a narrative synthesis of main results (32).

3. RESULTS

As summarized in Figure 1, out of a total of 1,541 titles found during database searches, 164 abstracts were reviewed, from which 67 publications were identified for full-text screening. The main reasons studies were excluded at the abstract screening stage were: no focus on vendors' and/or consumers' perspectives (58% of studies), no focus on Nigeria (19%), no focus on food safety (18%), and no full-text version being available (6%). Of the 67 full-text articles screened, 10 were excluded (five for having no vendor/consumer focus, four for duplicating results of other included papers, and one for having no Nigeria focus).

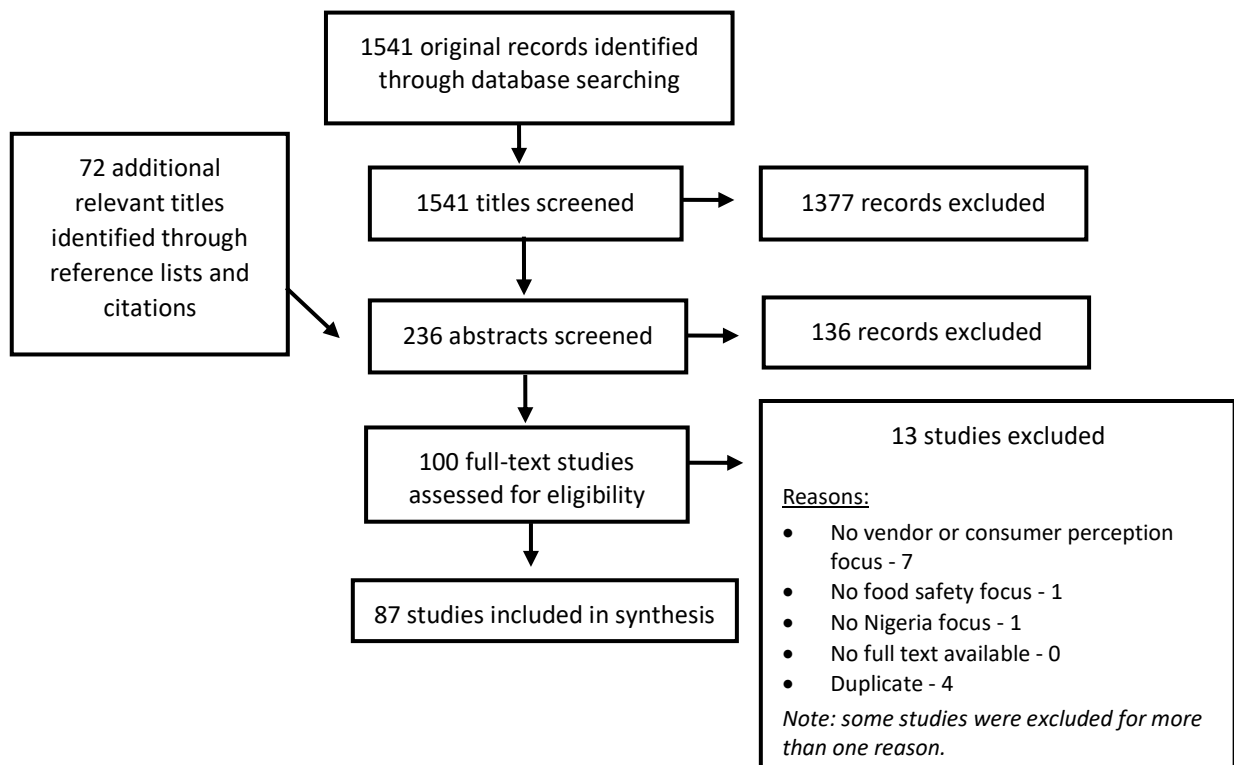


Figure 1 – Studies reviewed and included at each stage

The review of reference lists of the 57 included studies uncovered an additional 46 relevant titles; upon screening the abstracts of these, 22 were retained for full-text screening. Exclusion at the abstract stage was due to no full text being available (65%), no consumer/vendor perspective focus (17%), no food safety focus (13%), no Nigeria focus (4%), or duplication (4%). Of the 22 full-text articles screened, 19 were retained, with three excluded due to no focus on vendor/consumer perspectives. The review of studies citing the moderate-to-high quality studies already included in the review uncovered an additional 26

abstracts, 11 of which were retained for full-text screening. Exclusion at the abstract stage was due to no focus on consumer/vendor perspectives (40%), no food safety focus (20%), no Nigeria focus (27%), duplication (7%), or other reasons (7%). All 11 studies retained for full-text screening were included in the review. The total number of studies included in the final review is thus 87. These studies are summarized in Appendix Table A1.

3.1. Overview of research conducted

The 87 studies were concentrated in the post-2010 period, with 83% of studies being published after 2010 and 44% from 2016-2019, indicating a growing area of work. Eighty-two (94.3%) were published in scientific journals (though not necessarily peer-reviewed journals), while three were dissertations and two were published in conference proceedings.

Geographically, all but two studies focused only on Nigeria; of the remaining two studies (33,34), one compared results from Nigeria to one other country (Turkey) and another to four others (Cameroon, Ghana, Pakistan, and Malaysia). Eighty of the papers (91.9%) examined a sample within only one Nigerian state, while four (5.7%) looked at two states and the remaining three (3.4%) across three or more. Across Nigeria’s 36 states and one Federal Capital Territory, studies were unequally distributed, with 11 states having no studies and six having only one study while six states (Kaduna, Imo, Lagos, Osun, Oyo, and Ogun) had six or more studies; compared to population, Kano, Katsina, Rivers, Bauchi, Jigawa, and Benue states were particularly under-represented. As shown in Fig. 2, most of the research has been concentrated in the country’s southwest, south, and central regions, with less in the north and, particularly, the northeast. The majority of the studies (73.6%) focused on urban areas, with 5.8% examining rural areas, 2.3% examining both urban and rural areas, and the remaining 18.4% not specifying a rural or urban focus.

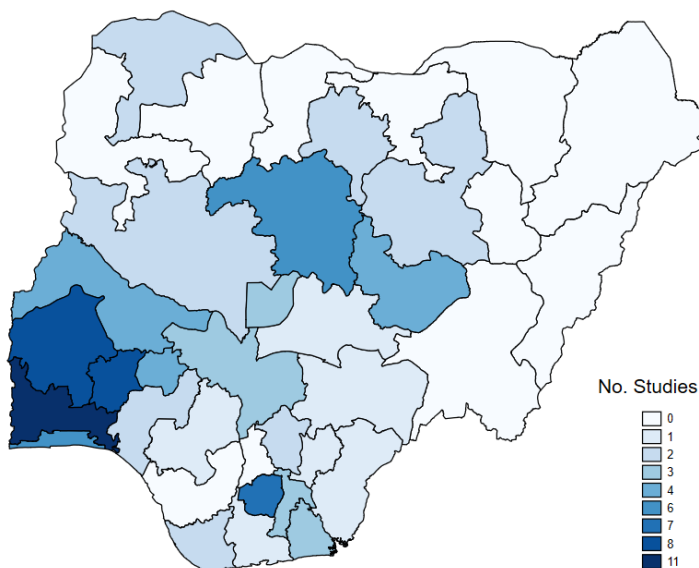


Figure 2 – Distribution of studies across Nigeria’s states

The majority of the studies (64.4%) focused only on vendors or food handlers (including those in restaurants and institutions); 34.5% focused just on consumers, and only one study (35) focused on both consumers and vendors. Only one study focused on a specific socio-cultural group (the Yewa ethnic community, in (36)). Table 1 shows the breakdown of studies by food of focus. Nineteen studies (22%) did not focus on any particular food type; this general focus was more common for the studies of consumers as opposed to food handlers/vendors. Nearly half of the studies focused on prepared foods sold ready to eat as a category, such as street food, cafeteria food, or restaurant food; 5% focused on packaged shelf-stable foods as a category. About one-quarter of studies examined a specific food or two specific foods, with beef; bread, grilled meat, and vegetables; and fish and milk being the most common. The studies of bread all focused on the issue of potassium bromate as an additive, whereas those on vegetables all focused on organic vegetables.

Food (Category) of Focus	Number of Studies	Percentage of studies
Prepared ready-to-eat foods	43	49%
Packaged foods	4	5%
Specific foods	23	26%
Beef	4	5%
Bread	3	3%
Grilled meat	3	3%
Vegetables (organic)	3	3%
Fish	2	2%
Milk	2	2%
Dog meat	1	1%
Millet dumpling w/ yoghurt	1	1%
Peanut cake	1	1%
Soy	1	1%
Sugar	1	1%
Vegetable oil	1	1%
Fermented foods	1	1%
No specific food focus	19	22%
Number	87	

Table 1 - Food categories studied

Note: four studies focused on more than one specific food type.

The vast majority of studies (81.6%) did not focus on any specific food safety hazard or issue; of the 16 studies that did, three focused on potassium bromate and three on agrochemicals (the bread and organic vegetables studies mentioned above), two on mycotoxins, and one each on oral-fecal parasites as a category, *T. gondii*, typhoid (*Salmonella typhi*), and *Salmonella* (not specified as typhoidal or non-typhoidal). Six studies focused on the issue of labelling. Considering the outlet, 38% of studies had no specific focus, 30% examined street food sellers, 15% examined schools and universities, 7% informal (“wet”) markets, 7% restaurants, 3% fast food outlets, 2% supermarkets, and one a hospital. Four studies considered multiple outlet types. The majority (74.2%) of the consumer-focused studies had no specific outlet of focus, whereas 82% of the vendor-focused studies did.

Considering study types, four of the studies were impact evaluations, normally focused on training interventions with different types of vendors and food handlers, whereas the

remainder were descriptive studies. In terms of data-collected methods, 60 of the 87 studies (69%) used a single data-collection method; by far the most common method used was an individual-level structured survey, which was used by 95.4% of studies (and 98.3% of those using only one method). In addition, 21.8% of studies used observations (of a food handler/vendor or his/her environment), 8.0% collected and analyzed food samples,⁴ 4.6% collected stool samples, 3.4% undertook key informant interviews, 2.3% undertook other semi-structured interviews, and 2.3% conducted focus-group discussions. Sample sizes ranged from 4 to 1,215, with the median sample size for the studies using a survey technique being 182. Only 17.2% of studies reported key results disaggregated by the gender of the respondent.⁵

In terms of topics, most studies focused on the respondent's food safety-related knowledge (66.7%) or self-reported practices (63.2%). About 23% examined what the authors referred to as "attitudes" related to food safety (following the "KAP" (Knowledge, Attitudes, Practices) research approach from public health and development (e.g., [37]), but the distinction between this and knowledge and/or practices was not always clear from the information reported. Only one study (38) reported on basic conceptions and beliefs related to food safety (i.e., whether and how respondents conceptualized of "food safety" or hygiene as a concept) and only two reported on traditional cultural beliefs and traditions related to food safety and hygiene. Eleven studies (12.6%) examined actual practices via observations, while nine (10.3%) included observations of the food preparation or sale environment; in both cases, this focused primarily on vendors. Finally, twelve of the studies (13.6%) examined respondent "willingness to pay" based on questions within a structured survey; all of these studies focused on consumers.

The majority of the studies (n=60, 69.0%) were assessed to be of low quality. The main quality issues noted were unclear respondent selection criteria or sampling/selection processes, small or non-representative samples, missing information on response rates and potential sources of bias, and poor question framing. Just three studies were assessed to be of high quality (3.4%), with 24 studies (27.6%) being of moderate quality.

3.2. Main results: vendor studies

The 57 studies of vendor perspectives used a wide range of different indicators and metrics, making it difficult to quantitatively summarize results across all studies and infeasible to attempt a meta-analysis. As such, we describe main trends in results as well as particularly interesting insights or aberrant results.

Most studies fell within the category of surveys examining knowledge and/or practice (usually self-reported) via closed-ended single-choice (e.g., true/false) or multiple-choice questions.

⁴ Of note, many additional studies using only biological samples have been conducted but are not covered here as they did not also collect information on consumer or vendor perceptions.

⁵ For three studies, this was irrelevant as they included only women (2) or only men (1).

The exact questions included varied by study, but similar themes emerged across many: critical moments for handwashing, refrigeration temperatures, different types of foodborne pathogens, the use of protective clothing/equipment, and the importance of cleaning surfaces and/or utensils. A set of example questions, drawn from four studies, is included in Box 1. of note, “attitude” questions seemed to have considerable overlap with “knowledge” questions.

In some cases, results were simply summarized question-by-question, but many studies combined the results of all knowledge and/or practice questions into scores and categorized knowledge or practice as “good” or “poor” (in some cases including an intermediate category). Others made similar overall judgments of knowledge and/or practice but without connection to a quantitative score. Of the 25 studies that made a clear judgement, nine classified knowledge as “poor or moderate” and 16 as “good or adequate.”⁶ Ten studies made a similar categorization for attitude, with all but two of these classifying attitude as “good.” For practices, 39 studies made clear classifications: ten studies classified it as “good or adequate” and 29 as “poor.” Those studies that examined whether there was an association between education level and food safety knowledge or practice (n=8) all found a positive one, as did those assessing the connection between training and food safety knowledge or practice (n=8). For gender, however, few significant associations were observed. Statistical methods used to test for difference varied and were not always clearly specified, but most examined bivariate associations and could thus be subject to confounding (e.g., in the case of education and training, which are likely correlated).

Where practice was observed (n=10), typical indicators included covering of food, wearing aprons and/or hairnets, having long nails, handling money or food with uncovered or unwashed hands, using dirty utensils and/or not washing utensils, and not working when ill. Observed practices were considered “poor” (in all or in part) in nine of the ten studies reporting on them. For observations of the environment, typical indicators used included access to water/handwashing facilities, set-up used to dispose of litter or presence of litter, presence of flies/rats, availability and type of toilet facilities, and cleanliness of the space. Several studies noted a lack of enabling infrastructure (e.g., running water and soap) at markets/vending sites. Box 2 highlights some examples of interesting studies that did not use the typical “KAP” methods.

Each of the four impact evaluations focused on face-to-face group-based food safety training for a different population: market processors/retailers of beef, food handlers in schools, food handlers in restaurants, and street food vendors. Three of the four used a control group, but none reported randomization. The intensity of the intervention varied widely, but all studies

⁶ Where studies cited a specific percentage of respondents as having “good” knowledge, we classified overall knowledge as “good” if that percentage was 50% or higher.

reported increases in knowledge and practices after the intervention, compared to beforehand.

The majority of vendor-focused papers, across all study types, concluded by recommending additional education or training of food vendors on food safety practices. Some also recommended increased regulation and/or enforcement or improvement of infrastructure.

Box 1: Examples of Typical Questions used in the Vendor-focused Studies, taken from (38–41)

Response options are given in parentheses, in italic text

Knowledge

- Is it necessary to wash your hands before cooking? *(Yes/No/Don't Know)*
- Is it hygienic to sneeze into your hands? *(Yes/No/Don't Know)*
- It is hygienic to cook without wearing an apron? *(Yes/No/Don't Know)*
- Is it safe to cook when you are sick? *(Yes/No/Don't Know)*
- Is it necessary to cook food thoroughly? *(Yes/No/Don't Know)*
- Hand washing is only necessary at the end food preparation and not before touching the food. *(True/False/Don't know)*
- Wearing of gloves while handling food reduces the risk of food contamination. *(True/False/Don't know)*
- Hot, ready to eat food should be maintained at temperature of about 21-30°C. *(True/False/Don't know)*
- Food handlers, raw food, and insects can be a source of contamination to food. *(True/False)*
- Washing and cleaning of working surfaces can reduce contamination of food. *(True/False)*
- Washing hands before and in-between food handling reduces contamination. *(True/False)*

Attitude

- Do you think that it is important to keep yourself clean as a cook? *(Yes/No/Don't Know)*
- Do you think coughing or sneezing over food is a problem? *(Yes/No/Don't Know)*
- Raw food should be kept separate from cooked food to prevent cross contamination. *(Agree/disagree/uncertain)*
- The use of cap, mask, protective glove and adequate protective clothing cannot reduce the risk of food contamination. *(Agree/disagree/uncertain)*
- Food products should be dated before storage to prevent spoilage and contamination. *(Agree/disagree/uncertain)*
- Protective clothing reduces the risk of food contamination. *(Yes/No)*
- Washing of hands before and after handling food is mandatory. *(Yes/No)*

Practices

- How often do you observe the following practices: *(Never / Occasionally / Very often / Always)*
 - Wash your hands before cooking?
 - Wash utensils before and after cooking?
 - Keep your cooking surroundings clean?
 - Separate raw and cooked foods?

Box 2: Examples of Interesting, Atypical Studies Uncovered

Iwar (2017) (38), a small-sample qualitative study examining vendors of grilled meat skewers in Abuja, was notable for its attempts to uncover the roots of respondents' conception of and motivations vis-à-vis food safety. The study noted how "participants' understanding of hygiene was related to popular culture rather than science," making connections between the vendors' perceptions of hygienic behavior or motivation to practice it and their religious or cultural background, such as the importance of ablution in Islam.

Three studies by the research group of Grace et al. focused on meat sellers in Ibadan. One, a formative study including participatory urban appraisal methods, focus group discussions, in-depth interviews, a survey of sellers, and sampling of meats, represented the most methodologically diverse study uncovered (39). Among other interesting results, the study found weaknesses in the current infrastructure and inspection regime and economic disincentives for compliance. It also noted important roles of gender and group membership in determining food safety. Finally, the study highlighted a fatalistic attitude towards illness: sellers recognized that they worked in an unhealthy environment but felt that, "Concerning diseases and illnesses, there is nothing we can do." A second paper (40) reported on an intervention with the group, which was a short-term success in terms of improved knowledge, attitude, and practice, but a third paper published nine years later (41) noted that this was undermined in the long term by a disabling policy environment, with vendors' trust and food safety deteriorating after attempts to relocate them to a modern market.

Uchendo et al. (2018) (35) was the only study identified that examined both consumers and vendors. Combining focus group discussions among female consumers with observations of market sellers and street vendors, the authors identified numerous sub-optimal practices. While the depth of information provided was limited, the study highlights how food can be contaminated before or after it reaches the consumer—or both—necessitating intervention at multiple levels to ensure safe food.

3.3. *Main results: consumer studies*

The 31 consumer populations studied varied widely from those recruited at specific points of sale, in some cases for specific foods (e.g., purchasers of millet-and-yoghurt from street vendors) to broad population categories (e.g., civil servants, secondary school students), with some studies providing no details on how "consumers" were defined.

The 16 studies assessing knowledge and/or self-reported practice via a survey tended to use similar questions to those used for vendors, but with less of a technical focus. Main topics examined for both knowledge and practice included general awareness, types and causes of foodborne illness, food vendors' hygiene as a source of illness, hand and utensil washing, food storage, clean water, and importance of proper cooking or refrigeration. Of the 13 studies to make a clear assessment of consumers' knowledge, seven assessed knowledge to be good or adequate, for some or all aspects, while five considered it poor. Of the 11 consumer-focused

studies reporting on practices, none included data from observations; all relied on self-reports. Five studies assessed practices to be good or adequate, while four considered them poor. Where associations with demographic characteristics were examined (n=7), studies generally found positive associations between knowledge or practice and education or income/spending.⁷ Only two studies (34,39) reported assessing attitudes, in addition to knowledge/practices. In one of those cases (39) it was unclear how “attitudes” were assessed; in the other, “attitude” questions all related to practices (e.g., “Do you wash your hands before and after cooking?”).

Findings for overall perceptions of the safety of foods in Nigeria varied widely, with some studies claiming most consumers found them unsafe or unhygienic (e.g., [40,41]) and others claiming consumers were largely satisfied with current food safety levels (e.g., [42]). Six studies (43–48) looked specifically at food safety-related label use; reports of label use varied widely across studies, though expiry dates tended to be among the types of information most often used. Three studies noted issues of either low use of or poor trust in food safety labels. Indeed, one study noted a “Nigerian factor” that “leaves consumers under the impression that anything goes and labels may not be worth it anyway” ([48], p. 26).

Twelve consumer studies (41,48–58) assessed willingness to pay for safer foods (including three each on organic vegetables and potassium bromate-free bread), though only ten clearly reported results on whether and/or how much consumers were willing to pay. Aside from the bread and organic vegetables studies, the question of “food safety” was generally generic and no clearly specified reduction in risk or hazard associated with “safer” food was given. Of these, eight concluded that most consumers were willing to pay a premium for “safer” food, whereas two concluded that only about one third of consumers would pay. The size of reported premiums consumers was willing to pay varied widely. There was generally found to be a positive association between willingness to pay and education and income, with mixed results for gender.

Again, most papers concluded with recommendations on educating or raising consumer awareness.

3.1. Associations between objective and subjective measures

Ten studies included results of food (n=7) or stool sample tests (n=3), or both (n=1), in addition to the measures of perception or practice. Of these, seven studies reported on both sample test results (stool or food) and knowledge, and three reported on both sample test results and self-reported practice. The associations between objective measures (i.e., results of tests) and more subjective KAP measures were not always examined but showed inconsistent patterns where they were.

⁷ The comments made above on weaknesses with statistical testing in vendor studies also apply to the consumer studies.

For example, Opara et al. (59) found low-to-moderate knowledge among vendors of the risk of vendors' poor personal hygiene leading to foodborne illness, which aligned to the result that numerous food pathogens (e.g., *Staphylococcus aureus*, *Shigella*, and *E. coli*) were readily isolated from the food samples. Isara et al. found similar trends: only 42.6% interviewed fast food vendors/handlers knew that micro-organisms could contaminate food, and the prevalence of food contamination at the fast food restaurants was found to be fairly high, 37.5%. However, Grace et al. (60) found that abattoir workers and retailers could still recall food safety best practices from a training nine years earlier, but that (due to enabling environment factors), meat safety had deteriorated. Idowu et al. (61) found that KAP of school-based food vendors were generally better than those of street vendors, and that school food vendors also recorded lower prevalence of infection than street food vendors—but this difference was not significant, and 97% percent of all vendors were infected with one or more fecal-oral-transmissible parasites. In contrast, Olalekan et al. (62) found that most school food handlers had poor (52.7%) or moderate (19.2%) knowledge but that most (92.4%) also tested negative for Salmonella infections.

Among consumers, Onyeka et al. (42) found that consumers were satisfied with quality and perceived safety of the studied fast foods, but tests showed high levels for some pathogens. Ezekiel et al. (63) found that all analyzed peanut cake samples contained AFB1 in concentrations exceeding the recommended levels, but 85% percent of the consumers lacked awareness of aflatoxin contamination and associated health risks.

4. DISCUSSION

This study has reviewed prior research on the perspectives and practices of consumers and vendors vis-à-vis food safety in Nigeria, identifying 87 relevant studies covering 26 states. This is an impressive volume of research for one lower-middle-income country, and the topic appears to be an active area of research.

However, the existing work leaves certain gaps, some of which can be filled by the EatSafe project. For example, about half of the reviewed studies examined prepared ready-to-eat foods. While some focus on ready-to-eat foods is justified, as such foods have been shown to have high prevalence of pathogens in sub-Saharan Africa (20), some additional work on fresh meat and other raw foods is merited. In particular, the lack of studies focused on fresh fruit and vegetables (aside from three on willingness to pay for organic vegetables) highlights a clear gap, as these foods are highly nutritious (66), under-produced and under-consumed in most of Africa (67,68), and known to pose risk of foodborne illness within the country (69). Both meat and fresh vegetables are focus commodities under EatSafe, making it well-positioned to help fill this gap. When examining consumers' and vendors' perceptions of food safety issues associated with fruit and vegetables, it will be particularly important to consider open-air wet markets, where most of the food eaten by lower-income consumers in Nigeria is purchased but which have come under scrutiny worldwide recently over worries about disease (70). Given their importance in Nigeria's food system (65), such markets were found

in this review to be under-studied, with only six studies focusing on them. EatSafe will focus explicitly on these markets, making a key contribution to fill this knowledge gap.

In addition, studies tended to focus only on one specific area within Nigeria, with most studies concentrated in urban areas and in the country's southwest, south, and central regions (likely at least partially linked to the locations of universities with food safety researchers). There is thus a need for more comparative work across countries or regions as well as additional research focused in rural areas (where half of Nigeria's population lives, (64)) and in the north/northeast. Such localized research is useful given Nigeria's federal system, as oversight of food vending is often devolved to the level of the state or local government authority (65). While EatSafe will also be narrow in its geographic focus, it will leverage the power of comparative analysis in future phases, once the project has (as planned) expanded to other countries using similar techniques.

The research discussed here also has a number of methodological gaps and weaknesses. In particular, there was very heavy reliance on the use of cross-sectional closed-ended surveys (used in 95% of studies), particularly of the "KAP" variety. Similar reliance on surveys has been found for food safety research in other settings (71). While useful for their rapidity and ability to provide a snapshot of characteristics or knowledge across a large sample, surveys have numerous weaknesses for the study of food safety perceptions and practices. As they rely on self-reported practices, there is considerable opportunity for results to be influenced by social desirability bias and other response biases (72,73); survey responses tend to provide a more optimistic picture of food safety behavior than other methods (71). Indeed, in the studies reported here, self-reported knowledge and/or practice were considered good in about 40% of instances – but observed practices were considered poor in nine of ten instances.

Response bias is particularly likely when questions are posed in a manner that makes the "right" answer clear, as was the case in many of the studies examined here, and when questions on practice are posed soon after questions on knowledge: respondents may feel uncomfortable to admit they do not follow practices that they have just described as optimal. There is thus a need for better survey questionnaire design as well as additional work using observations or other interviewing methods that allow for more follow-up and probing (e.g., focus group discussions or in-depth interviews). EatSafe will take this into account when designing its questionnaires and methods. Prior research in Canada has experimented with the use of video cameras to track food handlers' practices (74), which could be tested within the context of a Nigerian wet market or street vending site, should vendors and local stakeholders consent. While this may not be feasible within EatSafe's initial work in Nigeria, we will explore the possibility with local stakeholders for the future.

In addition, the decision on which practices were included in the KAP questionnaires did not appear to be risk-based. While some studies justified the choice of practices based on reference to a prior study or official guidance (e.g., the WHO Essential Safety Requirements for Street-vended Foods [75]), most provided no justification for the choice and did not clearly

link the practices examined to a contextually relevant risk assessment. The implication of using measures not based on identified risks is that there may be little or no association between high KAP scores, hazard levels in food, and actual exposure or risk—and thus attempts to improve KAP may have little effect on actual risk or hazard. Indeed, this study found highly inconsistent results for associations between KAP scores and actual hazards. EatSafe will help address this by considering risk when designing its questionnaires and indicators and, as feasible, using the results of its risk analysis (led by ILRI) to inform the other components of the research.

Moreover, while KAP surveys aim to examine knowledge (i.e., what is known), attitudes (i.e., what is thought), and practices (i.e., what is done), very few of the studies reviewed here actually included clear results related to consumer/vendor attitudes. Instead, results reported for “attitudes” tended to refer to either knowledge or practices. Similar inconsistencies and overlapping definitions have been found in much food safety research in high-income countries (76). Within the broad category of “attitudes”, very few papers considered the salience of food safety as an issue to consumers or vendors (i.e., their level of concern about it), relative to other important issues in their lives. Two exceptions, Grace et al. (60 [see Box 2]) and Idowu et al (61)⁸ highlight a fatalistic attitude towards food safety and a lack of agency felt by vendors to actually act on food safety. This offers a prime example of a type of attitudinal factor that deserves future study to be able to design appropriate motivations for action. Moreover, no papers examined how food safety compared in importance to other factors motivating food choice (e.g., affordability). These are key gaps, as understanding individuals’ motivations, beliefs, emotions, and personal value systems can be essential in communicating on risk and designing effective strategies to change behavior (77–81).

In expanding research in this area, it will be important to include more consideration of cultural issues. Iwar (38) demonstrated the usefulness of socio-cultural perspectives when studying food safety in Nigeria (which is home to over 250 ethnic groups) and similar contexts, and research elsewhere has shown that there is variation in food safety risk across ethnic groups (82). Such research will likely not be able to rely on surveys and closed-ended questions but will instead need to draw on techniques from anthropology, ethnography, and sociology, which may be better suited to probing in-depth for the “whys” hidden behind actions and beliefs. Over 35 years ago, a paucity of this type of work being done on the topic of food safety was noted (77); at least in the Nigerian setting, this seems to still be the case, though there are interesting examples from other low- and middle-income countries (e.g., 83,84). Additional research on this topic can also draw on the extensive work done in anthropology and the behavioral sciences on other issues of water, sanitation, and hygiene to try to understand root motivations and translate these into interventions based on

⁸ In this study focused on worms, 85% of food vendors opined that worms were part of the human body and “everybody was born with them and will die with them.” They thus considered deworming a fruitless effort, even though about half had been dewormed within the prior year.

emotional triggers (85–87). Mixed-methods research will be particularly relevant within this space, though it was rarely found in this review. EatSafe will contribute to this regard by pairing quantitative methods (the risk analysis and cohort study baseline) with qualitative methods (the FES) and experimental techniques (choice experiments).

Another gap was a lack of experimental approaches for understanding vendors and consumers perspectives and choices. No studies used experimental or behavioral science techniques (e.g., economic games, choice experiments, or field experiments testing different interventions aimed at “nudging” behavior) to understand consumer and/or vendor choices vis-à-vis food safety, though these methods are well suited to understanding decisions amid constraints and trade-offs. Such approaches have been used with success for studying food safety in other low- and middle-income countries (88,89). Experimental or game-based methods would be particularly useful for understanding willingness to pay for safer food, as the contingent valuation method used in all the willingness-to-pay studies cited here has considerable biases (90). EatSafe will begin to fill this research gap in Nigeria through its use of choice experiments.

In addition, the vendor-focused studies almost exclusively examined aspects of food safety directly under the control of the vendor him/herself, without investigating knowledge of hazards that might arise upstream (e.g., use of wastewater for irrigation, unclean processing facilities, or improper storage) or the vendors’ perceived ability to influence them. As food safety must be consistently assured across a supply chain, such backward (and, as relevant, forward) influences from one actor to another are important to understand. Finally, very few studies examined both the consumer and vendor perspective on the same issue. Doing so will be crucial to find relevant areas for intervention, as consumer preferences and incentives must align with those of vendors in order for any market-based approaches for improving food safety to be effective and sustainable. The EatSafe risk assessment, to the extent feasible, will take a cross-value-chain approach to assessing risk.

Considering the overall results, it has been documented elsewhere that larger portions of consumers are observed to have poor food safety practices than self-reported knowledge and attitudes around food safety would suggest (71). This review confirms that result: knowledge (and attitude, where assessed) was often assessed as being “good or adequate”, whereas practices were more likely to be classified as “poor”—particularly where based on observational data. This suggests that it is essential for food safety interventions to go beyond educating and increasing knowledge, such as by focusing on raising motivation and providing incentives, visual cues, or behavioral “nudges” (91) if they intend to affect practices in a meaningful way. This is in contrast to recommendations made by most of the studies reviewed here, which tended to focus on education and awareness-raising, even if the study had not established that a lack of knowledge or information was the key gap leading to poor practices or to exposure to food safety hazards. However, it aligns to prior systematic reviews in higher-income settings (76), which have concluded that alternative strategies in addition

to education and awareness-raising are needed to improve behavior change as relates to food safety. As such, EatSafe will prioritize these types of interventions when considering the approaches that it tests in the project's eventual implementation phase.

To improve food safety in Nigeria's informal markets, it is important to consider improving the enabling infrastructure. The studies covered here that included observations of the vending environment generally found it was inadequate from a food hygiene perspective, particularly with regards to lack of access to running water, soap, and sanitation facilities. Such improvements could be supported through the investment of revenues collected by market traders, as suggested by (65). An interesting approach to consider for the street food context is India's "street food hubs," which use a group-based training and certification approach, paired with promotional marketing, to enhance the safety of street foods (92).

Approaches related to labelling are also commonly used to improve food safety, but the results of the studies examined here call into question the usefulness of such approaches in Nigeria, particularly in informal markets. Not only were labels found to be used inconsistently, but several studies cited issues of trust associated with food labels. Moreover, while willingness-to-pay studies generally found positive willingness to pay, this was often small in magnitude and associated with higher incomes and more education—and, given the methodological weaknesses of contingent valuation discussed above, as well as the lack of specificity in defining the "safety" attribute for which consumers were paying, likely to overstate actual willingness to pay. As such, EatSafe will use choice experiments instead of stated willingness to pay and will be skeptical of intervention approaches dependent on the use of labels.

In general, the studies reviewed here found a fairly consistent association between education levels (and, for consumers, income levels) and food safety knowledge or practice. Given this, it will be important to appropriately tailor and target EatSafe's eventual interventions to lower-income, less-educated consumers. In contrast, few or inconsistent significant associations were found between gender and food safety perspectives or practices. This finding is interesting, given that prior research elsewhere has found gender to be the most consistent sociodemographic predictor of individuals' food safety risk perceptions (93), with women typically being more aware of food safety problems than men, likely due to their larger role in cooking. The lack of association may be due to many of the studies' samples being composed of a large majority of women (thereby reducing the statistical power of comparative tests), to the fact that male food vendors also have a high level of involvement with food sourcing and preparation, to confounding between gender and education, or to actual differences due to culture (as most prior research on risk perceptions and gender has been done in Western, high-income-country settings). Additional research on gender and food safety in Nigeria is warranted, as women play a large role in food markets in Nigeria and research elsewhere has documented that gender roles and responsibilities can be a

determinant of food safety risk and management (94). Gender will thus remain a cross-cutting theme throughout EatSafe’s work.

This review has several limitations. First, we relied exclusively on studies that were available electronically, which could have excluded some earlier work. Second, to maintain feasibility, our search was centered on the term “food safety”, which may have excluded relevant studies that did not refer to their topic as food safety *per se* (e.g., those examining “food quality” or “food spoilage”). Third, we used a rather vague construct of “practices and perceptions” to frame the review and included a broad range of different study types and populations; while this was a strength in terms of improving the breadth of research covered and appropriate for a scoping review, it precluded us from attempting any quantitative summary or meta-analysis. Fourth, we only included English-language results; as English is the most commonly used language for research in Nigeria, we do not expect this to have excluded many studies, but it may have excluded some. Finally, while we did allow for the inclusion of grey literature and directly searched several relevant websites and databases for it, we could not be exhaustive and likely omitted certain studies (e.g., those conducted by local NGOs or consumer groups).

5. CONCLUSION

Food safety is likely to become an increasingly problematic issue in rapidly urbanizing Nigeria, as food supply chains undergo rapid changes. For example, some supply chains are lengthening, while growing consumer incomes and less time for food preparation lead to greater consumption of foods outside of the home (15). Given this, it is essential to develop and implement approaches that can improve food safety and help reduce the country’s large burden of foodborne disease. Doing so requires developing a greater understanding of the knowledge, motivations, beliefs, and practices of actors throughout the value chain and particularly those of vendors and consumers—the two sides of “supply and demand,” as actualized in food markets. Generating this type of knowledge is central to the goal of the USAID-funded EatSafe project.

This systematic scoping review has made it clear that a comparatively large body of research has been conducted in Nigeria on consumer and vendor food safety perceptions and practices. However, additional work is needed that uses more diverse methods and seeks to identify root beliefs and motivations related to food safety. EatSafe has important aspects to contribute to this regard, particularly give its mixed-methods approach. In its implementation phase, this information can then be leveraged to incentivize vendors to provide—and consumers to demand—safer food. In developing such approaches, Nigeria (and EatSafe’s work within it) could serve as a model for other sub-Saharan African countries that are rapidly developing and will need to confront similar issues in the near future.

Recommendations for Intervention Design and Future Studies under EatSafe

EatSafe Nigeria aims to generate the evidence and knowledge on leveraging the potential for increased consumer demand for safe food to substantially improve the safety of nutritious foods in informal market settings in Nigeria. Central to EatSafe's work is understanding (and potentially shaping) the motivations, attitudes, beliefs, and practices of consumers and food vendors. While EatSafe will undertake novel primary research on consumer and vendor motivations and practices, it is essential to ensure that this work is informed by and builds on what has already been done—both in terms of methods used and results obtained. Based on the results of this review, we recommend EatSafe consider the following lessons emerging from this document in the design of its interventions going forward.:

- Pay attention to ethnicity and culture as determinants of belief or attitude, and examine differences across cultures
- Continue to make gender a cross-cutting theme of EatSafe work and disaggregate results by gender, where relevant
- Examine whether and how vendors and consumers knowledge of, and perceived ability to influence, pre-retail aspects of the supply chain
- Examine vendors and consumers jointly, including influences of one group on another
- Integrate a wider range of methods beyond closed-ended surveys (across or within studies), including experimental techniques and approaches from fields such as anthropology
- Examine raw foods, particularly those sold in informal open-air markets, especially fresh vegetables
- When using surveys, apply best practices in survey design (e.g., avoid leading questions and appropriately sequence questions)
- When assessing practices, use metrics that are based on contextually appropriate assessments of risk and hazard
- Examine attitudinal issues in more depth, including root beliefs related to safety and hygiene, motivations and the salience of food safety in comparison to other drivers of choice
- Treat self-reported practice data with skepticism
- Clearly define the target population and use clear respondent selection criteria
- Ensure all interventions are appropriately tailored to lower-income, less-educated consumers.

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APPENDIX: DETAILED SEARCH PARAMETERS

The following are the detailed search parameters used in the searches.

PubMed:

Search string: ((Food Safety[MeSH Terms]) OR (Foodborn*, or Food-born*, or Microb*, or Fertiliz*, or Herbic*, or Rodentic*, or Antimicrob*, or Enterovir*, or Histamin*, or Erysipelothr*, or Flie*, or Fly*, or Rodent*, or Bird*, or Fomite*, or Spoil*, or Contamina*, or Hygien*, or Coli*, or Salmonella*, or Noro*, or Campylobact*, or Monocytogen*, or Enterobact*, or Burnet*, or Brucel*, or Shig*, or Aflatox*, or Mold*, or Adulter*, or Lister*, or Lyster*, or Acrylami*, or Hazard*, or Pestic*, or Faec*, or Fec*, or Parasit*, or Helminth*, or *Toxi*, or Cronobact*, or Taeni*, or Tremat*, or Echino*, or Fasciolo*, or Heterophy*, or Metagoni*, or Starch*, or Protein*, or Pathogen*, or Zoono*, Nocardio* or Metal*, or Lead*, or Arsen*, or Mercur*, or Cadmi*, or Bovin*)) AND (Consum*, or Produc*, or Sell*, or Vendor*, or Farm*, or Pastoral*, or Men*, or Man*, or Male*, or Woman*, or Women*, or Female*, or Adolesc*, or Market*) AND (Nigeria, or West Afri*))

Google Scholar

Search string 1: "food safety" vendor "nigeria"

Search string 2: "food safety" market "nigeria" -vendor

Search string 3: "food safety" consumer "nigeria" -market -vendor

For each search, only the first 400 titles were screened, based on sorting by relevance under Google Scholar's algorithm

Institutional websites

FAO Food Safety Site: Search term: Nigeria

IFPRI: Search terms: "food safety" Nigeria

WHO: Search terms: "food safety" [MeSH] + Nigeria

World Bank: Search terms: "food safety" Nigeria

ILRI: Search terms: food safety; Country filter: Nigeria

Appendix Table 1. Summary of Studies Reviewed

Studies where the lead author is flagged with **Name*** and **Name**** were rated as being of moderate or high quality, respectively.

Abbreviations: C – consumer, V – vendor; NS – not specified; NOS – not otherwise specified; U/R – urban/rural; CSS – cross-sectional survey; FGD – focus group discussion; SSI – semi-structured interview; O – observation; FST – food sample testing

Lead Author (num. in ref. list)	Year	Geographic	Consumer or Vendor Focus?	Population(s)	Specific food	Outlet	Methods
Adebowale, OO (95)	2017	Ogun; urban & rural	C	Household consumers	NS	None	CSS
Adekoya, I (97)	2017	Southwest; no further specification	V	Sellers of fermented foods	Four fermented foods	None	CSS; FST
Adesokan, HZ* (98)	2015	Oyo; urban	V	Foodservice workers at major establishments	Prepared foods	Restaurants	CSS (self-admin.)
Adesope, AAA (49)	2010	Lagos & Oyo; urban	C	Sugar and vegetable oil consumers	Sugar; vegetable oil	None	CSS
Afolaranmi, TO (99)	2017	Plateau; urban	V	food vendors at four tertiary health institutions	Prepared foods	Hospitals	CSS
Afolaranmi, TO* (100)	2015	Plateau; urban	V	Food vendors in primary schools	Prepared foods	School	CSS
Afolaranmi, TO (101)	2014	Plateau; urban	V	food handlers in 15 boarding secondary schools	Prepared foods	School	Pre-/post-survey
Agwu, ACO (102)	2018	Abia; no U/R specification	V	Food handlers	NS	None	CSS
Ajayi, CO (103)	2014	Lagos & Osun; urban	C	Students, staff of university, religious event attendees	General food; milk, <i>Suya</i> (grilled meat skewers)	None	CSS

Akerele, D* (41)	2010	Sokoto; urban	C	Consumers of <i>kilishi</i> (dried meat)	Prepared foods (street food), <i>kilishi</i>	Street food	CSS
Akinbode, SO (50)	2011	Ogun; urban	C	Consumers at street food stalls	Prepared foods (street food)	Street food	CSS
Akinbode, SO* (51)	2012	Ogun; urban	C	Consumers of street food	Prepared foods (street food)	Street food	CSS
Alimi, BA (54)	2015	Kwara; urban	C	Consumers from street vendors	Millet and yoghurt snack	Street food	CSS
Aluh, DO (104)	2019	Kogi; rural	C	Secondary school students	NS	None	CSS (self-admin.)
Aluh, FO (105)	2017	Imo; rural	V	Mobile food vendors	Prepared foods (street food)	Street food	CSS (self-admin.)
Aluko, OO* (106)	2014	Osun; urban	V	Street food vendors in carparks	Prepared foods (street food)	Street food	CSS
Andy, E (107)	2015	Plateau; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS (self-admin.)
Anozie, GO (108)	2011	Abia; no U/R specification	V	Managers of restaurants in 4 tertiary institutions	Prepared foods	University	CSS
Anyam, OE (53)	2013	Lagos; urban	C	Consumers (NOS)	Bread	None	CSS
Aruwa, CE (109)	2017	Ondo; urban	V	Food handlers at university cafeterias	Prepared foods	University	CSS; palm samples
Awoyemi, AO (110)	2019	Kwara; rural	C	Farming households	NS	None	CSS
Ayinmode, AB (111)	2015	Ekiti & Ondo; urban	C	Dog meat consumers	Dog meat	None	CSS
Babalola, DA (45)	2016	Akwa Ibom; urban	C	Respondents (NOS)	Milk	None	CSS
Babalola, YT (43)	2014	Unspecified	C	Staff at 8 Nigerian state universities	Packaged foods	None	CSS (self-admin.)
Bamidele, JO* (112)	2015	Osun; urban	V	Food handlers at informal restaurants	NS	Street food	CSS

Cavus, O (33)	2019	Comparing Kano, Nigeria to Turkey; no U/R specification	V	Culinary students & chefs	NS	None	CSS
Chukuezi, CO (113)	2010	Imo; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS; O
Danilola, ST (44)	2017	Lagos; urban	C	Supermarket shoppers for packaged food	Packaged foods	Supermarkets	CSS
Diepolu, AO (52)	2009	Ogun; urban	C	University members (NOS)	Vegetables (organic)	None	CSS
Dontsop Nguezet, PM (48)	2011	Akwa Ibom; rural	C	Consumers (NOS)	Bread	None	CSS
Ehirim, NT (58)	2007	Bayelsa; no U/R specification	C	Consumers (NOS); most also fish farmers	Fish	None	CSS
Elechi, CE (114)	2018	Rivers; urban	V	Food handlers (various outlets)	Prepared foods	None	CSS
Emmanuel, LR (115)	2016	Osun; urban	C	Senior secondary school students	NS	None	CSS
Emmanuel, OI* (116)	2019	Imo; urban	V	Food vendors in informal restaurants and stalls	Prepared foods	Street food	CSS; O
Ezekiel, CN* (63)	2013	Lagos, Ogun, Oyo, Niger & Kaduna; no U/R specification	C	Market consumers	Peanut cake (snack)	None	CSS: FST
Ezenwoko, AZ (117)	2017	Sokoto; urban	V	food handlers in restaurants	Prepared foods	Restaurants	CSS
Falola, A (46)	2014	Kwara; no U/R specification	C	Shoppers at supermarkets or food shops	NS	Supermarkets, food shops	CSS
Faremi, FA (118)	2018	Osun; urban	V	Food handlers at a university	Prepared foods	University	CSS
Fasoyiro, SB* (119)	2010	Osun, Ogun, & Oyo; no U/R specification	V	Soy processors and vendors	Soy (milk, tofu)	None	CSS

Grace, D* (60)	2019	Oyo; urban	V	Processors and retailers of beef in a main market	Beef	Informal (wet) market	CSS
Grace, D* (120)	2012	Oyo; urban	V	Processors and retailers of beef in a main market	Beef	Informal (wet) market	SSI; FST
Grace, D** (121)	2012	Oyo; urban	V	Processors and retailers of beef in a main market	Beef	Informal (wet) market	CSS; FST; SSI; FGD
Grema, HA (122)	2018	Kaduna; urban	V	Handlers of fish in restaurants, street vendors & hawkers	Fish	Restaurants, street vendors and hawkers	CSS
Idowu, OA (61)	2006	Ogun; urban	V	Street and school food vendors	Prepared foods	School; street food	CSS; O; stool samples
Ifeadike, CO (123)	2014	FCT (Abuja); urban	V	Food handlers in Restaurants, bars, butcher shops, juice shops	NS	Restaurants, bars, butcher shops, juice shops	CSS
Imam, MI* (124)	2013	Oyo; urban	V	School food handlers	Prepared foods	School	CSS; O; FST; water samples
Iro, OK (125)	2017	Abia & Imo; no U/R specification	V	Beef handlers, including in abattoirs; markets, shops and/or supermarkets; restaurants	Beef	None	O
Isara, AR* (126)	2010	Edo; urban	V	Fast food restaurant food handlers	Prepared foods	Fast food	CSS; FST; stool samples
Ituma, BI* (127)	2017	Ebonyi; urban	V	Food handlers in restaurants	Prepared foods	Restaurants	Pre-/post-survey
Iwar, V* (38)	2017	FCT (Abuja); urban	V	<i>Suya</i> producers	<i>Suya</i>	Street food	SSI; O
Iwu, AC (128)	2017	Imo; urban	V	Food vendors (at hotels, school/	Prepared foods	None	CSS; O

				hospital cafeterias, restaurants, kiosks, street, hawkers)			
John, EJ (129)	2018	Cross River; urban	V	Food vendors (NOS)	NS	None	CSS (self-admin.)
Lawan, UN* (130)	2015	Kano; urban	V	Subsistence-level food vendors (stalls, street vendors, etc.)	NS	None	CSS
Mangbon, TA (132)	2014	Kaduna; no U/R specification	V	Street food vendors	Prepared foods (street food)	Street food	CSS; O
Metiboba, S (133)	2014	Kogi; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS; O
Musa, OI (134)	2003	Kwara; urban	V	Food vendors in secondary schools	Prepared foods	School	CSS; O
Nurudeen, AA (135)	2014	Kaduna; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS; O
Obayelu, OA (55)	2014	Oyo; urban	C	Consumers (NOS)	Vegetables (organic)	None	CSS
Odeyemi, OA (34)	2014	Six countries, including Nigeria; no subnational geography specified	C	NS	NS	None	CSS (online)
Odipe, OE (136)	2019	Ondo; urban	V	Food vendors at informal restaurants	Prepared foods	Street food	CSS; O
Odo, AN (137)	2018	Engu; urban	V	Food handlers in university	Prepared foods	University	CSS (self-admin.)
Ogbeyi, OG (138)	2019	Benue; urban	V	Market food vendors	NS	Informal (wet) market	CSS
Oghenekohwo, JE (139)	2015	Bayelsa; no U/R specification	V	Vendors within Niger Delta University	NS	University	CSS

Okojie, PW* (140)	2019	Edo; urban	V	Vendors of ready-to-eat foods at fixed points such as kiosks, cafeterias, stalls	Prepared foods (street food)	Street food	CSS
Okojie, PW* (141)	2014	Edo; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS; O
Oladoyinbo, CA (96)	2015	Ogun; no U/R specification	V	Food handlers of snacks and cooked foods	Prepared foods	None	CSS; O
Olalekan, AW* (62)	2018	Osun; urban & rural	V	School food vendors	Prepared foods	School	CSS; stool samples
Ologbon, OAC* (36)	2019	Ogun; rural	C	Heads of Yewa households	Packaged foods	None	CSS
Omemu, AM* (142)	2008	Ogun; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS
Omosho, BT* (47)	2008	Ekiti; urban	C	Adult consumers	Packaged foods (bread, sachet water)	None	CSS: SSI
Oni, OA (56)	2005	Edo; urban	C	Consumers of bread (NOS)	Bread	None	CSS
Onyeka, U (42)	2010	Imo; urban	C	Customers at fast food restaurants	Prepared foods	Fast food	CSS; FST
Onyeneho, SN** (143)	2013	Imo; urban	V	Chefs & managers of restaurants	Prepared foods	Restaurants	CSS
Opara, DAC (59)	2014	Akwa Ibom; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS; O; FST
Osagbemi, GK (39)	2010	Kogi; urban	C	Adults who play role in food handling	NS	None	CSS
Otu, SS* (144)	2014	Kaduna; urban	V	University food handlers	Prepared foods	University	CSS; O; stool samples
Oyawole, FP (57)	2016	Ogun; urban	C	Civil servants (NOS)	Vegetables (organic)	None	CSS

Pepple, N (145)	2017	FCT (Abuja); urban	V	Restaurant managers (hotels, fast food), hawkers	Prepared foods	Restaurants, street vendors and hawkers	CSS
Resnick, D** (65)	2019	Cross River & Niger; urban	V	Informal food sellers in main markets	NS	Informal (wet) market	CSS; SSI
Smith, SI (146)	2010	Lagos; urban	V	Food handlers in informal restaurants	Prepared foods (street food)	Street food	CSS
Temitayo, IO (147)	2015	Osun; urban	C	Senior secondary school students	NS	None	CSS
Uchendo, FN* (35)	2018	Lagos; urban	CV	Market and street food/fruit vendors; local women consumers	NS	Informal (wet) market; street vendors	O; FGD
Ugoani, JNN (40)	2016	Southeast; no further specification	C	Blue collar workers"; general population	NS	None	CSS
Umar, AAA* (148)	2018	Kaduna; urban	V	Street food vendors	Prepared foods (street food)	Street food	Pre-/post-survey; O
Yahaya, F (149)	2018	Bauchi; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS
Yakubu Madaki, MY* (131)	2019	Bauchi; no U/R specification	V	Food vendors at 6 universities	Prepared foods	University	CSS
Yusuf, TA (150)	2019	Nasarawa; urban	V	Street food vendors	Prepared foods (street food)	Street food	CSS