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Literature Review on Effective Food Hygiene Interventions for Households in Developing Countries

Monica Woldt and Gerald G. Moy

August 2015

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Food and Nutrition Technical Assistance III Project (FANTA)
1825 Connecticut Avenue, NW Washington, DC 20009
T: 202-884-8000 fantamail@fhi360.org www.fantaproject.org

This report is made possible by the generous support of the American people through the support of the Office of Health, Infectious Diseases, and Nutrition, Bureau for Global Health, U.S. Agency for International Development (USAID) and the USAID Office of HIV/AIDS under terms of Cooperative Agreement No. AID-OAA-A-12-00005, through the Food and Nutrition Technical Assistance III Project (FANTA), managed by FHI 360.

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Recommended Citation

Woldt, Monica and Moy, Gerald G. 2015. *Literature Review on Effective Food Hygiene Interventions for Households in Developing Countries*. Washington, DC: FHI 360/FANTA.

Contact Information

Food and Nutrition Technical Assistance III Project (FANTA)
FHI 360
1825 Connecticut Avenue, NW
Washington, DC 20009-5721
T 202-884-8000
F 202-884-8432
fantamail@fhi360.org
www.fantaproject.org

Acknowledgments

Experts contacted and persons providing information and materials for the literature review include James Akre, former Nutrition Advisor, Nutrition for Health and Development, World Health Organization (WHO), Geneva; Fred Angulo, Chief, Global Disease Detection Branch, Division of Global Disease Detection and Response, Center for Global Health, U.S. Centers for Disease Control and Prevention, Atlanta; Jenny Bishop, Regional Advisor for Food Safety, WHO Regional Office for the Western Pacific, Manila; Tommaso Calvali-Sforza, Regional Adviser for Nutrition, WHO Regional Office for the Western Pacific, Manila; Genaro Garcia, Regional Food Safety Adviser, Instituto Panamericano de Protección de Alimentos y Zoonosis (Pan American Institute for Food Protection and Zoonosis), Pan American Health Organization, Buenos Aires; Fanfan Han, Beijing Food Administration, Beijing Municipal Government; Christel Leemhuis, Director, Food Policy, Australian Department of Health, Canberra, Australia; Fritz Käferstein, former Director, Department of Food Safety and Nutrition, WHO, Nyon, Switzerland; Tanja Kuchenmueller, Scientist, Food Safety and Zoonoses Department, WHO, Geneva; and Yasmine Motarjemi, former Vice-President for Food Safety, Nestle, Vevey, Switzerland.

The authors extend deep gratitude to Merri Weinger, Rochelle Rainey, and Tim Quick of USAID/Washington; Julia Rosenbaum, Renuka Bery, and Daniel Campbell of FHI 360's WASHplus project; and Sandra Remancus, Gilles Bergeron, Megan Deitchler, Rebecca Egan, Tara Kovach, Jeff Feldmesser, Anna Lisi, and Pam Sutton of FHI 360/FANTA for valuable comments and assistance on this document and throughout its development.

Preface

In many parts of the developing world today, foodborne diseases and their prevention are still poorly understood. Even public health authorities are not fully cognizant of the potentially enormous health and economic burden that foodborne diseases place on their societies. While developed countries are moving toward strengthening the food safety assurance programs for their food supply systems, consumer food hygiene education is also receiving greater attention since unsafe practices in the home contribute to a large proportion of foodborne disease prevalence in developed countries (Redmond and Griffith 2003).

In developing countries, where controls by the food industry and government oversight are often inadequate, the role of the community and individuals in ensuring food hygiene is all the more important. This review examines the key priority food hygiene problems and critical actions to improve food hygiene in developing countries and evaluates available intervention studies that were aimed at specific critical actions in the handling of food in the home. An attempt has been made to navigate through the many factors and considerations in order to formulate recommendations for effective and sustainable food hygiene interventions that may be considered by donors, policymakers, and decision makers at the national and international levels.

Most challenging is the fact that food hygiene practices must be seen in the scientific, social, economic, and cultural contexts in which they occur. As a consequence, this review has included background information to provide the reader with an appreciation for the complexity that would accompany any proposed intervention. In this endeavor, the reader should be guided by the insight of Louis Pasteur, who famously said in 1854, “In the field of observation, chance favors only the prepared mind.”

Gerald G. Moy
Vandoeuvres, Switzerland

Monica Woldt
Washington, DC

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Abbreviations and Acronyms

CCP	critical control point
DALY	disability adjusted life year
FANTA	Food and Nutrition Technical Assistance III Project
FAO	Food and Agriculture Organization of the United Nations
FERG	Foodborne Disease Burden Epidemiology Reference Group
HACCP	Hazard Analysis and Critical Control Point
HIV	human immunodeficiency virus
PLHIV	people living with HIV
SBC	social and behavior change
U.S.	United States
USAID	U.S. Agency for International Development
WHO	World Health Organization

Executive Summary

Introduction

Data from the World Health Organization (WHO) indicate that foodborne and waterborne diarrheal disease kills an estimated 2 million people annually (WHO 2015). Evidence also suggests that food is equal to and may be more important than water as a route of transmission of diarrhea in developing countries (Motarjemi et al. 2012; Lanata 2003; Käferstein 2003; Motarjemi et al. 1993; Esrey and Feachem 1989). In response to the increased awareness regarding foodborne disease in developing countries, this literature review, which was requested by the U.S. Agency for International Development (USAID), investigates how donors, partners, and programs can reduce this burden. The objectives of this literature review are to (1) identify key priority food hygiene problems and critical actions to prevent foodborne illness at the household level in developing countries, (2) document interventions to improve household-level food hygiene and decrease the vulnerability of household members to foodborne illnesses, including key methods and approaches, (3) identify research and programming gaps in food hygiene at the household level, and (4) identify recommendations to improve food hygiene at the household level in the developing-country context.

This review specifically focuses on household-level food hygiene behaviors that result in infection with pathogenic microorganisms that cause diarrhea through the fecal-oral route, given the high burden of diarrheal disease in developing countries for all segments of the population and the contribution of foodborne illness to diarrheal disease.[1] The food hygiene topics that are not covered by this review include the prevention and control of chemical contamination of food that occurs inside or outside the home.

Methods

An initial literature search identified 1,403 journal articles covering roughly the past two decades. A total of 23 studies met the criteria for inclusion in this review. Fourteen studies identified food hygiene problem areas and critical actions to prevent foodborne illness, of which eight focused on complementary food preparation for young children and six on general food preparation in the home. The 14 studies included some older articles (published before 1990) because they were commonly cited in other literature as foundation studies. Nine intervention studies were identified. While several of the studies had methodological weaknesses, given the paucity of intervention studies in developing countries, these were included and the weaknesses discussed as part of the review. Seven of these studies focused on interventions for mothers of young children related to preparing complementary food and two focused on family food preparation.

[1] Foodborne illnesses may also lead to long-lasting disease and/or disability, for example, Guillain-Barre syndrome or reactive arthritis.

Summary of Results and Discussion

Key Household-Level Food Hygiene Problems and Critical Actions to Prevent Foodborne Contamination

The most common household-level problems that result in contamination of food with pathogenic microorganisms identified in this review include storage of cooked food at ambient temperature for an extended period (identified in 12 of 14 studies), inadequate reheating of food in terms of temperature and/or time (11 studies), contamination with pathogens from hands (11 studies), use of raw food products with a high level of pathogens (10 studies), contamination of pathogens from utensils (7 studies), use of water with high levels of pathogens (6 studies), and inadequate initial cooking of food (4 studies). The key problems were similar for complementary food preparation for young children and for family meal preparation. The critical actions necessary to decrease the risk of foodborne illness at the household level included thorough initial cooking and reheating of food, in terms of both temperature and time (14 studies); decreasing the time cooked food is stored at ambient temperature (11 studies); adequate handwashing before and during food preparation and before eating (8 studies); and adequate washing of utensils (6 studies). The critical actions were also similar for complementary food preparation for young children and for preparation of the family meal.

Such studies are important to understand the key problems and critical actions to prevent foodborne illness among specific populations and to be able to tailor social and behavior change (SBC) messages and activities to the local context. Two critical actions that require further study are adequate initial cooking and reheating of food and decreasing the time cooked food is stored at ambient temperature. There is also a need for continued focus on improving handwashing before food preparation, eating, and feeding a child or adult who needs assistance and on keeping diarrhea-causing pathogens out of the environment, especially through adequate disposal of feces from humans and animals.

Interventions to Improve Household-Level Food Hygiene and Key Methods and Approaches

The food hygiene intervention studies included in this review focused on provision of SBC messages and materials, educational sessions, and in some cases hands-on practice of desired behaviors through trained community volunteers or field workers. All nine studies demonstrated some adoption of targeted behaviors after the intervention, such as adequately cooking food before serving, heating leftover food before serving it, and not storing food at ambient temperature for extended periods. Three of the nine studies analyzed food samples for pathogenic microorganisms, and all three found that the number of pathogens in the food samples was significantly lower after the intervention. Another three studies collected data on diarrhea prevalence, and all three found that there was a lower prevalence of diarrhea after the intervention, although only one of these studies used a control group.

The key methods and approaches used in the intervention studies included formative research, the Hazard Analysis and Critical Control Point (HACCP) approach, and SBC; repeated and/or intensive exposure to messages and key practices; and interpersonal communication with respected, influential change agents.

Research and Programming Gaps in Food Hygiene at the Household Level

This review identified several research and programming gaps in food hygiene, including the need for high-quality studies that overcome methodological limitations found in some of the research included in this review; user-friendly tools to quickly identify and quantify the prevalence of risky food hygiene

practices at the household level; and more work on effective, long-term SBC strategies that include not only messages, but also an effective mix of channels, change agents, and intensity of exposure to promote effective behavior change in food hygiene. There is also a lack of research in food hygiene focused on vulnerable groups, especially pregnant women, people living with HIV, or those with tuberculosis, in developing countries. These groups have special vulnerabilities, and studies are needed to verify their needs and how they can be met, since the consequences of infection can be severe (Medeiros et al. 2001).

Recommendations

The following are specific recommendations for donors, partners, and programs regarding household-level food hygiene.

Recommendations for Immediate Implementation

- **Put into programming practice what is already known about food hygiene.** Key actions to reduce household-level foodborne illness in developing countries can be put into practice immediately in existing programs. SBC messages and materials developed around these key actions can be integrated into clinic- and community-level counseling for vulnerable populations.
- **Use quality improvement approaches and operations research to build upon what is known in food hygiene and fill programming gaps.** Quality improvement approaches can be used to ensure that high quality food hygiene activities are integrated into clinic- and community-level programs. Quality improvement approaches and/or operations research can be used within programs to identify food hygiene programming gaps and ways to strengthen program outcomes and impact.
- **Promote effective linkages between existing curative and preventive programs when diarrheal disease does occur.** When diarrheal disease does occur, effective linkages with existing curative services are essential. Children, pregnant women, people living with HIV, and individuals with tuberculosis should receive immediate, appropriate care and treatment, with follow-up counseling and support that includes food hygiene topics to prevent diarrheal disease.

Recommendations for Medium- and Long-Term Implementation

- **Conduct formative studies to inform program design.** Programs should emphasize and support formative analyses as a part of program design, including collecting qualitative and quantitative data among the target population to understand the most important food hygiene problems in the population; to understand the culture, norms, and beliefs that lead to specific food hygiene problems; and to understand why specific food hygiene behaviors are practiced while desired behaviors are not. These studies can also form part of operations research to make ongoing adjustments to programs.
- **Develop guidance on practical, feasible ways to address food hygiene in developing country contexts.** The critical actions to decrease the risk of foodborne illness in developing countries can be challenging for households to practice. Programs need practical guidance on how to address food hygiene behaviors that consider barriers that households encounter. Operations research can inform guidance development by identifying feasible actions that households can carry out in their specific situations.
- **Develop tools to assess food hygiene.** Given the lack of cost-effective tools for assessing food hygiene at the household level, donors and implementing partners should consider supporting the

development and validation of generic tools (for example, rapid assessment tools) and guides to assess food hygiene in developing countries at the household level, including assessing food hygiene behaviors and access to infrastructure and supplies that affect the capacity to practice desired food hygiene behaviors. Tools can then be adapted by programs to specific country contexts. These tools could also be developed as a part of operations research during program implementation.

- **Develop context-specific SBC strategies to improve food hygiene practices and periodically assess and adjust them to improve impact.** Programs should develop an SBC strategy that is based on theoretical behavior change models and/or theories of change and that contains an appropriate mix of channels and messages, with details regarding audiences, strategic approaches, activities, and materials, among other components. Results of quantitative and qualitative assessments with intervention participants and stakeholders should be used to change or redesign the intervention to ensure effectiveness. These studies can also form part of operations research within programs, as noted above.
- **Develop and test indicators to assess the outcomes and impact of food hygiene interventions.** There is a lack of standardized, validated indicators for measuring outcomes and impact of food hygiene activities. More research is needed in the development of practical, valid, standardized program indicators for food hygiene interventions that can be contextualized, as needed, to local situations. Development and testing of indicators could be conducted as a part of program implementation.
- **Integrate an appropriate package of water, sanitation, and hygiene interventions into programs.** Since the fecal-oral route of contamination is such a large contributor to diarrheal disease, programs should integrate an appropriate package of water, sanitation, and hygiene interventions, in particular, focusing on: handwashing, with soap if possible, at critical times; appropriate disposal of feces, both human and animal; and treating and safely storing drinking water. These actions can help make food hygiene interventions more effective.
- **Target food hygiene interventions for vulnerable populations.** To be most effective, food hygiene messaging and behavior change interventions should be targeted to vulnerable populations, including pregnant women and young children in clinic- and community-level programs, and people living with HIV and those with tuberculosis in programs addressing infectious diseases. These groups are at greater risk of infection from foodborne pathogens than the general population and have greater risk of mortality if exposed.
- **Include food hygiene components in policies, strategies, and programs.** Given the evidence that food is a common medium for transmission of diarrheal disease in developing countries and that unsafe food contributes to high levels of morbidity and mortality in these countries, relevant host country government and donor policies, strategies, and programs should include food hygiene components.
- **Support research on food hygiene.** Given the lack of sound research studies and program evaluations on household-level food hygiene interventions, more studies and/or program evaluations are needed to strengthen the evidence base.
- **Disseminate the results, lessons learned, and promising practices from food hygiene research and interventions.** Given the lack of information on food hygiene research and interventions in developing countries, it is very important that results and lessons learned from high quality research and program interventions be shared to foster learning and knowledge development (Curtis et al. 2011).

- **Support the WHO initiative to estimate the global burden of foodborne diseases.** National and international donors should continue to support this WHO initiative. Funding is particularly needed to support studies that determine foodborne disease burden estimates among vulnerable populations, especially children 6–23 months of age, pregnant women, people living with HIV, and those with tuberculosis.

1 Introduction

Data from the World Health Organization (WHO) indicate that foodborne and waterborne diarrheal disease kills an estimated 2 million people annually (WHO 2015). Evidence also suggests that food is equal to and may be more important than water as a route of transmission of diarrhea in developing countries (Motarjemi et al. 2012; Lanata 2003; Käferstein 2003; Motarjemi et al. 1993; Esrey and Feachem 1989). In response to the increased awareness regarding foodborne disease in developing countries, this literature review, which was requested by the U.S. Agency for International Development (USAID), investigates how donors, partners, and programs can reduce this burden. Specifically, this review:

1. Identifies key priority household-level problem areas that most frequently result in foodborne illness in developing countries and critical actions to prevent foodborne illness at the household level
2. Documents interventions to improve food hygiene at the household level and decrease the vulnerability of household members to foodborne illnesses, including identifying key methods and approaches, particularly those using social and behavior change (SBC)
3. Identifies research and programming gaps in food hygiene at the household level
4. Provides recommendations to improve food hygiene at the household level in the developing-country context

This report is intended for individuals interested in better understanding foodborne illness in developing countries and the means for its prevention and control at the household level, especially among vulnerable populations, including infants and young children, pregnant and lactating women, people living with HIV (PLHIV), and those suffering from tuberculosis. The report is also intended for individuals interested in the design, implementation, and monitoring and evaluation of interventions to improve food hygiene behavior.

After a brief background section on foodborne diseases, the review describes and assesses studies about food hygiene in homes in developing countries over roughly the past two decades. It specifically focuses on food hygiene behaviors related to infection from bacteria, parasites, and viruses that cause diarrhea through the fecal-oral route, given the high burden of diarrheal disease in developing countries for all segments of the population and the contribution of foodborne illness to diarrheal disease.[2]

The food hygiene topics that are not covered by this review include the prevention and control of chemical contamination of food that occurs outside the home at other points in the food chain, including production, processing, transport, and storage, where contamination is related to issues of food safety more than food hygiene and requires action at the level of policy, laws, and their enforcement and chemical contamination in the home, for example from mycotoxins in home-produced food.[3] The latter areas are not covered because the literature review is focused on the specific causes of and steps to prevent diarrhea caused by pathogenic microorganisms that can be controlled through actions taken at the household level.

[2] Foodborne illnesses may also lead to long-lasting disease and/or disability, for example, Guillain-Barre syndrome or reactive arthritis.

[3] Mycotoxins are toxic compounds produced by different types of fungus under favorable conditions of temperature and moisture. They commonly enter the food chain through contaminated food and feed crops, mainly cereals, and may cause adverse health effects such as cancer, gastrointestinal and kidney disorders, and/or immunosuppression (European Food Safety Authority 2014).

2 Background

2.1 Burden of Foodborne Disease in Developing Countries

Diarrheal disease is the leading cause of morbidity around the world, particularly in developing countries (WHO 2008). WHO estimates that in 2004 there were 2.2 million deaths caused by diarrheal disease among all age groups, 1.8 million in low-income countries alone, of whom 1.5 million were children under 14 years of age (WHO 2008). The worldwide incidence of diarrhea in 2004 was estimated to be 4.6 billion cases among all age groups.[4] Diarrheal disease is the second leading cause of burden of disease, measured as disability adjusted life years (DALYs), for all ages worldwide, after lower respiratory infections.[5] Burden of disease from diarrhea is highest in low-income countries and, in these countries, is highest among children under 14 years of age, especially among those under 5 years of age (WHO/UNICEF 2009). Diarrhea can cause acute wasting and is the most important infectious determinant of stunting of children's linear growth (Black et al. 2013).

Epidemiological data demonstrate that food is an important factor in transmitting pathogens that cause diarrheal illness (Motarjemi et al. 2012). Recent data from WHO indicate that globally foodborne and waterborne diarrheal disease kills an estimated 2 million people annually (WHO 2015). Up to an estimated 70 percent of diarrheal episodes among young children could be due to pathogens transmitted through food (Motarjemi et al. 1993; Esrey and Feachem 1989). This is because the amount of bacteria in contaminated food, when it remains at ambient temperature for extended periods, is much higher than in water; food provides a medium for exponential bacterial growth, while bacterial pathogens in water may survive for some time but will not increase significantly in the absence of other nutrients (Lanata 2003; Käferstein 2003).

Foodborne diseases are largely under-reported (Chan 2014). Evidence of the health and economic burden of foodborne disease has been stronger in developed countries than in developing countries (Rocourt et al. 2003; Mead et al. 1999; Scallan et al. 2011a and 2011b; Flint et al. 2005). In developing countries, health statistics for many foodborne diseases, when they are reported, are often recorded simply as "diarrheal diseases" because the specific pathogen is almost never identified.[6] The recording of foodborne disease as "diarrheal diseases" at the country level is carried over in WHO statistics, which also uses the term "diarrheal diseases" rather than specific foodborne pathogens. For this reason, the exact proportion of diarrhea in developing countries caused by contaminated food remains unclear. To address the lack of reliable estimates on foodborne diseases, WHO established the Foodborne Disease Burden Epidemiology Reference Group (FERG) in 2007 (WHO 2010). The FERG is a WHO advisory body mandated to fill gaps in knowledge on estimates of foodborne disease by conducting epidemiological reviews on mortality, morbidity, and disability for major foodborne diseases. The FERG uses the methodology developed for the WHO Global Burden of Disease,[7] which includes expressing results of disease burden

[4] This refers to episodes of illness.
[5] Burden of disease is measured as DALYs, a summary health metric that combines morbidity, mortality, and disability (Murray and Lopez 1996). DALYs were developed in 1993 by the Harvard School of Public Health in collaboration with the World Bank and WHO and are a useful tool for setting priorities for interventions.
[6] Diarrhea is defined as the passage of unusually loose or watery stools, usually at least three times in a 24-hour period, and characterized by the following clinical types: acute watery diarrhea, lasting several hours or days with the main danger of dehydration; dysentery, which is acute bloody diarrhea; persistent diarrhea, which lasts 14 days or longer and can cause malnutrition, non-intestinal infection, and dehydration; and diarrhea with severe malnutrition, which can result in severe systemic infection, dehydration, heart failure, and vitamin and mineral deficiency (WHO 2005).
[7] The Global Burden of Disease study was first commissioned in 1990 by the World Bank to prioritize diseases for interventions in developing countries.

in DALYs. Unfortunately, the initial Global Burden of Disease study included few foodborne diseases. To remedy the situation, the FERG has analyzed a range of foodborne diseases, including those caused by microbial, parasitic, and chemical agents.[8] The FERG meets annually to review progress and results and to plan future studies. Since the FERG was established, it has commissioned studies on the global burden of diarrheal disease and presented preliminary results on foodborne disease caused by selected parasites, chemicals, and toxins. WHO indicates that in 2015 it will, for the first time, publish estimates of the global burden of foodborne disease, showing the scale of the problem (Chan 2014).

2.2 Foodborne Pathogens and Basic Modes of Transmission

While a wide range of pathogens can cause foodborne diseases, viruses, bacteria, and parasites pose the greatest share of preventable foodborne threats (Fischer Walker et al. 2010).[9] Food is only a vehicle for virus and parasite transmission to a new host. However, for many bacteria, food offers an opportunity to grow exponentially to infectious levels. Some bacteria, such as *Staphylococcus aureus* and *Bacillus cereus*, will produce toxins while growing in food, resulting in foodborne intoxications (often called food poisoning). This basic difference in etiology is reflected in the variability in the time to onset of disease symptoms, which range from a few hours for foodborne intoxications to possibly weeks for foodborne infections. Symptoms are also highly variable, ranging from mild and self-limiting to permanently disabling and fatal (WHO 1984).[10] More than 120 important viral, bacterial, and parasitic agents transmitted by food have been identified (Motarjemi et al. 2014). Thirty-two of these are significant public health problems and more than half of these cause diarrhea, either alone or in combination with other adverse symptoms (see the list in **Appendix 1**).

While some pathogens can survive in the environment, the main reservoirs for these agents are domestic animals, household pests such as rats and mice, and humans. When animals and their products are used as food, these agents may be present in or on the food. Pathogens are usually present on the surface of food due to direct or indirect contamination from the animal, pest, or human reservoir. In the case of many parasites and certain bacteria, such as *Salmonella Enteriditis* in eggs, the agent is present within the food.

Many pathogens known to cause diarrhea are spread by the fecal-oral route. **Figure 1** shows the routes of transmission of pathogenic microorganisms in feces and the estimated percentage of reduction in diarrhea that occurs from consistent and correct practices to reduce diarrheal disease transmission, including proper food hygiene. The primary routes of transmission for human or animal feces to cause diarrhea include through contaminated (1) fluids, such as water contaminated with feces; (2) fingers, such as when hands become contaminated from one's own feces or those of a child, bedridden adult, or household animals or pests; (3) flies, which may carry feces and contaminate food or other surfaces; and (4) fields/floors, such as when agricultural fields are contaminated with untreated fecal waste or rain/irrigation water that is contaminated with feces, or when household floors are contaminated with fecal material that then is spread via fluids, fingers, and/or flies. All of these routes of transmission can

[8] This significant work is being carried out in cooperation with a number of national and international agencies, including the U.S. Centers for Disease Control and Prevention, the European Centre for Disease Prevention and Control, the National Institute for Public Health and the Environment in The Netherlands, the United States Department of Agriculture, and the U.S. Food and Drug Administration. In addition, the governments of the United Kingdom, Japan, Germany, Ireland, and Sri Lanka, among others, are providing funding and in-kind support.

[9] Prions and toxic chemicals are also important foodborne pathogens, but are not included in this review because control measures for these hazards are mainly implemented at the primary production and processing levels.

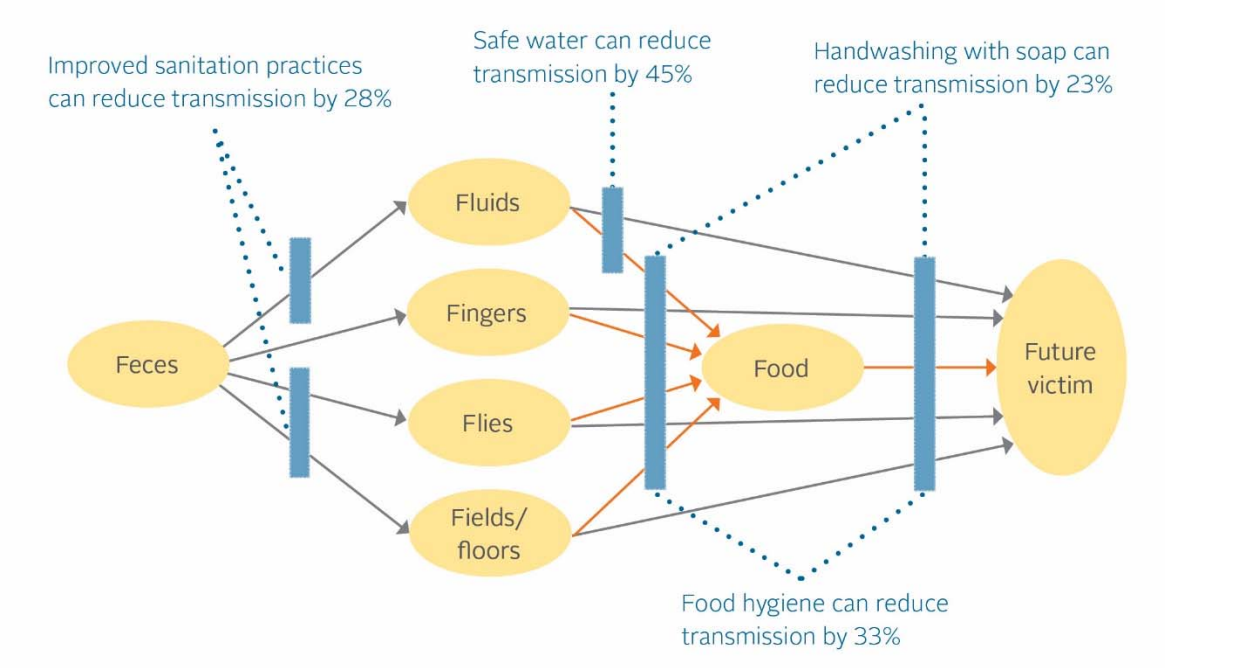
[10] Chronic illnesses caused by foodborne diseases are beginning to be recognized and evaluated, and, as more is learned, significant changes to DALY estimates may occur.

cause illness and diarrhea directly in an individual but can also do so via food contaminated by feces in fluids, on fingers, and/or from flies.

As shown in the diagram, food is a major route of transmission. According to WHO (2014) risk of diarrheal disease can be reduced by 28 percent through improved sanitation, including sewer connections; reduced by 45 percent through effective water treatment at the household level (such as boiling water or treating water with chlorine or other appropriate agents) and safe water storage; and reduced by about 23 percent through handwashing with soap. Appropriate food hygiene practices have been shown to reduce the risk of diarrhea by 33 percent (Sheth et al. 2006). This figure may be even higher given that up to 70 percent of diarrheal episodes among young children could be due to pathogens transmitted through food. Food hygiene behaviors, such as thorough cooking, storage at appropriate temperature, and handwashing with soap before preparing food, play an important role in interrupting transmission of diarrheal diseases regardless of whether the source of the pathogen is human or animal feces.

Safe or treated water is another critical component of food hygiene and preventing illness from drinking contaminated water or fluids. When an individual has diarrhea, it can be challenging to determine the extent to which food alone contributed to disease transmission, exclusive of water/fluids. Therefore, research studies that evaluate household food hygiene include assessment of pathogenic contamination of water. Past efforts in developing countries have focused on reducing diarrheal disease through treating drinking water and providing sanitation services, however, these have been met with mixed results in part due to the lack of appropriate hygiene education, including food hygiene (Zwane and Kremer 2007). Keeping food free of fecal contamination is one of the key ways to prevent the fecal-oral transmission of disease (Curtis et al. 2011).

Figure 1. Pathways of Transmission of Pathogens through the Fecal-Oral Route and Percentage Reductions in Risk of Diarrheal Disease from Improved Water, Sanitation, and Hygiene Practices



Adapted from Wagner and Lanoix 1958.

2.3 Vulnerable Groups at Risk of Foodborne Disease

While everyone is potentially susceptible to foodborne disease, certain vulnerable groups are often at greater risk of contracting a foodborne disease and/or suffering more severe consequences from the disease, including death. The main vulnerable groups include:

- **Infants and young children.** Their immune systems are still developing, and the protection afforded by the gut flora is not as effective as in adults, making infants and children more prone to foodborne disease.
- **Pregnant women.** Hormonal changes during pregnancy affect a mother's immune system, resulting in decreased immune function and greater susceptibility to foodborne disease. Also, the developing fetus is susceptible to foodborne pathogens that may not cause illness in the pregnant woman.
- **The immune-compromised.** People with weakened immune systems are prone to acquire foodborne disease. Particularly susceptible are those with chronic illness, such as HIV, tuberculosis, and chronic liver disease; those receiving treatment for cancer; or those with organ transplants.
- **The elderly.** Older people are more susceptible to foodborne disease because the natural defenses or ability to fight diseases decreases as people age.

2.4 International Activities to Promote Food Hygiene Interventions

WHO has long recognized the importance of reducing foodborne disease. In its 1984 report, *The Role of Food Safety in Health and Development*, an expert committee convened by WHO in cooperation with the Food and Agriculture Organization of the United Nations (FAO) stated: "Foodborne disease is perhaps the most widespread public health problem in the contemporary world and an important cause of reduced economic productivity" (p. 12). Among its recommendations, the expert committee emphasized educating food handlers and consumers in proper food hygiene and identified public education and community participation as essential strategies for intervention.

In 1992, the FAO/WHO International Conference on Nutrition adopted the *World Declaration and Plan of Action on Nutrition,* which recognized that "…access to nutritionally adequate and safe food is a right of each individual" (p. 1).

In 2001, WHO introduced the Five Keys to Safer Food—(1) keep clean, (2) separate raw and cooked food, (3) cook food thoroughly, (4) keep food at safe temperatures, and (5) use safe water and raw materials (WHO 2006a). The Five Keys to Safer Food promotes safe practices by all food handlers, including those in developing countries, and are adaptable for different target audiences around the world based on local situations. Key behaviors and their rationale are shown in **Table 1** and are reflected in a 2006 WHO training manual and poster. The messages are based in part on Hazard Analysis and Critical Control Point (HACCP) studies. HACCP is an approach, endorsed by WHO and the FAO, to ensuring appropriate food hygiene. In HACCP, a biological, chemical, or physical agent in food with the potential to cause an adverse health effect is a hazard, and a step at which control can be applied and is essential to

prevent or eliminate a food safety hazard or reduce it to an acceptable level is a critical control point (CCP) (FAO 1997).[11]

Table 1. WHO Five Keys to Safer Food

Key Behavior	Rationale
1. Keep clean	While most microorganisms do not cause disease, dangerous microorganisms are widely found in soil, water, animals, and people. These microorganisms are carried on hands, wiping cloths, and utensils, especially cutting boards, and the slightest contact can transfer them to food and cause diseases.
2. Separate raw and cooked food	Raw food, especially meat, poultry, and seafood, and their juices can contain dangerous microorganisms, which may be transferred onto other food during preparation and storage.
3. Cook food thoroughly	Proper cooking kills almost all dangerous microorganisms. Studies have shown that cooking food to a temperature of 70°C can help ensure it is safe for consumption. Foods that require special attention include minced meats, rolled roasts, large joints of meat, and whole poultry.
4. Keep food at safe temperatures	Microorganisms can multiply very quickly if food is stored at room temperature. By holding at temperatures below 5°C or above 60°C, the growth of microorganisms is slowed down or stopped. Some dangerous microorganisms still grow below 5°C.
5. Use safe water and raw materials	Raw materials, including water and ice, may be contaminated with dangerous microorganisms and chemicals. Toxic chemicals may be formed in damaged and moldy food. Care in selecting raw materials and simple measures, such as washing and peeling, may reduce these risks.

Source: WHO 2006a, pp. 12–21.

[11] For more information on HACCP, see http://www.fsis.usda.gov/Oa/background/keyhaccp.htm. Seven principles of HACCP in the food industry include: 1) hazard analysis, 2) critical control point identification, 3) establishment of critical limits, 4) monitoring procedures, 5) corrective actions, 6) record keeping, and 7) verification procedures (U.S. Department of Agriculture 1998).

3 Methods

For the literature review, searches for journal articles published over roughly the past two decades were conducted using the following databases: PubMed, Science Direct, Google Scholar, Scirus, Scopus, Database of Open Access Journals, and Evidence-Based Practice for Public Health. Searches for grey literature were conducted using databases from WHO and its regional offices, FAO, UNICEF, and USAID, as well as organizational websites, including, but not limited to, the International Scientific Forum on Home Hygiene and the U.S. Centers for Disease Control and Prevention.

The search terms included the following (alone or in relevant combinations): "food hygiene," "foodborne disease," "foodborne illness," "food safety," "diarrheal disease" ("diarrhoeal disease"), "fecal-oral route," "healthy marketplaces," "developing country," "intervention," "review," and "evaluation." The inclusion criteria for intervention studies and studies to identify key problem areas and critical actions to prevent foodborne illness are given in **Box 1**.

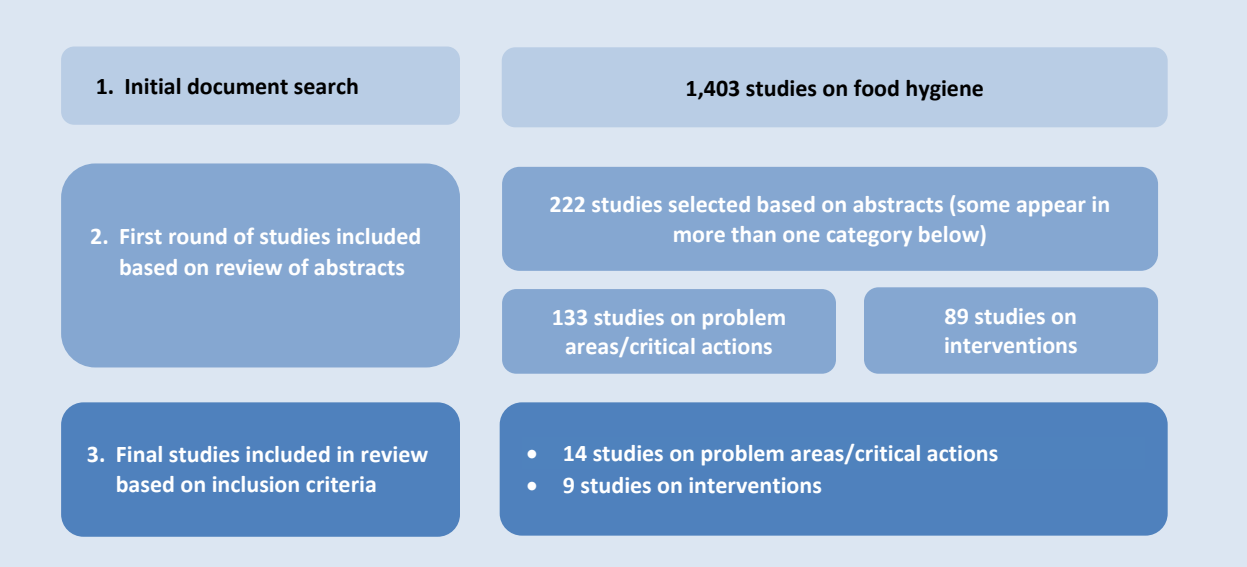
Of the 1,403 titles initially identified during the search, 14 studies that identified problem areas and critical actions in food hygiene met inclusion criteria for the literature review (see **Figure 2**). These studies are discussed in section **4.1** of this report. Some older studies, done before 1990, were included as they were commonly cited in other literature as foundation studies. In addition, nine intervention studies were identified that met the inclusion criteria for the review, which are discussed in section **4.2**. While some of the nine intervention studies had methodological weaknesses, given the paucity of intervention studies in developing countries, they were included and the weaknesses discussed as a part of the review.

Box 1. Inclusion/Exclusion Criteria for Intervention Studies and Studies on Key Problem Areas and Critical Actions to Prevent Foodborne Illness

1. Method appropriate to research question, with emphasis on randomized controlled trials, controlled before and after studies, uncontrolled studies, interrupted time series, and surveys and qualitative studies
2. An explicit link to theory
3. Clearly stated aims and objectives
4. A clear description of context with priority on developing countries, Africa, Asia, and Latin America
5. A clear description of study population, with priority on children under 2 years of age; children under 5 years of age; immune-compromised persons with HIV, tuberculosis, malaria and/or hepatitis; and pregnant and lactating women
6. A clear description of fieldwork methods, including use of accepted HACCP strategy methods to determine key problems and critical control points and use of accepted univariate and multivariate analyses to determine statistically significant associations and risk factors
7. Some validation of data analysis
8. Inclusion of sufficient data to support interpretation

Adapted from Jackson and Waters 2005.

Figure 2. Documents Selected for Literature Review



4 Results of the Literature Review

4.1 Studies on Priority Problem Areas and Critical Actions to Prevent Foodborne Illness at the Household Level

The review found 14 studies that identified key priority problem areas and critical actions for food hygiene at the individual/household level in developing countries. Eight studies focused on complementary food preparation and handling for young children and six focused on general food preparation in the home.

Studies focused on complementary food preparation for young children. Of the eight studies focused on key problems and critical actions for complementary food preparation and handling for young children, two were from Nigeria and one each from Bangladesh, Brazil, the Dominican Republic, India, Mali, and Thailand. The authors of five of these studies used the HACCP approach to identify key problems associated with different stages of food preparation and handling, assess the relative risks, and identify points where control measures could be effective to prevent foodborne disease. Using this approach, food preparation was observed; raw ingredients, water, and cooked food were tested for pathogenic microorganisms at various stages of the cooking process; and cooked food was tested within specified intervals during storage and before further consumption. Samples were collected aseptically in sterile containers, cooled, and maintained chilled until analysis in the laboratory. Temperature was also measured in food and water samples, as appropriate. Sheth et al. in India also tested for pathogenic microorganisms on utensils, mothers' fingernails, floors, and mops, while Michanie et al. in the Dominican Republic tested food contact surfaces in addition to food samples. Flow diagrams of food preparation and storage processes were developed to analyze and identify actual and potential sources of contamination with pathogenic microorganisms and critical points to prevent contamination.

The remaining three studies used approaches other than HACCP for analysis of sources of contamination of complementary food. The approaches used in these three studies included: multiple logistic regression to analyze the relationship among personal, clinical, and epidemiologic information regarding children's infection with diarrhea-producing bacteria or viruses (Brazil, Sobel et al. 2004); analysis of variance and bivariate analyses to analyze the relationship between food hygiene practices and maternal factors with bacterial count and coliform content of complementary food and water samples (Nigeria, Iroegbu et al. 2000); and multiple linear regression to analyze the relationship between food hygiene practices and maternal factors with bacterial count per gram and coliform content of weaning foods (Thailand, Imong et al. 1995).

The eight studies showed that the most common problems that were associated with contamination of complementary food with pathogenic microorganisms included: storage of cooked food at ambient temperature for an extended period, e.g., more than 6 hours (identified in seven studies); use of raw food products that had a high level of pathogens (six studies); contamination with pathogens from hands (six studies); inadequate reheating of food in terms of temperature and/or time (five studies); contamination with pathogens from utensils (four studies); and inadequate initial cooking of food (three studies). Other problems that were less frequently cited included use of water contaminated with pathogens (two studies); addition of food contaminated with pathogens to cooked food without adequate heating (one study); leaving cooked food uncovered for cooling or storage (one study); and cross-contamination from raw food to cooked food (one study). One study also found pre-mastication of food was associated with higher coliform counts in food, but this may have been related to feeding the child with hands contaminated with fecal coliforms.

The studies found the most frequently identified critical actions to eliminate, prevent, or minimize contamination of complementary food with pathogenic microorganisms were: thorough initial cooking and reheating of food, in terms of both temperature and time (eight studies); adequate handwashing before and during food preparation and before feeding children (six studies); adequate washing of utensils (six studies); and decreasing the time cooked food is stored at ambient temperature (six studies). Two additional critical actions that were mentioned less frequently were adequate treatment of water before use (two studies) and covering food with a lid during storage (two studies). The critical actions that were identified for each study are provided in **Table 2**.[12]

Studies focused on general household food preparation. Of the 14 studies that identified key priority problem areas and critical actions for food hygiene at the individual/household level in developing countries, 6 focused on key problems and critical actions for general food preparation in homes. Three of these studies were based in Peru and one each in Guinea, Pakistan, and Zambia. Five of the six studies on food hygiene at the general household level used the HACCP approach described earlier to identify key problems and critical control points. The remaining study (Guinea, St. Louis et al. 1990) was a case-control study that used multiple logistic regression to identify factors associated with cases of infection with Vibrio cholera.

The six studies showed that the most common problems that were associated with contamination of family foods with pathogenic microorganisms included: inadequate reheating of food in terms of temperature and/or time (six studies), storage of cooked food at ambient temperature for extended periods (five studies), contamination of hands with pathogens (five studies), use of raw food products that had a high level of contamination with pathogens (four studies), and use of water contaminated with pathogens (four studies). Other problems that were less frequently cited included contamination from utensils (three studies) and inadequate initial cooking of food (one study).

The studies found the most frequently identified critical actions to eliminate, prevent, or minimize pathogenic contamination of family meals were: thorough initial cooking and reheating of food, in terms of both temperature and time (six studies); decreasing the time cooked food is stored at ambient temperature (five studies); and to a lesser extent, adequate handwashing (two studies). The critical actions that were identified for each study are provided in **Table 3**.

[12] A detailed description of each study is available upon request from FANTA.

Table 2. Critical Actions to Eliminate, Prevent, or Minimize Contamination of Young Children's Complementary Food with Pathogenic Microorganisms

Author, Year, and Title	Critical actions to eliminate, prevent, or minimize contamination					
	Thorough cooking and reheating	Adequate handwashing	Adequate washing of utensils	Decreasing storage at ambient temperature	Adequate treatment of water	Covering food with lid
HACCP Studies						
Ehiri et al., 2001, "Critical Control Points of Complementary Food Preparation and Handling in Eastern Nigeria"	X			X		
Islam et al., 2013, "Hygiene Intervention Reduces Contamination of Weaning Food in Bangladesh"	X	X	X		X	X
Michanie et al., 1987, "Critical Control Points for Foods Prepared in Households in Which Babies Had Salmonellosis" (Dominican Republic)	X		X	X		
Sheth et al., 2000, "Hazard Analysis and Critical Control Points of Weaning Foods" (India)	X	X	X	X		
Touré et al., 2011, "Improving Microbiological Food Safety in Peri-Urban Mali: An Experimental Study"	X	X	X			X
Non-HACCP Studies						
Imong et al., 1995, "Maternal Behaviour and Socio-Economic Influences on the Bacterial Content of Infant Weaning Foods in Rural Northern Thailand"	X	X	X	X		
Iroegbu et al., 2000, "Bacteriological Quality of Weaning Food and Drinking Water Given to Children of Market Women in Nigeria: Implications for Control of Diarrhea"	X	X	X	X	X	
Sobel et al., 2004, "Pathogen-Specific Risk Factors and Prospective Factors for Acute Diarrheal Illness in Children Aged 12–59 Months in São Paolo, Brazil"	X	X		X		

Table 3. Critical Actions to Eliminate, Prevent, or Minimize Contamination of Family Food in the Home with Pathogenic Microorganisms

Author, Year, and Title	Critical actions to eliminate, prevent, or minimize contamination		
	Thorough cooking and reheating	Decreasing storage at ambient temperature	Adequate handwashing
HACCP Studies			
Bryan et al., 1992a, "Hazards and Critical Control Points of Food Preparation and Storage in Homes in a Village and a Town in Pakistan"	X	X	X
Bryan et al., 1988a, "Hazard Analyses of Foods Prepared by Inhabitants Near Lake Titicaca in the Peruvian Sierra"	X	X	
Bryan et al., 1988b, "Hazard Analysis of Foods Prepared by Migrants Living in a New Settlement at the Outskirts of Lima, Peru"	X	X	
Michanie et al., 1988, "Hazard Analysis of Foods Prepared by Inhabitants Along the Peruvian Amazon River"	X	X	
Schmitt et al., 1997, "Hazards and Critical Control Points of Food Preparation in Homes in Which Persons Had Diarrhea in Zambia"	X	X	
Non-HACCP Studies			
St. Louis et al., 1990, "Epidemic Cholera in West Africa: The Role of Food Handling and High-Risk Foods" (Guinea)	X		X

4.2 Interventions to Improve Food Hygiene and Decrease Vulnerability to Foodborne Illness

Nine studies related to food hygiene interventions in developing countries at the individual/household level that met most of the inclusion criteria were identified for the literature review. Seven of these studies focused on interventions for mothers of young children related to preparing complementary food—one study was conducted in rural areas in Bangladesh, three in urban slums (two in India and one in Brazil), one in an urban area in Vietnam, and two in peri-urban areas in Mali. The other two of the nine studies focused on food preparers in rural households in Cambodia and Laos. A brief summary of the food hygiene interventions, the outcomes measured in each study, and the results is presented in **Table 4**.

The majority of the studies were of short duration, approximately 1 month, although the 2013 Mali study by Touré et al. lasted 9 months, and the study by Takanashi et al. in Vietnam took place over 2 years. In all of the studies field workers or community workers/volunteers educated mothers or household members about key food and/or household hygiene practices, either through group sessions, home visits, or a combination of these. Some studies used additional SBC channels, where newsletters, loudspeaker announcements, and bulletin boards were employed, such as in the Vietnam study. Three of the studies used the HACCP approach to identify priority problems and critical actions that would be the focus of the educational sessions (Bangladesh, Islam et al. 2013; and Mali, Touré et al. 2011 and 2013). Four studies used formative research to inform the development of the behavior change messages and materials, for example, ethnographic studies, surveys, observation, group discussions, and/or food hygiene checklists (Brazil, Monte et al. 1997; Vietnam, Takanashi et al. 2013; Cambodia and Laos, Warnock, 2007a and 2007b). Two of the studies did not include information regarding use of formative research to develop and test SBC materials or messages (India, Sheth et al. 2004 and 2006). Only three of the nine studies collected data in both intervention and control areas (Bangladesh, Islam et al. 2013; India, Sheth et al. 2006; and Mali, Touré et al. 2013).

The outcomes measured by the studies include prevalence of diarrhea (3 studies), contamination of food or water with pathogens (3 studies), contamination of hands with pathogens (1 study), temperature of food prior to consumption (1 study), adoption of improved practices (7 studies), and improved knowledge (2 studies). All of the studies that collected data on diarrhea prevalence (India, Sheth et al. 2004, Sheth et al. 2006; Vietnam, Takanashi et al. 2013) found that there was a lower prevalence of diarrhea after the intervention, although only one of these studies used a control group (Sheth et al. 2006). In that study, the intervention group experienced a decrease in the prevalence of diarrhea, while in the same period the control group showed no difference in diarrhea prevalence. All of the 3 studies that analyzed food or water samples for pathogenic microorganisms (Bangladesh, Islam et al. 2013; and Mali, Touré et al. 2011 and 2013) found that the number of pathogens in the food or water was significantly lower after the intervention. Sheth and Obrah 2004 demonstrated that fewer mother's hands were contaminated with pathogens after the intervention (25 percent) compared to before the intervention (90 percent). Islam et al. 2013 showed that after the intervention the temperature of complementary foods provided to children was higher in intervention households compared to control households.

All of the studies that measured practices demonstrated some adoption of targeted behaviors after the intervention. These included, for example, improvement in adoption of handwashing at critical times, using separate or clean utensils and cutting boards for raw and cooked foods; adequately cooking food before serving; heating leftover food before serving it; not storing food at ambient temperature for extended periods; and keeping the house and areas around the house clean. The studies that measured knowledge (India, Sheth et al. 2006 and Mali, Touré et al. 2013) also demonstrated some improvements

in, for example, recall of messages regarding reheating food, using safe water, or handwashing at critical times, or the relationship between diarrhea and poor food hygiene practices.

Table 4. Summary of Food Hygiene Interventions, Outcomes Measured, and Results at the Individual/Household Level

Author, Year, and Title	Site	Target Group	Nature of Intervention	Outcomes Measured	Results
Islam et al., 2013, "Hygiene intervention reduces contamination of weaning food in Bangladesh"	Bangladesh (rural)	Mothers/ caregivers of children 6–18 months of age	Field workers educated mothers in intervention communities in critical actions over 4 weeks; priority problems and critical actions were identified through the HACCP approach; data was collected in intervention and control areas	• Pathogens in food and water • Temperature of food before eating	• Statistically significant reduction in pathogenic contamination of food and water in intervention households vs. control households • Temperature of food higher in intervention vs. control households
Touré et al., 2011, "Improving microbiological food safety in peri-urban Mali: an experimental study"	Mali (peri-urban)	Mothers/ caregivers of children 6–18 months	Field workers educated mothers in the use of critical actions and then monitored mothers' application of the actions over 1 day; priority problems and critical actions were identified through the HACCP approach	• Pathogens in food	• Diligent application of CCPs was successful in eliminating pathogens in children's complementary food
Touré et al., 2013, "Piloting an intervention to improve microbiological food safety in Peri-Urban Mali"	Mali (peri-urban)	Mothers/ caregivers of children 6–18 months	Field workers trained mothers in intervention group in critical actions over 3 weeks and conducted home visits every 2 weeks for 9 months; priority problems and critical actions were identified through the HACCP approach; data was collected in intervention and control areas	• Pathogens in food • Adoption of improved practices • Improved knowledge	• Statistically significant reduction in pathogens in complementary food in intervention group vs. control group • Mothers in intervention group had improved practices and knowledge
Monte et al., 1997, "Designing educational messages to improve weaning food hygiene practices of families living in poverty"	Brazil (urban slum)	Mothers of children 0–11 months	Field workers conducted trials of improved practices with mothers over 4 weeks; key practices were identified through a survey, ethnographic assessment, and observation	• Adoption of improved practices	• 53–80% of mothers adopted at least 1 practice • 60% of mothers who tried to adopt 4 practices were able to do so for 4 weeks
Sheth and Obrah, 2004, "Diarrhea prevention through food safety education"	India (urban slum)	Mothers of children 6–24 months	Community workers conducted home visits over 2 months providing educational messages and SBC materials	• Diarrhea prevalence • Pathogens on hands • Adoption of improved practices	• 40% of children had diarrhea after intervention vs. 92% before • 25% of mothers had pathogens on hands after intervention vs. 90% before • Adoption of improved practices higher after intervention

Author, Year, and Title	Site	Target Group	Nature of Intervention	Outcomes Measured	Results
Sheth et al., 2006, "Food safety education as an effective strategy to reduce diarrhoeal morbidities in children less than two years of age"	India (urban slum)	Mothers of children 6–24 months	Mothers in intervention households were provided food hygiene education over 4 weeks using SBC materials; data was collected in intervention and control areas	• Diarrhea prevalence • Adoption of improved practices • Improved knowledge	Compared to control group: • 33% reduction in diarrhea prevalence • Statistically significant improvement in adoption of hygiene practices • Improved knowledge about causes of diarrhea
Takanashi et al., 2013, "Long-term impact of community-based information, education and communication activities on food hygiene and food safety behaviors in Vietnam: A longitudinal study"	Vietnam (urban)	Mothers/ caregivers of children 6–48 months of age	Water Management Union including political and community leaders, health workers, and water system operators implemented SBC activities in a suburban village over 2 years; SBC materials developed using data from a survey and group discussions	• Diarrhea prevalence • Adoption of improved practices	• Statistically significant reduction in diarrhea in children under 5 (baseline: 21.6%, second evaluation: 5.9%) • Adoption of 11 of 17 food hygiene behaviors significantly improved
Warnock, 2007a, "Final report on community-based intervention study of food safety practices in rural community households of Cambodia"	Cambodia (rural)	Food preparers in rural households	Community volunteers educated households over 4 weeks with SBC materials and messages developed through a formative study using a validated food hygiene checklist	• Adoption of improved practices	• 29–53% increase in adoption of targeted food hygiene practices
Warnock, 2007b, "Final report on community-based intervention study of food safety practices in rural community households of Lao PDR"	Laos (rural)	Food preparers in rural households	Community volunteers educated households through a 2–3 hour small group session using SBC materials developed through a formative study using a validated food hygiene checklist	• Adoption of improved practices	• 95% of households washed hands with poured water after the intervention vs. 30% before the intervention

4.2.1 Key Methods and Approaches Used to Design and Implement Food Hygiene Interventions at the Household Level

The intervention studies included in this review used various key methods and approaches to design and implement study activities, some of which were reported by the authors to have contributed to or were associated with positive study results. These methods and approaches include use of formative research, the HACCP approach, and SBC; repeated and/or intensive exposure to messages and key practices; and interpersonal communication with respected, influential change agents. Each of these aspects is described next, along with, when available, aspects that the authors reported as contributing to positive study results.

Formative research. Four of the nine studies used formative research to design the interventions. Monte et al. (1997) in Brazil collected both qualitative and quantitative data through a rapid ethnographic assessment, community survey, and structured observations to design the intervention, messages, and materials; identified adoption constraints that were used to develop motivational messages; and tested proposed behaviors through household trials. Four food hygiene behaviors were prioritized for the trials based on specific criteria, including the prevalence of the inappropriate practice in the community, the likely impact on decreasing pathogenic contamination of complementary food if the behavior was changed, and whether the behavior could be changed given culture and resources. The ethnographic work revealed the concept of the *cuidadosa,* or "careful" mother and was used in message development and intervention strategies.

Warnock (2007) in Cambodia and Laos worked with local partners to develop a food hygiene checklist tool based on WHO's Five Keys to Safer Food messages and tested the tool in rural communities. Village volunteers were then trained for 2 days on use of the tool. After the training, volunteers worked in pairs to use the tool to collect formative data in randomly selected village households in various communities. Through the formative work, investigators identified the major food hygiene problems and designed the intervention activities around improving problem behaviors. As another example, Takanashi and colleagues (2013) conducted a study in Vietnam that included group discussions with caregivers to inform selection of behaviors, channels for communication, and development of the SBC messages.

HACCP approach. Three of the nine studies used the HACCP approach to identify key problems and critical actions and test the application of the critical actions to reduce pathogens in complementary food prepared by mothers or caregivers. In Islam et al. (2013) in Bangladesh, 30 mothers were assigned to an intervention group and 30 to a control group. After identification of critical control points, three field workers trained mothers/caregivers in the intervention group for 4 weeks in key behaviors to prevent bacterial contamination of complementary food. Complementary food and water were tested for contamination with pathogenic microorganisms at baseline, after the 4-week training, and 3 months after the intervention. The baseline results demonstrated substantial contamination of complementary food in the study population. The intervention, which involved mothers and caregivers applying the critical actions identified through the HACCP approach, significantly reduced fecal bacterial contamination in complementary food and water.

Touré et al. (2011, 2013) in Mali also determined the effectiveness of implementation of defined critical actions to reduce pathogenic contamination in complementary food. In 2011 researchers worked with 15 randomly selected mothers from a health center nutrition education group in a peri-urban area of Bamako to identify key problems and critical control points in the preparation of two common complementary

foods.[13] Trained field staff worked with the mothers over several days to adopt the critical actions to reduce pathogenic contamination. The results showed that the critical actions, when followed diligently, were successful in eliminating pathogens from the complementary food. In 2013 field workers worked with 30 mothers over a longer period of time, 9 months, to practice adopting the actions. Results demonstrated a statistically significant reduction in fecal coliform contamination of complementary food between the baseline study and immediately after the training and between baseline and 3 months after the training among mothers in the intervention group ($p < 0.008$), while mothers in the control group had no reduction in fecal coliform contamination of complementary food during the same time period. These intervention studies that identify critical control points and key actions and test actions with potential users are important to ensure that identified actions, when practiced as intended, do eliminate or minimize bacterial contamination. If they do not, more observations may be necessary to see whether critical actions are implemented as intended or whether other critical actions need to be added to the recommended behaviors.

SBC. Six of the nine studies mentioned development of specific SBC messages and/or materials for the targeted audiences to influence behavior change. Monte et al. in Brazil (1997) developed messages that instructed mothers on what to do, how, and when, and included motivators for practice, including messages related to mothers' existing knowledge about infant growth and well-being, and popular ideas about diarrheal disease, dehydration, and death. The messages were developed based on the results of the formative work noted previously. Among mothers who tried to adopt at least one practice over 4 weeks, 53–80 percent were able to do so, while 60 percent of mothers who tried to adopt four practices were successful. The authors reported that the results demonstrated that their methodology (including use of rapid ethnographic assessment, survey, structured observation, and household trials) was successful in achieving this behavior change. The authors also noted the need to design and implement a communication strategy, which they had not done. A communication strategy would include, in addition to messages, information on audiences, strategic approaches, channels, activities, and materials, among other components.

In Cambodia and Laos, Warnock (2007) worked with national partners to develop food hygiene posters to model desired food hygiene behaviors. In Cambodia, for example, the poster highlighted the concepts of "clean," "separate," and "cook well done." After the intervention there was a 29–53 percent increase in adoption of the targeted food hygiene practices in the study population. Results of the study were discussed with key local stakeholders who had implemented the intervention to identify enablers and barriers to behavior modification. Reported enablers to behavior change included clear messages that were easy to understand and practice, new information that was interesting to participants, skill building, an attractive poster, and having no additional costs involved in behavior adoption. However, community volunteers recommended using a larger poster, clearer images, changes to the images to improve their appropriateness for the audience, and providing education in more frequent, shorter sessions. Post-intervention discussions that were held with key local stakeholders who had implemented the interventions provided useful information, however it would have been beneficial to also consider focus group discussions with participants to obtain their perspective on the interventions, such as on the work of the volunteers, the messages, and the materials.

In India, Sheth et al. (2004, 2006) developed messages that were shared via calendars, pamphlets, posters, flash cards, role play, storytelling, and puppets. The messages were designed to be clear, unambiguous, and relevant to the local context. The materials and approaches to sharing messages were designed to be simple to use, attractive to stimulate action, practical, and fun.

[13] The mothers were randomly selected from a group of 70 mothers who volunteered to be candidates.

In Vietnam, Takanashi et al. (2013) developed 17 food hygiene messages that were transmitted through five SBC channels, including workshops, newsletters, loudspeaker announcements, bulletin board announcements, and flip charts for use in community meetings and home visits. The study included an intervention phase for 1 year, followed by a self-sustaining phase for 1 year during which activities were maintained by water management unions. Among the various SBC channels, flip chart communication via community groups and home visits were significantly associated with a greater number of good food hygiene behaviors. The authors attributed this to the quality of the flip charts in terms of the level of information provided, their colorful images, ease of use, and portability, and to the high level of interpersonal communication that they encouraged.

Repeated and/or intensive exposure to messages and key practices. All of the studies included home visits and/or group educational sessions with mothers/caregivers that in some cases also included hands-on practice and provision of SBC materials (posters/pamphlets). The studies in Bangladesh (2013) and Mali (2011 and 2013) that used the HACCP approach involved intensive 3- to 4-week hands-on training sessions for mothers led by trained field workers, while in Mali (2013), mothers also received follow-up home visits every 2 weeks for 9 months. The studies in Brazil and India (2006) also involved intensive home visits over a short period (4 weeks). Takanashi et al. in Vietnam (2013) applied intensive approaches in one village over 2 years. Messages were communicated via loudspeaker announcements twice per week; materials placed on bulletin boards; and flip charts used with caregivers during community gatherings and home visits, with an average of 35 home visits per month, and each targeted home visited twice in 12 months. Sheth et al. in India (2004) used a less intensive approach, providing two sessions of food hygiene training to eight community workers, who then visited 25 homes each over 2 months. Warnock in Cambodia and Laos included a 1-day training for community volunteers on the use of the food hygiene SBC materials, followed by two to three sessions by volunteers with participants over 1 month. Several of the authors acknowledged that more studies are needed that specifically analyze the frequency and intensity of exposure to messages and key practices needed for adoption of targeted behaviors, given several of the studies were too intensive to realistically be scaled up.

Use of interpersonal communication with respected, influential change agents. The studies in Cambodia and Laos found that enablers to adoption of promoted food hygiene behaviors included easy access to strong role models, such as village health support group volunteers in Cambodia and trained food hygiene educators in Laos. Sheth et al. in the 2004 study in India also attributed positive results to community workers and their good rapport with the community, motivation, interest, and the regular reinforcement and follow-up they provided. Monte et al. (1997) in Brazil attributed the success of trials of new behaviors to the strong, trusting relationships between the members of the field worker team, who were selected from the intervention community after consultation with local leaders, and the participants themselves. Field workers showed respect for participants' knowledge and opinions, and equal value was placed on participant adoption or non-adoption of practices, given the reasons for each were equally significant as an input to improve the intervention. Takanashi et al. in Vietnam (2013) also found that interpersonal communication via flip charts used during home visits was associated with the adoption of a greater number of positive food hygiene behaviors than the study's other methods for communicating messages; the study attributed this to the flip charts and the level of interpersonal communication achieved during a home visit.

4.2.2 Limitations of the Food Hygiene Intervention Studies

Short study duration. The majority of the interventions in the studies were relatively short, approximately 1–2 months. Authors of five of the nine studies recommended that further investigations be conducted with a larger population for a longer period to determine whether the results are reproducible and/or applicable on a larger scale (Islam et al. 2013; Monte et al. 1997, Toure et al. 2011; Toure et al.

2013; and Takanashi et al. 2013). Further studies would also be useful to better understand the factors that contribute to long-term adoption, or inhibit adoption, of key food hygiene practices so that such factors can be considered in program redesign.

Lack of a control group. Only three of the nine studies included a control group (Islam et al. 2013; Sheth et al. 2006; and Toure et al. 2013). The study by Takanashi et al. (2013) in Vietnam specifically identified lack of a control group as a study limitation. If feasible, future studies should include control groups to assist in determining associations between the intervention and outcomes such as behavior adoption, pathogenic contamination of food, and/or diarrheal incidence.

Lack of blinding or not reporting on blinding procedures. In the three studies where a control group did exist (Bangladesh, Islam et al. 2013; Mali, Touré et al. 2013; and India, Sheth et al. 2006), only Touré et al. stated that laboratory technicians were blinded to the origins of the food samples they tested. It was not clear if blinding was used in the remaining 2 studies. This may not necessarily influence the outcome for the study in Bangladesh because of the objective nature of the results, that is, pathogenic contamination of complementary food. However, in the case of the study by Sheth and colleagues in 2006, lack of blinding could potentially influence the household environmental sanitation scores, which could be more subjective, particularly regarding "cleanliness around the house," and personal hygiene scores, such as "physical appearance."

Self-selection to intervention groups or unclear selection criteria. The participants in the two studies in Mali were self-selected from among mothers attending nutrition education sessions at a local health center. Self-selection of participants may bias results and/or make it difficult to determine whether the results could be replicated among a broader population. The authors of the studies in Mali acknowledged this limitation but felt the results represent important steps in the process of developing and testing actionable recommendations for improving food hygiene at the household level in developing countries. The studies in Cambodia, Laos, and the 2006 study in India did not indicate how participants were selected.

Self-reporting behaviors. In Vietnam, Takanashi et al. 2013 acknowledged that assessed changes in behavior after the intervention through self-reporting by participants was a limitation in their study. Observation is preferred over self-reported behavior change because of the potential for bias in self-reporting. An interesting method used in a study among food service handlers in Canada (Chapman et al. 2010) was video observation. The authors selected video observation because they considered it less intrusive than direct observation and because it provides valid and reliable data and allows for more close examination of behaviors and multiple observers to code behaviors, thus reducing coding bias. Also, the study used more than one camera, which allowed observation of several food handlers concurrently. This proved useful because the study found that indirect cross-contamination (involving contamination through equipment, food contact surfaces, or hands) was much more likely to occur than direct cross-contamination (where a ready-to-eat food is contaminated through direct contact with a raw contaminated food item) and that many of the recorded indirect cross-contamination events occurred when multiple food handlers used common food contact surfaces, utensils, or equipment. Although the study was conducted in a developed country, using video with the consent of the participants is a method that could be considered in a developing country if culturally acceptable.

Incentives provided to participants. Several studies provided intervention participants with incentives. For example, in Laos, soap and a towel were provided to participants, and in Cambodia, soap was provided. In both cases, the provision of these incentives could have biased the results, given, for example, in Cambodia one outcome measure was handwashing with soap. Participants in the study by

Touré et al. (2011) in Mali received funds to purchase the ingredients for the complementary food before preparation with the field worker; however, given the intervention was to test the effectiveness of adopting identified critical actions under the direction of the field worker, this may not have affected the results. In the 2013 Mali study by Touré and colleagues, handwashing kits including a water container, basin, and soap were provided to participants, but they were given to both intervention and control mothers/caregivers.

Lack of or inconsistent reporting of statistical significance of results. The studies in Cambodia and Laos did not report on the statistical significance of results, and the studies in India by Sheth and colleagues in 2004 and 2006 did not consistently report on levels of statistical significance of findings. In these cases it is difficult to interpret the results.

Lack of information on pretesting of SBC messages or materials. Of the six studies that mentioned the development of SBC messages or materials, only one, the 1997 study by Monte et al. in Brazil, discussed the testing of the messages. None of the remaining five studies discussed the process for pretesting and finalizing SBC messages or materials. Pretesting messages and materials with the target audience is important to ensure that the target audience understands the messages and can relate to the images and materials to improve the adoption of desired practices.

Lack of links to social and behavioral change theories or models for behavior change. None of the intervention studies were clearly linked to social and behavioral change theories or models for behavior change. This would be useful to help ensure interventions consider the various factors that influence behaviors and behavior change, including not only knowledge and beliefs but also skills and access to needed materials to practice new behaviors and social norms that influence the practice of behaviors.

5 Discussion

Key Problems and Critical Actions to Prevent Household-Level Foodborne Contamination

Of the 14 studies that focused on key food hygiene problems and critical actions to prevent foodborne contamination, the critical actions identified included thorough initial cooking and reheating of food, in terms of both temperature and time (14 studies); decreasing the time cooked food is stored at ambient temperature (11 studies); adequate handwashing before and during food preparation and before feeding children (8 studies); and adequate washing of utensils (6 studies). Such studies are important to understand the key problems and critical actions to prevent foodborne illness among specific populations and to be able to tailor SBC messages and activities to the local context. Behavior change messages and activities should be focused on the most critical "small doable actions" for a target population and should avoid overwhelming individuals with behaviors to change, some of which may not be effective in decreasing foodborne illness in the target group (USAID 2011).

Critical Household Food Hygiene Actions

- Cooking at adequate temperature and time
- Decreasing the time food is stored at ambient temperature
- Reheating at adequate temperature and time
- Adequate handwashing to avoid contamination
- Use of clean utensils to avoid contamination
- Storage of food at sufficiently low or high temperature to prevent bacterial multiplication

Two of the most commonly cited critical actions in the studies in this review were adequate initial cooking and reheating of food and decreasing the time cooked food is stored at ambient temperature. However, there is little formative work or research on these key actions, such as on what household members believe or understand about these actions and what options or opportunities may facilitate household implementation of the actions, including new technologies or innovations. More research is needed in this area.

The results highlight the need for a continued focus on improving handwashing before food preparation, eating, or feeding a child or adult who needs assistance. As discussed previously, handwashing with soap can reduce diarrhea around 23 percent (WHO 2014). In addition to dissemination of key messages around handwashing, programs will need to help households and communities identify ways to improve access to water and/or soap, including consideration of options such as public-private partnerships.[14] Ensuring water is available close to the home is essential. When water is more than 1 kilometer from the home, mothers tend to economize on water use if the water supply at home begins to run out before the scheduled time to collect more—water is used more frequently when it is more readily available in and around the house (Cairncross 1997). Access to water would also facilitate keeping utensils clean, which was another key action, particularly for food hygiene for complementary feeding. If soap is not available, rubbing hands with ash under running water is an acceptable alternative (Baker et al. 2014).

In addition, activities that will help keep diarrhea-causing pathogens out of the environment will also help improve food hygiene, especially adequate disposal of feces, both from humans and animals, given many pathogens associated with infectious diarrhea are transmitted through the fecal-oral route (Motarjemi et al. 2011; Curtis et al. 2000). As with handwashing, interventions will need to focus on messaging for key

[14] More information on public-private partnerships can be found at the Global Public-Private Partnership for Handwashing at http://globalhandwashing.org/.

stakeholders and assist households and communities with selecting the most appropriate options for safe disposal of human and animal feces. Adequate disposal of feces will also help reduce contamination of raw food grown in fields or sold in markets by fecal material in the environment. However, for field crops, additional interventions such as treatment of fecal waste used as fertilizer and wastewater used for irrigation will be necessary early in the farm-to-fork continuum, before food reaches the household. To improve food hygiene and hygiene/sanitation in markets, community-level approaches with the involvement of key local government officials and the private sector will be needed. WHO has developed a manual, *Five Keys to Growing Safer Fruits and Vegetables* (2012), that can be used to train rural farmers and workers on food hygiene in the cultivation of fruits and vegetables (see **Box 2**). WHO also has a Healthy Marketplaces program that aims to ensure that markets provide safe and nutritious food and implement actions to reduce contamination, minimize bacterial growth, and destroy pathogens in both raw and prepared food sold in markets (WHO 2003; 2006b).

Box 2. WHO's Five Keys to Growing Safer Fruits and Vegetables

1. Practice good personal hygiene
2. Protect fields from animal fecal contamination
3. Use treated fecal waste
4. Evaluate and manage risks from irrigation water
5. Keep harvest and storage equipment clean and dry

Source: WHO 2012

Although there is a need for more research regarding some aspects of key problems and critical actions to prevent household-level foodborne contamination, the critical key actions mentioned previously can be put into immediate practice in programs, including adequate initial cooking and reheating of food, decreasing the time food is stored at ambient temperature, adequate handwashing, and use of clean utensils to avoid contamination. SBC messages and materials can be developed around these key actions, which can be integrated into current clinic- and community-level activities for vulnerable populations.

Use of the HACCP Approach

The HACCP approach has been recommended to identify critical control points and key actions in the preparation, handling, and serving of complementary food to facilitate targeting of educational messages and prevention efforts and resources in food hygiene (Ehiri and Prowse 1999; Islam et al. 2013). In this review, 10 studies used HACCP approaches to identify hazards associated with different stages of food preparation and handling, assess the relative risks, and identify points where control measures could prevent foodborne disease. Other studies could have benefited from using HACCP analysis to identify sources of contamination and critical control points.

Although HACCP methods are effective when done well, they can also be expensive, logistically complex, and time-consuming (Monte et al. 1997). Some experts have argued that adequate bacteriological evidence exists to allow for educated guesses regarding which specific behaviors to target without the use of HACCP analyses. For example, it may be adequate for program designers to conduct observation studies among a target population to identify potential sources of contamination based on existing bacteriological evidence and WHO's Five Keys to Safer Food. The observation results could then be used to develop tools to further quantify the prevalence of risky practices, which in turn could be used to focus behavior change activities on the most prevalent risky food hygiene behaviors. However, studies are needed to validate such approaches. In reality, there is still a need to learn more about food hygiene practices in low-income settings, critical actions that can reduce or eliminate foodborne pathogens in

these settings, and effective interventions that could mitigate risks (Guatam et al. 2015). The HACCP approach could help program designers and planners select the most critical actions to decrease foodborne illness. Formative studies to develop SBC messages and activities that are adapted to the local context and that consider the feasibility of adopting new behaviors, including local facilitators and barriers to adoption, would complement HACCP results.

Social and Behavior Change in Food Hygiene Programming

The success of the nine intervention studies included in this review appeared to be attributable, in part, to their use of the following SBC methods and approaches in their program design and implementation: effective use of formative research, effective SBC messages, repeated and/or intensive exposure to messages and key practices, and use of interpersonal communication with respected, influential change agents.

A clear understanding of food hygiene perceptions and practices, through formative research, is an important first step to ensure interventions consider culture, norms, and beliefs in SBC approaches and activities. There is also a need to understand motivators and barriers for adopting positive food hygiene behaviors in a particular context and to use the results of formative work in this area to design effective SBC messages and strategies. For example:

- A review of 11 studies in Africa, Asia, and Latin America showed key motivators for handwashing were "disgust of dirty hands" and "to do what everyone else was perceived as doing" (social norms) (Curtis et al. 2009). Other motivators included personal comfort and "nurture/the desire to care for one's children." These emotional or cultural motivators are important to consider in addition to cognitive and rational reasons. Fear of illness or disease was not a strong motivator of behavior change.
- In a study by Usfar et al. (2010) in Indonesia, mothers sometimes associated children's diarrhea with children's developmental milestones, such as teething, crawling, or walking. In this case, mothers may not be convinced of the need for certain food hygiene practices if they feel that their child's diarrhea is related to developmental milestones and, in this case, messages developed around "nurturing" may be more effective than "fear" in motivating behavior change.
- In the same study in Indonesia, "disgust" was a strong motivator for mothers, who washed cutting boards only if they had been used for meat, fish, chicken, or other item thought to be "smelly," but did not think boards needed washing after cutting vegetables, since they were not perceived as "smelly." This was also true for handwashing, as mothers believed they needed to wash their hands after working with "smelly" fish but not after working with vegetables, even though both could be contaminated with pathogenic bacteria.
- A study by Nauta et al. (2008) in the Netherlands found that information on food hygiene aimed at eliciting disgust, combined with a behavioral cue at the time of food preparation in the home, decreased cross-contamination more than the provision of the information alone. The behavioral cue was a message in a recipe about being careful to prevent cross-contamination. The behavioral cue may have served to help participants practice specific food hygiene behaviors to prevent cross-contamination, rather than their usual food preparation habits. Use of a behavioral cue during food preparation may also prove useful in interventions in developing countries.

The intervention studies in this review also included several SBC channels and activities, such as intensive one-on-one home visits, group educational sessions, hands-on practice, and provision of SBC materials such as posters and pamphlets. A study in Ghana of a national campaign promoting handwashing with soap found the greatest impact on handwashing behavior was from using a mix of

channels, including community events and at least one mass media channel (radio or TV) (Scott et al. 2008). The authors noted that an integrated multichannel approach ensured widespread reach in the behavior change campaign. Similar studies are needed to better understand the most effective mix of locally appropriate SBC channels and messages to promote key behavior change in food hygiene in specific situations (Curtis et al. 2001).

The interventions in this review also used repeated and/or intensive exposure to messages and key practices and interpersonal communication with respected, influential change agents. However, there is lack of research on the intensity of exposure and types of change agents that are most effective in producing lasting behavior change in food hygiene practices. Data are needed to determine "how much intervention produces how much behavior change, and hence what level of investment is most cost effective" and also the kind of intervention that is needed, including intensity of exposure and kinds of change agents, to ensure behavior change is maintained over time in a given population (Curtis et al. 2011).

Food hygiene interventions at the household level should also investigate the use of food for young children or other family members from street and market vendors. In a study in urban Indonesia (Usfar et al. 2010) and the study by Iroegbu and colleagues (2000), some mothers said they purchased certain prepared complementary food for young children from vendors. If a large proportion of mothers obtain prepared food from vendors for their children, themselves, or other family members, interventions will need to include information about proper handling of the food before giving it to children or consuming it, and/or interventions among vendors themselves.

As noted, none of the intervention studies had a clear link to social and behavioral change theories or models for behavior change. Such a linkage would help ensure that interventions consider the factors that affect behaviors and behavior change, such as knowledge, beliefs, skills, social norms, and access to resources needed to practice new behaviors. These factors need to be considered at the individual, family, community, and national levels, considering the overall enabling environment. It is important to clearly identify any limitations of an intervention study related to the theories or models that the study links to, for example, aspects of a model that were not included in an intervention and a description of how this could affect results. Authors may also recommend further studies that may be needed to investigate aspects of a model that were not addressed in an intervention study.

Vulnerable Groups

While this review included studies about key problems in food hygiene related to complementary food preparation for young children, no studies were found on key problems and critical actions for other vulnerable groups in developing countries, such as pregnant women, PLHIV, or people with tuberculosis. The critical actions for complementary food preparation and for general food preparation in the home were very similar, and one may perhaps assume they would also be similar for these vulnerable groups. However, these groups also have special vulnerabilities and needs, and studies to verify these needs are required, since consequences of infection can be severe (Medeiros et al. 2001).

Similarly, although seven of the intervention studies focused on influencing food hygiene knowledge, attitudes, and practices of mothers/caregivers of young children, there were no intervention studies that focused on other vulnerable target groups. There have been adaptations of the Five Keys to Safer Food produced for PLHIV in developing countries, such as WHO's 2010 *How to Integrate Water, Sanitation, and Hygiene into HIV Programmes*, but no intervention studies have validated their impact on behavior and disease outcome. Unfortunately, many studies, including those conducted by WHO, are often not

reported in peer-reviewed literature (Moy 2011). There is a strong need for intervention studies in food hygiene among these types of vulnerable groups in developing countries.

A limited number of food hygiene intervention studies among specific vulnerable groups in developed countries do exist and may help inform development of programs for similar vulnerable groups in developing countries. For example, Hoffman and colleagues (2005) conducted formative research and, based on the results, developed and tested SBC materials to promote safe food handling at the household level among PLHIV in the United States. The work involved needs-assessment focus groups with PLHIV and interviews with health care providers to better understand what information should be included in SBC materials, development of materials and testing with PLHIV and health care providers, and revision of materials based on testing results. In a developing-country context, a similar intervention could include needs-assessment focus groups with PLHIV, women in programs for prevention of mother-to-child transmission of HIV, key family members, health staff at local clinics or hospitals, and community health volunteers/home-based care providers to develop SBC materials and modes of delivery to improve food hygiene behaviors and prevent foodborne illness.

Measuring and Evaluating Food Hygiene Interventions

Projects that integrate food hygiene interventions may face challenges when developing their program monitoring and evaluation system due to a lack of standardized, validated indicators for measuring outcomes and impact of food hygiene activities. The interventions studies in this review did not address monitoring and evaluation of food hygiene programs. Some indicators may be relatively easy to develop, such as indicators related to knowledge of food hygiene practices in a specific context, or self-reporting of practices, however, neither knowledge nor self-reporting are good indicators of practice (Biran et al. 2012). Researchers working on the development of handwashing indicators have a great deal of experience developing indicators of handwashing practice, and much could be learned from their work. More research is needed in the development of practical, valid, standardized program indicators for food hygiene interventions that can be contextualized, as needed, to local situations.

6 Recommendations for Donors, Partners, and Programs

Recommendations for Immediate Implementation (Within 1 Year)

Put into programming practice what is already known about food hygiene. Key actions that can be put into practice within existing programs to reduce household-level foodborne illness in developing countries include adequate initial cooking and reheating of food, decreasing the time food is stored at ambient temperature, adequate handwashing, and use of clean utensils to avoid contamination. SBC messages and materials can be developed around these key actions, which can be integrated immediately into clinic- and community-level counseling for vulnerable populations, including pregnant women, young children, PLHIV, and those with tuberculosis.

Use quality improvement approaches and operations research to build upon what is known in food hygiene and fill programming gaps. Quality improvement approaches, such as plan, do, study, act (PDSA) cycles, mentoring, and coaching, can be used to ensure that food hygiene is integrated into clinic- and community-level programs, and that food hygiene programming is of high quality. Quality improvement approaches and/or operations research can also be used within programs to identify programming gaps in food hygiene and ways to strengthen program outcomes and impact, for example, through adjusting SBC strategies, or testing food hygiene assessment tools or indicators in a program setting.

Promote effective linkages between existing curative and preventive programs when diarrheal disease does occur. When diarrheal disease does occur, effective linkages with existing curative services are essential. Children with diarrheal disease should be referred to clinic- or community-based workers to provide oral rehydration therapy to prevent dehydration and zinc supplements to reduce the severity and duration of the diarrheal episode. Pregnant women, PLHIV, and individuals with tuberculosis should also seek immediate care for treatment. Follow-up counseling and support that includes food hygiene topics should be provided to mothers, caregivers, and families to prevent diarrheal disease.

Recommendations for Medium- and Long-Term Implementation (1–5 Years)

Conduct formative studies to inform program design. Programs should emphasize and support formative research as a part of program design, including collecting qualitative and quantitative data among the target population, to understand the most important food hygiene problems the population faces; the culture, norms, and beliefs that lead to specific food hygiene problems; and why specific food hygiene behaviors are practiced while desired behaviors are not. Trials of identified critical actions among the target population are important to better understand whether these actions can be readily and sustainably adopted, enablers and barriers to adoption, and any adaptations that may be necessary for adoption. Formative work is particularly important for food hygiene behaviors such as adequate initial cooking and reheating, and decreasing the time food is stored at ambient temperature, which were critical actions in the studies included in this review and for which few formative studies or implementation assessments exist. If feasible, HACCP analyses can be conducted to identify key problems in food hygiene and critical control points among the target population or to test whether critical actions result in the desired elimination or minimization of contamination. Formative studies can also form part of operations research to make ongoing adjustments to programs.

Develop guidance on practical, feasible ways to address food hygiene in developing country contexts. The critical actions to decrease the risk of foodborne illness in developing countries can be challenging for households to practice, especially decreasing the time that food is kept at ambient temperature when there is no electricity or refrigeration, adequate cooking and reheating of food when there is lack of time or fuel, and washing hands or utensils when water sources are distant and/or unsafe. Programs need practical guidance on how to address food hygiene behaviors that consider barriers that households encounter. Operations research can inform guidance development by identifying feasible actions that households can carry out in their specific situations.

Develop tools to assess food hygiene. Given the lack of available tools for assessing food hygiene at the household level, donors and implementing partners should consider supporting the development and validation of generic tools (for example, rapid assessment tools) and guides to assess food hygiene in developing countries at the household level, including assessing food hygiene behaviors and access to infrastructure and supplies that affect the capacity to practice desired food hygiene behaviors. Tools can then be adapted by programs to specific country contexts. Tools can also be developed as a part of operations research during program implementation.

Develop a context-specific SBC strategy to improve food hygiene practices. Programs should develop an SBC strategy that is based on theoretical behavior change models and/or theories of change and that has an appropriate mix of channels and messages, with details regarding audiences, strategic approaches, activities, and materials, among other components. SBC messages, training materials, and job aids should be tested and modified as necessary before implementation. WHO's Five Keys to Safer Food applies to all cultures and communities and already includes messages and materials that could be used as a start. However, they must be adapted for different country contexts based on formative results discussed previously and based on availability and access to supplies or infrastructure to practice behaviors, given that foods, eating practices, and the enabling environment vary greatly from one country to another and even within the same country (Chan 2014).

Assess and evaluate SBC strategies and adjust as needed to improve impact. Quantitative and qualitative assessments and evaluations with intervention participants and stakeholders can identify factors that facilitate or inhibit adoption of key food hygiene practices, including skills and access to materials needed to employ new behaviors and the knowledge, beliefs, and social norms that influence the practice of the behaviors. The results can be used to change or redesign interventions to ensure effectiveness. Routine supervision, analysis of monitoring data, and application of quality improvement techniques can be used to ensure quality of implementation. Assessment and evaluation of SBC strategies can also form part of operations research within programs, as noted above.

Develop and test indicators to assess the outcomes and impact of food hygiene interventions. There is a lack of standardized, validated indicators for measuring outcomes and impact of food hygiene activities. More research is needed in the development of practical, valid, standardized program indicators for food hygiene interventions that can be contextualized, as needed, to local situations. Development and testing of indicators could be conducted as a part of program implementation.

Integrate an appropriate package of water, sanitation, and hygiene interventions into programs. Since the fecal-oral route of contamination is such a large contributor to diarrheal disease, programs should integrate an appropriate package of water, sanitation, and hygiene interventions, in particular, focusing on: handwashing, with soap if possible, at critical times (including after defecating or cleaning a child or adult who needs assistance and before preparing food, eating, or feeding someone who

needs assistance); appropriate disposal of human and animal feces; and treating and safely storing drinking water. These actions will have a positive impact on food hygiene interventions. Ideally programs, whether working alone or in coordination with other programs, will also work with host country governments and communities to increase access to water, options for feces disposal, and soap. Although soap can be costly for many economically constrained households, public-private partnerships offer the opportunity to increase soap distribution. If soap is not available, rubbing hands with ash is an acceptable alternative (Baker et al. 2014). A description of key hygiene behaviors in handwashing, water treatment and storage, and sanitation can be found in **Appendix 2**.

Target food hygiene interventions for vulnerable populations. To be most effective, food hygiene messaging and behavior change interventions should be targeted to vulnerable populations. Programs addressing infectious diseases, such as HIV or tuberculosis, should consider integrating food hygiene messaging. People with these diseases are at greater risk of infection from foodborne pathogens than the general population and have greater risk of mortality if exposed. Clinic- and community-level programs that serve pregnant women should also integrate food hygiene messaging and behavior change around food hygiene. Programs addressing infant and young child feeding should continue to include messages and activities to improve food hygiene for this vulnerable group.

Include food hygiene components in policies, strategies, and programs. Given the evidence that food is a common medium for transmission of diarrheal disease in developing countries and that unsafe food contributes to high levels of morbidity and mortality in these countries, relevant host country government and donor policies, strategies, and programs should include food hygiene components. Governments and ministries are encouraged to invest in programs to change hygiene behavior, including food hygiene, and champions for this change are needed at all levels (Curtis et al. 2011). Food hygiene promotion needs to be a part of job descriptions of health workers and community volunteers at various levels; health workers and volunteers need to be trained in current SBC methods; and institutions that train them need to be trained as well (ibid). In light of USAID's Multi-Sectoral Nutrition Strategy 2014–2025, which advocates for stronger coordination and collaboration across programs and activities, food hygiene is a cross-cutting theme that should be integrated across sectors. By strengthening the coordination and collaboration of programs, specifically water, sanitation, and hygiene programs and other nutrition, health, and agriculture programs, greater reductions in morbidity and mortality can be realized.

Support research on food hygiene. Given the lack of sound research studies and program evaluations of household food hygiene interventions, more studies and/or program evaluations are needed to strengthen the evidence base. Such studies need to have strong methods, including, for example, use of the HACCP approach to identify and test critical actions, if feasible; sufficiently long follow-up of households and individuals; rigorous intervention design and results reporting; and use of health models to provide greater theoretical basis for studies. Both large- and medium-scale program trials and evaluations are needed to learn more about key aspects of effective formative work, design, planning, and monitoring and evaluation of food hygiene interventions. Furthermore, research assessing the causal link between specific hygiene practices and diarrheal incidence and its subsequent impact on nutritional status is critical to inform future interventions and identify behaviors and practices that are the most critical to prevent foodborne illness.

Widely disseminate results, lessons learned, and promising practices from food hygiene research and interventions. Given the lack of information on food hygiene research and interventions in developing countries, it is important that results and lessons learned from high-quality research and program interventions be shared to foster learning and knowledge development (Curtis et al. 2011). Of

particular priority are the results of trials of food hygiene interventions; cost effectiveness of various mixes of channels, intensities of messages and activity delivery, and types of change agents; and innovative technologies for practicing good food hygiene.

Support the WHO initiative to estimate the global burden of foodborne diseases. National and international donors should continue to support this WHO initiative. Funding is particularly needed to support studies that determine foodborne disease burden estimates among vulnerable populations, such as children 6–23 months of age, pregnant women, PLHIV, and people with tuberculosis. Reliable epidemiological data are urgently needed to enable policymakers and other stakeholders to appropriately allocate resources to undertake foodborne disease prevention and control efforts and to monitor and evaluate those efforts.

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Appendix 1. Common Foodborne Pathogens

Pathogens in bold are commonly associated with diarrhea, either alone or with other symptoms.

Bacterial

- *Clostridium botulinum* (intoxication)
- *Brucella*
- ***Campylobacter* spp.**
- ***Vibro cholerae***
- ***Enterohemorrhagic Escherichia coli***
- ***Clostridium perfringens***
- ***Enterotoxogenic Escherichia coli* (ETEC)**
- ***Escherichia coli* O157:H7**
- *Helicobacter pylori*
- *Listeria monocytogenes*
- ***Salmonella Enteritidis***
- ***Salmonella* ssp.**
- ***Shigella***
- *Salmonella typhi*
- ***Vibrio parahaemolyticus***
- ***Vibrio vulnificus***
- ***Yersinia enterocolitica***

Parasitic

- ***Entamoeba histolytica***
- *Anisakis*
- *Ascaria* (intestinal roundworm infection)
- ***Cryptosporidium* spp.**
- *Cyclospora*
- *Diphyllobothrium*
- ***Giardia lamblia***
- *Taenia solium* (neurocysticercosis or pork tapeworm infection)
- *Toxoplasma gondii*
- *Trichinella spiralis*

Viral

- Hepatitis A virus
- Hepatitis E virus
- **Norovirus**
- **Rotavirus**
- **Uncharacterized gastroenteritis virus**

Appendix 2. Key Hygiene Behaviors for Handwashing, Water Treatment and Storage, and Sanitation

Optimal Handwashing

- Use soap or ash every time you wash your hands.
- Wash hands under poured or flowing water. This removes the dirt and germs. A washbasin in which many people wash their hands in the same water does not prevent infection.
- Wash hands before handling, preparing, or eating food; before feeding someone or giving medicines; and wash hands often during food preparation.
- Wash hands after going to the toilet, cleaning a person who has defecated, blowing your nose, coughing, sneezing, handling an animal or animal waste, and both before and after tending to someone who is sick.

Water Treatment Methods

- Households should first separate drinking water from other household water. Treat all drinking water using an effective treatment method, as listed below, and then store safely (see storage details that follow).
  - Chlorination
  - Boiling
  - Solar disinfection (SODIS) using heat and UV radiation
  - Filtration using different types of filters
  - Combined chemical coagulation, flocculation, and disinfection

Water Storage Methods

- Store treated water in an appropriate vessel preferably with a narrow neck and a tap.
- If the container does not have a tap, pour the water into a clean pitcher to serve or use a ladle to dispense water.
- Hang the ladle on the wall.
- Do not touch the inside of the container with hands.

Sanitation/Feces Management

- Ensure latrines meet minimum standards, including a cleanable platform, a cover over the pit, housing that provides privacy, and a handwashing station nearby (ideally located next to the latrine and/or cooking area). If a latrine is not available, sharing with others in the community should be considered, or, in the interim, burying feces away from the house or facility.
- Maintain latrines properly by clearing the path to the latrine, removing obstacles such as stones and branches, and filling holes in the path to facilitate easier access. The platform, seat, walls, or other surface of the latrine should be feces free. All anal cleansing materials should be placed in the latrine itself. A scoop of lime or ash in the latrine after defecation can reduce odors and deter flies.
- Modify latrines for children and people with limited mobility. The modifications may require building supports (poles, ropes, stools) to make children or weak household members comfortable using the latrine or providing simple commodes to place over the latrine pit or bedpans/potties.

Source: USAID/WASHplus 2013

Contact Information:

Food and Nutrition Technical Assistance III Project (FANTA)
FHI 360
1825 Connecticut Avenue, NW
Washington, DC 20009-5721
Tel: 202-884-8000
Fax: 202-884-8432
Email: fantamail@fhi360.org
Website: www.fantaproject.org

Cover photo by Iain McLellan, FANTA/FHI 360

Recommended Citation: Monica Woldt and Gerald G. May. 2015. *Literature Review on Effective Food Hygiene Interventions for Households in Developing Countries.* Washington, DC: FHI 360/FANTA.

This report is made possible by the generous support of the American people through the support of the Office of Health, Infectious Diseases, and Nutrition, Bureau for Global Health, U.S. Agency for International Development (USAID) and the USAID Office of HIV/AIDS under terms of Cooperative Agreement No. AID-OAA-A-12-00005, through the Food and Nutrition Technical Assistance III Project (FANTA), managed by FHI 360.