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FOODBORNE ILLNESS PREVENTION IN DEBRE BERHAN, ETHIOPIA: PRELIMINARY EFFORTS TO UNDERSTAND HOUSEHOLD AGRICULTURAL PRACTICES

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ABSTRACT

While strategies to mitigate risks for foodborne illness and childhood diarrhea via sanitation and behavioral interventions have been explored, there is a dearth of knowledge about household practices regarding food production and use, livestock, and other sources of risk for foodborne illness in urban and peri-urban areas. The objective of this research was to increase understanding of household agricultural practices in Debre Berhan, Ethiopia in order to design targeted behavioral interventions to improve food safety and decrease diarrheal disease. A convenience sample of 21 teachers and parents were recruited for a mixed-methods pilot survey. The survey covered topical areas such as methods for growing, washing, and cooking produce, specifically focusing on practices in home vegetable gardens. Participants were also asked about fertilizers and manures used, animals on the property, and irrigation water sources. Descriptive statistics were calculated, and data were analyzed with SAS 9.2. The majority of participants (76.2%) reported growing some or all of their own food, and many used compost (62.5%) and manure (62.5%) as fertilizer. Uncomposted manure was used as fertilizer by half (50.0%) of respondents who reported the use of manure. Respondents most commonly reported raising chickens (23.8%), yet among those using manure, they most commonly reported using sheep or lamb manure as fertilizer (50%). Most (93.7%) respondents used municipal water to irrigate their crops, while none of the respondents reported using surface water to irrigate. Nearly all (95.2%) reported always washing their produce before eating it. Respondents most commonly requested education regarding how to more effectively grow produce. This study suggests that children and adults in Debre Berhan may have a high risk of exposure to pathogens via contact with uncomposted manure and multiple species of animals. Findings identify an opportunity for increased education in the topical areas of urban agriculture and diarrheal disease prevention. In particular, education regarding the safe utilization of manure as fertilizer could be included in agricultural extension programs. Additional research is needed to understand the extent of exposure via common household sources to pathogens that cause diarrheal disease.

Key words: Diarrhea, Livestock, Small-scale agriculture, Food safety, Urban agriculture

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INTRODUCTION

Diarrhea is a leading cause of morbidity and mortality in Ethiopia and among under five children in developing countries worldwide [1]. A number of studies in Ethiopia demonstrate links between diarrhea risk and other health determinants (for example, social-behavioral characteristics such as family relationships, household composition, socioeconomic status, education, housing, access to safe water, waste disposal practices, and handwashing practices) [1, 2, 3, 4, 5, 6, 7, 8, 9].

There is, however, limited research investigating the relationships between household food handling and food growing practices that contribute to diarrheal disease in Ethiopia. While data from studies of butchers, abattoirs, and food handlers in Ethiopia provide some insight into diarrheal disease risks, there are gaps in understanding whether these risks are relevant in home-based settings. One study focusing on choices that impact food safety in the home found that healthcare professionals in Ethiopia were more likely to consume pasteurized or boiled milk than non-healthcare professionals [10]. In another study, testing on samples taken from a goat abattoir found that 2.5% of samples tested positive for *Escherichia coli* O157, an enterohemorrhagic strain of *E. coli*. Every isolate from this abattoir was resistant to at least two antibiotics, and two of the six positive samples were resistant to more than five antibiotics [11]. In another study, more than 27% of raw meat samples from butchers tested positive for *E. coli,* and 21% tested positive for *Staphylococcus aureus* [12].

A critical aspect of foodborne illness is infectious disease carried by livestock. This risk is especially important in Ethiopia, as a large proportion of the population engages in subsistence agriculture [13], and it is common for livestock to live in close proximity to humans [14]. Findings from studies of disease carriage in livestock indicate that there is a great potential for zoonotic disease transmission from infected animals. Aklilu *et al.* [15] found that in Debre Berhan, a small, rapidly industrializing city, 85% of lambs with diarrhea tested positive for *E. coli* and 9% for *Salmonella* spp. Despite this known risk, few studies have investigated the implications of proximity to livestock and livestock caretaking chores in childhood diarrheal disease risk. Another study conducted in Debre Berhan found that, in addition to factors such as the mother recently having diarrhea and crowding in the home, living with cattle increased risk of diarrhea [7].

Conversely, Mediratta *et al.* [3] grouped animal exposures simply based on whether animals were in the compound and if children played with animals. Mediratta *et al.* [3] did not find an association between diarrheal disease and the presence of animals in the family compound or children playing with animals. It is possible that this discrepancy between Mediratta *et al*. [3] and Mamo and Hailu [7] stems from Mediratta *et al*. [3] asking about animal exposure in general versus Mamo and Hailu [7], specifically asking about cattle.

A meta-analysis of studies investigating the connection between domestic animal contact and diarrheal disease, which included research conducted in high-, middle-, and low-income countries and two studies from Ethiopia, found an overall positive association between exposure to domestic animals and diarrheal disease [16]. In the two papers from

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Ethiopia, Lengerh *et al.* [17] found a positive association between general animal exposure and *Campylobacter,* while Wegayehu *et al.* [18] found a positive association between ruminant exposure and *Giardia*. These studies may have more granularly investigated the relationships between enteric disease and specific animals.

Given our knowledge about risk factors associated with childhood diarrhea, the lack of research on foodborne illness contracted within the household, and the potential for foodborne illness in connection to animal exposure, this study examined household agricultural practices in order to increase understanding of risks for childhood diarrheal diseases in the household setting. The overarching objective of this preliminary work was to inform the design of educational materials to improve food safety, decrease foodborne illness, and eliminate under- five diarrheal disease through safe agricultural practices.

MATERIALS AND METHODS

A pilot survey was developed to learn about personal and household practices related to food safety and agriculture. Surveys were conducted at local elementary schools that were selected for proximity to Debre Berhan University, the site of an ongoing collaboration between agricultural faculty there and in the United States. Debre Berhan is located about two and a half hours northeast of Addis Ababa in a subtropical highland climate with a population of 100,055 [19]. A convenience sample of 21 teachers and parents, 18 or older, with children and/or with food gardens, were recruited by school principals and the project team. All provided oral informed consent. The survey was conducted orally in Amharic by members of the research team fluent in both Amharic and English, and responses to questions were written in English on paper forms by the interviewers.

The survey covered topical areas such as methods for growing, washing, and cooking produce. Participants were also asked about fertilizers and manures used, animals on the property, and irrigation water sources. The question formats included multiple choice/Likert-scales and open-ended responses. Surveys were validated by pilot testing in the United States with native Amharic speakers born and raised in Ethiopia for clarity and applicability. This research protocol was approved by the University of Maryland Institutional Review Board. Data were analyzed using SAS 9.2. Open-ended questions were analyzed by hand for emergent trends. Due to the small sample size, only descriptive statistical analyses were conducted.

RESULTS AND DISCUSSION

Of the 21 respondents that participated in the pilot survey, 62% were male, and 38% were female. The majority were married and had children (Table 1). Most respondents (95%) always washed their produce before consuming. Over a third of respondents mentioned eating raw meat, a common practice in some regions of Ethiopia. Three-quarters (76.2%) of respondents reported growing some or all of their own food (Table 2). Some respondents reported having animals on their property, with the most commonly reported species including chickens, sheep or lambs, and cats (Table 3).

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For those respondents growing their own food, fertilizer source varied. While none of the respondents used chemical fertilizers on their crops, 62.5% used compost, 18.7% used uncomposted kitchen scraps, and 62.5% used manure (Table 2). Of those who reported the species from which this manure came, five reported using manure from chickens, four reported using manure from sheep or lambs, three reported using manure from cattle, and one reported using manure from a horse. Of those reporting the use of manure on food crops half used uncomposted manure. Most (93.7%) respondents used municipal water to irrigate their crops, and 82.4% of respondents felt their municipal water source was safe. None of the respondents reported using surface water to irrigate their food gardens (Table 2).

Given that the overarching objective of this research was to inform the design of an educational program to improve food safety and decrease diarrheal disease from household sources, a final question on the survey assessed what types of educational programming would be helpful to participants. Respondents most wanted additional education to strengthen their capacity to grow their own food and to improve produce yield (Table 4). They were also interested in education about how to prepare food safely and how to make and use compost.

This pilot study helps strengthen understanding of personal and household behaviors related to food safety and agriculture, which can either promote or prevent diarrheal disease [20]. Additionally, while research is needed to compare the various irrigation and wash water sources in this region, municipal water is generally lower in pathogens and less significantly impacted by animals than surface water sources. The use of rain barrel water, however, could be concerning given previous findings that such water may be contaminated by feces from animals on rooftops and birds [21].

When asked which household agricultural practice topics were of greatest interest, most respondents requested education regarding how to grow food crops and properly make compost. Some respondents also asked for food safety training, which could easily be incorporated into education modules on composting, fertilizing, or food preparation. Findings from this study highlight some challenges of developing culturally relevant messages in this domain. For example, because eating raw meat is common and culturally important in some regions of Ethiopia, food safety messages that address cooking meat to a safe minimum internal temperature must also consider the cultural context and practices of the community.

Future research should include a comprehensive investigation of household food safety and agricultural practices alongside an assessment of pathogens present in irrigation water, washing and drinking water, animal manure, and compost. More research is needed on food handling practices in the home as well as contact with and handling of livestock. Household exposure is a known risk for foodborne illness, and fully understanding household behaviors and practices is crucial to designing effective, responsive interventions [22].

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Limitations

The primary limitation of this research was the small convenience sample, which limits the generalizability of the findings. Additionally, respondents with strong feelings about or extensive experience with agriculture may have self-selected to participate in survey, thus biasing the results. However, this pilot study serves as a foundation for future work using more rigorous sampling methods and robust measures to advance literature on household agricultural practices and household risks for diarrheal disease.

CONCLUSION

Understanding household food production and preparation practices illuminates risks for exposure to pathogens that cause diarrheal disease. In particular, this study suggests that children and adults in Debre Berhan, Ethiopia may have a high risk of exposure to pathogens via contact with uncomposted manure and multiple species of animals. Further research that examines the extent of this exposure from various common household sources could advance direct, culturally relevant educational initiatives aimed at reducing exposure and related diarrheal diseases.

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Table 1: Demographic characteristics of the sample (n=21)

Male: n (%)	13 (61.9)
Female: n (%)	8 (38.1)
Age in years: Average (min, max)	50 (28, 59)
Married: n (%)	18 (85.9)
Households with children n (%)	19 (90.5)
Number of children in households with children: Median (min, max)	3 (1, 5)

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Table 2: Personal and household practices regarding food safety and agriculture

How often do you…	**Always** n (%)	**Sometimes** n (%)	**Never** n (%)
Wash produce before eating (n=)	20 (95.2)	1 (4.8)	0 (0)
Children wash produce before eating (n=)	19 (95.0)	1 (5.0)	0 (0)
	Yes n (%)	**No** n (%)	
Use municipal water to wash your produce (n=21)	21 (100)	0 (0)	
Eat raw meat (n=20)[1]	7 (35.0)		
Grow some or all of your own food (n=21)[2]	16 (76.2)	5 (23.8)	
Use chemical fertilizer (n=16)	0 (0)	16 (100)	
Use manure as fertilizer (n=16)	10 (62.5)	6 (37.5)	
Use fresh, uncomposted manure (n=10)[3]	5 (50.0)	5 (50.0)	
Use compost as fertilizer (n=16)	10 (62.5)	6 (37.5)	
Use uncomposted kitchen scraps as fertilizer (n=16)	3 (18.7)	13 (81.3	
Use no fertilizer (n=16)	2 (12.5)	14 (87.5)	
Use collected rainwater to irrigate food crops (n=16)	2 (12.5)	14 (87.5)	
Use municipal water to irrigate food crops (n=16)	15 (93.7)	1 (6.3)	
Use surface water to irrigate food crops (n=16)	0 (0)	16 (100)	
Think municipal water is safe and healthy (n=17)	14 (82.4)	3 (17.6)	

[1]Participants were not explicitly asked whether they eat raw meat, but responses from those who volunteered this information when asked about consuming any raw foods were summed
[2]Questions regarding fertilizer and irrigation use the denominator of 16, as participants were asked only if they grew their own food
[3]Question regarding uncomposted manure uses a denominator of 10, as it was asked only of those who said they used manure on crops

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Table 3: Types of animals on property and use of animal manure

Animal type	**Number of respondents reporting animal on property** n (%)	**Number of respondents reporting using animal's manure on crops** n (%)
Chickens	5 (23.8)	4 (19.0)
Sheep/lambs	3 (14.3)	5 (23.8)
Cats	3 (14.3)	0 (0)
Dogs	2 (9.5)	0 (0)
Cattle/cows	1 (4.8)	3 (14.3)
Horses	0 (0)	1 (4.8)
Total	9	10

Table 4: Educational topics requested by participants

Topic area	**Number of respondents requesting topic** n (%)
How to grow/improve yield of fruit	5 (23.8)
How to grow/improve yield of vegetables	5 (23.8)
How to use manure, use fertilizer, and/or make and use compost	4 (19.0)
How to prepare food safely	4 (19.0)
How to save seeds	2 (9.5)
Soil types and preparation	2 (9.5)
How to prevent pests	1 (4.8)
How to grow food for sale	1 (4.8)

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