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Assessing the Role of Maternal and Community Capabilities in Preventing Childhood
Diarrhea

A thesis submitted in partial fulfillment of the requirement
for the degree of Bachelor of Science in Interdisciplinary Studies from
The College of William and Mary

by

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Accepted for Honors
(Honors, High Honors, Highest Honors)

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Abstract

This paper examines the potential implications of incorporating a framework of maternal and community capabilities into interventions targeting the global burden of childhood diarrheal disease. To assess these maternal and community capacities as they relate to hygiene-related infectious diseases – both diarrheal and parasitic – primary, interview-based qualitative research was conducted in a rural Nicaraguan community, in conjunction with a large cross-sectional data analysis of maternal and household determinants from demographic health surveys pulled from 17 countries of interest. I propose that these capabilities play a critical role in mediating the impact of diarrheal diseases on children, and through this paper explore the key areas that would be most effective to target in an intervention effort, comparing them to the dominant focus areas in current global health diarrheal prevention projects to identify existing gaps and propose further directions for study. Logistical analysis of maternal empowerment variables identified through a review of the literature in conjunction with interview data from mothers in Nicaragua demonstrates both the important protective effects of maternal social support and educational capacity on child diarrheal diseases, and the complexities in regional and child-age variation that must be taken into consideration when structuring hygiene-focused health interventions.

Acknowledgements

I would first like to express my extreme gratitude to my entire examining committee: Scott Ickes for providing me with continual guidance and support even as my thesis repeatedly followed Murphy's Law and for never abandoning hope that the research would work out, David Aday for the initial encouragement to even consider undertaking this kind of research and for always being willing to lend an ear to my rambling theories and concerns, and Camilla Buchanan for being so willing to join my committee at the last minute and providing such wonderful feedback throughout the conclusion of this project.

Additionally, I'm incredibly grateful for all of the support provided by the Charles Center and various generous donors who funded my research through the Honors Fellowship and allowed me to carry out much of the work necessary for this thesis – my travel to Nicaragua and subsequent work throughout the year would not have been possible without them.

I would also like to extend my heartfelt gratitude to the people of Cuje, Nicaragua for allowing me to impose upon their time with my interviews, and to Dr. Blanco from the MINSA health administration for repeatedly agreeing to sit down with me and discuss the health demographics and priorities of the region.

Finally, I'm incredibly grateful to my friends and family for supporting me throughout this process, never once complaining about the increased presence of phrases like "fecal coliforms" in our daily conversations, and only occasionally informing me that I was starting to come across as a bit deranged as deadlines approached – I wouldn't have been able to do this without them.

Contents

Abstract.....	i
Acknowledgements.....	ii
Contents.....	iii
I. Introduction	1
Why childhood diarrhea?.....	1
Current strategies to address diarrheal disease	2
Maternal capabilities	4
Community capabilities	5
II. Maternal & Community Determinants in Rural Nicaragua	7
Subjects and methods	7
Study setting	7
Participant recruitment and data collection	9
Survey development and data coding	10
Results	11
Data analysis.....	11
Water safety	11
Formal health interactions	13
Hygiene education	14
Perceptions of cause & risk	16
Social support	17
Discussion.....	19
Conclusions	21
III. Maternal & Household Capabilities on a Global Scale	22
Introduction.....	22
Methods.....	23
Country & survey selection	23
Variable identification & analytic strategy.....	24
Results	25
Maternal factors and diarrheal prevalence.....	25
Maternal factors and diarrheal treatment with ORS	28
Maternal factors and hydration during diarrheal disease.....	30
Maternal factors and intestinal parasite diagnosis & treatment.....	32
Maternal factors and water treatment	36
Discussion.....	37
Conclusions	42
IV. Conclusions	43
Works Cited	46
A. Tables & Figures	50

I. Introduction

“Diarrhea is the second biggest killer of children worldwide, and you've probably been asked to care about things like HIV/AIDS or T.B. or measles, but diarrhea kills more children than all those three things put together. It's a very potent weapon of mass destruction.”

-Rose George, 2013

Why childhood diarrhea?

At first glance, describing diarrhea as a “weapon of mass destruction” might seem a tad hyperbolic. After all, diarrheal disease as defined by the WHO as simply “the passage of three or more loose or liquid stools per day” – the makings of discomfort, surely, but not catastrophe. In its most serious forms, however, diarrheal disease – which is most commonly associated with infections of the intestinal tract – can result in death from severe dehydration and fluid loss. The WHO states that diarrheal disease is the second leading cause of death among children under the age of five; it results in the death of approximately 760,000 children every year, a devastating burden stemming from a disease that is both preventable and treatable.

In developing nations, children under the age of three will experience an average of three episodes of diarrhea every year. Even if they survive these repeated bouts of infection and dehydration, the long-term health impacts of these episodes will echo throughout their lives. Experiencing acute diarrheal disease during childhood has a demonstrated association with poor nutrition and growth outcomes among children. Studies have established a strong link between severe diarrheal disease and malnutrition (Ferdous et al. 2013), and some have posited an additional causal link to poor cognitive development (Guerrant et al. 2013). One multi-country analysis found that 25% of all childhood stunting could be attributed to experiencing five or more diarrheal episodes

before 24 months of age (Checkley et al. 2008), and other studies have demonstrated associations between childhood diarrheal episodes and changes in gut microbial population that result in nutritional malabsorption (Prendergast et al. 2014). In short, from a review of the current literature on diarrheal disease it becomes clear that George's assertion about the destructive burden of this illness skews closer to understatement than aggrandizement.

Current strategies to address diarrheal disease

“Diarrheal disease” is itself something of a sweeping, all-inclusive term; it's associated closely with poor access to clean water and limited sanitation systems, but can be brought about by an incredibly broad range of bacteria, viruses, and parasites – everything from cholera to rotavirus to *E. coli*. These diseases can be spread through a wide variety of routes, from food and water-borne, to fecal-oral, or person-to-person contact. This breadth of potential causative agents and transmission mechanisms is particularly important as it underlines the point that placing the focus solely on treatment-based approaches to address this disease burden is both unrealistic and insufficient. Even when low-cost, broadly applicable treatments such as zinc supplementation (Black et al. 2012) and oral rehydration solution (Sillah et al. 2013) are readily available, public health projects have encountered significant barriers in ensuring their use (Malhotra et al. 2013).

Additionally, there are demonstrated overlaps in the epidemiology of childhood diarrhea and that of pneumonia, potentially due to a correlation in risk factors such as undernutrition and inadequate breastfeeding practices for the two diseases (Walker et al. 2013). This connection is of particular significance, as pneumonia is the leading cause of death among children under five. Because these two diseases are so closely intertwined,

there's the potential for a decrease in incidence or severity of childhood diarrhea to have implications and ramifications far beyond simply cutting back on the number of children who suffer from bouts of diarrhea annually. The relationship between these two top drivers of childhood mortality has particular bearing on the global public health priorities: MDG (Millennium Development Goal) 4 was targeted at decreasing childhood deaths by two-thirds globally, but this proved a difficult goal to accomplish without explicitly targeting the two biggest killers of children under five; hence, the new WHO/UNICEF Global Action Plan for the Prevention and Control of Pneumonia and Diarrhea (GAPPD), an ambitious proposal that lays out a strategy for ending all preventable childhood deaths due to pneumonia and diarrhea by the year 2025 (WHO 2013).

This framework - proposed jointly by the WHO and UNICEF - is three-sided, with a tripartite focus on “protecting, preventing, and treating”. The protection goals outlined include exclusive breastfeeding, adequate complementary feeding, and vitamin A supplementation. The prevention goals are centered around vaccination, handwashing, safe water and sanitation access, reducing household air pollution, and HIV prevention. The treatment goals include the previously mentioned ORS/zinc-supplementation as well as improved care seeking and enhanced case management. Much of this framework, particularly the components targeting childhood diarrheal disease, builds off of preexisting knowledge and beliefs from the dominant water, sanitation, and hygiene (WASH) methodology that's heavily promoted by a wide variety of international public health organizations. In general, these strategies place the greatest emphasis on improved water supply and sanitation, as well as addressing desired behavior changes such as handwashing with soap (Ngure et al. 2014).

Maternal Capabilities

Some studies have hinted that even when fully and correctly implemented, WASH-focused strategies may still fail to result in the desired behavioral changes and diminished disease burdens, with this failure being ascribed to issues with “attitude” and “lack of will” (Akter et al. 2014). While it’s clear that the ultimate causative agent of childhood diarrheal diseases stems from contaminated water sources (due to bacterial and viral pathogens) fully eradicating these infectious agents will likely prove challenging, even with the advent of such powerful protective measures as the rotavirus vaccine, which has the potential to save millions of lives but isn’t sufficient to prevent all diarrheal infections. With these hygiene-related infectious diseases, one appealing potential approach to reducing the incidence and recurrence of these illnesses is by examining maternal and community capabilities and assessing how they interplay with both clean water access in general, and the occurrence of these diseases in particular.

Maternal capabilities can encompass a range of factors, including physical, psychological, social, and autonomous. Several studies have examined associations between one or more of these variables and childhood diarrheal outcomes. One study in Guatemala found a link between levels of maternal education and improved maternal child illness practices, including management of diarrhea (Webb et al. 2009); another study in Ethiopia found that maternal barriers to pursuing care for their child included limited decision-making power within the household, concerns about geographic and financial barriers, and low expectations of medical service availability (Tefara et al. 2014). Researchers in Nepal noted similar implications for child health when maternal capabilities including financial autonomy, access to education, and decision-making over health were limited (Ansari et al. 2012). Another study in Guatemala emphasized the

mother's perception of disease severity and support from the family to provide care as key mediators in decisions to seek treatment for diarrhea in children (Bruce et al. 2013). In sum, there is a wealth of evidence in the literature emphasizing the potentially critical role that these maternal capabilities can play in determining child health and disease outcomes, particularly with regard to hygiene-related infections.

Community capabilities

Community capabilities are another potential route for assessment, as they incorporate the overall structure of the community, the level of support offered to individuals, and the relative ease of access to critical health systems – including the presence of community health workers and the distance that must be travelled to obtain medical care. A study in Malawi established a correlation between the presence of health surveillance assistants in rural communities and the level of knowledge mothers displayed about the causes of and appropriate treatments for childhood diarrhea (Masangwi et al. 2012). Another group of researchers in Indonesia found that maternal participation in community activities – also known as social capital – had a direct association with the health of their child (Sujarwoto et al. 2013). A study carried out in a slum in Delhi highlighted the potential influence of community development on the dissemination of information to mothers about childhood diarrhea and nutrition (Pahwa et al. 2010). More robust examinations of the impact of community development on improving child health have been conducted in the U.S. (Komro et al. 2013) but no such studies have taken place in the context of the developing world where diarrheal diseases are most prevalent and dangerous.

Both maternal and community capabilities have shown promising associations with child health and diarrheal outcomes within limited settings. Up to this point, however, no full-scale review has been conducted to identify the primary mediators between these capabilities and illnesses, nor a cumulative summary of potential interventions to address disparities in this area. There has also been minimal analysis of the potential interrelations and overlap between maternal empowerment and community development, and the ways in which these two frameworks could theoretically aid in the construction of a model approach towards childhood diarrheal treatment and prevention that goes further than the current WASH methodology in addressing the underlying causes of these diseases.

This thesis will examine the mediating effects of these dual capabilities on childhood diarrheal outcomes, utilizing both a qualitative survey-based approach to model a framework of health beliefs and perceptions surrounding hygiene-related infectious diseases among mothers and community health workers in rural Nicaragua, and a quantitative cross-sectional analysis of maternal and household constraints on diarrheal diagnosis and treatment across 17 countries. The goal of this joint research is to identify the critical mediating variables not currently under consideration in dominant hygiene and sanitation strategies, explore their impact within both a local and global context, and subsequently determine the potential for integration into future public health interventions targeted at relieving the enormous burden of disease posed by childhood diarrhea.

II. Maternal & Community Determinants in Rural Nicaragua: A Qualitative Assessment

Subjects and Methods

Study Setting

Cuje is a rural, mountainous region located in the far north of Nicaragua, a four-hour drive from the capital city and a scant 30 kilometers from the border of Honduras. The transit to the community from the local health clinic meanders along unpaved dirt roads for the better part of an hour, climbing ever further away from even the basic infrastructure of the closest town. There's no electricity or any sort of water or sanitation infrastructure outside of wells and latrines. The majority of families in the area rely on a combination of subsistence farming and migrant labor for survival – many of the men in the community will leave for months at a time to work in other regions of the country, predominantly on the farming of cash crops such as coffee. Coffee is one of the critical commercial exports of the country, and the natural boom-bust cycle of the crop can have devastating impacts on the economy (Habib-Mintz, 2004) as evidenced by the 33% decline in coffee export in 2013 due to the outbreak of a rust fungus. Most water is accessed from a few wells scattered sporadically across the region (some of which are contaminated or have dried up; others are entangled in a complex web of politics regarding who has access), various cisterns and rain catchment systems (though few are extensive enough to cope with the lengthy dry period) as well as local springs and streams. Latrines have been provided for residents in a haphazard manner – some come from the municipality, others from local or international NGOs, and most are in varied states of disrepair.

Reliable health indicators for the area are hard to come by – the most recent USAID demographic health survey for Nicaragua is from 2001, and while the WHO has some data up through 2013 it's primarily focused on broad indicators of life expectancy and mortality (WHO Statistical Profile, 2013). UNICEF data for the country indicate that 22% of all children suffer from moderate-to-severe stunting, and only 37% of the rural population has access to improved sanitation facilities (UNICEF 2011). What is relatively easy to confirm is that Nicaragua is the poorest country in Central America, and the second poorest in the entire Western Hemisphere; an estimate from 2009 puts 42.5% of the country as living below the global poverty line.

Through the analysis of triage and diagnostic data from a local free annual health clinic as well as conversations with local health officials, access to clean water and the subsequent implications for diarrheal outcomes in the population as a whole (though particularly among children) has emerged as a priority focus area for intervention in the region.

An ongoing community-based participatory development project conducting research in Chaguite, one of the communities within the micro region of Cuje, has established through extensive surveying and meetings – both focus group and community-wide – that the underlying health concerns in the region encompass three main areas: clean water access, nutrition, and deforestation. Additionally, a study analyzing health and demographic surveillance data from León, Nicaragua found that there were significant barriers to the appropriate management of childhood diarrhea within households, particularly with regards to nutrition and healthcare access (Becker-Dreps et al. 2014).

Participant recruitment and data collection

A total of 25 semi-structured, in-depth interviews were carried out in May 2014 with a combination of local mothers and community health workers (CHWs, known as “brigadistas” in the area). Follow-up interviews with 8 brigadistas took place in December 2014, in addition to conversations with the head of the local health system in the winter and again in March 2015. The mothers were recruited via focus group – all were from the community of Chaguite, and were evenly selected from among the five focus groups in the area (largely driven by geographic considerations). Brigadistas were selected from each of the eight communities that comprise Cuje as a whole (a map of the microregion of Cuje is presented in **Figure 1**) – in some communities there are multiple brigadistas and in those cases every effort was made to speak with the brigadistas assigned to maternal and child health considerations.

All participants were given the option of whether or not to participate in the interviews, each interview was prefaced with a confidentiality disclosure (as laid out in PHSC-2014-02-15-9318-sbickes – Human Subjects’ approval was obtained from the College of William & Mary) and informed consent was obtained in every instance. Interviews with mothers generally took place in their homes, while interviews with brigadistas either occurred in their own houses or in the local health outposts (referred to as “casa bases” – essentially an empty building that can be used for a multitude of community purposes).

Interviews were conducted entirely in Spanish by the researcher and transcribed in Spanish before subsequent translation into English for coding purposes. For every interview there was a second Spanish-speaking student there to ensure accuracy of

understanding and transcription of responses. Field notes taken during each interview encompassed not only the transcribed responses but also issues with questions (to allow for adjustment and revision) and observations regarding both body language of the interviewee and details about the surrounding area (i.e. proximity to a well, cistern, or spring).

Survey development

To assess the various factors involved in both access to safe drinking water, prevalence of diarrheal disease, and underlying factors that might drive both of those issues through maternal and community capabilities, core research questions for both the maternal and CHW interviews were structured around the framework of the Health Belief Model. Questions were designed to address every component of the model: perceived severity, perceived susceptibility, perceived benefits, perceived barriers, modifying variables, cues to action, and self-efficacy (**Table 1**). This model is designed to assess the ways in which personal perceptions of a disease drive both disease prevention and health promotion efforts. The main reason for selecting this particular model was that several intervention and treatment methods were known to be present in the community (including the treatment of water with chlorine to make it safe to drink, and the use of ORS to treat residents suffering from dehydration) so the goal was to combine more baseline inquiries about access to water and health services with inquiries about the underlying factors behind maternal behavior with regards to childhood diarrhea. Sample questions from the maternal and CHW interviews are outlined in **Table 2** and **Table 3**, respectively.

Data coding

All interviews were transcribed in Spanish, then translated into English, with the alternate speaker who was at the interview present to check for accuracy. These transcripts were then revised to clarify certain terms and add context from field notes, and then uploaded to and coded using Dedoose, a web application for mixed methods research. The codes applied were developed based off of the core guiding questions for the research, and are outlined in **Table 4**. As this study was focused on the qualitative assessment of community and maternal capabilities rather than any quantitative analysis, the focus was on the content of the coded regions, rather than the numeric quantities of each category.

Results

Data analysis

Once each of the interviews had been coded according to the established methodology, excerpts for the maternal interviews were extracted and compared across focus group regions, while CHW interviews were compared across communities. In both instances, several key areas of interest began to emerge. These areas of interest, based on the overall coding framework, were: (1) water safety, (2) formal health interactions, (3) hygiene education, (4) perceptions of cause & risk, and (5) social support.

Water Safety

The issues of cleanliness and water access were recurrent themes throughout virtually all of the interviews; as noted in the discussion of location, Cuje is a region heavily impacted by seasonal water access, with a significant fluctuation between the wet and dry seasons. This barrier of inconsistent access to various water sources appears to

exacerbate the water safety issues in the region, as highlighted by discussions of the proximity to a reliable drinking water source – several mothers indicated that their primary source for drinking water is only seasonally available, so in the dry season they must either travel significantly further to collect water or use a water source that they view as being less safe. As one brigadista noted, not all of the families in the area have the ability to save or collect water, and not everyone has access to water in the first place.

Discussions about water safety additionally brought to light a significant gap between perceptions of water treatment measures and implementation between the brigadistas and the community residents. The characteristic response of brigadistas to questions about water treatment tended to observe that community residents wouldn't use chloro (the most common treatment mechanism in the area, supported by the governmental health system) because they didn't like the taste, and wouldn't boil their water because it occupied too much of their time. By comparison, the most common refrain from the maternal interviews on this subject was that while they did use chloro when it was available, the “centro” (the MINSA center located at a central point in Cuje) did not consistently supply it, and so when the chain of supply from the government broke down they were left without resources to treat their water. No mothers cited disliking the taste of chloro as a reason for not treating their water.

There was also a significant variation across regions of the community in terms of who reported consistent access to water treatment supplies – certain “focus group” regions were unanimous in asserting that they always were able to treat their water, but at least one group expressed issues with supply across every interview, indicating that there are geographic limitations even to accessing basic preventative supplies that are, in

theory, supposed to be provided to every household. The government health center was the only identified source of water treatment supplies across all interviews; when prompted regarding local pharmacies, respondents indicated that such a measure would be both geographically and economically untenable. Some brigadistas stated that they were responsible for distributing chloro throughout their communities, but this was not consistent across all communities, indicating that it may not be a formally established system of distribution.

Formal Health Interactions

Most respondents indicated a high reliance on the formal health institutions – the center, the local doctors and nurses, and occasionally the community health workers were mentioned, but no other community health infrastructure or organizing was mentioned. The distribution of references to formal health system interactions across age and number of children is visualized in **Figure 2**. The general trend was towards a much greater emphasis (among the maternal interviews) on the benefits of medical treatment to resolve diarrheal illnesses and parasitic infections. The most frequent complaints among the maternal interviews revolved around the distance to the centro, the fact that there was rarely a doctor at the centro, and the general lack of necessary medicines at the centro. Several CHWs expressed their frustration with this mentality, with one noting: “I advise them to organize together to prevent disease, but for them the general perception is that the solution lies at the centro.” The centro was frequently cited not just as the primary source of treatment, but also the best possible route for prevention, as reinforced by the distribution of chloro. Measures such as ORS and antiparasite medicine were generally

cited as preventative mechanisms. Several of the mothers who noted that they and their children are generally healthy ascribed this wellbeing to frequent visits to the centro.

The sense of powerlessness and lack of control over health was reinforced by these discussions of formal health structures. One mother stated that: “We aren’t doctors, we don’t have the power to fix it ourselves”. Another noted that: “I think we can limit our exposure with treatment from the centro”.

A few of the CHWs highlighted the particular difficulty that mothers face in getting treatment for their children through the formal health system. As one of them outlined: “Mothers have trouble getting their children to the centro when they’re sick. Right now the ambulance is reserved for pregnant mothers, so bigger kids have to go by foot when they’re sick, which is hard on them and their mothers.”

Hygiene Education

Another divide between the CHWs and the general community was highlighted by the discussion of the role of hygiene education. While most of the brigadistas launched into in-depth descriptions of the preferred methods for water treatment and house cleaning, rattling off a lengthy list of everything that must be kept clean, from hands to food, most of the mothers would confirm that “charlas” (public health education events put on by either brigadistas or MINSA nurses) did sporadically take place, they rarely knew whether the charlas were regularly scheduled events – most reported only hearing the charlas when they were taking their sick children in for consults with the doctors – and few could comment on what they learned from them beyond the benefits of using chloro to treat their water, and the importance of keeping their children and house

clean. The distribution of references to hygiene education across age and number of children is visualized in **Figure 3**.

Most of the CHWs expressed a certain degree of frustration regarding their work towards hygiene education. Low attendance at the charlas was frequently cited as a problem, as was mothers forgetting the things they'd been taught. One brigadista lamented the fact that “most of the things we tell them, they won't put into practice”. Another took a more reflective stance on the issue, noting, “There are a lot of things that we know as brigadistas that we've learned empirically. We really want to work for the community, but we need more training to be more effective.”

With regards to where the brigadistas themselves get their training from, most discussed workshops run by the government where they had the opportunity to expand their knowledge on certain issues determined to be health priorities, including childhood diarrhea.

“When we meet, we are educated on how to prevent these diseases – like diarrhea, and parasites. We talk about personal hygiene, keeping the house clean, keeping animals out of the house, using chloro with water, boiling water if you don't have chloro. This is the way to avoid diarrhea.”

One brigadista stated that in their opinion, the best medicine is to simply avoid getting the disease in the first place; the vast majority of responses coded as being focused on prevention are derived from interviews with CHWs, while the only preventative measure cited by mothers was the treatment of water prior to drinking.

Perceptions of Cause & Risk

The widest variety in responses came from the questions centered around maternal perceptions of diarrheal disease causes and risk factors. Some commonly referenced points of concern were dirt, dirty water, dirty food, and lack of personal hygiene. Mothers were divided, however, on whether they had the power to prevent diarrheal diseases from occurring, as well as whether these diseases posed a greater risk to children, adults, or both.

The understanding of causative agents behind diarrheal diseases in the region is best encapsulated by the model described on one of the maternal interviews: “I believe that they happen because something comes in from the outside. It gets into the water, makes it dirty. Makes it contaminated.” Many residents also ascribed these illnesses to the absence of chloro.

In terms of power to prevent the diseases from occurring, responses ranged from mothers who believed that they had no power whatsoever to stop their children from getting sick to those who believed they had total control over whether their children contracted disease. Many asserted that if they were able to the centro quickly enough and were able to get adequate medicine for their child, they would be able to stop them from getting sick. Others focused in on the issue of dirt, and the fact that these illnesses were already present in their environment. This perspective is perhaps best encapsulated by one mother’s response:

“I think that since these diseases are already present in our community, they’re much harder to get rid of – once they’re here, you can never make them completely disappear.”

A few of the brigadistas asserted opinions in contradiction to this, with one noting that “with a strong foundation and structure I believe they can be avoided.”

With regards to relative risk, opinions varied regarding whether these diarrheal diseases posed a greater risk to mothers or children, although the majority asserted that children were at a heightened level of risk, for reasons ranging from smaller size to lack of strength to greater exposure (since children are outside playing in the dirt). There was a great deal of emphasis on the danger these diseases posed in terms of bringing on stomach pain, and the connection to parasitic infections. Several mothers noted concerns about the risk of these diseases negatively impacting the growth of their child.

Social Support

The issue of social support was one of the most striking to emerge from the maternal interviews – many cited lack of support as one of the barriers to pursuing medical care for themselves or their child when sick, and few could list people in the community outside of their own household who would be able to help them if someone fell ill. The mothers stated unanimously that when their children get sick, they are the only ones who take care of them. When the mothers themselves get sick, about half had a relative or husband they could call on to help out around the house or with the children, but half stated that because they were living alone, or far from the community, they had no one to provide assistance or support; this isolation and marginalization was also reflected in responses to questions about ongoing participation in community projects to address issues of water safety and access.

Several mothers stated that while when their children fell ill, they would make sure to take them to the centro immediately, they weren't able to take the same measures

for their own health. This lack of support was emphasized as being particularly problematic for mothers with more than one child, as there was no one in the household to look after the children if the mother fell ill, or to look after the other children if one of them needed to be taken to the centro for a consultation. The insular nature of family-based support was also emphasized, with only one mother citing someone from outside her nuclear family as a source of support and assistance, while several mothers stated that they had previously relied on their parents for support that they (due to age, infirmity, distance, or death) could no longer feasibly provide.

Conceptual framework development

Several key factors and barriers that influence both maternal and community capabilities to combat childhood diarrhea were consistently identified throughout these interviews, and have been organized into an overall framework for conceptualizing these issues within the rural Nicaraguan context (**Figure 4**). Maternal and CHW responses to interviews emphasized the mediating influences of social support systems, information access, and key perception components of the health belief model, as well as clarifying the most relevant proximal causes of diarrheal disease in the region: the limited accessibility of safe water, the weakness of the existing formal health structure, and the constraints on establishing a hygienic household environment. All of these identified variables drive the hygiene and water treatment practices enacted by mothers in the area, and ultimately contributed to the diarrheal outcomes of the children in each household interviewed.

Discussion

This conceptual framework is useful for examining the broad strokes and implications of these interviews, but loses some of the more interesting nuances and details that emerged over the course of transcribing and coding the conversations, particularly the distinct perspectives held on certain topics by the brigadistas as compared to the feedback from the majority of the mothers.

The disjuncture between the responses of mothers and community health workers at various points throughout these interviews highlight some of the gaps in traditional strategies for combating hygiene-related infectious diseases, particularly those that result in child diarrhea. Two of the biggest issues center around the education-based model of addressing behavior change – this is a dominant approach within the public health field as a whole (Glanz et al. 2008) and in particular with regards to WASH strategies (Fisher et al. 2011) but the majority of maternal responses to these interviews support the idea that simply holding educational workshops (“charlas” in this context) is insufficient to bring about effective behavior change. Many mothers were able to parrot back the activities they should carry out to protect themselves and their child – including handwashing practices, household cleanliness, and water treatment – but few expressed any belief that these practices would truly alter their risk of contracting diarrhea.

Additionally, there are issues identified that fall far outside the scope of straightforward educational interventions, including the lack of resource access, the absence of necessary social support systems, and a general absence of community organizing initiatives. The absence of necessary resources has implications for both mothers and CHWs, as mothers aren’t able to secure access to the necessary supplies for

prevention or treatment efforts (rendering their relative belief in the effectiveness of those interventions largely irrelevant) while CHWs aren't able to pursue the additional training they feel is necessary or develop any projects designed towards longer-term prevention of these diseases, such as wells or water-catchment systems to provide more reliable sources of uncontaminated water for their communities.

The absence of social support also has implications beyond simply limiting the mobility of mothers or their ability to fully pursue care for their children. Mothers that can't leave their house even to seek out necessary medical care for themselves or their child are unlikely to have the ability to engage in community meetings or events, further exacerbating feelings of isolation and marginalization, and limiting the overall input of mothers into ongoing community projects. These feelings of helplessness also play into perceptions of capability to change health risks or outcomes.

The overall absence of community organization and reliance on a very limited formal health structure is another barrier to improving health outcomes in the community. As noted, the resources that the government is able to provide to the area are limited in the extreme, and unlikely to drastically improve in the coming years. Much of the political will in the region is driven by issues that make for good publicity but don't necessarily address the underlying causes of poor health; for instance, there's an ongoing project aiming to provide access to electricity to various regions on the mountain, despite the fact that many of these communities still don't have adequate or consistent access to water or sanitation infrastructure. Community organizing and structure has been shown to have a positive impact on health outcomes (Komro et al. 2013), but unlike treatment with anti-parasitic medication it isn't a simple or straightforward rapid solution.

Conclusions

Based on the coded analysis of these interviews with mothers and community health workers throughout the region, a conceptual framework was constructed to outline the underlying causes in the area that drive the ultimate outcome of childhood diarrhea, while highlighting the mediating variables emphasized across the community (See **Figure 4**). What this framework underlines is that simply targeting hygiene and water treatment practices in the region – the most proximal factors influencing childhood diarrhea in the area – is doing little to address the underlying mediators that lie between the ultimate causative agents (poverty, low education, poor health infrastructure, limited community capacity). While it may be difficult to construct an intervention that is fully responsive to these underlying causes, the mediating variables that encapsulate maternal social support, access to information, perceptions of risk and capacity to prevent, and limitations placed on the CHWs in the region are all integral to the construction of an effective project in the area. By incorporating considerations of maternal empowerment and community development into current WASH policy, it would be possible to address some of the current gaps in ongoing hygiene projects in the area, and potentially decrease the burden of childhood diarrheal diseases in these communities.

III. Maternal & Household Capabilities on a Global Scale: A Quantitative Analysis

Introduction

The qualitative interviews of mothers and health workers in Nicaragua provide a window of insight into the barriers to accessing health care and the range of maternal beliefs regarding risk and susceptibility to diarrheal diseases, with a particular emphasis on the impact on children in the community. To gain a better understanding of the implications of these maternal and structural capabilities on an international scale, and thus assess their implications for global WASH strategies currently under implementation, a study was constructed to conduct a broad quantitative analysis describing the influence of these variables on diarrheal outcomes and treatments.

To carry out this study, data from the Demographic Health Surveys (DHS) – nationally representative surveys that provide information on a wide range of population and health markers and are updated approximately every five years – were compiled to allow for regional and age-stratified analysis of maternal, household, and diarrheal variables across a broad sample size. While international studies of this scale have been conducted before, their focus has been on simple household variables (Fink et al. 2011) or have been very narrow in their geographic focus (Caruso et al. 2011). No one has previously used a framework of maternal capacities across this many regions to assess their impact on hygiene-related infectious diseases. The purpose of this study is to assess the role of various maternal empowerment variables, in conjunction with basic household data, in driving diarrheal disease outcomes and treatment decisions among children under five, to better inform current global public health policy in this area.

Methods

Country Selection

The selection of countries to incorporate into this qualitative assessment was based on both geographic location and the current updating of the surveying. Four geographic regions were identified as being of particular interest: (1) Southeast Asia, (2) Latin America & Caribbean, (3) Sub-Saharan Africa, (4) South Asia. These regions were selected on the basis of both their global distribution and the prevalence of adverse childhood diarrheal outcomes within those areas (UNICEF, 2009). Within those categories, 5 countries were selected for each region, based purely on how recently their surveying data had been updated. A map of this geographic distribution can be found under **Figure 6**. From there, three countries had to be excluded when the decision was made to narrow the restrictions from “most recently updated” to “DHS Survey VI”, as the recode for version VI differed significantly from version V. The countries included in the final version of the study are outlined in **Table 5**.

Survey Selection

Within the DHS surveys, multiple categories exist. The individual and household recodes were examined for potentially applicability, but eventually the children recode datasets (KR) were settled on as being the best source of data on both childhood disease outcomes and maternal empowerment variables. The KR datasets were downloaded from the USAID Demographic Health portal after requesting permission from the institution, and subsequently all 17 datasets were appended using STATA11 software.

Variable Identification

Relevant variables for hygiene, maternal empowerment, and diarrheal outcomes were then identified using the DHS-VI recode file, and subsequently assessed to ensure an adequate volume of responses for those variables. The hygiene variables were selected to address the two broad categories of (1) clean water access, and (2) adequate sanitation resources. Variables for maternal empowerment were selected within the categories of (1) human capabilities, (2) social capabilities, (3) psychological capabilities, (4) financial autonomy, (5) sexual autonomy, (6) physical autonomy, (7) decision making, and (8) barriers to healthcare. Diarrheal outcome variables were selected based on (1) prevalence of illness and (2) treatment of illness. The full focus area cores and variables are outlined in **Table 6**.

Analytic strategy

Predictors of diarrheal outcomes and treatment were compared with maternal empowerment factors and assessed using logistic regressions. The core *outcome variables* selected as being of particular interest for this study were (1) childhood diarrhea within the past two weeks, (2) diarrheal diagnosis and treatment with ORS, (3) hydration decisions for children with diarrhea, and (4) diagnosis with and treatment for intestinal parasites. A fifth outcome variable, water treatment decisions, was examined but found to be restricted to a single geographic region in its scope. The core *predictor variables* selected for this analysis were time to water source (water access), maternal decision-making regarding health (decision-making), maternal media access (social capabilities), maternal travel away from the home (physical autonomy), maternal literacy (human capabilities) maternal attitudes towards wife-beating (psychological capabilities),

maternal education (human capabilities), and maternal wealth percentile (financial autonomy). Variables examining sanitation structures and specific references to health care barriers were also included in the initial analysis, but discarded due to the absence of statistically significant results and relatively small sample size across all survey data.

These variables were selected based on a conceptual framework structured around the proposed underlying influence of maternal capabilities (as well as certain community-related factors such as ease of access to water sources) fully outlined in **Figure 5**. In this framework, informational/social support, emotional social support, abuse perceptions, media access, and maternal access to care are all positioned as mediating between the proposed underlying factors of income poverty and education, and the ultimate outcomes of unclean water intake and diarrheal disease outcomes among children. This framework was constructed based off of both input from the literature highlighting the importance of maternal determinants in driving child health (Caruso et al. 2011) and the qualitative interview response assessment from mothers in rural Nicaragua (as delineated in Figure 3). In order to build this statistical model, covariate analyses of the pertinent variables from the appended DHS data were conducted to determine the relative power of associations and ensure that there was an adequate sampling pool present that fully represented all four geographic regions. Table 6 highlights the categories of variables initially examined, and in each instance multiple possible variables were analyzed to identify the strongest candidates for inclusion in the model.

The data being sampled was limited to children under the age of five, and then stratified by both region and child age to allow for comparison across geographic area and between children under a year old and between one and five years of age.

Results

Maternal factors and diarrheal prevalence, full sample

Households that lived farther from a water source experienced more hygiene-related illness. Mothers who lived more than an hour from a water source were 1.12 times as likely to report among their youngest child in the previous two weeks (All data for this section can be found under **Table 7**). Mothers who traveled away from home at least twice in the past year had an increase in childhood diarrhea prevalence of similar magnitude to water source distance (OR=1.14, 95% CI = 1.09, 1.20) p=0.000).

Household wealth was inversely associated with diarrhea prevalence. Mothers in the poorest forty percentile of households throughout the survey were 1.21 times as likely to report diarrhea among their child in the previous two weeks compared to those in the upper 60% wealth percentiles. The factor with the strongest magnitude on diarrhea was beliefs about abuse towards women. Mothers who believed that a husband beating his wife was justifiable under some circumstances were 1.26 times as likely to report diarrhea in the two weeks preceding the survey among children than those who did not find this practice justifiable.

Mothers who reported being able to make decisions about their child's health had a lower prevalence of diarrhea among their youngest child (OR=0.96, 95% CI = 0.92, 1.00, p=0.053). Maternal media access was protective against diarrhea, but the result was not statistically significant.

Maternal factors and diarrheal prevalence, by region

Southeast Asia

Results stratified by region indicated significant variation in the influence of maternal capacity factors on diarrheal prevalence. Decision-making power with regards to health among mothers, which did not have an effect on the cumulative level, had an inverse association with diarrheal prevalence in Southeast Asia (OR=1.26, 95% CI = 0.49, 0.69, p=0.000), as did literacy (OR=0.75, 95% CI = 0.63, 0.90, p=0.002). Beliefs about wife-beating again played a significant role in this region (OR=1.19, 95% CI = 1.05, 1.36, p=0.008) with only a minor variation from the full sample analysis.

Latin America & the Caribbean

Decision-making power about health had a similar protective effect among mothers in Latin America (OR=0.80, 95% CI = 0.73, 0.89, p=0.000), and maternal education level was also inversely associated with childhood diarrhea, unlike at the full survey level where it had no significant effect. Mothers who had received at least some education were 0.88 times as likely to report diarrhea among their children in the past two weeks. Meanwhile travel away from home, literacy, and beliefs about wife-beating were all positively associated.

Sub-Saharan Africa

In Sub-Saharan Africa, decision-making about health and access to media both exhibited a protective effect against diarrhea, while travel away from home, belief in acceptability of wife-beating practices, maternal education, and being in the poorest 40% wealth percentile were all positively associated with child diarrhea.

South Asia

Within South Asia, only belief in the acceptability of wife-beating had a statistically significant association, but it was quite large – mothers who reported that there were acceptable reasons for husbands to beat their wives were 2.63 times as likely to have had a child experience diarrhea in the past two weeks.

Maternal factors and diarrheal prevalence, by child age

Children under the age of one had a very similar distribution of results to that of the general population; increased distance to water, maternal time away from home, maternal literacy, acceptance of wife-beating practices, and being in the poorest forty percentile of the population were all positively associated with childhood diarrheal experiences in the past two weeks (All data regarding age stratification can be found under **Table 8**). No variables had a significant inverse relationship with the odds of diarrhea. Among children older than a year but under five years of age, time to water source and maternal literacy did not have a significant association, but decision-making about health (OR=0.94, 95% CI = 0.90, 0.99, p=0.023) and access to media (OR=0.93, 95% CI = 0.89, 0.98, p=0.008) both had a significant effect on decreasing the odds of a child having had diarrhea in the past two weeks.

Maternal factors and diarrheal treatment with ORS, full sample

The wealth percentile of the household had a significant impact on the likelihood of a child in that household experiencing diarrhea and subsequently receiving oral rehydration solution (ORS) as treatment; families in the poorest forty percent of the population were 0.90 times as likely to have a child experiencing diarrhea be treated with ORS. Mothers who had travelled away from the home at least twice in the past year had

an inverse association with their child having diarrhea and receiving ORS treatment (OR=0.91, 95% CI = 0.83, 1.00, p=0.044). Mothers who reported having access to at least one form of media exhibited an inverse relationship to the outcome of interest of equal magnitude. No other variables under consideration had a statistically significant association with childhood diarrhea in conjunction with ORS treatment.

Maternal factors and diarrheal treatment with ORS, by region

The only region to exhibit statistically significant associations between the household and maternal variables and the likelihood of a childhood experiencing diarrhea and subsequent treatment with ORS was sub-Saharan Africa. The associations in the Sub-Saharan African region closely mirrored those of the general sample population. Mothers in the poorest forty percentile of households in the Sub-Saharan African region countries were 0.87 times as likely to report diarrhea in their child followed by ORS treatment compared to those in the upper 60% wealth percentiles. Maternal access to media exhibited a similar inverse relationship to child diarrhea and ORS treatment in Sub-Saharan Africa as with the global sample (OR=0.88, 95% CI = 0.79, 0.98, p=0.018) and maternal travel away from home at least twice in the year led to a significantly decreased likelihood of a child experiencing diarrhea being treated with ORS (OR=0.85, 95% CI = 0.76, 0.96, p=0.006).

Maternal education exhibited a significant positive association of 1.15 with child diarrhea and ORS treatment within the Sub-Saharan African region absent in the general population sample or in other regional samples.

Maternal factors and diarrheal treatment with ORS, by child age

Within the age stratification, no significant effects were observed among any of the variables of interest for children under the age of one. The time to water for the household was inversely associated with child diarrhea cases being treated with ORS, but was not statistically significant.

Among children between the ages of one and five, mothers who reported having access to at least one form of media were 0.86 times as likely to have a child experience diarrhea and subsequently report treatment with ORS. A similar inverse relationship was reported among mothers who travelled away from home at least twice a year (OR=0.88, 95% CI = 0.79, 0.98, p=0.016). Households in the poorest forty percent of the population had diminished odds of childhood diarrhea followed by ORS treatment as compared to the upper sixty percent of the population (OR=0.90, 95% CI = 0.81, 0.99, p=0.030).

Maternal factors and hydration during diarrheal disease, full sample

Maternal education had a positive association with children experiencing diarrhea being given a normal or increased amount of fluids to drink throughout their period of illness, and exhibited the greatest degree of magnitude on determinations about hydration practices during diarrhea. Mothers who had experienced at least some years of schooling reported a 1.27 odds ratio of giving their child either equivalent or greater amounts of fluids to drink throughout their period of diarrheal disease. Mothers who had the power to make decisions about their own health also exhibited a positive association with fluid distribution to their sick children, with a 1.15 likelihood of ensuring that their child was drinking more or equal to normal while experiencing diarrhea.

Maternal travel away from the household had an inverse association on hydration practices for children experiencing diarrhea, reporting a negative association of 0.87 with giving their child more or equal fluids to normal.

Maternal factors and hydration during diarrheal disease, by region

Only two out of the four regions under consideration exhibited statistically significant associations between the variables and outcome of interest. The Southeast Asia region & Latin America region experienced no significant deviations from the broad population outcomes; households in Southeast Asia in the poorest forty percent of the population had a highly inverse relationship with increased or equivalent hydration for children experiencing diarrhea, but the association was not statistically significant (OR=0.76, 95% CI = 0.57, 1.02, p=0.071).

Mothers in Sub-Saharan Africa who reported the power to make decisions about their own health and who reported having received at least some education had positive associations with hydration practices. The association between maternal health decision-making was of equal magnitude between the Sub-Saharan African region and the whole study population (OR=1.15, 95% CI = 1.03, 1.28, p=0.011). The association between maternal education and increased or equivalent child hydration during diarrheal illness was of a higher magnitude (OR=1.45, 95% CI = 1.31, 1.61, p=0.000) than in the general population.

Maternal factors and hydration during diarrheal disease, by child age

Maternal education and decision-making power with regards to health had significant positive associations with child hydration practices during diarrhea across both age stratifications. Among children under one year of age, the association between

decision-making over health among mothers had a positive association of even greater magnitude than the general population (OR=1.20, 95% CI = 1.02, 1.26, p=0.017) with increased or equal fluids for children, while among children ages one to five maternal education had a greater positive magnitude of association (OR=1.28, 95% CI = 1.17, 1.41, p=0.000).

Additionally, among children ages one to five maternal travel away from the home had an inverse association with hydration practices. Mothers who reported travelling away from home at least twice in the past year were only 0.87 times as likely to give their child either a normal or increased amount of fluids during periods of diarrheal disease.

Maternal factors and intestinal parasite diagnosis & treatment, full sample

Households located further from their water source were more likely to have a child experience and be treated for parasitic infection. Houses where the mother reported having to travel over an hour to get their water were 1.14 times as likely to have had a child become infected with and subsequently be treated for intestinal parasites within the past six months. Several maternal variables also had significant associations with childhood parasitic infection and treatment. Mothers who reported having decision-making power over their health were 1.50 times as likely to have a child be treated and diagnosed with intestinal parasites over the past six months, and mothers who reported literacy and some level of education exhibited a similar positive association with child parasitic infection diagnosis and subsequent treatment (OR=1.50, 95% CI = 1.46, 1.55, p=0.000), (OR=1.08, 95% CI = 1.05, 1.11, p=0.000).

Mothers who reported a belief that spousal abuse was justifiable under certain circumstances were 1.24 times as likely to have had a child be diagnosed and treated for parasitic infection in the past six months.

Households in the poorest forty percentile of the population in the survey reported a negative association with intestinal parasites, with mothers in the lowest forty percent only 0.82 times as likely to have a child experience and be treated for intestinal parasites in the past six months.

Maternal factors and intestinal parasite diagnosis & treatment, by region

Southeast Asia

The variables with a significant impact on intestinal parasite diagnosis and treatment experienced some variation across regions. Within Southeast Asia, maternal health decision-making and literacy exhibited positive association of a similar magnitude as compared with the general population under survey. Mothers in Southeast Asia also reported a positive association with media access, with mothers who had access to at least one form of media 1.28 times as likely to have a child be diagnosed with and subsequently treated for intestinal parasitic infection. Maternal travel away from home, however, exhibited a negative association, with mothers who had travelled away from their household at least twice in the previous year only 0.88 times as likely to have a child be treated for diarrhea in the past six months as compared with mothers who did not travel away from home.

Latin America & the Caribbean

Household distance from water exhibited a significant effect on child intestinal parasite diagnosis and treatment in Latin America & the Caribbean, with mothers who

lived over an hour from their water source reporting an inverse association with child intestinal parasites (OR=0.72, 95% CI = 0.60, 0.86, p=0.000). The positive associations with media access and maternal education mirrored those seen in Southeast Asia and the general survey population, respectively (OR=1.42, 95% CI = 1.27, 1.59, p=0.000), (OR=1.49, 95% CI = 1.38, 1.59, p=0.000), but in Latin America & the Caribbean maternal travel away from home also had a positive association with childhood intestinal parasitic infection and treatment (OR=1.27, 95% CI = 1.14, 1.41, p=0.000). Additionally, mothers in the poorest forty percent of the population were 1.35 times as likely to report that one of their children had experienced and been treated for a parasitic infection within the past six months.

Sub-Saharan Africa

Within the Sub-Saharan African region, all variables with the exception of distance to water source exhibited a statistically significant association with intestinal parasite outcomes among children. Maternal decision-making power of health exhibited a positive association of similar magnitude to the general population with children being diagnosed with and treated for intestinal parasites (OR=1.56, 95% CI = 1.51, 1.62, p=0.000). Maternal access to media and travel away from the household, neither of which had a significant effect at the survey population level, both exhibited inverse associations with childhood parasitic diagnosis and treatment within the Sub-Saharan African region, with mothers who reported access to at least one form of media 0.92 times as likely to have a child become infected with, and subsequently treated for intestinal parasites, and mothers who traveled away from the home 0.87 times as likely to experience the same outcome. Maternal literacy had a positive association, albeit at a lower magnitude than

the general population (OR=1.18, 95% CI = 1.11, 1.26, p=0.000). Mothers in Sub-Saharan Africa who reported acceptance of wife-beating practices in some scenarios were 1.58 times as likely to have a child experience and be treated for intestinal parasites. Mothers in the lowest forty wealth percentile, however, were only 0.70 times as likely to report that their child had been diagnosed and treated for intestinal parasites as compared with mothers in the upper sixty percentile.

South Asia

Associations in the South Asia region differed significantly from those of the survey population as a whole; households located over an hour from their water source were only 0.57 times as likely to have a child be diagnosed and treated for intestinal parasites. Additionally, while maternal literacy exhibited a similar positive association to the general population (OR=1.30, 95% CI = 1.09, 1.56, p=0.005), maternal education actually had an inverse relationship with the outcome variable, with mothers who reported receiving some education 0.84 times as likely to have a child be treated for intestinal parasites. The wealth percentile of the household, which exhibited an inverse relationship with child parasitic treatment at the population level, in the South Asia sample led to an increased odds ratio of 1.18.

Maternal factors and intestinal parasite diagnosis & treatment, by age

Among children under a year of age, maternal decision-making about health (OR=1.17, 95% CI = 1.07, 1.27, p=0.000), maternal acceptance of wife-beating practices (OR=1.59, 95% CI = 1.47, 1.73, p=0.000), and maternal education (OR=1.11, 95% CI = 1.03, 1.20, p=0.005) all exhibited positive associations with a child being treated for intestinal parasites. Maternal access to media resources and maternal travel away from

home both exhibited inverse associations with child parasitic outcomes not present in the general population. The wealth percentile of the household had an association of greater magnitude among children under a year in age than among the population as a whole, with mothers in the lowest forty percentile of the survey population 0.79 times as likely to report a child having experienced and been treated for intestinal parasites in the past six months.

For children ages one to five, all variables under consideration in the study exhibited a statistically significant association with child intestinal parasite diagnosis and treatment. Time to water access, maternal decision-making about health, maternal literacy, and maternal acceptance of wife-beating practices all had associations of similar magnitude to the general study population. Maternal education had a positive association of greater magnitude, with mothers who had received at least some education 1.14 times as likely to have a child be diagnosed with and treated for intestinal parasites.

Additionally, maternal access to media (OR=1.05, 95% CI = 1.02, 1.09, p=0.003) and maternal travel away from home (OR=1.05, 95% CI = 1.01, 1.09, p=0.011), which did not display statistically significant associations at the general population survey level, were both positively association with intestinal parasite diagnosis and treatment among children aged one to five years. Household wealth had an inverse association with childhood parasites of similar magnitude to the general population.

Maternal factors and water treatment

Water treatment data was only available for the Southeast Asia region, but nonetheless exhibited some interesting and statistically significant associations that are worth taking into consideration (see **Table 9**). Mothers who reported access to at least

one type of media were 1.32 times as likely to treat their water. In addition, maternal education and literacy both displayed positive associations with water treatment decisions, as mothers who reported literacy and at least some education were 1.29 times and 1.40 times as likely to treat their water, respectively.

Mothers who reported that there were some scenarios in which it was acceptable for a husband to beat their wives were 0.82 times as likely to treat their water as mothers who did not. Additionally, the wealth percentile of the household played a significant role in water treatment decisions, as mothers who reported being in the poorest forty percent of the study population were only 0.56 times as likely to treat their water as those in the upper sixty percentile.

Discussion

As mentioned in the initial introduction of this chapter, this study is of particular interest and importance because it is the first to conduct an examination of the influence these maternal capabilities on this broad of a scale. With an initial sample of 180,870 mothers who reported having a child under 60 months in age distributed across four geographic regions and a total of seventeen countries, there's the ability to observe trends in maternal empowerment and household capacities on a global level. A number of interesting results emerge as a result of this analysis.

The frequent discrepancy between the outcomes related to maternal literacy versus maternal education is of particular interest as it underlines the complexity of public health "education" strategies. Although there were instances when these two variables were entirely comparable (both contributed to an increased likelihood of a child being treated for intestinal parasites), there were also several instances where formal

maternal education level had a significant protective effect – as with hydration patterns for children suffering from diarrhea – but simply assessing maternal literacy had no effect. Complicating this dynamic is the role of maternal access to media; while under the posited conceptual framework it exists in a separate mediating category to the human capabilities of education and literacy, all three variables are assumed to have some input into the informational capabilities of mothers, yet demonstrated very different influences on the diarrheal outcomes of children. Most studies examined to prepare for the writing of this paper included only one of these variables as an assessment of this informational capacity, (Mihrete et al. 2014) but these results underline the importance of a multivariate analysis of maternal human capabilities, and demonstrate the danger of conflating literacy with education level (Avachat et al. 2011). Additionally, neither maternal education nor literacy levels had any significant impact on the treatment of childhood diarrhea with ORS, despite the general assertion in the literature that maternal education plays a direct role in child diarrhea treatment outcomes (Kadam et al. 2013).

Another notable deviation from the expected model of maternal capabilities was the role of maternal travel away from the home – this variable was structured to encapsulate the physical autonomy of mothers, posited as a mediating determinant of child health, yet what was seen throughout the analysis was an inverse relationship between the capacity of a mother to travel away from her home at least twice in a year and the health outcomes of her child. Mothers who exhibited higher physical autonomy had a higher likelihood of their child having experienced diarrhea in the past two weeks and were less likely to treat their child with ORS or provide increased hydration during a diarrheal episode. On the other hand, decision-making power over health and maternal

attitudes towards wife beating both exhibited influences in line with those proposed by the model of maternal capabilities, with decision-making power having a significant effect on both hydration behavior during child diarrhea and intestinal parasite treatment, and acceptance of spousal abuse having a strong positive correlation with the child experiencing diarrhea and intestinal parasitic infection.

Household capabilities – delineated through the conceptual model as accessibility of water and relative income within the population – tended to have a similar effect direction and magnitude across all outcome variables, with the exception of intestinal parasitic infection. The likelihood of a child having been diagnosed with and subsequently treated for intestinal parasites in the past six months had a significant positive correlation with the time to travel to the house's water source, but had an inverse relationship with the poverty level of a household – families in the poorest forty percent of the population were significantly less likely to have a child be treated for intestinal parasites.

Regional variations are also of particular interest, in part because they underline the necessity of considering geographic context when structuring an intervention. Some variables, such as attitudes towards wife beating, were constant in their influence across all four regions. Other factors, however, such as maternal literacy and access to media, varied in both their magnitude of influence, and in some cases even the directionality of their impact, from region to region. Access to media, for instance, had a significant protective effect against childhood diarrhea in Sub-Saharan Africa, but exhibited no such influence in any of the other regions; meanwhile maternal literacy had a protective effect against child diarrhea in Southeast Asia, but actually significantly increased the

likelihood of a child having experienced diarrhea in the past two weeks in Latin America and the Caribbean. The aforementioned negative correlations associated with maternal travel away from home were also only significant in the Sub-Saharan African and Latin American regions when stratified out – physical autonomy of the mother had no significant correlation with diarrheal outcomes or treatment in either of the Asian regions under study. Researchers examining diarrheal and acute respiratory tract infections among children in Indonesia found that maternal agency related to decisions to leave the home to visit friends or relatives had a protective effect against these diseases (Agustina et al. 2014); it's interesting to compare the influence of that assessment of the influence of maternal agency against what can be seen in these results.

The age of the child was also an important consideration; most studies and programs focus in on “children under five” due to their susceptibility to particularly adverse consequences from bouts of diarrhea; what the results demonstrate, however, is that certain variables of interest may only have an impact if the child falls within a certain age bracket within the broad “under five” umbrella. While acceptance of wife beating had a positive correlation with diarrheal and parasitic infection across all age strata, certain factors including maternal literacy and access to media only exhibited a significant protective effect for children between one and five years, demonstrating no such decreased odds for children under a year in age who are the most vulnerable to these diseases (Parashar et al. 2003).

There are certain limitations on this study and its data. First, as a cross-sectional study the data here encapsulates the population of interest at a singular point in time. Taking this snapshot of a broad global population allows for the comparison of a

multitude of variables simultaneously, but it's difficult to ascribe any sort of "cause and effect" relationship to what's seen here, given the absence of longitudinal analysis. It's also important to bear in mind the potential for ecological fallacy in ascribing any sort of inferences to the individual based on this aggregate assessment of population-level data. These data analyses are useful and informative from a policy and project development perspective, but as demonstrated by the variations even within broad geographic regions it is still critically important to be cognizant of the local context where a proposed hygiene-focused project is being implemented. Additionally, as most of this data was collected through survey methods, there's the potential for both recall bias and for the stigma associated with certain variables to play a role in the response given.

In addition, the broad scope of countries under consideration meant that some variables of interest, which were only asked about in certain regions, had to be excluded from the general study in order to preserve a broader sample size and applicability. While all of these surveys are from the same DHS recode and have been updated within the past five years, there may also be some regional variations in how questions were asked or responses coded, which is difficult to control for beyond stratification by region. One other limitation on the analysis of these regressions is the fact that some of the response variables encapsulate multiple outcomes within a single category – for instance, with regards to intestinal parasites, that question involves both diagnosis and treatment of infection, making it difficult to fully tease apart the implications of variable associations.

Conclusions

Even with these limitations, though, the study retains a significant amount of statistical power and allows for the analysis of several critical household and maternal empowerment capabilities and their implications for childhood diarrheal diseases on an unprecedented scale. These results highlight both the importance of these maternal capabilities in mediating hygiene-related infectious disease outcomes, and the complexities inherent in these same capabilities. When assessing childhood diarrheal causes and treatment outcomes, it's critically important to take into account both regional and age variation, and to examine the multiple relevant components of vaguely-termed mediators like "empowerment". It would be useful, moving forward, to build on this analysis by incorporating variables specifically targeted at hygiene-related behaviors to capture another, more proximal layer of influential factors in child health outcomes, as well as to further examine and interrogate the notion of education in public health methodology to ensure that such interventions are fully addressing all necessary dimensions of autonomy and personal efficacy.

IV. Conclusions

“The 1.8 million child deaths each year related to clean water and sanitation dwarf the casualties associated with violent conflict. No act of terrorism generates economic devastation on the scale of the crisis in water and sanitation. Yet the issue barely registers on the international agenda.”

-Rose George, 2008

Childhood diarrhea is a growing area of focus within the global health field, and a particularly appealing target for integrating considerations of maternal and community capabilities, given the relative complexity of the disease epidemiology and barriers to focusing on a singular causative agent or treatment. Proposed interventions have largely been structured around a WASH-style methodology (Campbell et al. 2014) or have focused in closely on maternal education (Webb et al. 2010). Few projects have emphasized the roles of maternal empowerment and community support in mediating hygiene-related infectious disease outcomes for children, and those studies that have tend to be focused in on a singular region or determinant (Bruce et al. 2014).

This paper has worked to analyze the meanings of these maternal and community capabilities and to assess the role they play both within the microcosm of a single region in rural Nicaragua, and on a global macro scale across the four geographic regions most significantly impacted by childhood diarrheal diseases. The aim was to examine the relative magnitude of influence of these capabilities on both diarrheal prevalence and treatment, while constructing a conceptual framework to delineate the ways in which these variables mediate between underlying and proximal causes of disease.

This framework highlights both critical focus areas and current areas of weakness in the dominant WASH strategies designed to address these hygiene-related infectious diseases. In particular, this thesis emphasizes the complexities of discussing maternal

“education” in the context of public health interventions, and highlights current gaps in the prevalent literature on diarrheal disease with regards to the importance of maternal self-efficacy and decision-making.

Education-based strategies are dominant in dialogues about hygiene and sanitation-focused health projects, but what this paper demonstrates is that such strategies must employ a joint consideration of demographic education variables (encapsulating a range of factors including formal education, literacy, and access to information) with the most effective way to deliver health-focused education in a way that supports the actual implementation of that knowledge by mothers. As demonstrated by the qualitative assessment of maternal beliefs about hygiene and diarrhea in Nicaragua, many mothers may be fully aware of the causes of, and recommended treatments for, childhood diarrhea, yet fail to enact preventative measures or seek out appropriate treatment. The reasons for this seeming cognitive dissonance are connected to inadequacies in the overall health infrastructure of the area, but are also driven by maternal perceptions of personal risk and ability to successfully avoid these diseases – issues of maternal efficacy not commonly referenced in WASH-related diarrheal interventions.

The existence of social support structures for mothers and the ways in which those structures drive their autonomy are also shown to have a significant impact on the diarrheal prevalence and treatment outcomes for their children, and warrant consideration when constructing projects designed to address these resultant health consequences. Maternal interview data suggests that in the absence of a strong social support network, improvements to the formal health system will fail to benefit all members of a community, while analyses of international demographic data indicate that simply

targeting the physical autonomy of mothers will not improve diarrheal outcomes for their children, underscoring the importance of addressing a full spectrum of maternal capabilities when structuring interventions to mitigate hygiene-related infectious diseases.

The ultimate aim of this thesis was to determine the roles played by maternal and community capabilities in mediating the impact of diarrheal diseases on children, and to gauge which of these areas would be most effective to target in an intervention effort. What this study established was the necessity of moving projects targeting childhood diarrhea beyond abstract notions of “behavior change” and “social determinants” and towards a concrete understanding of the critical influence of maternal decision-making and autonomy on these diseases, while emphasizing the necessity of taking regional complexities and contexts into account.

We’ve come a long way towards moving childhood diarrheal diseases to the forefront of the international health agenda since George wrote *The Big Necessity* in 2008, but now that these devastating diseases have registered on the international scale, it’s critically important that global health policy and practices reflect the best, most fully realized understanding of their complicated web of underlying and mediating causes, and not focus solely on the simplest, most cost-effective solutions. Cheap, broad-spectrum treatments like ORS are only as potent as mothers believe them to be, and education initiatives have little utility if they aren’t carried out concurrently with efforts to support the maternal implementation of that learning. These considerations should be incorporated into hygiene-focused interventions in the future, particularly those hoping to reduce the burden of childhood diarrheal disease.

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APPENDIX – Tables & Figures

Figure 1. Map of Cuje, Nicaragua

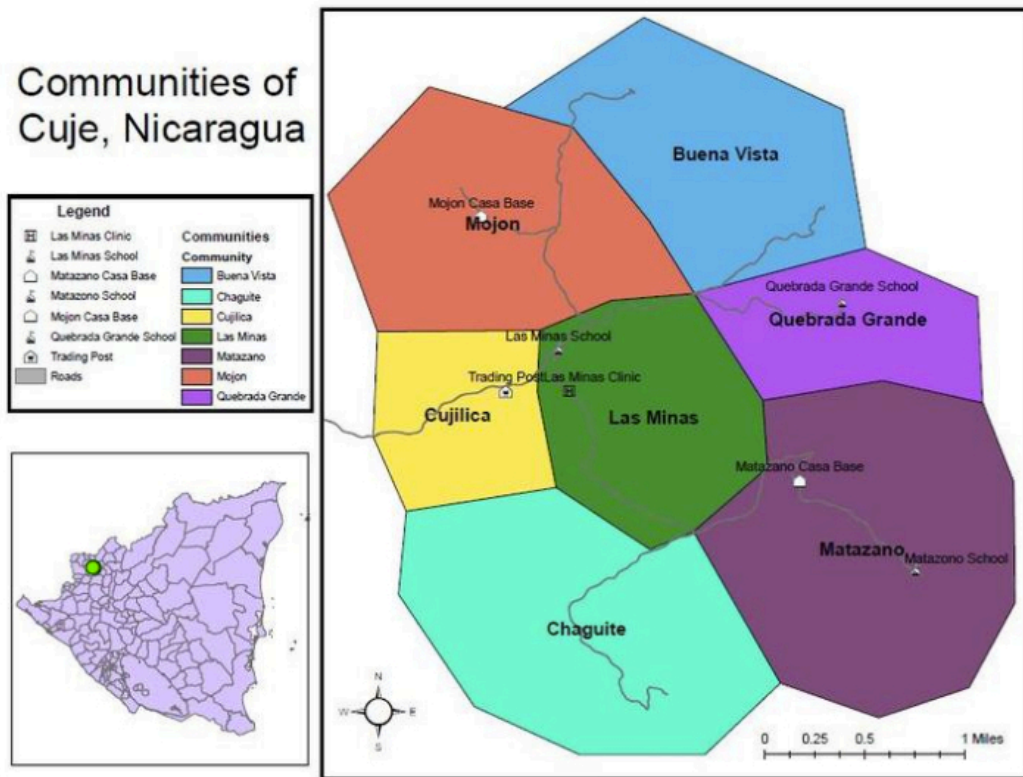


Table 1. Core Guiding Questions

- Basic demographic information
- Infrastructure - access to water and health care services
- Prior Experiences
- Children Impact
- Perceived Susceptibility/Risk
- Perceived Benefits
- Cues to action
- Self-Efficacy

Table 2. Sample Questions from Mother Interviews

- What experiences have you had with hygiene-related infectious diseases (illness related to the cleanliness of your living environment)?
- What about diarrheal diseases specifically?
- With what frequency have you experienced these diseases?
- Is there a specific time of year or specific circumstances associated with when you experience these diseases?
- Why do you believe these diseases happen?
- Whom do you go to about these illnesses? What sorts of support systems are in place for the treatment of these diseases?
- How frequently are your children impacted by these diseases? (When they were babies?)
- Who helps you take care of the children when you are sick? When the children are sick?
- How likely do you feel you are to have problems with diarrheal diseases?
- How likely do you feel your children are?
- What are things that could be changed to limit your exposure to diarrheal problems? To parasites?
- How much do you think these interventions could positively impact your life/your children's lives?
- What have you heard about the dangers of diarrhea?
- What efforts has the health care system made to help you prevent these problems?
- How much do you feel these calls to action have encouraged you to change behavior/enact interventions?
- How much power do you think you have to change your risk of diarrhea? To protect your children from this illness?

Table 3. Sample Questions from CHW Interviews

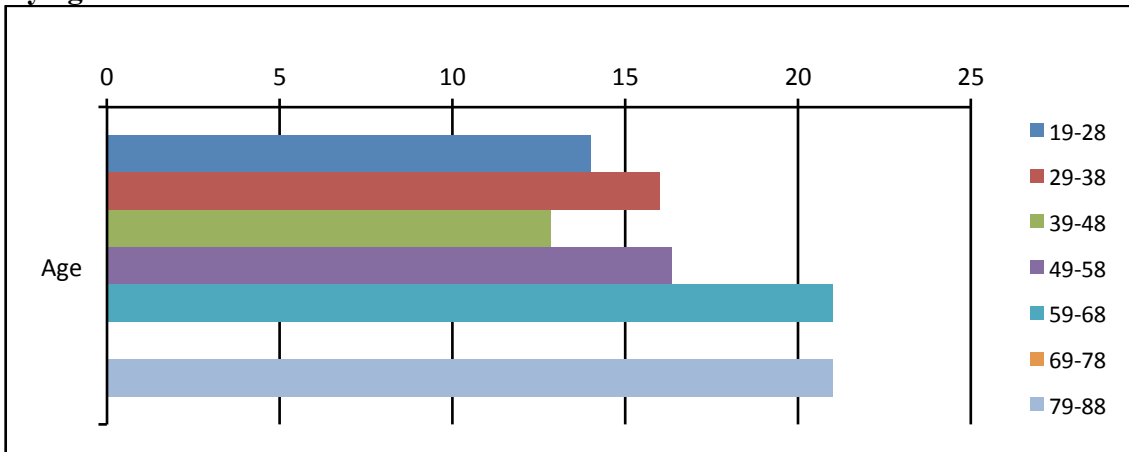
- What current practices do you engage in to promote the awareness of diarrheal diseases?
- What current practices do you engage in to promote the use of clean water?
- What are the biggest challenges you face in encouraging community members to change/enact these practices?
- What are the biggest challenges you think mothers face in preventing these diseases/engaging with health programs?
- What are your opinions on the effectiveness of the interventions currently being used?
- If you had access to additional resources, what would you do to address diarrheal diseases?
- Besides improving material resources in the area, what else can you think of to do to promote hygiene/prevent diarrheal diseases?

Table 4. Interview Coding Methodology

<i>Code</i>	<i>Definition</i>
Social Support	Support caring for children/self
Hygiene Education	Experiences with hygiene education
Formal Health Interaction	Experiences with the formal health system (i.e. clinic, doctor)
CHW Interaction	Interactions with CHWs
House cleanliness	Discussion of methods for keeping the house clean
Personal hygiene	Discussion of hand-washing practices, body washing
Food hygiene	Discussion of practices for cleaning food
Water safety	Discussion of perceptions regarding the safety/cleanliness of the water used
Child illness experience	Discussion of experiences with children having diarrhea/parasites
Personal illness experience	Discussion of experiences having diarrhea/parasites
Perceptions of disease cause	Discussion of beliefs about why these diseases occur
Perceptions of personal capability to prevent disease	Discussion of beliefs about whether these diseases can be stopped/power to stop them
Prevention via material resources	Discussion of material resources used to prevent these illnesses
Treatment via material resources	Discussion of material resources used to treat these illnesses
Prevention via non-material resources	Discussion of alternative disease prevention mechanisms (not based on material items)
Seasonal disease patterns	Discussion of the impact of the changing seasons on disease susceptibility/prevalence
Perceptions of personal susceptibility	Discussion of how likely they are to experience these diseases
Perceptions of disease threat	Discussion of how dangerous these diseases are to themselves or others
CHW Constraints	Discussion of barriers faced by CHWs to the effective implementation of prevention/treatment mechanisms

Figure 2. Number of times interactions with the formal health systems referenced:

By age



By number of children

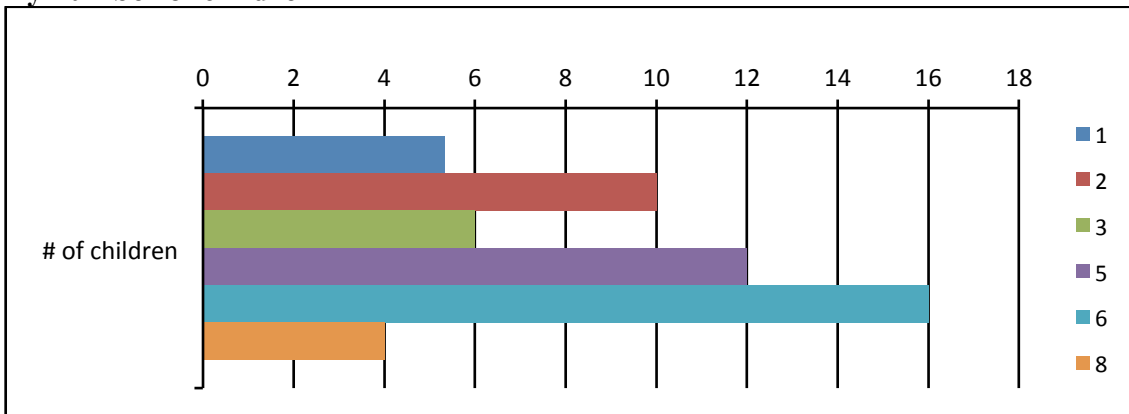
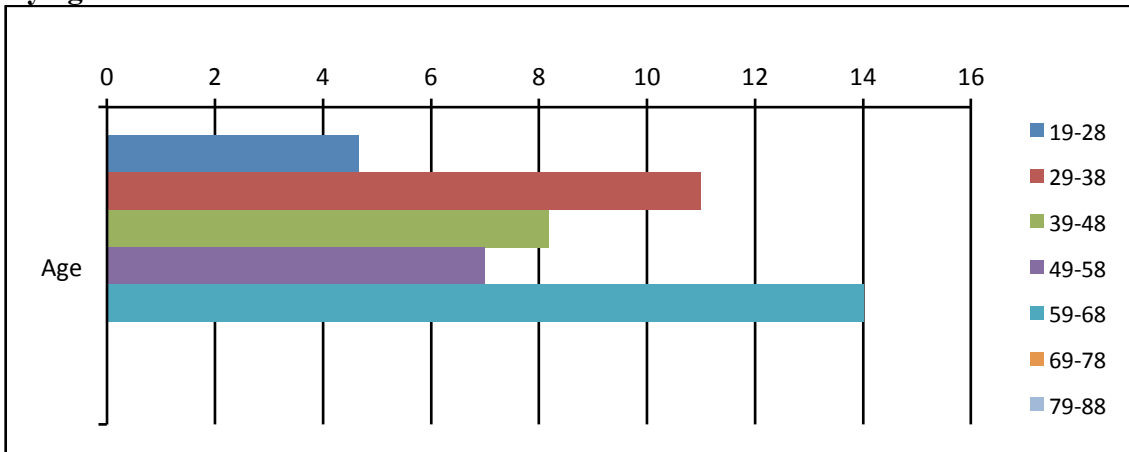


Figure 3. Number of times hygiene education referenced:

By age



By number of children

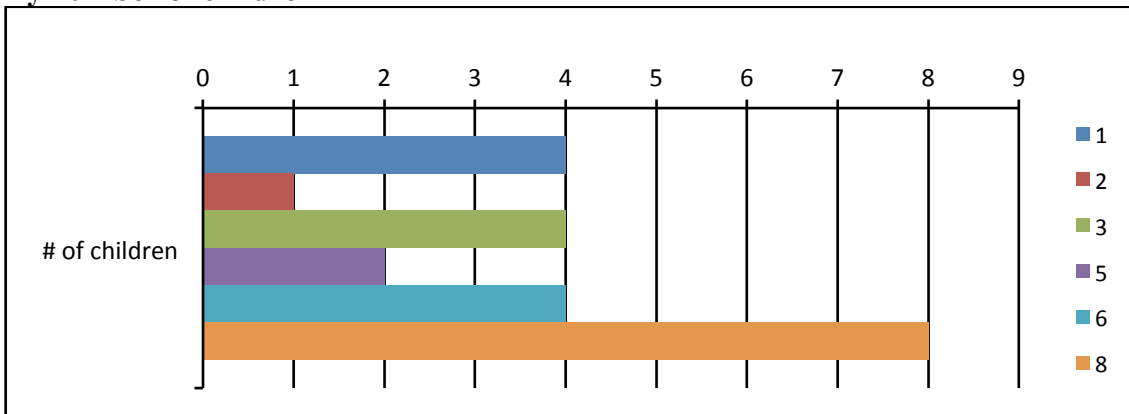


Figure 4. Conceptual Framework for Role of Maternal & Community Capacities on Diarrheal Outcomes in Rural Nicaragua

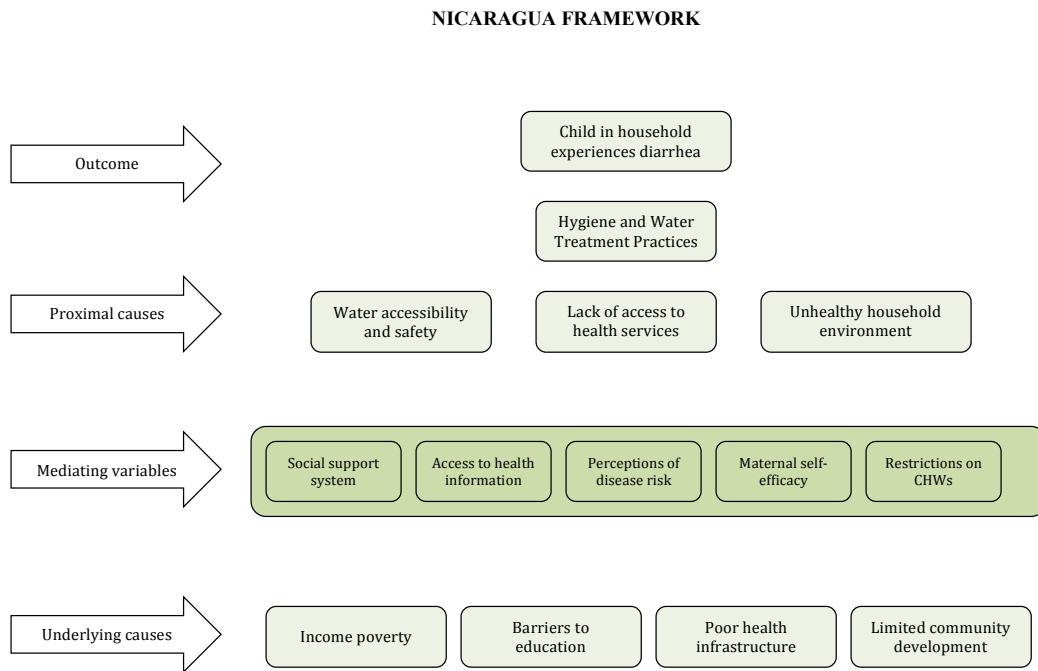


Figure 5. Conceptual Framework for Selection of Maternal & Household Variables

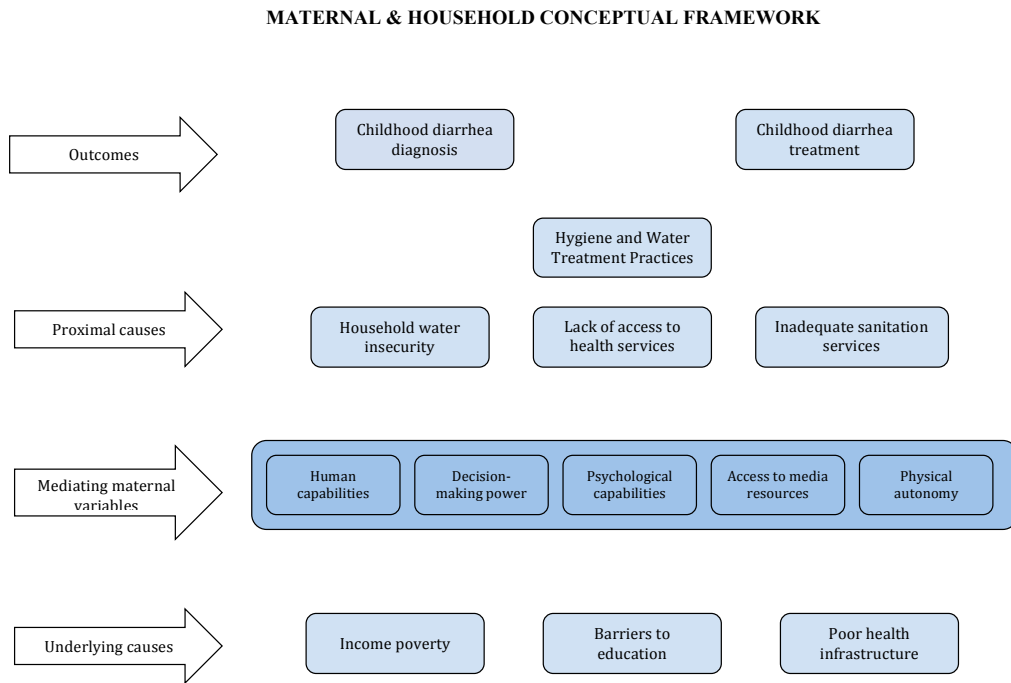


Figure 6. Geographic Distribution of Countries & Regions Selected for Study Inclusion

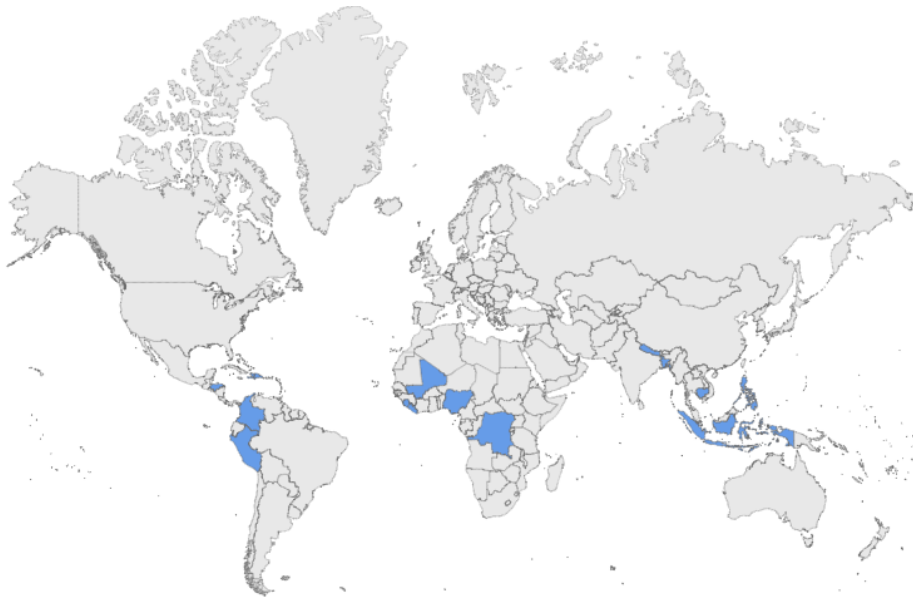


Table 5. DHS-VI Survey Selection

<i>Region</i>	<i>Country and Year</i>
Southeast Asia	Bangladesh (2011)
	Indonesia (2012)
	Philippines (2013)
	Timor-Leste (2010)
Latin America & Caribbean	Colombia (2010)
	Dominican Republic (2013)
	Haiti (2012)
	Honduras (2012)
	Peru (2012)
Sub-Saharan Africa	Democratic Republic of the Congo (2014)
	Liberia (2013)
	Mali (2013)
	Nigeria (2013)
	Sierra Leone (2013)
South Asia	Bangladesh (2011)
	Nepal (2011)
	Pakistan (2013)

Table 6. Core Focus Areas of Selected Variables

<i>Broad Focus</i>	<i>Category</i>	<i>Variables</i>
Hygiene	Clean Water Access	Water source, time to water, water treatment
	Adequate Sanitation	Toilet facility, toilet facility shared
Maternal Empowerment	Human Capabilities	Literacy, maternal education
	Social Capabilities	Access to media resources (TV, radio, newspaper)
	Psychological Capabilities	Goes out without telling husband, argues with husband, acceptability of wife beating
	Financial Autonomy	Has comparable income to husband, makes decisions about use of money
	Sexual Autonomy	Makes decisions about using contraception, valid reasons for refusing sex with husband
	Physical Autonomy	Traveled away within past 12 months
	Decision-Making	Makes decisions about own health, household spending, visiting friends
	Barriers to Healthcare	Visited health facility in past 12 months, has barriers to health including cost, distance, access to female provider
Diarrheal Outcomes	Prevalence of Illness	Diarrhea in the past two weeks
	Treatment of Illness	Treated for intestinal parasites, diarrhea treated with ORS or antibiotics, amount given to eat or drink while suffering from diarrhea

Table 7. Adjusted logistic regression coefficients (Odds ratios) of predictive power of maternal agency constructs and household capabilities on hygiene-related infectious disease outcomes (Stratified by region)

	Diarrhea in past two weeks	Provision of ORS during diarrheal episode	Water intake during and after diarrheal episode	Treated for intestinal parasites in past 6 months
All Regions Combined				
Time to water source (under 1 hour is referent)	1.12(1.06,1.19)***	0.95(0.86, 1.06)	1.05(0.93, 1.18)	1.14(1.10,1.19)***
Decision regarding health (no involvement is referent)	0.96(0.92,1.00)	1.00(0.92, 1.09)	1.15(1.05, 1.26)**	1.50(1.461,55)***
Access to Media (no access is referent)	0.96(0.92,1.00)	0.91(0.83, 0.99)*	0.98(0.90, 1.08)	1.03(0.99,1.06)
Travelled away from home at least twice in past year (no travel is referent)	1.14(1.09,1.20)***	0.91(0.83, 1.00)*	0.87(0.79, 0.96)**	1.03(1.00,1.07)
Literacy (no literacy is referent)	1.09(1.02,1.16)*	1.08(0.94, 1.23)	0.96(0.84, 1.11)	1.42(1.36,1.49)***
Attitudes toward wife beating (never justified is referent)	1.27(1.21,1.31)***	1.01(0.93, 1.10)	0.95(0.88, 1.04)	1.24(1.20,1.28)***
Maternal education level (no education is referent)	1.03(1.00,1.07)	1.06(0.99, 1.14)	1.27(1.17, 1.37)***	1.08(1.05,1.11)***
Poorest forty percent of population (income above forty percent is referent)	1.21(1.15,1.26)***	0.90(0.82, 0.98)*	1.00(0.91, 1.10)	0.82(0.80,0.85)***
Southeast Asia				
Time to water source (under 1 hour is referent)				
Decision regarding health (no involvement is referent)	0.58(0.49, 0.69)	0.81(0.57, 1.16)	0.96(0.65, 1.42)	1.31(1.14,1.50)***
Access to Media (no access is referent)	0.95(0.83, 1.10)	1.21(0.92, 1.58)	0.87(0.65, 1.17)	1.28(1.16,1.42)***
Travelled away from home at least twice in past year (no travel is referent)	1.02(0.87, 1.19)	1.04(0.79, 1.37)	1.07(0.79, 1.45)	0.88(0.79,0.99)*
Literacy (no literacy is referent)	0.75(0.63, 0.90)**	1.11(0.80,1.56)	0.85(0.60, 1.22)	1.38(1.21,1.57)***
Attitudes toward wife beating (never justified is referent)	1.19(1.05, 1.36)**	1.04(0.82, 1.31)	1.15(0.89, 1.49)	1.08(0.98,1.19)
Maternal education level (no education is referent)	0.98(0.87, 1.11)	1.06(0.86, 1.32)	1.01(0.80, 1.27)	1.08(0.99,1.18)
Poorest forty percent of population (income above forty percent is referent)	1.11(0.96, 1.28)	1.17(0.89, 1.53)	0.76(0.57, 1.02)	0.93(0.83,1.03)
Latin America and Caribbean				
Time to water source (under 1 hour is referent)	1.00(0.83, 1.20)	1.07(0.70, 1.64)	0.79(0.50, 1.26)	0.72(0.60,0.86)***
Decision regarding health (no involvement is referent)	0.80(0.73, 0.89)***	0.92(0.71, 1.18)	1.00(0.75, 1.32)	0.93(0.85,1.02)
Access to Media (no access is referent)	0.98(0.97, 1.10)	0.96(0.71,1.30)	1.21(0.86, 1.70)	1.42(1.27,1.59)***
Travelled away from home at least twice in past year (no travel is referent)	1.26(1.11, 1.43)***	0.89(0.66, 1.19)	0.87(0.63, 1.21)	1.27(1.14,1.41)***
Literacy (no literacy is referent)	1.25(1.08, 1.46)**	0.84(0.58, 1.23)	0.74(0.48, 1.14)	1.02(0.89,1.16)
Attitudes toward wife beating (never justified is referent)	1.45(1.26, 1.68)***	1.34(0.93, 1.94)	0.93(0.61, 1.41)	0.96(0.83,1.10)
Maternal education level (no education is referent)	0.88(0.81, 0.96)**	0.96(0.79, 1.16)	0.94(0.75, 1.16)	1.49(1.38,1.59)***
Poorest forty percent of population (income above forty percent is referent)	1.04(0.93, 1.16)	0.81(0.62, 1.05)	0.82(0.61, 1.11)	1.35(1.22,1.48)***
Sub-Saharan Africa				
Time to water source (under 1 hour is referent)	1.08(0.98, 1.19)	1.15(0.95, 1.40)	1.06(0.86, 1.30)	0.94(0.87,1.01)
Decision regarding health (no involvement is referent)	0.92(0.89, 0.97)**	0.99(0.89, 1.10)	1.15(1.03, 1.28)*	1.56(1.51,1.62)***
Access to Media (no access is referent)	0.83(0.78, 0.87)***	0.88(0.79, 0.98)*	0.92(0.82, 1.02)	0.92(0.89,0.96)***
Travelled away from home at least twice in past year (no travel is referent)	1.20(1.13, 1.27)***	0.85(0.76, 0.96)**	0.82(0.73, 0.92)**	0.87(0.83, 0.91)***
Literacy (no literacy is referent)	0.96(0.88, 1.06)	1.01(0.84, 1.21)	0.85(0.70, 1.02))	1.18(1.11,1.26)***
Attitudes toward wife beating (never justified is referent)	1.60(1.52, 1.69)***	1.08(0.98, 1.20)	1.09(0.98, 1.20)	1.58(1.52,1.64)***
Maternal education level (no education is referent)	1.07(1.02, 1.12)*	1.15(1.05, 1.27)**	1.45(1.31, 1.61)***	1.22(1.18,1.27)***

Poorest forty percent of population (income above forty percent is referent)	1.09(1.04, 1.15)**	0.87(0.78, 0.96)**	0.98(0.88, 1.09)	0.70(0.67,0.72)***
South Asia				
Time to water source (under 1 hour is referent)	1.18(0.87, 1.62)	0.81(0.47, 1.38)	1.20(0.62, 2.34)	0.57(0.45,0.71)***
Decision regarding health (no involvement is referent)	0.86(0.73, 1.02)	1.26(0.94, 1.70)	0.64(0.45, 0.92)*	1.27(1.12,1.44)***
Access to Media (no access is referent)	0.91(0.76, 1.10)	0.79(0.57, 1.10)	1.39(0.94, 2.04)	1.27(1.10,1.46)**
Travelled away from home at least twice in past year (no travel is referent)	1.14(0.96, 1.35)	1.01(0.75, 1.37)	0.91(0.64, 1.31)	1.02(0.90,1.16)
Literacy (no literacy is referent)	0.90(0.71, 1.15)	1.06(0.68, 1.66)	0.82(0.49, 1.38)	1.30(1.09,1.56)**
Attitudes toward wife beating (never justified is referent)	2.63(1.14, 6.05)	1.54(0.28, 8.60)	1.69(0.19, 14.79)	0.47(0.21,1.02)
Maternal education level (no education is referent)	1.04(0.92, 1.18)	0.87(0.69, 1.11)	1.05(0.80, 1.39)	0.84(0.77, 0.93)**
Poorest forty percent of population (income above forty percent is referent)	0.90(0.75, 1.09)	0.82(0.59, 1.14)	1.15(0.77, 1.70)	1.18(1.02,1.36)*

* result was significant, $p < 0.05$

** result was significant, $p < 0.01$

*** result was significant, $p < 0.001$

Table 8. Adjusted logistic regression coefficients (Odds ratios) of predictive power of maternal agency constructs and household capabilities on hygiene-related infectious disease outcomes (Stratified by child age)

	Diarrhea in past two weeks	Provision of ORS during diarrheal episode	Water intake during and after diarrheal episode	Treated for intestinal parasites in past 6 months
All Ages Combined				
Time to water source (under 1 hour is referent)	1.12(1.06,1.19)***	0.95(0.86, 1.06)	1.05(0.93, 1.18)	1.14(1.10,1.19)***
Decision regarding health (no involvement is referent)	0.96(0.92,1.00)	1.00(0.92, 1.09)	1.15(1.05, 1.26)**	1.50(1.461.55)***
Access to Media (no access is referent)	0.96(0.92,1.00)	0.91(0.83, 0.99)*	0.98(0.90, 1.08)	1.03(0.99,1.06)
Travelled away from home at least twice in past year (no travel is referent)	1.14(1.09,1.20)***	0.91(0.83, 1.00)*	0.87(0.79, 0.96)**	1.03(1.00,1.07)
Literacy (no literacy is referent)	1.09(1.02,1.16)*	1.08(0.94, 1.23)	0.96(0.84, 1.11)	1.42(1.36,1.49)***
Attitudes toward wife beating (never justified is referent)	1.27(1.21,1.31)***	1.01(0.93, 1.10)	0.95(0.88, 1.04)	1.24(1.20,1.28)***
Maternal education level (no education is referent)	1.03(1.00,1.07)	1.06(0.99, 1.14)	1.27(1.17, 1.37)***	1.08(1.05,1.11)***
Poorest forty percent of population (income above forty percent is referent)	1.21(1.15,1.26)***	0.90(0.82, 0.98)*	1.00(0.91, 1.10)	0.82(0.80,0.85)***
Under 1 year				
Time to water source (under 1 hour is referent)	1.30(1.17,1.44)***	0.82(0.66,1.02)	0.94(0.74,1.18)	0.99(0.88,1.11)
Decision regarding health (no involvement is referent)	1.03(0.96,1.12)	1.06(0.89,1.26)	1.20(1.00,1.44)	1.17(1.07,1.27)***
Access to Media (no access is referent)	1.04(.95,1.12)	1.11(0.93,1.33)	1.02(0.84,1.24)	0.89(0.82,0.97)**
Travelled away from home at least twice in past year (no travel is referent)	1.19(1.09,1.30)***	1.02(0.84,1.23)	0.87(0.71,1.06)	0.82(0.74,0.90)***
Literacy (no literacy is referent)	1.17(1.02,1.33)*	1.03(0.78,1.36)	1.05(0.78,1.41)	1.12(0.98,1.28)
Attitudes toward wife beating (never justified is referent)	1.20(1.11,1.30)***	0.90(0.76,1.07)	1.00(0.84,1.20)	1.59(1.47,1.73)***
Maternal education level (no education is referent)	1.01(0.94,1.08)	1.04(0.89,1.21)	1.21(1.03,1.42)*	1.11(1.03,1.20)**
Poorest forty percent of population (income above forty percent is referent)	1.21(1.11,1.31)***	0.92(0.77,1.10)	1.08(0.90,1.31)	0.79(0.72,0.86)***
Between 1 and 5 years				
Time to water source (under 1 hour is referent)	1.06(1.00,1.13)	1.01(0.90,1.14)	1.09(0.95,1.25)	1.19(1.14,1.25)***
Decision regarding health (no involvement is referent)	0.94(0.90,1.00)*	0.98(0.89,1.08)	1.13(1.02,1.26)*	1.56(1.51,1.61)***
Access to Media (no access is referent)	0.93(0.89,0.98)**	0.86(0.77,0.95)**	0.97(0.88,1.08)	1.05(1.02,1.09)**
Travelled away from home at least twice in past year (no travel is referent)	1.13(1.07,1.19)***	0.88(0.79,0.98)*	0.87(0.78,0.97)*	1.05(1.01,1.09)*
Literacy (no literacy is referent)	1.07(0.99,1.16)	1.09(0.94,1.27)	0.94(0.80,1.11)	1.48(1.41,0.57)***
Attitudes toward wife beating (never justified is referent)	1.28(1.22,1.34)***	1.05(0.96,1.15)	0.94(0.85,1.04)	1.23(1.19,1.27)***
Maternal education level (no education is referent)	1.03(0.99,1.08)	1.07(0.99,1.17)	1.28(1.17,1.41)***	1.14(1.12,1.18)***
Poorest forty percent of population (income above forty percent is referent)	1.20(1.14,1.27)***	0.90(0.81,0.99)*	0.98(0.88,1.08)	0.82(0.79,0.85)***

* result was significant, p<0.05

** result was significant, p<0.01

*** result was significant, p<0.001

Table 9. Adjusted logistic regression coefficients (Odds ratios) of predictive power of maternal agency constructs and household capabilities on water treatment practices in Southeast Asia

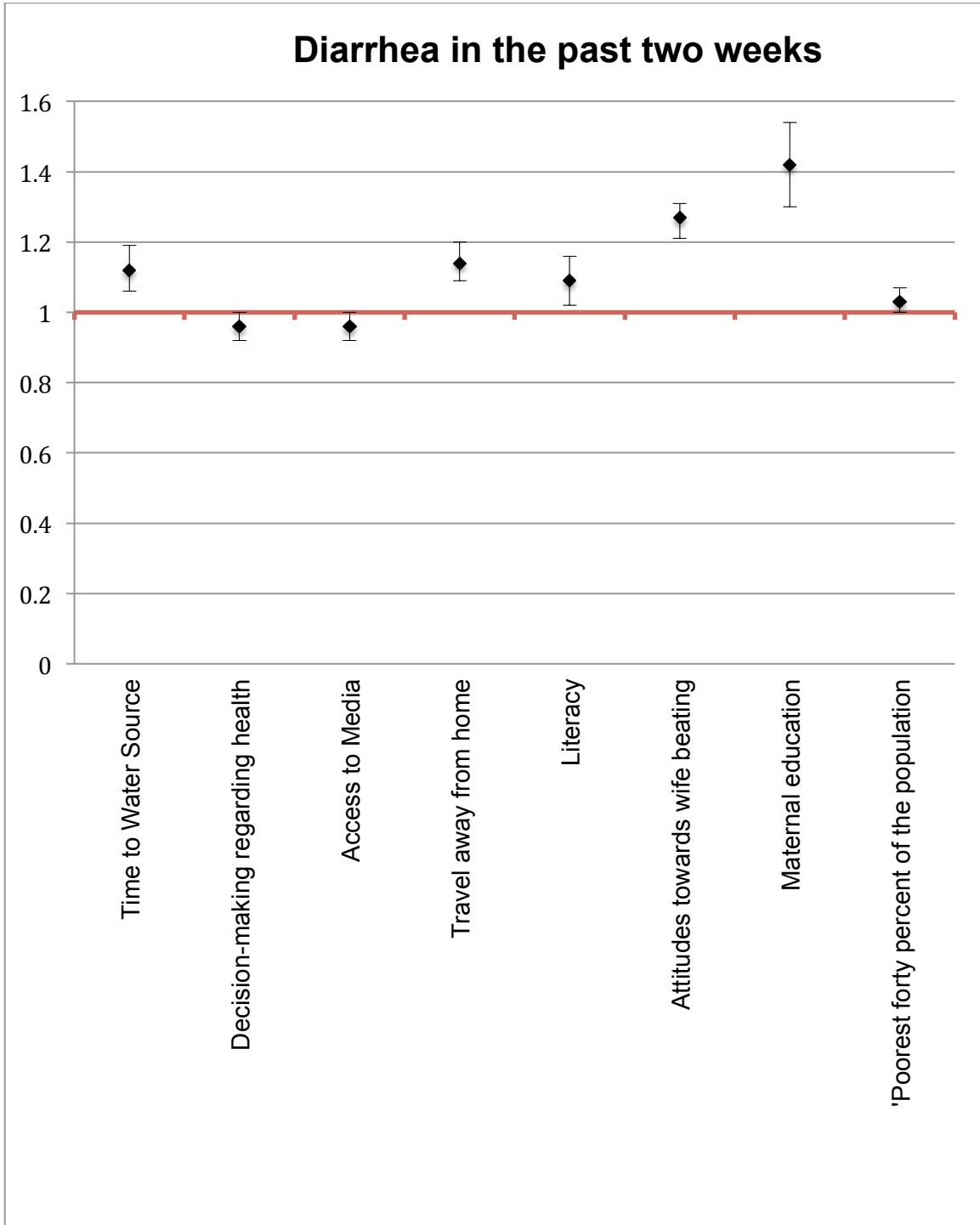
	Water Treatment
Southeast Asia	
Time to water source (under 1 hour is referent)	
Decision regarding health (no involvement is referent)	0.95(0.80,1.12)
Access to Media (no access is referent)	1.32(1.17,1.48)***
Travelled away from home at least twice in past year (no travel is referent)	1.09(0.95,1.25)
Literacy (no literacy is referent)	1.29(1.11,1.50)**
Attitudes toward wife beating (never justified is referent)	0.82(0.73,0.91)***
Maternal education level (no education is referent)	1.39(1.25,1.56)***
Poorest forty percent of population (income above forty percent is referent)	0.56(0.50,0.64)***

* result was significant, $p < 0.05$

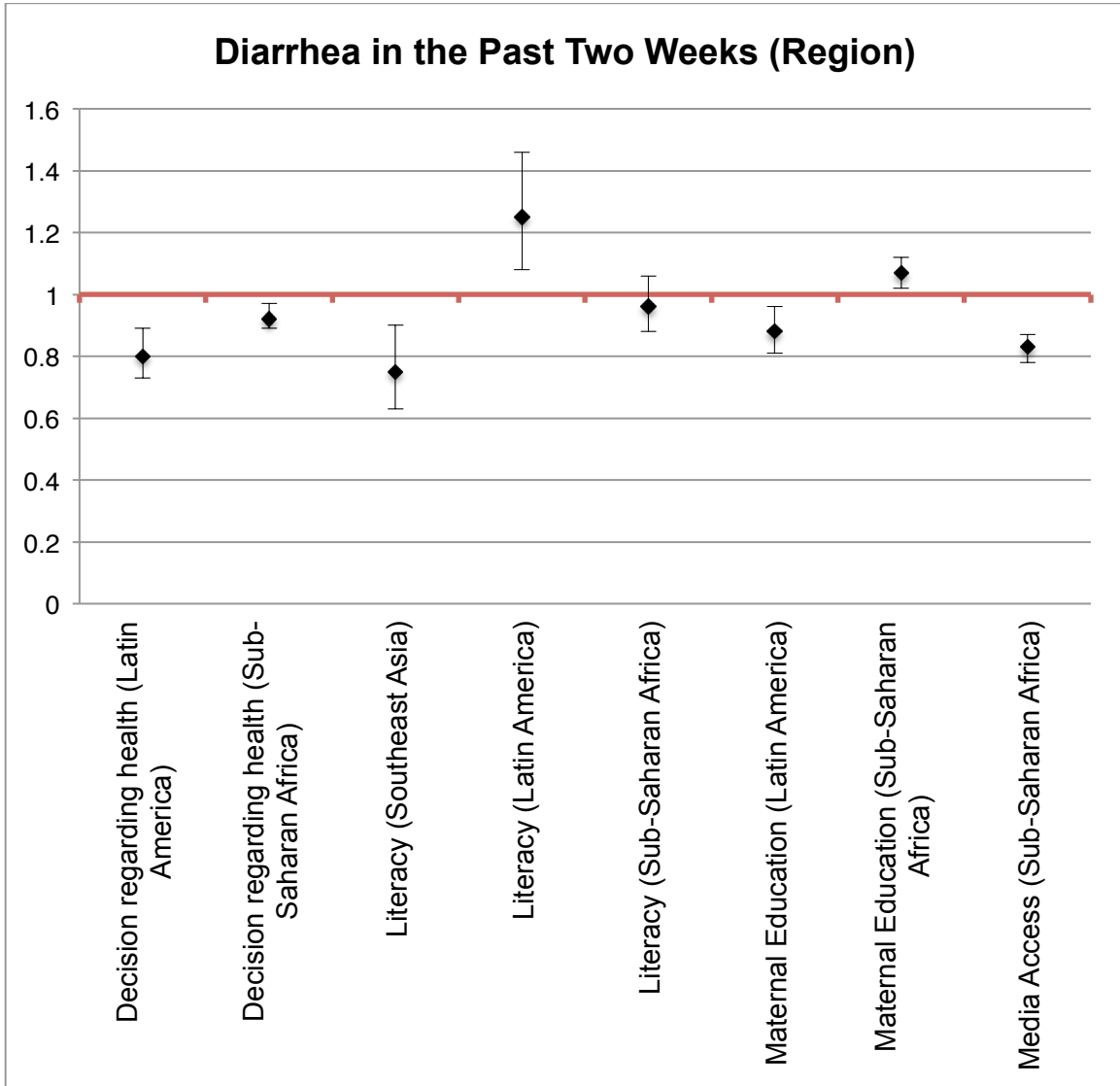
** result was significant, $p < 0.01$

*** result was significant, $p < 0.001$

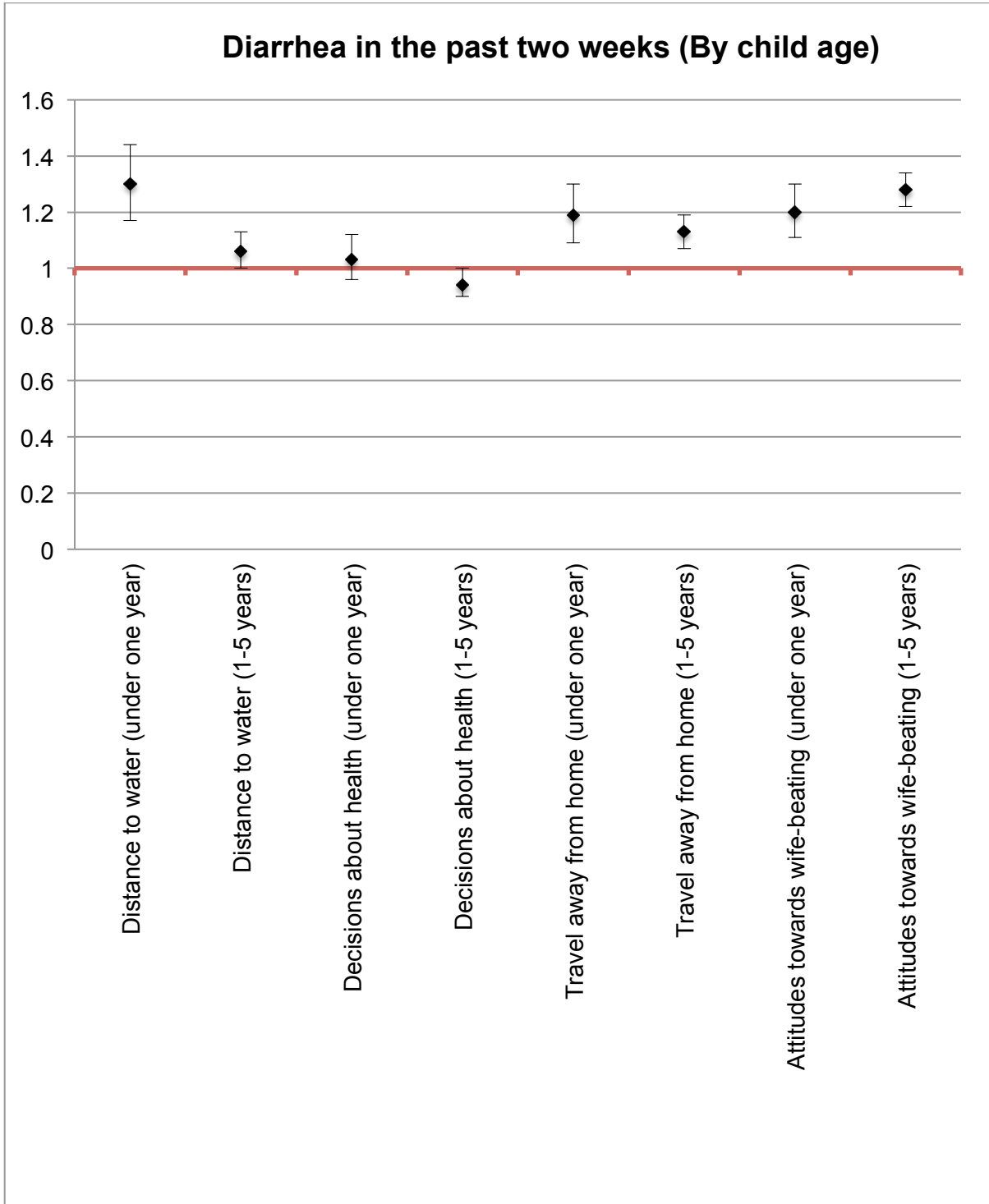
Supplemental Figure 1



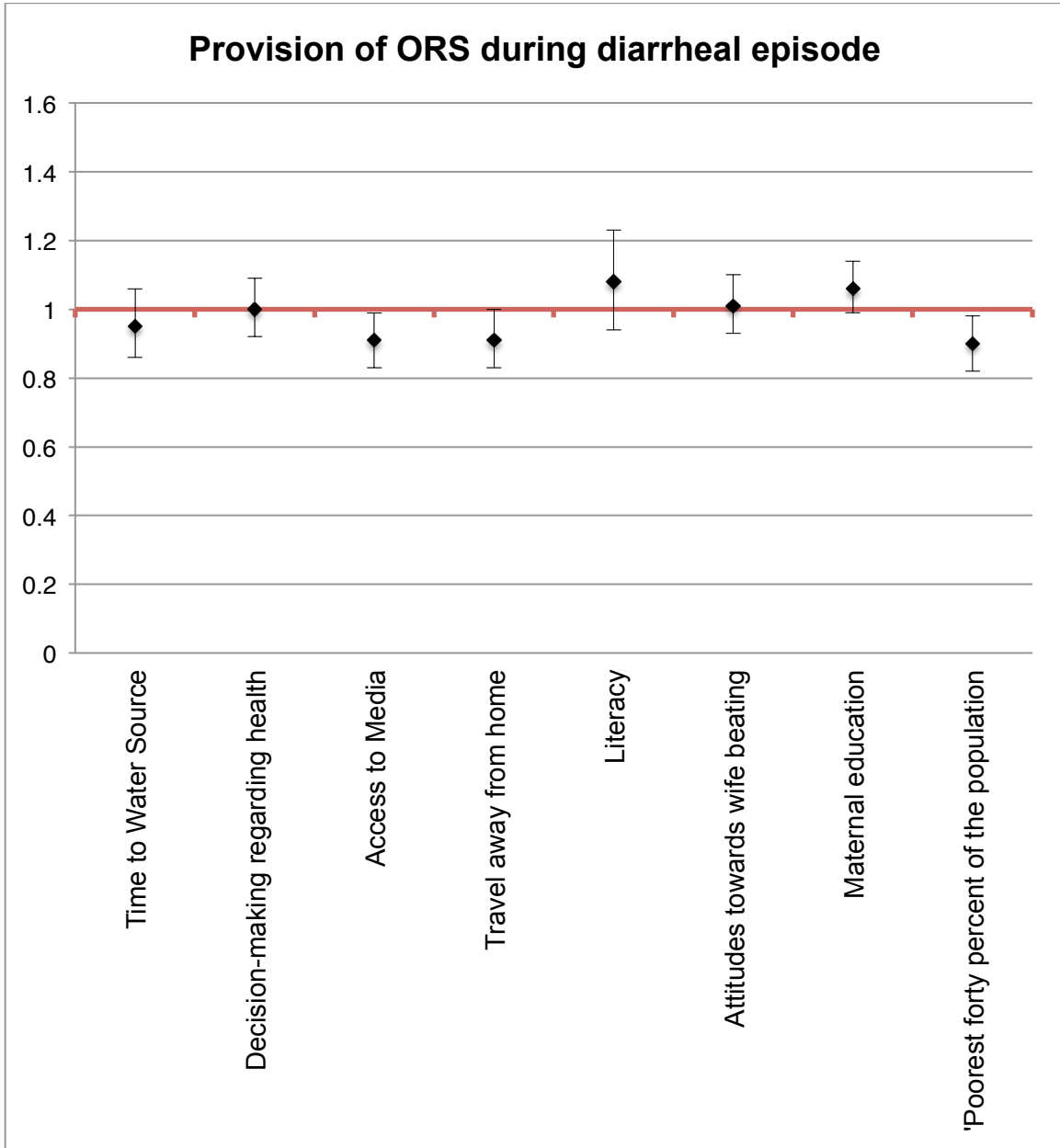
Supplemental Figure 2



Supplemental Figure 3



Supplemental Figure 4



Supplemental Figure 5

