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Maternal Social and Behavioral Factors Associated with the Household WASH Environment in Rural Ethiopia

By

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Master of Public Health

Global Epidemiology

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Abstract

Maternal Social and Behavioral Factors Associated with the Household WASH Environment in Rural Ethiopia

By Erin Maurer

INTRODUCTION: In rural Ethiopia, the two-week prevalence of diarrhea in children under five is 13%, and 44.4% of children are stunted, indicating high rates of child illnesses often associated with inadequate drinking water, poor sanitation, and improper hand hygiene (WASH). Because women are the primary caretakers of the home and children in sub-Saharan Africa, we investigated associations of maternal social and behavioral factors with whether a household prioritizes improved WASH in rural Ethiopia.

METHODS: We conducted a secondary analysis of cross-sectional data from the CARE Ethiopia's 2014 Nutrition at the Center (N@C) Baseline Survey. Study participants included women of reproductive age (15-49 years) who had given birth in the previous 36 months and lived in the Amhara district of Ethiopia (N=2,132). A six-variable WASH index was dichotomized to represent poor and good household WASH environments, and seven maternal factors were included in a multivariable logistic regression model that controlled for socioeconomic status, district of residence, and maternal age. The six WASH variables were then each included as the dependent variable in multivariable logistic regression models with each of the seven maternal factors, for a total of 7 final models.

RESULTS: Six maternal social and behavioral factors were statistically significantly associated with a good household WASH environment: participation in women's empowerment groups [OR(95%CI) = 2.59 (2.09, 3.21)], participation in household decision-making [OR(95%CI) = 1.98 (1.45, 2.69)], women who do not accept hitting [OR(95%CI) = 1.59 (1.28, 1.98)], moderate/high social capital [OR(95%CI) = 1.52 (1.23, 1.88)], maternal literacy [OR(95%CI) = 1.43 (1.15, 1.78)], and antenatal care attendance [OR(95%CI) = 1.30 (1.04, 1.63)]. In the additional adjusted multivariable models, each of the six individual WASH variables were found to be associated with a variety of maternal social and behavioral factors.

CONCLUSION: These findings indicate that maternal social factors, behaviors, and empowerment status may be associated with the household WASH environment, and suggest that interventions designed to address maternal empowerment and education could lead to improved WASH outcomes in rural Ethiopia.

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Chapter I: Literature Review

Global Burden of Stunting and Diarrhea

Child health has improved markedly since 1990, with a 53% decrease in child mortality both globally and in sub-Saharan Africa. Of the preventable illnesses affecting children, diarrheal diseases are the second leading cause of death in children under five, with an estimate of 1.87 million child deaths each year (1). Roughly two billion cases occur globally each year, and diarrheal diseases are the leading cause of malnutrition in children less than 5 years old (2). Africa and South-East Asia represent 78% of diarrheal deaths among children; 73% of these deaths occur in just 15 countries (2). The concentration of deaths due to diarrheal diseases in these developing regions represents stark inequalities in basic health between developing and developed countries.

In addition to the burden of diarrhea, children in developing countries experience malnutrition that can lead to stunting and wasting. Child stunting, also known as linear growth failure, primarily occurs in the first 2 years of life when the mean length-for-age Z scores (LAZ) of children drop below -2.0 standard deviations (3). Wasting and underweight status also develops during the first 2 years of life when the mean weight-for-age Z scores (WAZ) drop below -2.0 standard deviations (3). Stunting and wasting can be the result of lack of adequate macronutrients or micronutrients, improper breastfeeding, and disease burden resulting in reduced eating or nutrient absorption. In 2010, an estimated 171 million children under five years old were stunted, 167 million of which resided in developing countries (4). This translates to 26.7% prevalence of

stunting in children worldwide. Of note, forty percent of children in Africa are stunted, representing the highest prevalence of stunting of any region worldwide (4).

Diarrhea has been implicated as a contributor to stunting, and malnutrition has been known to increase the risk of diarrhea, creating a 'dual burden' of diarrhea and malnutrition in children (5, 6, 7, 8). In a pooled analysis of nine studies with diarrhea and growth data, 25% (95% CI 8-38%) of all stunting in 24 month old children was attributable to having five or more episodes of diarrhea in the first 2 years of life (5). The odds of stunting increased multiplicatively with each diarrheal episode and day of diarrhea. These results show that a higher cumulative burden of diarrhea increases the risk of stunting, a result supported by numerous studies (6, 7, 8). It is also widely accepted that poor nutritional status, measured by malnutrition indicators like LAZs and WAZs, leads to an increased risk of diarrhea episodes (9, 10, 11, 12). It is important to note that these associations are often specific to the local environmental, cultural, and socioeconomic context.

Diarrhea and diarrhea related malnutrition are primarily caused by inadequate drinking water, poor sanitation, and improper hand hygiene. In 2012, a retrospective analysis of data from 145 countries estimated the effects of water quality, sanitation, and hygiene (WASH) on child morbidity. The analysis estimated 502,000 diarrhea deaths were caused by inadequate drinking water, 280,000 by inadequate sanitation, and 297,000 by inadequate hygiene (13). These deaths were attributed primarily to dehydration from diarrhea and the effects of under nutrition as a result of poor WASH environments. This

study also estimated that 361,000 deaths of children under five could be prevented through improvements in WASH.

Addressing diarrheal diseases and improving nutrition are essential to decreasing child mortality and morbidity rates, a concern reflected by the UN Millennium Development Goal (MDG) 4 which aimed to reduce child deaths by 2/3 by the year 2015. Progress has been made towards this goal; in developing countries the percentage of underweight children under 5 years old fell from 28% in 1990 to 17% in 2013 (14). The global prevalence of stunting in children under 5 has decreased in the last decade from 33% in 2000 to 25% in 2013 (15). Globally, the under five mortality rate has decreased by 53% in the last 25 years, from 91 deaths per 1,000 live births in 1990 to 43 in 2015 (16). Overall, the number of under five deaths has dropped from 12.7 million in 1990 to 5.8 million in 2015 (16). While progress has been made, diarrhea and malnutrition still contribute to child mortality today. WHO estimates that every day in 2015, 16,000 children will die of preventable causes including diarrhea and malnutrition (17). This is especially true in sub-Saharan Africa, which has seen the slowest rate of decline in child mortality. The post-2015 development program will need to continue to focus on childhood illnesses like diarrhea and nutrition to continue to reduce the rates of mortality.

Environmental Enteropathy (EE)

Government, NGO, and global health programs have focused heavily on WASH and nutrition improvements in the years since the MDGs were introduced, leading to huge improvements, but also showing to be incomplete in their impact on child health (3). As

emphasized by the literature described above, successful WASH interventions result in a significant reduction in diarrhea, and successful nutrition interventions result in a significant reduction in stunting. But the prevalence of both is still high in low-income countries, even after successful WASH or nutrition interventions. For example, the *Lancet* Nutrition Series models suggested that even if all existing nutrition interventions were implemented in 99% of communities worldwide, only a 33% reduction in stunting would result (3). And if all WASH interventions were implemented in 99% of the population, only a 30% reduction in diarrhea would result (3).

One of the major hypothesized causes of this gap in expected improvements in stunting is Environmental Enteropathy (EE), an asymptomatic, sub-clinical intestinal damage and inflammation caused by continuous fecal-oral contamination. An individual with EE does not present with diarrhea or other obvious disease symptoms. However, the changes to the structure of the intestine and chronic inflammation ultimately result in increased intestinal permeability, impaired gut immune function, malabsorption, and growth faltering (stunting) (3). When children ingest high concentrations of pathogenic bacteria due to unsanitary living environments or contaminated food, these bacteria may colonize in the small intestine and induce an immune response. This colonization may lead to a permeable gut (reviewed in [18]). Growth of a child may be affected by this malabsorption, paired with poor nutrition and the high-energy demands of a young child. Because this condition shows no symptoms, EE has been largely overlooked by studies and programs aimed at improving nutritional outcomes (reviewed in [18]). If environmental enteropathy, not diarrhea, is the primary cause of undernutrition resulting

from poor sanitation and hygiene, then the *Lancet* series may have underestimated the contribution of sanitation and hygiene to growth improvements (reviewed in [18]).

Several recent studies have suggested an association between poor WASH, environmental enteropathy, and stunting (19, 20, 21, 22, 23). In a study among children in rural Gambia, EE was estimated to explain 40-64% of growth faltering (19), while another study in Gambia showed that 50% of children 5-6 months of age and 95% of children above 10 months of age had evidence of EE (20). Furthermore, two recent studies from Ethiopia show a direct link between WASH and child stunting (21, 22, 23). In one study, children from the dirtiest households, defined as poor domestic and care-giver hygiene, had a 0.32 lower adjusted mean HAZ than children from the cleanest households (22). In another food-insecure region of Ethiopia, children ages 6-36 months gained 0.33 Z-score in mean height-for-age (HAZ) over 5 years in areas receiving WASH interventions, compared to children in villages that did not receive WASH interventions (23). The WASH interventions included a protected water supply, sanitation education, soap use, hand-washing practices, sanitary facility construction, home cleanliness, construction of separate houses for animals, and keeping water clean. In addition, areas that received nutrition education or health education without WASH did not show effects on child growth (23).

A study in rural Bangladesh made the final link between the household WASH environment, EE, and stunting. It found that that children living in clean households had improved measures of gut function measured by lower lactulose:mannitol levels–a

biological indicator of EE that measures two sugars (lactulose and mannitol) in urine–and a 0.54 SD improvement in growth measured in HAZ compared with children living in contaminated environments. The study concluded that the results "are consistent with the hypothesis that environmental contamination causes growth faltering mediated through environmental enteropathy" (24).

Overall, this literature suggests that if a decrease in EE risk through improvements in the household WASH environment was a measure of program success, rather than diarrhea alone, WASH programs may demonstrate an increase in their effect on nutrition outcomes like stunting.

In the past, the only way to test for EE was by taking a biopsy of the intestine, an invasive and expensive procedure, but improvements have been made to ensure future EE research (reviewed in [25]). Today, EE can be diagnosed using the 'dual-sugar' lactulose:mannitol test, cheaper and non-invasive compared to the biopsy (reviewed in [18]). However, biopsies, dual-sugar tests, and even stunting as measures for EE can still be expensive and difficult to measure in low-resource settings. Without access to biological markers, other factors need to be explored as indicators of EE risk in children. These factors could be environmental, social, economic, or behavioral.

While the household WASH environment cannot diagnose diarrhea, stunting, or EE in a child, it can serve as a proxy for measuring the risk of disease and disability within a household. Household hygiene, sanitation, and water quality directly influences the

frequency and quantity of child hand-to-mouth bacterial contamination, which is the foundation of diarrhea, exacerbates malnutrition, and increases EE risk. These household WASH environmental factors are observable and measurable through survey tools, unlike clinical EE testing which is invasive and expensive.

Maternal Social and Behavioral Factors and Health

In addition to the household WASH environment, women's social, behavioral, and economic factors are important indicators of development and child health. The WASH environment and maternal social and behavioral factors are the primary focus of this study. Generally, maternal social factors include marital status, economic status, ethnicity, employment status, social capital and education (reviewed in [26]). Maternal factors that include both social and behavioral aspects include measures of gender equity and attitudes such as civic participation, household decision-making, mobility, and acceptance of gender violence (reviewed in [27]). Behavioral factors may also include health-seeking behaviors like attending antenatal care, giving birth in a healthcare facility, acquiring full vaccination for their children, and general involvement of the mother in child care and health. For the purposes of this research, 'maternal social and behavioral factors' refers to all the social and behavioral factors noted above.

Current research indicates that various maternal social and behavioral factors are associated with child health outcomes. In general, when women have more decision-making influence within the home, more resources go to their children (28), a fact that may contribute to health seeking behaviors and therefore child health. More specifically,

associations between health service utilization, non-acceptance of gender violence, women's autonomy, and child health have been found. (29, 30, 31, 32, 33). A study in Nigeria found that women with high household decision-making were more likely to have their children fully immunized than women with low decision-making abilities [OR (95% CI) =1.64 (1.25, 2.14)] (30). In addition, women who believed that violence against women, specially wife beating, is not acceptable were more likely to have their child fully vaccinated than women who believed wife beating was acceptable [OR (95% CI) = 1.47 (1.16, 1.85)] (30). Another study in Nigeria found that facility delivery among pregnant women was significantly associated with high decision-making authority [OR (95% CI) = 1.26 (1.10, 1.44)] and lacking the right to refuse sex [OR (95% CI) = 0.79 (0.71, 0.88)] (31). Other studies have shown associations between women's autonomy and health seeking behaviors (32). In Ethiopia and Eritrea, factors associated with an increase odds of seeking healthcare included women's autonomy (OR=1.46), maternal education (OR=2.99), working status (OR=1.23) maternal age 30-34 compared to 20 or less (OR=1.49), and household poverty level comparing the richest to the poorest (OR=1.53) (32). In Zimbabwe, women with no household decision-making abilities were more likely to have low BMI than women who had a say in household decision-making (OR=2.6) (33). Women were also more likely to have a low BMI they had no say in purchases (OR=1.69) and had no say in her working status (OR=1.75) (33). This is a key finding, since low BMI can be a sign of chronic energy deficiency (CED), which can increase the risk of maternal mortality and morbidity, as well as increase the risk of low birth weight babies among pregnant women with CED (29). A recent study exploring gender equity as a means to improve maternal health in Africa found that

women with high decision-making abilities were less likely to have low BMI [OR (95% CI) = 0.78 (0.63, 0.97)], and more likely to take a sick child with an acute respiratory infection in for treatment [OR (95% CI) = 1.31 (1.12, 1.54)] (29). In relation to gender violence, women who did not accept wife beating were less like to have a low BMI [OR (95% CI) = 0.88 (0.84, 0.92), more likely to have a facility delivery [OR (95% CI) = 1.10 (1.05, 1.16)], and more likely to have a fully immunized child [OR (95% CI) = 1.27 (1.16, 1.40)], all essential health seeking behaviors in improving maternal and child health (29).

There is some emerging research on the associations between maternal social and behavioral factors and child nutrition status, primarily stunting. In a study in rural Uganda, children of non-educated mothers were significantly more likely to be stunted compared to children of educated (more than primary school) mothers [OR (95% CI) = 2.1 (1.1, 3.9)] (34), a finding supported by another study in the slums of Nairobi [OR (95% CI) = 1.28 (1.10, 1.50)] (35). Maternal health-seeking behavior was also significantly associated with a decreased risk of stunting in the slums of Nairobi (35) and Cameroon (36). In Bangladesh, malnourishment in children under five (HAZ or WAZ below 2 standard deviations) was significantly associated with no maternal education compared to more than 11+ years of education [OR (95% CI) = 1.39 (1.09, 1.78)], the lowest poverty quintile compared to the highest quintile [OR (95% CI) = 1.64 (1.34, 2.01)], and a lack of toilet facilities [OR (95% CI) = 1.43(1.30, 1.56), and having a piped water was associated with a decrease risk of malnutrition [OR (95% CI) = 0.71(0.60, 0.84)] (37). A comprehensive literature synthesis of women's empowerment and child

nutritional status in South Asia concluded that women's empowerment measured by autonomy, control, and decision-making power in the household is generally associated with children nutrition status (reviewed in [38]).

While existing literature examines the associations between maternal social and behavioral factors, child nutrition and child health, the associations between maternal social and behavioral factors and the WASH environment are unexplored. A poor WASH environment is a key risk factor for childhood diarrhea, stunting, and EE risk. This gap in knowledge connecting maternal social and behavioral factors with WASH will be the focus of this research.

Diarrhea, Stunting, EE, and Risk Factors in Rural Ethiopia

Rates of mortality are high in Ethiopia, especially in rural areas. One in every 11 children dies before their fifth birthday, and one in every 17 Ethiopian children dies before their first birthday (39). Childhood mortality is higher is rural areas compared to urban areas (39). However, progress has been made; infant mortality has declined by 39% between 2000 and 2011, from 97 deaths per 1,000 live births to 59 deaths per 1,000 live births.

The prevalence of diarrhea, stunting, and under nutrition are high in rural Ethiopia, contributing to the high infant and child mortality rate. The DHS 2011 data found that 13% of children under age 5 had diarrhea in the two weeks prior to the survey. Diarrhea prevalence was highest among children residing in households that drink from

unprotected wells and those that reside in rural areas (39). A 2013 study in the Kersa district of Eastern Ethiopia found that the two-week prevalence of diarrhea among children under five was 22.5% (40). Significant risk factors related to diarrhea prevalence included improper refuse disposal practices [OR(95% CI) = 2.22 (1.20, 4.03)], lack of hand washing facilities [OR(95%CI) = 1.92 (1.29, 2.86)], living in a rural area [OR(95%CI) = 1.81 (1.12, 3.31)], the presence of two or more siblings in a household [OR(95%CI) =1.74 (1.33, 2.28], and the age of the child [OR(95%CI) = 2.25(1.50, 3.36)] (40). The study concluded that efforts to reduce childhood diarrhea should focus on improving household sanitation, personal hygiene, and child birth spacing. Malnutrition is a major issue in Ethiopia and presents as stunting, underweight, wasting, and thinness (low BMI for age). Anemia is also prevalent; about 44% of children age 6-59 months are anemic (39). In 2012, Ethiopia saw a low birth weight prevalence of 20%, an underweight prevalence of 28.7%, a stunting prevalence of 44.4%, and a wasting prevalence of 9.7% (41).

A few recent studies support these 2012 UNICEF malnutrition statistics, though the prevalence and risk factors vary depending on child age and region. A study in the Somali region of Ethiopia found the prevalence of wasting, stunting, and underweight among infants and young children was 17.5%, 22.9%, and 19.5% respectively (42). A study in the Fogera and Libo Kemkem districts of Ethiopia found a stunting prevalence of 42.7% among school age children in rural areas, which was significantly associated with a fever in the previous 2 weeks [OR(95%CI) = 1.62 (1.23, 2.32)] and consumption of food from animal sources [OR(95%CI) = 0.51(0.29, 0.91)] (43). Another study among

school age children (6-13 years of age) in the Fogera district found a stunting prevalence of 30.7%, an underweight prevalence of 59.7%, and a thinness prevalence of 37.2%. Children were more likely to have a low BMI for age if the child was not immunized [OR(95%CI) = 1.55(1.13, 2.14)], and if a latrine was unavailable [OR(95%CI) = 1.50 (1.09, 2.06)] (44). This was the only study found to connect malnutrition to the WASH environment in Ethiopia, reporting that a lack of proper sanitation was associate with a higher risk of thinness.

There are currently no published studies that examine the prevalence or risk factors of environmental enteropathy among children in Ethiopia.

WASH in Rural Ethiopia

According to the Progress on Drinking Water and Sanitation 2014 Update, there have been marked improvements in improved drinking water and sanitation facility access in the last two decades both globally and in Ethiopia (45). In 1990, only 13% of the global population had access to an improved drinking water source, increasing to 52% in 2012. In 1990, only 2% of the population had access to improved sanitation facilities, improving to 24% in 2012. Despite these advances, there is still a lack of improved water and improved sanitation in Ethiopia, especially in rural areas. UNICEF estimates that in 2012, only 39.9% of rural residents had access to improved drinking water, and only 19.4% of rural residences had access to improved sanitation facilities (41). The 2011 Ethiopia DHS reports even lower numbers among the rural population, with 41.6% of the

population using an improved drinking water source and 6.8% of the population using an improved sanitation facility (39).

Few studies examine hygiene practices among Ethiopians, so an accurate prevalence of proper hygiene behaviors is not available. One study found an association between lack of maternal hand washing before feeding a child and infant mortality (OR=2.50, 95%CI [1.32, 4.76]) (46), and another study of people living with HIV/AIDS in Gondar City, Ethiopia found that 51.7% of participants had poor hygiene practices (47).

A few studies investigate associations between the household WASH environment and diarrhea among children in rural Ethiopia, including associations of diarrhea with maternal social and behavioral factors. One study on indigenous and resettlement communities in the Assosa district of Western Ethiopia found that strong predictors of diarrhea among children included using an unprotected community water source [OR (95% CI) = 8.4, (3.59-31.85)], using water storage containers [OR (95% CI) = 2.2 (1.02, 4.89)] and maternal knowledge on causes, transmission and prevention of diarrheal disease [OR (95% CI) = 3.62 (1.23,4.71)] (48). Another study found risk factors associated with diarrhea included maternal illiteracy [OR (95% CI) = 1.74 (1.03, 2.91)], monthly family income less than 650 Birr [OR (95%CI) = 1.75 (1.06, 2.88)], maternal lack of hand washing at critical times [OR (95% CI) = 2.21 (1.41, 3.46)], lack of soap use for hand washing [OR (95% CI) = 7.40 (2.61. 20.96)] and improper refuse disposal [OR (95% CI) = 3.19 (1.89, 5.38)] (49). These findings are supported by another Ethiopian study, which found risk factors associated with childhood diarrhea included a low

maternal education [AOR (95% CI) = 1.81 (1.12, 2.76)], absence of a toilet facility [AOR (95% CI) = 3.5 (2.4, 5.2)], improper child stool disposal [AOR (95% CI) = 2.05(1.36, 3.10)], having more than five children [AOR (95% CI) = 1.73(1.03, 2.93)], and child age [AOR (95% CI) = 1.9 (1.2, 3.6)] (50). This study also found that when toilet facility access was stratified by maternal education, child of mothers with no education were the most vulnerable to diarrhea in the absence of toilet facilities [OR (95% CI) = 9.16 (5.79, 14.48)] (51). Our research investigates the associations of maternal social and behavioral factors with a composite WASH index intended to describe a household's overall WASH access, including water, sanitation, and hand washing with soap. The existing research detailed above is important for determining which variables to include in a WASH index categorization that is specific to the Ethiopia context.

Maternal Social and Behavioral Factors and Health in Ethiopia

Context: Maternal Demographics and Health

Ethiopia's 2011 Demographic Health Survey outlines several general characteristics of the population related to maternal demographics and health (39). About a quarter of the population lives in urban areas, with the remaining 75% living in rural areas. Literacy rates are lower among women (56.9%) than men (75%). Among 15-49 year olds, 62.8% of women are married by age 18, and by age 25, 91.4% of women are married. The mean number of children born to rural women age 40-49 is 7.3 children; among those with no education, the average number of living children is 7.2, compared to 2.4 children among women who completed secondary education (39). Infant mortality rate is higher in rural areas (76 per 1,000 births) compared to urban areas (59 per 1,000 births), and among

women with no education (81 per 1,000 births) compared to women with more than secondary education (22 per 1,000 live births). This trend holds true for under-five mortality, with a higher rural under-five mortality rate (42 per 1,000 live births) compared to urban (25 per 1,000 live births), and a higher under-five mortality rate among women with no education (121 per 1,000 live births) compared to women with primary (88 per 1,000 birth), secondary (46 per 1,000 births) and more than secondary education (24 per 1,000 births) (39).

The 2011 Demographic Health Survey also outlines characteristics of the population related to maternal health facility use, education and poverty level. In Ethiopia, 10% of births are attended by skilled health personnel. In rural areas, only 14.4% of women attend the recommended four or more antenatal care visits, and 63.1% do not attend any antenatal care visits (39). In rural areas, 96.9% of women reported at least one problem with accessing health care. Problems with accessing health care included some gender equity concerns, specifically getting permission to go for treatment (32.6%) and getting money for treatment (72.8%), and also included distance to the health facility (77.1%), not wanting to go alone (63.9%), having to take transport (81.3%), concern there may not be drugs (62.4%) and having too much work inside/outside the home (65.9%) (39). Mothers with more than secondary education were least likely to have stunted children (19%) compared to mothers with no education (47%), a trend that is also seen with the household health index: a higher proportion of children whose mothers are in the lowest household wealth quintile are stunted (49%) compared to children whose mothers are in the highest wealth quintile (30%) (39).

Context: Women's Decision-Making and Gender Equity

In general, the majority of women in Ethiopia have poor decision-making abilities and purchasing power, and lack the ability to reject gender violence (39). Women in urban areas (40%) are more likely than women in rural areas to make independent decisions about the money they earn (34%), and about 55% of women in Ethiopia make joint decisions with their husband regardless of rural or urban residency. While only 13.4% of women make independent decisions about their own health care, 5.8% make their own decisions about major household purchases, and 17.2% make independent decisions about visiting her family or relatives, about 60% of women make these choices jointly with their husbands. 24.9% of women rely on their husbands to make decisions about their health care, 32.8% rely on their husbands to make decisions about household purchases, and 21.3% of women rely on their husbands to make decisions about visiting family or relatives. 68% of women agree that wife beating is sometimes justified, and the acceptance of wife beating inversely correlated with education and wealth. Only about half of women in Ethiopia know there is a law against wife beating (39).

Context: Current studies/findings

Several recent studies investigated the associations between maternal social and behavioral factors and maternal and child health in Ethiopia (7, 8, 40, 46, 51). One of these studies examined the determinants of maternal health service utilization in Ethiopia, and found that education of women, place of residence, ethnicity, parity, women's autonomy, and household wealth had significant associations with use of maternal health services (51). Women who completed higher education were more likely to use antenatal

care services [AOR (95% CI) = 3.8 (1.8, 7.8)], skilled delivery attendants [AOR (95% CI) =3.4 (1.9, 6.2)], and postnatal care services [AOR (95% CI) = 3.2 (2.0, 5.2)]; women who lived in urban areas were more likely to use antenatal care services [AOR (95% CI) = 2.3 (1.9, 2.9)], skilled delivery attendants [AOR (95% CI) =4.9 (3.8, 6.3)], and postnatal care services [AOR (95% CI) = 2.6 (2.0, 2.4)]; finally, women who make decisions around health care spending with their husbands are more likely to use antenatal care services [AOR (95% CI) =1.3 (1.1, 1.5)] and use skilled delivery attendants [AOR (95% CI) = 1.4 (1.1, 1.7)] (51). Antenatal care attendance, use of skilled delivery attendants, and postnatal care services are all maternal health seeking behaviors that have an influence on the health of their children. Maternal education and autonomy of health care spending were associated with essential health seeking behaviors, an essential finding for programming interventions to improve health.

Several recent studies specifically investigated maternal social and behavioral factors associated with nutritional status of infants and young children in Ethiopia (42, 43, 44, 52, 53). A case-control study in rural eastern Ethiopia found that wasting was associated with poor [AOR (95% CI) = 1.49 (1.02, 2.20)] and middle [AOR (95% CI) = 1.52 (1.05, 2.20)] household socioeconomic status, individual household decision-making on child care or treatment [AOR (95% CI) = 1.62 (1.23, 2.20)], lack of maternal access to a health facility [AOR (95% CI) = 1.56 (1.14, 2.20)], narrow birth interval between children [AOR (95% CI) = 1.65 (1.23, 2.20)] and non-exclusive breast feeding [AOR (95% CI) = 1.43 (1.05, 1.94)] (52). The study concluded that efforts to improve young child feeding, health services, child birth spacing behavior, household decision-making, and exclusive

breastfeeding practices among the poor mothers in rural areas are essential to decreasing child under nutrition, a finding supported by other research (42, 53). A cross-sectional study in Filitu town of the Somali region of Ethiopia found that breastfeeding was associated with a decreased odds of wasting; a high dietary diversity score and introduction of complementary feeding at 6 months were associated with a decreased odds of stunting; breastfeeding was associated with a reduced odds of underweight; and diarrhea in the past 15 days was associated with an increase odds of wasting [AOR (95% CI) = 2.13 (1.55, 4.69)] and an increased odds of underweight [AOR (95% CI) = 3.45 (1.17, 7.72)] (42). Therefore, dietary diversity, appropriate age at complementary feeding, breastfeeding, and diarrhea control likely need to be included in interventions aimed to reduce under nutrition among infants and young children in Filitu, Somalia region, Ethiopia (42).

There are no current studies investigating the maternal social and behavioral factors associated with diarrhea, WASH, or EE in Ethiopia.

Research Need, Goal, and Aims

Need: CARE International needs easy to measure, affordable indicators to implement and evaluate WASH and nutrition programming in Rural Ethiopia with the end goal of reducing childhood illnesses, primarily stunting, diarrhea and environmental enteropathy.

Goal: The goal of this research is to investigate the associations between maternal social and behavioral factors and the household WASH environment, which likely influences the diarrhea/stunting/EE risk for children, in rural Ethiopia.

Aims:

1. To investigate which maternal social and behavioral factors are associated with the overall household WASH environment in rural northeastern Ethiopia, using data from CARE Ethiopia's Nutrition at the Center (N@C) baseline survey, a cross-sectional observation study (n=2,123 household primary caregivers with children 0-36 months of age). Maternal social and behavioral factors include maternal literacy, social capital, acceptance of gender violence, participation in women's empowerment groups, antenatal care attendance, household decision-making, and mobility.
2. To investigate which maternal social and behavioral factors are associated with specific WASH environment characteristics. Household WASH environment characteristics include improved sanitation access, handwashing/hygiene practices, making water safe methods, ensuring no child open defecation, presence of soap for hand washing, and presence of water for handwashing.
3. To discuss how significant associations from Aim 1 and Aim 2 may influence WASH programming in Ethiopia for CARE International and other development organizations. This will be examined through a discussion comparing significant findings to existing research, and expanding on the potential for future projects and research.

Significance

This study will examine the maternal social and behavioral factors contributing to the household WASH environment in rural Ethiopia, that ultimately influence the risk of

diarrhea, stunting, and environmental enteropathy for children. These factors can serve to determine the social and behavior change areas to address when implementing WASH, nutrition, or joint programming, with the end goal of reducing WASH related disease risk. This research may help to reduce cost barriers for WASH and EE research, and improve effectiveness and feasibility in WASH and nutrition interventions.

Chapter II: Manuscript

MATERNAL SOCIAL AND BEHAVIORAL FACTORS ASSOCIATED WITH THE HOUSEHOLD WASH ENVIRONMENT IN RURAL ETHIOPIA

By

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ABSTRACT

INTRODUCTION: In rural Ethiopia, the two-week prevalence of diarrhea in children under five is 13%, and 44.4% of children are stunted, indicating high rates of child illnesses often associated with inadequate drinking water, poor sanitation, and improper hand hygiene (WASH). Because women are the primary caretakers of the home and children in sub-Saharan Africa, we investigated associations of maternal social and behavioral factors with whether a household prioritizes improved WASH in rural Ethiopia.

METHODS: We conducted a secondary analysis of cross-sectional data from the CARE Ethiopia's 2014 Nutrition at the Center (N@C) Baseline Survey. Study participants included women of reproductive age (15-49 years) who had given birth in the previous 36 months and lived in the Amhara district of Ethiopia (N=2,132). A six-variable WASH index was dichotomized to represent poor and good household WASH environments, and seven maternal factors were included in a multivariable logistic regression model that controlled for socioeconomic status, district of residence, and maternal age. The six WASH variables were then each included as the dependent variable in multivariable logistic regression models with each of the seven maternal factors, for a total of 7 final models.

RESULTS: Six maternal social and behavioral factors were statistically significantly associated with a good household WASH environment: participation in women's empowerment groups [OR(95%CI) = 2.59 (2.09, 3.21)], participation in household decision-making [OR(95%CI) = 1.98 (1.45, 2.69)], women who do not accept hitting [OR(95%CI) = 1.59 (1.28, 1.98)], moderate/high social capital [OR(95%CI) = 1.52 (1.23, 1.88)], maternal literacy [OR(95%CI) = 1.43 (1.15, 1.78)], and antenatal care attendance [OR(95%CI) = 1.30 (1.04, 1.63)]. In the additional adjusted multivariable models, each of the six individual WASH variables were found to be associated with a variety of maternal social and behavioral factors.

CONCLUSION: These findings indicate that maternal social factors, behaviors, and empowerment status may be associated with the household WASH environment, and suggest that interventions designed to address maternal empowerment and education could lead to improved WASH outcomes in rural Ethiopia.

INTRODUCTION

Child health has improved markedly since 1990, with a 53% decrease in child mortality both globally and in sub-Saharan Africa. However, children under 5 years old still suffer from preventable diseases like diarrhea and malnutrition, with almost 16,000 children dying each day of 2015 (17). Of the preventable illnesses affecting children, diarrheal diseases are the second leading cause of death and the leading cause of malnutrition in children under five (2). Child malnutrition, in addition to micronutrient deficiencies, often presents as stunting, when the mean length-for-age Z scores (LAZ) of children drop below -2.0 standard deviations (3). Worldwide, 26.7% of children under five years old are stunted, and in Africa 40% of children are stunted (4). Malnourished children residing in poor living conditions may also suffer from Environmental Enteropathy (EE). EE is defined as asymptomatic intestinal damage and inflammation caused by continuous fecal-oral contamination (3). The intestinal damage caused by this continuous fecal-oral contamination is linked to malabsorption of nutrients (3). Due to the resulting malabsorption of nutrients, EE has been linked to high stunting rates regardless of a child's nutritional diversity and food quantity (3, 24). Environmental enteropathy, diarrhea, diarrhea-related stunting, and other water-borne diseases are primarily linked to inadequate drinking water, poor sanitation, and improper hand hygiene (WASH) (2, 3, 24). A household's WASH environment therefore greatly contributes to child health and mortality (17).

WASH related diseases and child health are known to be influenced by many contextual, social, and behavioral factors, including socioeconomic status, social norms, and

women's empowerment (49, 50, 54, 55). Research and programming around women's empowerment involves numerous social and behavioral factors of women and mothers, including economic status, social capital, education, civic participation, household decision-making, mobility, gender violence acceptance, and health seeking behaviors. Existing research indicates that these factors are consistently associated with child health. Women who have high decision-making abilities are more likely to fully vaccinate their children (30), have high health seeking behaviors for themselves and their children (31, 32), and are less likely to have a stunted child (35, 36). Maternal literacy and education, acceptance of gender violence, and socioeconomic status are also widely accepted to influence health seeking behaviors and child health outcomes (29, 30, 31, 32, 38). While there is extensive research on child health and women's empowerment, it is unknown whether maternal social and behavioral factors influence whether a household prioritizes improved water quality, sanitation facilities, and hygiene behavior in any geographic region, including sub-Saharan Africa.

There is a need to research the WASH and women's empowerment connection in order to examine potential social and education-based areas of intervention to improve WASH outcomes. Initiatives to address WASH are largely knowledge and behavior based, and require actions like building a latrine, consistently using a latrine, having hand washing water and soap available, and using treatments to improve water quality. The connection between WASH and women's empowerment has only recently been explored in the context of development (17, 29).

An ideal location to study this gap in the research is in Ethiopia, where women's empowerment concerns, lack of access to improved WASH, and child health issues are prevalent (39, 41). In Ethiopia, the two-week prevalence of diarrhea in children under five is 13%, and 44.4% of children are stunted (39). Rural resident access to potable water (39.9%), sanitation facilities (19.4%), and hygiene education is low (41). Research to examine factors associated with improved WASH is therefore essential to improving child health in Ethiopia. In addition, women's empowerment is coming to the forefront of development research and programming in Ethiopia (32, 39, 50, 51). Thus, the objective of this research is to investigate associations between maternal social and behavioral factors and the household WASH environment in rural Ethiopia. By understanding what maternal social and behavioral factors influence the household WASH environment, research can make the connection between women's empowerment and WASH, and development initiatives can have a greater impact on child health outcomes like stunting and diarrhea in Ethiopia.

METHODS

Data Source

A secondary analysis of the CARE Ethiopia 2014 Nutrition at the Center (N@C) Baseline Survey cross-sectional data was conducted for this investigation. N@C is a multi-sector program with the goal of improving nutritional status of women and children in identified resource poor regions. N@C programming is implemented by CARE USA in Bangladesh, Benin, Ethiopia, and Zambia. In Ethiopia, N@C builds on the existing Productive Safety Net Program (PSNP), a food security program that began in 2005 in the Amhara region of South Gondar, Ethiopia. An IRB waiver of approval was obtained and CARE USA granted permission for use of the baseline data. Information collected from the baseline is expected to guide CARE N@C intervention design and set targets for key outcome and impact indicators (56).

Study Population

The source population for this study was all residents of three districts in the Amhara region of South Gondar, Ethiopia. A total of 22 kebeles in Ebinat and Simada and 10 kebeles in Tach Gyant are included. A kebele is the smallest unit of residence in Ethiopia, similar to a village or neighborhood. The total source population was 223,483.

The study participants were women of reproductive age (15-49 years of age) who had given birth in the previous 36 months and lived in the Ebinat, Simada, and Tach Gaynt districts during the study period. Eligible participants must also have resided in the survey area for more than six months and her youngest child must live with her at the

time of the survey. A total of 2,132 mothers or primary caregivers, along with one of their children age 0-36 months, are included in the final survey.

Variable Selection and Categorization

After conducting a review of existing literature and examining variables measured in the N@C data, independent exposure variables were defined as maternal social and behavioral factors that could be associated with the WASH environment. Seven independent exposure variables were chosen for analysis—maternal literacy, antenatal care attendance, social capital, household decision-making, autonomy of movement, gender violence attitudes, and women's empowerment group participation—and were all coded to be dichotomous.

Maternal literacy was categorized as 'literate' and 'illiterate' based upon a participant's ability to read a provided sentence. Antenatal care attendance, defined as attending antenatal care at least once during the participant's last pregnancy, is categorized as 'yes' and 'no'.

Social capital was determined by as series of five questions regarding the level of support a participant receives from her community in the form of childcare, food quantity or quality, health care, and family issues. Each answer was categorized as 0=Low Social Capital, 1=Moderate Social Capital, and 2=High Social Capital. A mean of the five answers was calculated for each participant, and the scores ranged from 0.00 to 2.00. Based on value distribution, lower mean scores of 0.00

through 0.40 were combined and defined as ‘low social capital’, middle range scores of 0.41 to 1.40 were combined and defined as ‘moderate social capital’, and higher mean scores ranging from 1.41 through 2.00 were combined and defined as ‘high social capital’. Since we were interested in the highest level of social capital compared to all lower levels, ‘low’ and ‘moderate’ categories were combined to create a dichotomized variable: ‘low/moderate social capital’ and ‘high social capital’.

Household decision-making level was determined by a series of eight questions regarding participation in decision-making about personal health, child health, large household purchases, visiting family or friends, money spending, selling assets, work status, family planning, sex, child feeding, and food sharing. Each answer was categorized as 0=No Participation, 1=Some Participation, and 2=Alone/Jointly with Husband. A mean of the eight answers was calculated for each participant, and the scores ranged from 0.00 to 2.00. Based upon value distribution, the lowest mean scores 0.00 through 0.49 were combined and defined as ‘no participation’, the middle mean scores of 0.50 through 1.49 were combined and defined as ‘some participation,’ and the highest mean scores ranging from 1.50 through 2.00 were combined and defined as ‘myself alone/jointly with husband.’ Because we were interested in the highest level of household decision-making compared to all lower levels, the ‘no participation’

and ‘some participation’ categories were combined to create a dichotomized variable: ‘no/some participation’ and ‘alone/jointly with husband’.

Autonomy of movement was defined by a series of eight questions regarding the ability to do as one pleases without permission from another person, typically the husband. Answers were categorized as 0=No/Limited Mobility and 1=Yes (Mobility without permission). A mean index for mobility was calculated for each participant, and mean scores ranged from 0.00 to 1.00. The mean scores were divided at the mid-point of 0.50 based upon the distribution of values. Lower mean scores between 0.00 and 0.49 were combined and defined as ‘no/limited mobility’, and higher mean scores ranging from 0.50 to 1.00 were combined and defined as ‘yes (mobility without permission)’.

Gender violence attitudes was measured as a perception, rather than past experience with intimate partner violence. A series of five questions were asked regarding a participant’s acceptance of a husband hitting his wife, and each participant’s answers were categorized as 0=“Does Not Accept Hitting” and 1= “Accepts Hitting”. An additive index for gender violence was calculated, and scores ranged from 0 to 5 in whole number intervals. A score 0 was defined as ‘does not accept hitting’, and scores ranging from 1 to 5 were defined as ‘accepts hitting’. This categorization is based on the Demographic and Health Survey Program recommendations that a woman should not accept hitting under any circumstances.

Empowerment group participation, defined as participating in one or more community, government, or NGO facilitated women's empowerment group, was dichotomized to 'no' and 'yes'.

Potential confounding variables included poverty level, district of residence, and maternal age. Poverty level was equally distributed into quintiles. Poverty level variability between quintiles was low because the sample population was all rural and therefore economically similar. Due to this low variability, the quintiles were condensed into three categories for analysis: 'poorest/lower middle', 'middle/upper middle', and 'highest'. This categorization allows for a more meaningful interpretation of economic differences for this population. Maternal age was included as a continuous variable.

The primary dependent variable, labeled 'household WASH environment index', is a new index calculated by C ARE USA and based upon water, sanitation, and hygiene indicators measured and analyzed in existing WASH research and programming (4, 43). The household WASH environment index was categorized on a six-point scale as 'poor' (0 - 3) or 'good' (4 - 6). A point was given for each 'Yes' answer to the following six WASH components: improved toilet access (Yes/No), child latrine/pot defecation (vs. open defecation) (Yes/No), hand-washing at 3 critical times (Yes/No), soap for hand-washing available (Yes/No), water for hand-washing present (Yes/No), and use at least one method to make drinking water safe (Yes/No).

Data Analysis

Data analysis was conducted using SPSS Statistics Version 20.0 (Armonk, NY: IBM Corp). Frequencies were determined for all independent maternal social and behavioral factors, confounders, and selected maternal characteristics including number of children. Crude odds ratios and 95% confidence intervals were calculated for the seven independent exposure variables through bivariate logistic regression to determine associations between the WASH index and the independent variables.

Since this analysis was hypothesis generating, all independent exposure variables were further analyzed at the multivariable level by unconditional logistic regression, regardless of significance at the bivariate level. Also included in the primary multivariable model were the potential confounders that could influence the WASH environment, socioeconomic status and district of residence.

The six individual components of the WASH index were then used as dependent variables in unconditional logistic regression models containing all seven previously identified independent maternal factors and the three confounding variables. This resulted in a total of seven final multivariable models.

Multicollinearity diagnostics (57) were conducted and showed no collinearity between independent variables in the final multivariable models (VIF value range 1.01 – 1.03, Condition Index value range 2.8 – 21.8). The Hosmer-Lemeshow test was used to detect and confirm goodness-of-fit for the each of the final models (p-values > 0.05). Adjusted

odds ratios and 95% confidence intervals were estimated using unconditional multivariable logistic regression to assess the strength of association (57). A p-value of <0.05 was used to declare statistical significance in the multivariable analysis.

RESULTS

A total of 2,132 women were included in this study, and had a mean age of 29 years and an average of three living children (Table 1). Forty percent of participants live in Tach Gyant, 34% in Ebinat, and 26% in Simbada. About 40% of participants were in the poorest/lower middle and middle/upper middle economic levels, with the remaining 20% in the highest economic level. About a third of participants participate in women's empowerment groups. The majority of women had high levels of household decision-making. About a third of women do not accept hitting. About half of women had high social capital. About a third of the participants are literate. The majority of women attended antenatal care at least once during their last pregnancy and the majority also had autonomy of movement. About a quarter of the women had a good household WASH environment, with a score of 4 to 6 on the six-point WASH index, while the remaining three-fourths of women had a poor household WASH environment with a WASH index score of 0 to 3 points.

The household WASH environment index is composed of six independent WASH components (Table 2). About 40% of women in the study had an improved toilet, and about a third wash their hands at all three critical times. Twenty five percent of women use at least one method to make their drinking water safe. One-fifth of women ensure that their youngest child does not practice open defecation. About a third of women have soap present in their household specifically for hand washing, and only 15% have a water station in their household for hand washing.

Bivariate and multivariable associations of maternal social and behavioral factors with a mother's household WASH environment index are shown in Table 3. All seven maternal factors were analyzed together in the multivariable model, regardless of significance at the bivariate level. Also included in the multivariable model were the potential confounders: poverty level, district of residence, and maternal age. The bivariate and multivariate analyses resulted in comparable magnitudes of associations for six of the seven maternal factors; all six of these maternal factors were statistically significantly associated with having a good household WASH environment in the both models. Women who participated in women's empowerment groups were statistically significantly about two-and-a-half times more likely to have a good household WASH environment. Women who participate in household decision-making were twice as likely to have a good household WASH environment relative to women who did not participate in household decision-making. Women who were literate, who had high social capital, and who did not accept hitting from their husbands were independently about 1.5 times more likely to have a good WASH environment. In the bivariate analysis, women who attended antenatal care were about 1.6 times as likely to have a good household WASH environment, an odds ratio, in the adjusted model, that decreased to 1.3 after adjusting for confounders and other maternal factors. Autonomy of movement was not significantly associated with the household WASH environment in either the bivariate or multivariable model.

Associations were also found between maternal social and behavioral factors and the six individual WASH components (Table 4). All seven independent maternal factor

variables were analyzed in six additional multivariable models with each WASH component as a dependent variable, in order to analyze specific WASH behavioral and resource based components with the maternal factors. Also included in each of the six multivariable models were the potential confounders: poverty level, district of residence, and maternal age. Individual WASH components were statistically significantly associated with different combinations of the seven maternal social and behavioral factors. In general, while all maternal social and behavioral factors had an association with either soap or water available for handwashing, women who participate in women's empowerment groups and women with high social capital had the highest odds ratio associated with having soap and water for handwashing. These women were about twice as likely to have soap and water for handwashing than women who were not participating in empowerment groups or had low social capital. All maternal social and behavioral factors had at least one association with having an improved latrine (Household Sanitation) or with washing their hands at three critical times (Household Hygiene), but those who do not accept gender violence and those with high levels of autonomy of movement were about 1.5 times as likely to have an improved latrine and wash their hands at three critical times. Only one maternal factor, high household decision-making, was associated with using at least one method to make water safe (Household Water Quality). Women who attended antenatal care at least once during their last pregnancy and women who have autonomy of movement were each about 1.7 times as likely to ensure their child did not open defecate than women who did not attend antenatal care or did not have autonomy of movement, while the majority of the other maternal factors had no association with child open defecation. Only two findings showed an inverse

association between a maternal social factor and a WASH component: women who had autonomy of movement were slightly less likely to have water available for handwashing than women who did not have autonomy of movement, and women who participated in household decision-making were slightly less likely to wash their hands at three critical times than women with no participation.

In summary, after adjusting for socioeconomic status, district of residence, and maternal age, most maternal social and behavioral factors were statistically significantly associated with the household WASH environment index and a variety of individual WASH components. Overall about 12% of the variation in the household WASH environment can be attributed to these maternal social and behavioral factors (Nagelkerke R-squared = 0.118) (Table 3).

DISCUSSION

Our findings support the hypothesis that maternal social and behavioral factors, specifically participation in women's empowerment groups, participation in household decision-making, not accepting gender violence, moderate/high social capital, maternal literacy, and antenatal care attendance, are associated with a good household WASH environment in rural Ethiopia. Additionally, individual access and behavior specific WASH characteristics were associated with different combinations of maternal social and behavioral factors. The reasons for these associations are likely multidimensional, and may be related to maternal health seeking behaviors, access to WASH knowledge, and access to WASH resources as a result of maternal social factors and behavioral practices.

An essential component to emerging development initiatives, participation in women's empowerment groups, enables women to improve their empowerment status and actions within their families and communities. This factor had the highest odds ratio association with the household WASH environment index, and was associated with 4 of the 6 WASH environment characteristics. One hypothesis to explain this finding is that involvement in women's empowerment groups may expose women to more knowledge sharing through peers or health care providers, which may influence their health behaviors related to WASH. While there are no reported studies that specifically examined participation in women's empowerment groups and the WASH environment, several studies did examine the association of women's empowerment or autonomy with health seeking behaviors (29, 30, 32, 33, 38). For example, a cross-sectional study of the 2005 Ethiopia DHS data found a statistically significant direct association between women's autonomy and health

care-seeking behavior (32). Based on a comprehensive literature synthesis of women's empowerment and child nutrition status in South Asia it was concluded that women's empowerment measured by autonomy, control, and decision-making power in the household is generally associated with child nutritional status (reviewed in [38]). Participation in women's empowerment groups may therefore influence health seeking behavior, or access to health knowledge or activities that may include WASH education or resources, like hand washing with soap. Participation in women's empowerment groups may also serve as a proxy for women's empowerment components not captured by household decision-making, autonomy of movement, or gender violence attitudes.

Household decision-making and gender violence non-acceptance are key components of advancing gender equity and therefore women's empowerment (58), and in this study were statistically significantly associated with a good household WASH environment. Household decision-making was strongly associated with if a household uses at least one method to make drinking water safe. This suggests that a woman's contribution to decision-making is likely key to improving water quality at the household level. In support of this finding, when women have more decision-making influence in the home, more resources go to their children (28). From our results, it is hypothesized that women who have joint decision-making with their husband or are able to make decisions independently may be more likely to choose healthy behaviors related to WASH or to spend money on health-seeking WASH resources, such as latrine materials. While there are no reported studies of associations between household decision-making or gender violence with the WASH environment, current research does indicate that maternal

household decision-making and gender violence acceptance are associated with maternal health service utilization, childhood vaccination, maternal body mass index (BMI), child nutrition status, and child diarrhea incidence (29, 30, 32, 38, 59, 60). For example, a study of 2008 DHS data from Nigeria of currently married women with a child between 12 and 23 months found that women with high household decision-making were more likely to have their child fully immunized than were women with low decision-making, and women who believed that wife beating is not acceptable were also more likely to have their child fully immunized than were women who believed that wife beating was acceptable (30). Another study of eight diverse African DHS datasets found that women with high decision-making were less likely to have a low BMI and more likely to take a child sick with an acute respiratory infection for treatment (29). In addition, women who felt that wife beating is not acceptable were less likely to have a low BMI, slightly more likely to have a facility delivery, and more likely to have a fully immunized child (29). A study on 2003 DHS data from Bolivia found that mothers with high levels of agency and higher levels of education were less likely to report that their child experienced diarrhea (59). A similar study using 2003 DHS data from Indonesia reported that high levels of maternal agency was strongly associated with a decreased prevalence of diarrhea and acute upper respiratory infections in children (60). While these findings do not specifically analyze household WASH environment variables, they do support the hypothesis that high household decision-making abilities and women who do not accept gender violence are more likely to exhibit health seeking behaviors for themselves and their children. These positive health behaviors may ultimately extend to the household

WASH environment, and therefore could influence child health through decreased risk of diarrhea, stunting, and environment enteropathy (EE).

Social capital refers to the features of social relationships, including levels of interpersonal trust, social reciprocity and mutual aid between family and community members. Research on social capital and health is currently limited, but may have an impact on health seeking behaviors or through improved knowledge and access to resources from social connections (61). Like decision-making and gender violence acceptance, research on social capital has primarily focused on maternal health seeking behavior and maternal health outcomes. A cross-sectional study in Tanzania of mothers with children less than five years old found that compared to those in the lowest social capital quintile, delivering in a health facility increased significantly with an increase in social capital level (61). This finding indicates that social capital may influence health-seeking, and ultimately maternal and child health, through increased health seeking behavior. This may be driven by social approval from their peers. Social capital may also influence health seeking behavior in relation to WASH activities and behaviors, or improve knowledge about WASH practices through peer discussion. More research is needed to understand the reasons behind this association.

Maternal literacy, alternatively studied as maternal education level, is one of the most extensively studied maternal factors associated with health outcomes. Our results suggest that literate mothers in rural Ethiopia are more likely to ensure that soap is available for handwashing and wash their hands hands at three critical times than mothers who are

illiterate. In existing literature, maternal literacy or a higher maternal education level was found to be associated with increased health seeking behaviors (32), decreased risk of child stunting and malnourishment (34, 35, 37), and decreased risk of diarrhea (49, 50). Furthermore, women with higher education level in Ethiopia are much more likely to seek health care in the form of antenatal services, use of skilled delivery attendants, and postnatal care (51). Maternal literacy is widely associated with child health outcomes and health seeking behavior, and therefore may be associated with the household WASH environment in this study due to the health-seeking behaviors of literate women. Literate women may also be more likely to have knowledge of WASH behaviors through school courses or other unknown factors.

In our study, antenatal care attendance was included as a proxy to account for an association of a specific maternal health-seeking behavior with the household WASH environment. Our results suggest that women who attend antenatal care at least once during pregnancy are more likely to have a good household WASH environment, more likely to wash their hands and have soap for handwashing, and more likely to ensure that their child does not open defecate than women who do not attend antenatal care at all. In many studies on maternal health seeking behavior, antenatal care attendance is often chosen as a primary exposure or outcome variable, because antenatal care attendance is often used a predictor of maternal health seeking behavior and child health outcomes (46, 51). In our study, the higher health seeking behavior of women who attended antenatal care may account for the association with a good household WASH environment.

Additionally, it is possible that antenatal health care workers provide knowledge to mothers related to WASH behaviors.

Autonomy of movement was unique in that it was the only variable not associated with the household WASH environment index, but had varying directions of association with the specific WASH environment characteristics. While having freedom of movement was significantly associated with washing hands at three critical times and ensuring a child used a potty or diaper, it was also associated with being slightly less likely that the household has water for hand washing. Due to lack of existing research, it is unclear why these results were found. It is possible that having freedom to move outside of the home means that women spend less time in the home. Less time in the home could mean less time to dedicate to maintaining WASH resources, like hand washing stations. Other maternal factors may have a greater positive net influence on the household WASH environment. More research is needed to determine the theoretical explanation behind these varying associations, and the overall net effect on the WASH environment.

The existing literature primarily separates out women's empowerment into more specific factors like decision-making, mobility, health care spending, and gender violence acceptance. Our study is unique in that it used participation in women's empowerment groups as an independent factor. This allowed us to take a specific development initiative—women's empowerment group participation—and associate that participation to the WASH environment, accounting for other possible unmeasured women's empowerment factors in addition to household decision-making and gender violence

acceptance. Our study also utilized dependent and independent factors that can be directly influenced and measured by development and education initiatives, namely specific WASH improvements and women's empowerment and maternal behavioral factors. To our knowledge, this is the first study to examine associations between maternal social and behavioral factors and the WASH environment. However given the hypothesis-generating nature of this study, there were several possible limitations that can be addressed by future research. First, the variables selected for analysis were limited to those available in the CARE N@C dataset, a survey that primarily focused on nutrition and agriculture. A more extensive survey with additional questions about the WASH environment and maternal social and behavioral factors may improve the thoroughness of the research and provide additional findings. Second, it is unknown if WASH or women's empowerment initiatives were implemented in these communities by other NGOs and government programs. Prior initiatives could have created a bias in the data on improved WASH outcomes. Finally, our dataset included only rural Ethiopian residents, excluding information about mothers in larger towns and cities of Ethiopia. While this information would be useful in obtaining results applicable to a broader population, our results present a rural-specific context useful to development programming.

The results from this study indicate the important associations between maternal social and behavioral factors on the household WASH environment in rural Ethiopia, a novel finding. Previous research has shown that the household WASH environment is a key determinant of child health outcomes, specifically stunting, diarrhea, and environmental

enteropathy. If a household's WASH environment is dependent on women's empowerment and social and behavioral factors, as this research suggests, we can create and implement WASH development programs that address women's empowerment with the ultimate goals of improving WASH outcomes and WASH sustainability. With further research, these women's empowerment evidence-based and cross-sectoral WASH programs could be more effective at improving WASH outcomes than existing programs. The improvements in WASH from these enhanced programs could greatly influence child health. There is great potential for future programming and research to incorporate women's empowerment and education into WASH development projects, to reduce stunting, diarrhea, and environmental enteropathy in children.

TABLES

Table 1. Selected characteristics of mothers with children 0-36 months old in northeastern rural Ethiopia, CARE Nutrition at the Center (N@C) 2014 Baseline Survey (N=2,132)

Characteristics	N	%
Maternal age, years		
Mean (standard deviation)	29.0 (6.1)	
Number of living children		
Mean (standard deviation)	3.2 (1.8)	
District[a]		
Tach Giant	855	40.1
Ebinat	715	33.5
Simbada	562	26.4
Poverty level[b]		
Poorest/lower middle	847	39.7
Middle/upper middle	864	40.5
Highest	421	19.7
Empowerment group participation[c]		
Yes	624	29.4
Household decision-making level[d]		
Myself alone/jointly with husband	1,769	83.0
Gender violence attitude		
Does not accept hitting	727	34.1
Social capital[e]		
High	1,212	56.8
Maternal literacy		
Literate	726	34.1
Antenatal care attendance[f]		
Yes	1,350	63.5
Autonomy of movement[g]		
Yes	1,641	77.0
Household WASH[h] environment[i]		
Good	564	26.6

[a] District where participant permanently resides, all located in the northeastern region of rural Ethiopia
[b] Poverty level quintiles equally distribute participants; condensed into three categories for analysis – see Methods
[c] Participates in one or more community, government, or NGO facilitated women's empowerment group; dichotomized to 'yes' and 'no'
[d] Household decision-making determined by participation in decision-making about: personal health, child health, large household purchases, visiting family or friends, money spending, selling assets, work status, family planning, sex, child feeding, and food sharing; dichotomized to 'myself alone/jointly with husband' and 'no/some participation'.
[e] Social capital determined by the level of support a participant receives from her community in the form of childcare, food quantity or quality, health care, and family issues; dichotomized to 'low/somewhat' and 'moderate/high'.
[f] Attended antenatal care at least once during last pregnancy; dichotomized to 'yes' and 'no'.
[g] Ability to go and do as one pleases without permission from another person (typically the husband); dichotomized to 'yes' and 'no'.
[h] Water quality, sanitation, and hygiene practices
[i] A 6-point additive index of household WASH resources and practices, dichotomized to 'poor' (0-3 points) and 'good' (4-6 points) – see Methods

Table 2. Variables included in the 6-point additive index of dependent 'household WASH environment' variable

Variable	**N**	**%**
Presence of soap for hand washing[a]		
Soap present	777	36.4
Water station for hand washing[b]		
Yes	327	15.3
Household sanitation		
Improved toilet[c]	852	40.2
Household hygiene		
Hand washing at all 3 critical times[d]	775	36.4
Household Water Quality		
Use one or more methods to make water safe[e]	531	24.6
Child Open Defecation		
No open defecation[f]	451	21.2

[a] An observed variable indicating if soap is present in a specific place for hand washing; soap can be bar soap, detergent (powder/liquid/paste), liquid soap (including shampoo), and other

[b] An observed variable indicating if water is present in a specific place for hand washing

[c] Improved toilet facilities include: Flush/pour flush to piped sewer system, flush/pour flush to septic tank, flush/pour flush to pit latrine, ventilated improved pit latrine, pit latrine with slab, and composting toilet Unimproved toilet facilities include: Flush/pour flush to elsewhere, flush/pour flush to unknown/not sure, pit latrine without slab/open, bucket, hanging toilet/latrine, no facilities/bush, and other

[d] Three critical times include (1) After toilet use, (2) Before feeing the child, and (3) After changing the baby

[e] Methods to make water safe include: boil water, add bleach/chlorine, strain it through a cloth, use water filter (ceramic/sand/composite), solar disinfection, let it stand and settle, use purifying tables, other

[f] The last time her child defecated, the child used a potty, used a washable diaper, used a disposable diaper, or used a latrine. Open defecation: the child went in his/her clothes, went in the house, went outside of the house/yard, or don't know

Table 3. Associations of maternal social and behavioral factors with having a good WASH[a] environment compared to a poor household WASH environment (CARE Ethiopia N@C Baseline Survey 2014)

Variable	Unadjusted[b] OR(95%CI)[c]	Adjusted[d] OR (95% CI)
Empowerment group participation[e]		
No	1.00	1.00
Yes	2.70 (2.21, 3.31)**	2.59 (2.09, 3.21)**
Household decision-making level[f]		
No/some participation	1.00	1.00
Myself alone/jointly with husband	1.90 (1.42, 2.54)**	1.98 (1.45, 2.69)**
Gender violence attitude		
Accepts hitting	1.00	1.00
Does not accept hitting	1.41 (1.16, 1.72)**	1.59 (1.28, 1.98)**
Social capital[g]		
Low/moderate	1.00	1.00
High	1.69 (1.38, 2.06)**	1.52 (1.23, 1.88)**
Maternal literacy		
Illiterate	1.00	1.00
Literate	1.60 (1.32, 1.96)**	1.43 (1.15, 1.78)**
Antenatal care attendance[h]		
No	1.00	1.00
Yes	1.57 (1.27, 1.93)**	1.30 (1.04, 1.63)*
Autonomy of movement[i]		
No	1.00	1.00
Yes	1.12 (0.89, 1.41)	1.03 (0.80, 1.31)

[a] WASH: Water quality, Sanitation and Hygiene
[b] Bivariate logistic regression of independent variable with WASH environment
[c] OR (95%CI): Odds Ratio (95% Confidence Interval)
[d] Unconditional multivariate logistic regression ORs are adjusted for all other variables in the multivariate model, N = 2,108. Potential confounding variables included in the adjusted model are poverty level, district of residence, and maternal age but are not reported in this Table
[e] Participates in one or more community, government, or NGO facilitated women's empowerment group
[f] Household decision-making determined by participation in decision-making about: personal health, child health, large household purchases, visiting family or friends, money spending, selling assets, work status, family planning, sex, child feeding, and food sharing
[g] Social capital determined by the level of support a participant receives from her community in the form of childcare, food quantity or quality, health care, and family issues
[h] Attended antenatal care at least once during last pregnancy
[i] Ability to go and do as one pleases without permission from another person (typically the husband)
* p-value <0.05
** p-value ≤ 0.001

Table 4. Associations of maternal social and behavioral factors with specific WASH[a] environment characteristics, adjusting for poverty level, district of residence and maternal age (CARE Ethiopia N@C Baseline Survey 2014)

Variable	Soap for Hand Washing Adjusted[b] OR (95%CI)[c]	Water for Hand Washing Adjusted OR (95%CI)	Household sanitation Adjusted OR (95%CI)	Household Hygiene Adjusted OR (95% CI)	Household Water Quality Adjusted OR (95%CI)[d]	Child Open Defecation Adjusted OR (95%CI)
Empowerment group participation[e]						
No	1.00	1.00	1.00	1.00		1.00
Yes	1.98 (1.62, 2.42)***	2.14 (1.66, 2.75)***	1.41 (1.15, 1.73)***	1.33 (1.08, 1.64)**		1.14 (0.90, 1.44)
Household decision-making level[f]						
No/some participation	1.00	1.00	1.00	1.00	1.00	1.00
Myself alone/jointly with husband	1.14 (0.88, 1.46)	1.80 (1.24, 2.60)**	1.09 (0.85, 1.40)	0.74 (0.58, 0.94)*	2.72 (1.96, 3.78)***	1.27 (0.94, 1.71)
Gender violence attitude						
Accepts hitting	1.00	1.00	1.00	1.00	1.00	1.00
Does not accept hitting	1.00 (0.82, 1.23)	1.53 (1.18, 1.99)***	1.56 (1.28, 1.89)***	1.56 (1.28, 1.89)***	0.88 (0.71, 1.10)	1.40 (1.12, 1.76)**
Social capital[g]						
Low/somewhat	1.00	1.00	1.00	1.00	1.00	1.00
Moderate/high	1.83 (1.51, 2.22)***	1.76 (1.35, 2.29)***	1.52 (1.26, 1.83)*	1.29 (1.07, 1.56)**	0.97 (0.79, 1.19)	0.93 (0.75, 1.16)
Maternal literacy						
Illiterate	1.00	1.00	1.00	1.00	1.00	1.00
Literate	1.30 (1.06, 1.59)*	1.06 (0.81, 1.38)	1.15 (0.94, 1.41)	1.29 (1.06, 1.59)*	1.14 (0.91, 1.41)	1.25 (0.99, 1.57)
Antenatal care attendance[h]						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.35 (1.10, 1.64)**	1.07 (0.82, 1.40)	1.17 (0.97, 1.42)	1.25 (1.02, 1.52)*	1.01 (0.81, 1.25)	1.68 (1.32, 2.13)***
Autonomy of movement[i]						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	0.84 (0.67, 1.05)	0.71 (0.53, 0.94)*	1.07 (0.86, 1.33)	1.52 (1.21, 1.92)***	0.89 (0.70, 1.13)	1.63 (1.24, 2.15)***

[a] WASH: Water quality, Sanitation and Hygiene
[b] Unconditional multivariable logistic regression ORs are adjusted for all other variables in the multivariate model
[c] OR (95%CI): Odds Ratio (95% Confidence Interval)
[d] Empowerment group participation removed from model due to violation of goodness of fit test
[e] Participates in one or more community, government, or NGO facilitated women's empowerment group
[f] Household decision-making determined by participation in decision-making about: personal health, child health, large household purchases, visiting family or friends, money spending, selling assets, work status, family planning, sex, child feeding, and food sharing
[g] Social capital determined by the level of support a participant receives from her community in the form of childcare, food quantity or quality, health care, and family issues
[h] Attended antenatal care at least once during last pregnancy
[i] Ability to go and do as one pleases without permission from another person (typically the husband)
* p-value <0.05
** p-value < 0.01
*** p-value =<0.001

Chapter III: Public Health Implications

The findings of this research suggests that women's empowerment, as represented by maternal social and behavioral factors, is associated with the household WASH environment in Ethiopia. There are several potential public health implications for child and family heath, research and development programming.

- This is the first study to examine if women's empowerment factors are associated with the household WASH environment, adding a new layer to the connection between empowerment and health
- Mothers who are empowered may practice behaviors or have access to resources that contribute to a better WASH environment, and ultimately lead to better child health at the household level due to a decrease in WASH associated diarrhea, malnutrition, and environmental enteropathy
- This study supports further research to examine if women's empowerment is associated with the WASH environment in other contexts in Ethiopia, sub-Saharan Africa, or beyond
- Programming to address WASH that incorporates a component of women's empowerment may lead to better WASH outcomes. This study supports implementing programming and research to examine if this hypothesis holds.
- Programming to address malnutrition that incorporates a component of women's empowerment may lead to better nutrition outcomes, due to a possible impact on WASH related malnutrition. This study supports implementing programming and research to examine if this hypothesis holds.

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