Dietary Outcomes, Nutritional Status and Household WASH Practices

Oyedolapo Anyanwu (1), Shibani Ghosh (1), Meghan Kershaw (1), Abuye Cherinet (2), Eileen Kennedy (1,3)

1. Tufts University, Friedman School of Nutrition Science and Policy, Boston, MA
2. Save the Children, Addis Ababa, Ethiopia
3. Corresponding Author: 150 Harrison Avenue, Boston, MA 02111, Eileen.Kennedy@Tufts.edu

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Authors have no conflicts of interest to declare.

Abbreviations used: BMI, body mass index; ENGINE, Empowering New Generations for Improved Nutrition and Economic Opportunities; GoE, Government of Ethiopia; MDD, minimum dietary diversity; MUAC, mid-upper arm circumference; NNP, National Nutrition Program; SDGs, Sustainable Development Goals; SUN, Scaling Up Nutrition; TP, time point; WASH, water, sanitation and hygiene

Summary
In Ethiopia, improvements in water, sanitation and hygiene significantly improved a woman’s minimum dietary diversity and mid-upper arm circumference.
Abstract

**Background:** The Government of Ethiopia has made a major commitment toward improving food security, diet, nutrition, and health through a series of national nutrition plans. The focus of these plans is on providing both nutrition specific as well as nutrition sensitive approaches for achieving national priorities for health and nutrition. The present study conducted a secondary analysis of data provided through a larger birth cohort study conducted in Ethiopia between 2014 and 2016. **Objectives:** The overall objectives of this research were to assess the relationship between minimum dietary diversity in women and Water, Sanitation and Hygiene (WASH), and evaluate the association between mid-upper arm circumference (MUAC) in women and WASH. **Methods:** In addition to descriptive statistics, the study used mixed effects logistic regression analyses to investigate the relationship between dietary diversity, MUAC and household WASH practices. **Results:** Improved WASH practices were associated with an increased probability (p = .0.040) that a woman would consume a diet with foods from five or more food groups. A beneficial effect was observed for improved WASH practices and a decrease in low MUAC. Improved household WASH practices were successful in contributing to improved dietary diversity in women as well as an improved MUAC. **Conclusions:** Interventions aimed at improving the diet and nutritional status of women during and after pregnancy should include relevant WASH components as essential elements in multi-sector nutrition programming. **Keywords:** Dietary diversity; WASH; MUAC; food groups; multi-sector; ENGINE
Introduction

Global nutrition initiatives such as the Scaling Up Nutrition Movement (SUN) (1) and USAID Feed the Future (2) emphasize a multi-sector approach to improving diet, health, and nutrition, with a particular emphasis on the first 1000 days. Within this context, the Government of Ethiopia (GoE) has made a major commitment toward improving food security, diet, nutrition, and health. These commitments are evident in the National Nutrition Strategy, the series of National Nutrition Plans (NNP), and the Seqota Declaration, which vows to end stunting in children less than two years of age by 2030 (3). Within the nutrition portfolio of the GoE, there is a particular emphasis on vulnerable groups including pregnant and lactating women and children up to age two – a group commonly referred to as the first 1000 days.

The NNP I and II (3) were based on the premise that both direct, specific approaches as well as nutrition sensitive policies and programs are needed to improve nutrition in Ethiopia due to the myriad number of underlying drivers of unhealthy diets and poor nutritional status. While some focused, nutrition specific interventions (vitamin A supplementation) have demonstrated effectiveness (4-5), the GoE has employed a multi-sector strategy to achieve the nutrition objectives in their nutrition programs since research suggests that nutrition specific interventions, by themselves, are often insufficient in achieving the goals for improving nutrition and health (4-5). Examples of nutrition specific interventions include those that address the immediate causes of maternal, fetal and preschooler malnutrition (5). These approaches can include improving maternal diets, improving prenatal access to health care, maternal education, micronutrient supplementation, and disease prevention, to name a few. Nutrition sensitive interventions address the underlying determinants of health and nutrition and focus on sectors outside the health
domain. These strategies can include nutrition sensitive agriculture and improving the water, health, and sanitary environment of the household (6).

To that end, ENGINE (Empowering New Generations for Improved Nutrition and Economic Opportunities), a USAID-funded project, was implemented in Ethiopia from 2011 to 2016. ENGINE used a multi-sectoral approach to achieve the goals articulated in the NNP. Chief among the objectives of the NNP was improved diet quality, nutritional status, and health of women and preschool-aged children.

Many factors influence a woman’s nutritional status, foremost among them is diet and nutritional status prior to pregnancy. An equally important predictor of women’s nutritional status is the overall water, health, and sanitation environment faced by households (7).

The purpose of the present paper is twofold: (1) to assess the relationship between minimum dietary diversity in women (MDD) and WASH and (2) to evaluate the association between mid-upper arm circumference in women (MUAC) and WASH.

**Methods**

As part of the ENGINE project, a longitudinal birth cohort study was implemented from 2014 to 2016 in three woredas (districts) of Oromiya, including Woliso, Goma and Tiro Afeta. The study sites were entirely rural. The present paper is based on secondary analysis of extant data derived from a more extensive birth cohort study; details on the protocol used are provided in a separate publication (7). The overall goal of the study was to assess the effects of a multi-sectoral strategy to improve health and nutrition among pregnant women and children under two years of age. Pregnant women (n=4,680) were recruited using a rolling enrollment and surveillance approach. The women were identified by health workers with pregnancy being confirmed via a urine test.
The age range of women was 15 to 50 years; estimated gestation at time of enrollment in the study was 12 to 32 weeks. The data were collected every three months starting in pregnancy, at birth, 3-, 6-, 9- and 12-months post-partum. Data on the household, the pregnant woman, and her child were collected throughout the duration of the study. The present paper is limited to a discussion of women’s minimum dietary diversity, mid-upper arm circumference and household WASH practices. Data on study time points, household wealth and the education of the head of household were used to control for potential confounding factors.

Descriptive statistics were calculated for the mother and study child: mean, percentages (%) to characterize the distribution of mothers’ weight, weight status, and proportion of low-MUAC, from birth of infants to one year. Weight status was derived using BMI formula: kg/m² and WHO BMI cut-offs: underweight = <18.5; normal weight = 18.5 to <25; overweight and obese >=25 to <30. Next, the distribution of the minimum dietary diversity for women (MDD) was examined by the levels of household WASH practices; the MDD has been demonstrated to be a valuable proxy indicator for the nutrient adequacy of the diet (8). MDD was defined as having consumed five or more food groups (of a total of 10 food groups) in the past 24 hours and is presented as a proportion of women who have met the MDD. Low-MUAC was defined as MUAC <23cm (4). The focus was on low-MUAC rather than weight as an outcome of interest in this analysis because it is often considered a more valid indicator for undernutrition in pregnant women (7). Although our analyses are for the post-pregnancy period, weight retention due to pregnancy could still bias the results.

To assess the WASH behaviors of households, data were combined on household water source and use, sanitation and hygiene practices to develop a composite WASH score. The WASH score was stratified into quintiles of WASH practice: level one = poor WASH level; level two = fair
WASH level; level three = good WASH level; and level 4 = very good WASH level (9). The household water source/use measured whether there was rainwater harvesting and storage of water separately in the household; the sanitation and hygiene component was based on the method of waste disposal including the presence of a garbage pit, trash discarded in the garden, bush or open burning, toilet/latrine use for defecation and urination, child handwashing following defecation, and mother’s handwashing prior to food preparation and before serving a meal and the child eating.

The wealth index was derived from household data based on a principal component analysis that included housing conditions and availability of basic services like treated water and electricity; the index was then categorized into quintiles (7).

Finally, a mixed effects logistic regression analysis was used to investigate the relationship between MDD and household WASH practices. Although data was collected for MDD and MUAC across all study time points (pregnancy, at birth, 3-, 6-, 9- and 12-months post-partum), household WASH variables were assessed only at three time points (pregnancy, three- and nine-months post-partum.). Thus, the analyses focused on the timepoints for which there was complete data for all variables of interest. To assess the relationship between MDD and WASH, time point (TP) one was eliminated from the analyses and only data for three months and nine months post-partum was used due to the methodological difference in capturing dietary intake at pregnancy (use of quantitative 24hr recall) relative to the other study time points where qualitative 24hr recalls were used (n=7,812). For the MUAC and WASH relationship, data at three time points were used: pregnancy, three months, and nine months post-partum (n= 11,506).
Results

Distribution of mothers’ anthropometrics from birth of infant to one year (TP3 to TP7):

Weight, Weight Status and MUAC

Table 1 presents data on the mean weight of women from time point three (birth of study child) to time point seven (one year of age of study child). Maternal weight gain during pregnancy was not available; data on preconception weights were also not available and women entered the birth cohort study at varying points of time, making measurement of weight gain during pregnancy impractical. As noted, MUAC is considered a good proxy for nutritional status of women.

As shown in Table 1, the mean weight of mothers, not surprisingly, was highest at time point three – birth of the infant. Maternal weight decreased progressively from birth through 12 months post-partum (end of the study). The declining weight across the time periods is due in part to loss of prenatal weight gain; however, as already indicated, the exact contribution of pregnancy weight gain to this weight loss cannot be ascertained.

Most women have weights (Figure 1) within the normal range (BMI of 18.5 to 24.99). However, the proportion of women in the normal weight category steadily decreased from about 85% at birth of infant to 70% at 12 months post-partum. Conversely, the proportion of underweight women increased from 8% at birth of infant to about 28% at 12 months of infant, a 20-percentage points difference. Overweight and obesity were less common in women.

Figure 2 shows the distribution of mothers with low-MUAC from birth till 12 months post-partum. The proportion of mothers with low-MUAC markedly reduced from 46.75% at birth of infant to about 36% at infant age of three months, but mothers became progressively thinner
from infant age of six months to 12 months. This makes sense, because during the period of birth to three months of child age, mothers typically have a better diet with higher intake of animal source foods and more diet diversity. The traditional diet of Ethiopian women in rural areas has limited diet variety, based primarily on a basic staple (10).

Women's Dietary Outcome and Household WASH Practices

Table 2 shows a positive relationship between MDD and household WASH practice at ages three to six months of infants. The proportion of women meeting the MDD increased dramatically from 8.8% to 21.5% in tandem with higher levels of household WASH practices (p<0.0001).

A similar beneficial effect was observed for improved household WASH behaviors on the proportion of mothers with low-MUAC across three time points - the percentage of women with low MUAC decreased from 44.1% to 35.3% in the highest WASH category (Figure 3).

Do Household WASH behaviors significantly predict mother's dietary outcomes?

Table 3 presents the results for the association between the proportion of women meeting MDD and WASH scores. The model in Table 3 was adjusted for study time point, wealth quintile, and education level of head of household. When the WASH score was divided into quartiles of WASH practices, the odds of achieving MDD were significant (p = 0.040).

Compared with households with poor WASH scores, women from households in the fair WASH level had 24% increased odds of meeting the MDD for the good and the very good WASH levels, the odds of meeting the MDD increased by 45% and 41% respectively.

The association between low MUAC and the household WASH score was significant (p =0.017) (Table 4). For every unit increase in the household WASH score, the odds for a low MUAC decreased. Compared to a household with a poor WASH score, households in the fair WASH
category had 20% reduced odds for a low MUAC. The improvement in women’s MUAC was a reduced odds of 29% and 25% for those in the good and very good categories respectively.

Discussion

The Sustainable Development Goals (SDGs) announced by the United Nations in 2015 (11) stress the availability of clean water and proper sanitation as critical elements for achieving SDG six – global health. In Ethiopia, of the total population, only 38% have access to a safe drinking water source and only 12 percent use improved sanitation facilities (12). Thus, the issue of lack of water and sanitation facilities is one concern of the GoE that is reflected in the multi-sector nutrition plans.

Much of the research on the effects of WASH interventions on nutrition have focused on preschool-aged children, and to a lesser extent, on pregnant and lactating women (13). There is clear evidence that effective WASH interventions reduce malnutrition levels by reducing enteric infections through improved water and sanitation in low- and middle-income countries (14).

The research on the effectiveness of individual components of WASH on decreasing malnutrition and/or improving nutritional status provides mixed results (13; 15-20). Several reasons account for this ambiguity; many studies have examined only certain components of WASH and not the range of practices in the entire domain of water and sanitation. The impact indicator in evaluating WASH varies, with most typically a measure of underweight, stunting, or rates of diarrhea in children used to assess impact. The research designs and length of WASH interventions have varied from several months to several years. These combined factors make it impossible to derive consensus on the most effective WASH policies and programs.
The data presented in this brief are one of the first instances in which the association between women’s dietary diversity, mid-upper arm circumference, and household WASH practices have been documented. The results are encouraging. Both the minimum dietary diversity and mid-upper arm circumference in women improved as the household WASH scores improved. As noted, the odds of improved MDD increased anywhere from 24% to 45%. Similarly, the probability of a low MUAC within the WASH categories decreased from 20% to 29% as the WASH scores improved.

There are three components of any intervention that are important in assessing effectiveness: impact; feasibility/practicality; sustainability. The positive impact of improved WASH on the dietary outcomes of women is unambiguous from the results presented. Improved dietary diversity and nutritional status, as measured by MUAC, were evident as the quality of WASH at the household level improved. Thus, the positive impact of WASH practices has been demonstrated as part of the ENGINE multi-sector nutrition project.

This study used a composite indicator to reflect WASH; this included measures of water source and use, waste disposal methods, latrine/toilet use, and handwashing practices around cooking, preparing, and serving foods, as well as child feeding behaviors. Improvements in each of these components were feasible in the areas targeted by ENGINE.

Finally, the issue of sustainability of interventions is essential to ensure that the positive impacts are sustained. The investments in WASH infrastructure – improved water sources and harvesting, and improved sanitation facilities are likely to be sustained in the longer term. What is less clear is whether the behaviors that were promoted in handwashing techniques and hygienic practices related to child feeding will be similarly maintained. The evidence from successful behavior change campaigns has stressed the fact that these approaches must be
regularly updated and revitalized to ensure long term positive effects (13). Strategies to refresh communications around WASH activities should be a part of future nutrition plans in Ethiopia.

Conclusions

Improved WASH activities were successful in contributing to improved dietary diversity in women as well as an improved MUAC. Interventions aimed at enhancing the diet and nutritional status of women during and after pregnancy should include relevant WASH components as essential elements in multi-sector nutrition programming.

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Author Contributions

SG conceptualized the study design; OA, SG, MK, AC, EK participated in the analysis and writing of the paper.

Ethical issues

Ethical approval was granted from the Institutional Review Board of Jimma University in Ethiopia (RPGC/264/2013) and Tufts University in USA (Tufts Health Sciences Campus IRB reference number: 11088) before commencement of the study. Informed consent was obtained from the participants after a detailed explanation of the objectives of the study. Data was registered and stored in a secured server and access to the data was upon permission of the principal investigators with personal identifiers removed. During the study, women or infants who experienced health problems were referred to a nearby health facility for proper medical care.
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Figure 1: Mother’s weight status over time.
Figure 2: Proportion of low-MUAC in mothers over time
Figure 3: Low-MUAC by HH Wash Practice level in pregnancy, at 3-and 9-months post-partum
Abbreviations

MDD = Minimum Dietary Diversity

MUAC = Mid-Upper Arm Circumference

WASH = Water, sanitation and hygiene
| Study Time Point | Months Post-Partum | No of observations | Mean weight in kg (SD) | Min  | Max  |
|------------------|-------------------|--------------------|------------------------|------|------|
| TP3              | Birth             | 4,427              | 52.98 (6.59)           | 31.33| 86.22|
| TP4              | 3 months          | 4,193              | 51.16 (6.50)           | 32.83| 86.07|
| TP5              | 6 months          | 4,068              | 50.17 (5.36)           | 31.52| 83.43|
| TP6              | 9 months          | 4,002              | 49.45 (6.24)           | 31.53| 81.92|
| TP7              | 12 months         | 3,601              | 48.89 (6.12)           | 31.63| 80.65|
| **Total**        |                   | **20,291**         | **50.62 (6.54)**       | **31.33**| **86.22**|
Table 2

| WASH Practice levels (n=8,197) | No. of observations | MDD-met Yes (%) | t    |
|--------------------------------|---------------------|----------------|------|
| 1                              | 2,250               | 8.80           |      |
| 2                              | 2,888               | 13.30          |      |
| 3                              | 1,109               | 18.49          |      |
| 4                              | 1,950               | 21.54          |      |

Notes: Wash Practice level created by summing WASH variables into a score, from 0 to 16, and then categorizing into quartiles of WASH practice: 1= "Poor WASH Practice"; 2 = "Fair WASH Practice"; 3 = "Good WASH Practice"; 4 = "Very Good WASH Practice"
Table 3

| Outcome Var: | MDD met (yes/no) | MDD met (yes/no) |
|--------------|------------------|------------------|
|              | (Model 1: Unadjusted univariate) | (Model 2: Adjusted) |
| Wash Practice | OR    | 95% CI   | P-value | OR    | 95% CI   | P-value |
| Wash score   | 1.08  | 1.103–1.14 | 0.001** | 1.05  | 1.00–1.10 | 0.068   |
| WASH Practice Quartiles | | | | | | |
| 1 Ref. - Ref. | - | - | | Ref. - Ref. | - | - |
| 2            | 1.31  | 1.06–1.62 | 0.012* | 1.24  | 1.003–1.54 | 0.047* |
| 3            | 1.60  | 1.23–2.09 | 0.001** | 1.45  | 1.10–1.89 | 0.007* |
| 4            | 1.69  | 1.30–2.20 | 0.0001*** | 1.41  | 1.08–1.85 | 0.012* |
| P-trend      | 0.0007** | | | P-trend | 0.040* |

Notes: n=7,812. 1Model 2 adjusted for: study timepoint, wealth quintile and household head education level. WASH Practice Quartiles: 1=Poor; 2=Fair; 3=Good; 4=Very Good. P-values: * indicates statistical significance at 5%, ** at 1%, and *** at 0.1% level of significance.
Table 4

| Wash Practice | OR     | 95% CI    | P-value | OR     | 95% CI    | P-value |
|---------------|--------|-----------|---------|--------|-----------|---------|
| Wash score    | 0.92   | 0.88 – 0.96 | 0.0001*** | 0.94   | 0.90 – 0.99 | 0.008*  |
| WASH Practice Levels |         |           |         |        |           |         |
| 1             | Ref.   | -         | -       | Ref.   | -         | -       |
| 2             | 0.77   | 0.65 – 0.91 | 0.002*  | 0.80   | 0.68 – 0.95 | 0.009*  |
| 3             | 0.66   | 0.52 – 0.83 | 0.0001*** | 0.71   | 0.56 – 0.90 | 0.005*  |
| 4             | 0.67   | 0.53 – 0.84 | 0.001**  | 0.75   | 0.59 – 0.96 | 0.022*  |
| P-trend       | 0.0006** |           |         | P-trend | 0.017*    |         |

Notes: n=11,506. \(^1\)Model 2 adjusted for: study timepoints, wealth quintile and household head education level. WASH Practice Quartiles: 1=Poor; 2=Fair; 3=Good; 4=Very Good. P-values: * indicates statistical significance at 5%, ** at 1%, and *** at 0.1% level of significance.