



The Role of Household Assets in Improving Women's Dietary Diversity in Ethiopia

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ABSTRACT

Background: ENGINE (Empowering New Generations for Improved Nutrition and Economic Opportunities) was a US Agency for International Development (USAID)-funded project implemented in Ethiopia from 2011 to 2016. ENGINE used a multisectoral approach to achieve the goals articulated in the Government of Ethiopia's National Nutrition Plan, among which is improvement in the dietary intakes of women and preschool-aged children.

Objectives: The objectives of the present research are 2-fold: 1) to document trends in women's dietary diversity (WDD) and 2) to identify factors associated with dietary diversity for women.

Methods: Descriptive statistics and multivariate, pooled analyses were calculated.

Results: Results indicate that WDD was low, ranging, on average, from 3.0 to 4.0 (out of a possible 10). Across the time points covered reflecting pregnancy and 1-y postpartum, only ~13% to 17% of women met the Minimum Dietary Diversity Score for Women (MDD-W).

Conclusions: The production of both food and cash crops and the rearing of livestock were significant predictors of improved dietary diversity in women. The focus of ENGINE on a diverse set of agricultural activities improved WDD and MDD-W in a population of women where dietary diversity is poor. *Curr Dev Nutr* 2022;6:nzab131.

Keywords: diet diversity, women, pregnancy, Ethiopia, vitamin A-rich foods, animal-source foods

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Manuscript received July 26, 2021. Initial review completed October 14, 2021. Revision accepted October 25, 2021. Published online October 30, 2021.

Supported by Feed the Future, the US Government's Global Hunger and Food Security Initiative, through the US Agency for International Development, under the terms of agreement no. AID-633-A-16-0007.

Author disclosures: The authors report no conflicts of interest. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the US Agency for International Development.

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Abbreviations used: ENGINE, Empowering New Generations for Improved Nutrition and Economic Opportunities; GOE, Government of Ethiopia; MDD-W, Minimum Dietary Diversity Score for Women; NNP, National Nutrition Program; USAID, US Agency for International Development; WDD, women's dietary diversity.

Introduction

A woman's nutritional status before and during pregnancy affects birth outcomes. Poor nutritional status during pregnancy is associated with increased rates of low birth weight, prematurity, and increased infant morbidity and/or mortality (1). In Ethiopia, the statistics are not encouraging: 27% of women of child-bearing age, 26% of adolescents, and 26% of pregnant women are underweight (2).

Many factors influence a woman's nutritional status, chief among them is diet. Suboptimal diets are the major contributor to the global burden of disease and one of the most modifiable factors for improved health and nutrition (3). The National Nutrition Program (NNP) of the Government of Ethiopia (GOE) (4) has focused on improving the health and nutritional status of pregnant women and children up to age 2, using a combination of direct, nutrition-specific interventions combined with nutrition-sensitive approaches. A basic premise of the NNP is that direct nutrition interventions alone will be insufficient to achieve the goals and objectives embedded in the GOE strategies due to the mul-

iple underlying drivers of diet and nutrition. Examples of nutrition-specific interventions include those that address the immediate causes of maternal, fetal, and preschooler malnutrition (5). These approaches for women 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.

ENGINE (Empowering New Generations for Improved Nutrition and Economic Opportunities) was a US Agency for International Development (USAID)-funded project implemented in Ethiopia from 2011 to 2016. ENGINE used a multisectoral approach to achieve the goals articulated in the NNP. Chief among the objectives of the NNP was an increase in the production and consumption of nutrient-rich foods for women and children. An extensive literature review has shown that increased dietary diversity of nutrient-rich fruits, vegetables, and animal-source foods contributes significantly to an improved quality of consumption patterns for women and children (6). A prime objective of

TABLE 1 Percentage of women reporting the consumption of vitamin A–rich foods in the past 24 h

Study time point (TP)	No. of observations	Percentage consuming vitamin A–rich foods	Percentage consuming animal-source foods
TP2	900	10.22	24.44
TP3	4052	6.22	46.47
TP4	4197	5.84	18.89
TP5	4073	6.97	18.41
TP6	4005	7.24	18.60
TP7	3603	6.16	19.09
Total	20,830	6.65	24.38

ENGINE was implementation of approaches to enhance the dietary diversity in vulnerable groups. The Feed the Future Ethiopia Growth through Nutrition Activity (GtN) is the follow-on program to ENGINE, which was implemented from 2016 to 2021 and builds upon the legacy and activities of ENGINE.

The purpose of the present paper is 2-fold: 1) to document trends in women's dietary diversity (WDD) and 2) to identify factors associated with dietary diversity for women from research conducted under ENGINE in order to better inform multisectoral nutrition programming including Growth through Nutrition.

Birth Cohort Study

As part of the ENGINE project, a longitudinal birth cohort study was implemented from 2014 to 2016 in 3 districts—Goma, Waliso, and Tiro Afeta—covering only rural areas. The overall goal of the study was to assess the effects of a multisectoral strategy to improve health and nutrition among pregnant women and children under 2 y of age. Pregnant women ($n = 4680$) were recruited using a rolling enrollment protocol. The women were identified by health workers with pregnancy confirmed by a urine test. The age range of women was 15 to 50 y; estimated gestation at time of enrollment in the study was 12 to 32 wk. Data collection started in pregnancy and ended at 12 mo postpartum. Data on the household, the pregnant woman, and her child were collected through the duration of the study. More details on household and women's characteristics are provided elsewhere (7). The present article is limited to a discussion of WDD. The study conducted pooled analyses to assess WDD across 7 time points starting at birth ($n = 24,158$). The FAO-recommended Minimum Dietary Diversity Score for Women (MDD-W) is used as the metric to assess WDD (6). The MDD-W has been demonstrated to be a valuable proxy indicator for the nutrient adequacy of a diet. For time period 1, WDD was derived from a quantitative 24-h recall, whereas for time periods 2–7, the WDD was a count of food groups consumed in the previous 24 h and presented as a mean value. Because of the difference in the protocols used, most of the tables concentrate on time periods 2 to 7. The MDD-W was defined as having consumed 5 or more food groups (from a total of 10 food groups) in the past 24 h and is presented as a proportion of women who have met the MDD-W.

Ethical approval was granted from the Institutional Review Board of Jimma University in Ethiopia (RPGC/264/2013) and Tufts University in the United States (Tufts Health Sciences Campus Institutional

Review Board 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 were 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 had health problems were referred to a nearby health facility to seek proper medical care.

Does Dietary Diversity in Women Vary over Time?

The average WDD was low across all 7 time periods, ranging from a mean of 2.37 to 3.51. Across all time points, the mean WDD was below the target of 5 food groups.

The proportion of women meeting the MDD-W was also low in each of the time periods, ranging from 12.9% to 20.3%, with the percentage of women meeting the MDD-W being highest at time point 3, reflecting the time of birth of the study child.

While the overall proportion meeting the MDD-W was low over time, assessing MDD-W by the type and number of crops that a household produces shows an interesting pattern. The proportion of women meeting the MDD-W stratified by the number of food crops produced by the household ranged from a low of 10.9% for those households producing zero food crops to a high of 26.9% for those producing 6 food crops. The food crop categories included cereals, fruit trees, roots and tubers, vegetables, pulses, and herbs and spices. The percentage of women meeting the MDD-W more than doubles from households producing no food crops to those cultivating 6 food crops (irrespective of type of food crop).

The relation between MDD-W and household production was explored further by stratifying MDD-W by number of livestock owned by the household. Livestock included cattle, mule or horse, ruminants, poultry, and beehives. There was no difference in the proportion meeting the MDD-W by number of livestock per household. These descriptive data are explored further in the next section, which elucidates the determinants of MDD-W.

The ENGINE project also promoted increased consumption of vitamin A–rich fruits and vegetables and animal-source foods (which can also be good sources of vitamin A). **Table 1** highlights the percentage of women eating vitamin A–rich fruits and vegetables and animal-source foods in study time periods 2 to 7. Consumption of any vitamin A–rich fruits and vegetables was low in each of the time periods, with an average across all the time periods of only 6.65%.

TABLE 2 Association between the WDD score and household agricultural asset types¹

Outcome variable: household agricultural assets	WDD score		
	B (SE)	95% CI	P
Agricultural land	0.06 (0.02)	0.04, 0.09	0.0001***
Farm equipment	0.10 (0.02)	0.06, 0.14	0.0001***
Food crops	0.05 (0.01)	0.04, 0.07	0.0001***
Nonfood crops	0.11 (0.02)	0.07, 0.14	0.010*
Livestock	0.06 (0.01)	0.05, 0.08	0.0001***

¹ $n = 24,158$. Each row represents a single mixed-effects model adjusted for study timepoint, wealth quintile, and program participation. *P* values: *Significant at the 5% and ***0.1% level of significance. WDD, women's dietary diversity.

There is a difference, however, in the pattern of consumption of animal-source foods. First, there is a higher percentage of women eating any animal-source foods when compared with vitamin A-rich fruits and vegetables, averaging 24.38% over the entire time. Worth noting is the fact that time point 3 shows a noticeably higher intake of animal-source foods, which coincides with the period of birth of the study child.

Is Women's Dietary Diversity Score Related to Household Agricultural Assets?

It was important to ascertain the association between a household's availability of agricultural assets and WDD, in part, to better understand possible policy and programmatic levers that could be used to enhance diet quality. This relation was assessed using 1) the mean WDD for women and 2) the percentage of women meeting the MDD-W.

Table 2 summarizes the results of multivariable mixed-effects linear regression analysis that examined the association of mean WDD and specific household agricultural assets adjusted for study time point, household wealth quintile, and program participation. The household assets included agricultural land availability, farm equipment, production of food crops, production of nonfood crops, and livestock ownership. Wealth quintile was estimated from a construction of wealth index based on a principal component analysis of survey respondents' housing conditions and availability of basic services like treated water and electricity, and then categorized into quintiles. Program participation was a binary indicator for whether the index woman participated in 1 or more nutrition-related events.

All agricultural assets were significantly associated with mean WDD. In the adjusted model, for every 1-unit increase in agricultural land available to households, WDD score significantly increased by 0.06 points ($P < 0.001$). The presence of farm equipment, whether mechanized or nonmechanized or both, was significantly associated with an increase in the WDD score by 0.10 points ($P < 0.0001$). Households that produced food crops had significantly higher WDD. WDD score was predicted to increase by 0.05 points ($P < 0.001$). In addition, the production of nonfood crops (cash crops and oil seeds) also contributed significantly to an improved WDD for women; for each 1-unit increase in the type of nonfood crops grown by the household, WDD score increased by 0.11 points ($P = 0.01$). Thus, the production of both food and nonfood crops is a significant predictor of improved diet quality in women. Finally, livestock production was also a significant predictor of

TABLE 3 Association between women's MDD-W (all TPs) and household agricultural assets availability (TP1)¹

Outcome variable: household agricultural assets	MDD-W met (yes/no) (model 2: adjusted ²)		
	OR	95% CI	P
Agricultural land	1.10	1.01, 1.19	0.024*
Farm equipment	1.23	1.10, 1.38	0.0001***
Food crops	1.13	1.09, 1.18	0.0001***
Nonfood crops	1.36	1.21, 1.52	0.0001***
Livestock	1.15	1.11, 1.20	0.0001***

¹ $n = 24,158$. *P* values: *Significant at 5% and ***0.1% level of significance. MDD-W, Minimum Dietary Diversity Score for Women; TP, time point.

² Model adjusted for study time point, wealth quintile, and program participation.

improvement in the WDD score; for each 1-unit increase in livestock raised by households, women's WDD score improved by an increase of 0.06 points ($P < 0.0001$).

The study also examined the association between the proportion of women meeting the MDD-W and household assets. As shown in **Table 3**, a 1-unit increase in the type of agricultural land available to households significantly predicted higher odds of a woman meeting the minimum dietary diversity by 10%. The availability of 1 or more types of farm equipment was significantly associated with 23% increased odds of women meeting the MDD-W. The cultivation of food crops and non-food crops were both significant predictors of an increased odds of women meeting the MDD-W by 13% and 36%, respectively. Finally, the presence of livestock was associated with MDD-W, with each 1-unit increase in number of types associated with 15% increased odds of meeting the MDD-W.

A final model was developed to ascertain whether disaggregating household assets into categorical variables had any association with a woman meeting the MDD-W. As shown in **Table 4**, having any type of farm equipment (compared to none) was significantly associated with a 23% increased odds of meeting the MDD-W. For food crops, the odds of meeting the MDD-W were significant only when 2 or more types of food crops were grown within the household. The availability of 2 types of food crops is associated with a 40% higher odds of achieving the MDD-W. For 3 crops cultivated, the odds increased by 46%, for 4 types of crops the odds increased by 57%, and for 5 crops the odds of meeting the MDD-W were 83% higher. This relation is most dramatic for households growing 6 crop types, with 4.65 times higher odds of meeting the MDD-W. Cultivation of nonfood crops was also significantly associated with increased odds of meeting the MDD-W; for 1 nonfood crop the odds were 36% higher, whereas for 2 types, the odds increased by 83%. Both associations were significant ($P = 0.001$). Finally, compared with no availability of livestock, rearing of any type of livestock is significantly associated with higher odds for meeting the MDD-W; the odds increase progressively from 51%, 61%, to 78% as livestock availability increased from 2, 3, and 4 livestock. For households having 5 types of livestock, the odds were 2.33 times higher of meeting the MDD-W.

Discussion

The present study assessed the trends in WDD using data from the birth cohort study conducted under the USAID-funded ENGINE. The

TABLE 4 Household agricultural assets as categorical variables¹

Outcome variable: household agricultural assets	MDD-W met (yes/no) (model 2: adjusted ²)		
	OR	95% CI	P
Agricultural land			
0	Ref.	—	
1	1.10	0.90, 1.34	0.374
2	1.20	0.99, 1.46	0.064
P-trend			0.078
Farm equipment			
0	Ref.	—	
1	1.23	1.10, 1.38	0.0001***
Food crops			
0	Ref.	—	
1	1.12	0.94, 1.33	0.194
2	1.40	1.19, 1.66	0.0001***
3	1.46	1.23, 1.74	0.0001***
4	1.57	1.30, 1.90	0.0001***
5	1.83	1.40, 2.40	0.0001***
6	4.65	2.29, 9.42	0.0001***
P-trend			0.0001***
Nonfood crops			
0	Ref.	—	
1	1.36	1.19, 1.55	0.0001***
2	1.83	1.38, 2.42	0.0001***
P-trend			0.0001***
Livestock			
0	Ref.	—	
1	1.25	1.06, 1.47	0.007*
2	1.51	1.29, 1.76	0.0001***
3	1.61	1.37, 1.90	0.0001***
4	1.78	1.47, 2.15	0.0001***
5	2.33	1.75, 3.11	0.0001***
P-trend			0.0001***

¹Significant at 5% and ***0.1% level of significance. MDD-W, Minimum Dietary Diversity Score for Women; Ref., reference.

²Model adjusted for study time point, wealth quintile, and program participation.

ENGINE project had the primary goal of improving the nutritional status of women and young children through a combination of direct, nutrition-specific interventions combined with nutrition-sensitive approaches involving a variety of sectors. A key strategy in ENGINE to achieve this primary goal was increased production and consumption of nutrient-rich foods. There were a variety of activities included in ENGINE aimed at improving diet quality. The project emphasized improving maternal and infant nutrition by promoting dietary diversity using a combination of individual counseling, enhanced community conversations, and using the health and agriculture sector to increase nutrition awareness. ENGINE also actively promoted nutrition-sensitive agriculture techniques and livestock management to increase the production and consumption of diverse foods. This was done through homestead production of horticultural crops and livestock such as chickens, demonstration of agronomic practices, and preparation of diversified foods at farmer training centers. The most vulnerable households (>90% of which were headed by women) were given support, including provision of and training on poultry, small livestock, and homestead gardening of nutrient-rich vegetables. Water, sanitation, and hygiene (WASH) activities were also mainstreamed as part of ENGINE. Many of these same activities have been continued and even expanded upon

in the current Growth through Nutrition Activity. This study focuses on the links between nutrition-sensitive agriculture and WDD.

Women in many low- and middle-income countries have a poor diet quality, as evidenced by a low level of dietary diversity; Ethiopia is no exception. Data in this study show that the mean dietary diversity score for women was low, ranging, on average, from 3.0 to 4.0. Across the time points covered in the birth cohort study reflecting pregnancy and 1-year postpartum, only ~13% to 17% of women met the MDD-W. It was only in time period 3 (birth of the study child) that the percentage of women achieving the MDD-W reached 20%. This is possibly due to the celebration of the child's birth, which may include eating foods that are only consumed around special occasions.

The models presented in Tables 1 to 4 provide insights into some of the drivers of improved diet quality, with a focus on household agricultural assets. It is easy to jump to the conclusion that improved WDD is related solely to higher household income, since more land, more equipment, more food, and nonfood cultivation and rearing of livestock can be viewed as a proxy for income. This would be a simplistic explanation of factors associated with a higher WDD. The multivariate models presented in this study controlled for household wealth, so this factor, by itself, does not capture the totality of variables influencing WDD or MDD-W.

Production of food crops is associated with both an increased mean WDD and the likelihood that a woman will achieve the consumption of 5 or more foods per day. This finding is reinforced by the data in Table 4 showing that growing 2 or more food crops had a progressively more significant influence on improving a woman's diet quality. Similarly, the cultivation of any type of nonfood crop, primarily cash crops, had a positive, significant association with improving women's diet quality. There are several interpretations of these results. First, households producing even a small number of food crops will see an improvement in women's diets. This can result either from the direct consumption of the food crops produced and/or the sale of some or all of these crops. Similarly, the results found a positive, significant association between nonfood crop production and improved women's diet quality. These data would indicate that nonfood crops, which tend to be cash crops, result in higher household incomes, which, in turn, contribute to an improvement in diet quality. Finally, the rearing of livestock improved the diet quality for women. One overall conclusion from these data is that production diversity, including livestock, is associated with a better diet quality.

These results are encouraging for several reasons. First, the GOE in national agricultural strategies has recommended the production of food and nonfood crops. The data from the ENGINE study would suggest that this duality of food and cash crops has produced benefits in increasing the nutrient density of diets.

The results also suggest that the program components emphasized by ENGINE and Growth through Nutrition appear to have been appropriate in contributing to the achievement of the MDD-W. Both projects have emphasized an increased production and consumption of a more diverse set of nutrient-dense crops and animal-source foods. In this article we report that higher cultivation of food crops has a positive effect on WDD.

The presence of livestock within the household is also a significant factor in improving diet quality. Here again, ENGINE and Growth through Nutrition have facilitated the raising of poultry, including in the

most vulnerable households, as 1 mechanism for enhancing diet quality. These findings indicate that increasing the types of livestock produced in the household should be a positive strategy for improving dietary diversity within the household.

As noted earlier, ENGINE included both nutrition-sensitive and nutrition-specific components. Although the analysis in this article concentrated only on the nutrition-sensitive activities conducted under ENGINE, it is worth noting that households received nutrition counseling and enhanced nutrition communication as part of the project. While we cannot disentangle how much of the improvement in the diet quality of women can be attributed to the specific program subcomponents, there is some indication from other research that both direct and indirect approaches are critical for improving diet quality. In research from the same regions as were included in ENGINE, the provision of nutrition services increased nutrition knowledge of women, which was 1 factor associated with improved diet quality (8).

The effects of gender on asset ownership can be important; male ownership compared with female ownership of agricultural assets might affect WDD. However, the majority of the women in the birth cohort study reported joint ownership and only very few women reported sole ownership of agricultural assets. Thus, the effect of gender differences in ownership could not be elucidated in the present assessment.

In summary, a household's agricultural assets are 1 key strategy for improving diet quality. A clear recommendation from this study is that nutrition-sensitive interventions—in particular, agricultural activities—can be a key mechanism for improving the diet quality of women.

Acknowledgments

The authors thank Jennifer Stickland for her help in preparation of this manuscript. The authors' responsibilities were as follows—SG: conceptualized the study design; OA, SG, MK, and EK: analyzed the data; OA, SG, MG, CA, and EK: wrote sections of the manuscript; and all authors: commented on the various drafts of the manuscript, contributed

to the development of this manuscript, and read and approved the final manuscript.

Data Availability

The data in this manuscript can be made available upon request pending application and approval.

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