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Children's diets, nutrition knowledge, and access to markets

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ABSTRACT

Chronic undernutrition in Ethiopia is widespread and many children consume highly monotonous diets. To improve feeding practices in Ethiopia, a strong focus in nutrition programming has been placed on improving the nutrition knowledge of caregivers. In this paper, we study the impact of improving nutrition knowledge within households and its complementarity with market access. To test whether the effect of nutrition knowledge on children's dietary diversity depends on market access, we use survey data from an area with a large variation in transportation costs over a relatively short distance. This allows us to carefully assess the impact of households' nutrition knowledge with varying access to markets, but still within similar agro-climatic conditions. We find that nutrition knowledge leads to considerable improvements in children's diets, but only in areas with relatively good market access.

Keywords: dietary diversity, food markets, remoteness, Ethiopia

JEL codes: O12, Q12, Q18, I15

1. INTRODUCTION

Within development study and practice, the last ten years has seen a significant increase in interest in policies and interventions that improve the nutritional status of pre-school children – height, weight, and micronutrient status. This interest, exemplified by the Sustainable Development Goal of eliminating stunting and wasting by 2030 (United Nations 2015) is based on two considerations. First, improvements in nutritional status are an intrinsically valuable development outcome. Second, the preponderance of evidence shows that the harm caused by undernutrition in early life – both lost physical growth and neurological damage – is not fully recovered, leading to lower levels of height, schooling, cognitive skills, and ultimately income in adulthood (Black et al. 2013; Hoddinott et al. 2013). Children's nutritional status is determined by the quantity and quality of the child's diet and their health status. While at the household level, raising incomes improves household food security (Hidrobo et al. 2015), there is now considerable evidence that the link between income and children's nutritional status is weak or non-existent (Manley, Gitter, and Slavchevska 2013).

In light of this, attention has shifted to other factors that may affect children's diets. One is caregiver knowledge regarding correct child feeding practices both during the first six months of life, when children should be exclusively breastfed, and in the introduction and increased use of complementary foods between 6 and 24 months of age. If caregivers do not understand the importance of providing children with certain foods, or if they perceive healthy foods to be harmful, they will not provide these to their children even when they are available in the household. For example, in Ethiopia – the focus of our work – a study found that mothers do not feed young children vegetables because these are perceived to be difficult to digest and lead to stomach illnesses (USAID 2011). A second study, based on focus group discussions and observation, found that Ethiopian mothers did not feed pre-school children meat or other animal source foods because they believed that children cannot digest these (Alive & Thrive 2010). These examples highlight a lack of caregiver understanding of the importance of diet quality. In response, Behavioural Change Communication (BCC) interventions that seek to improve caregivers' nutrition knowledge have gained popularity among policymakers in low income countries (WHO and UNICEF 2003; USAID 2014; African Union 2015). BCC has been found to be effective at improving child feeding practices in a number of randomized control trials in different settings, but many of these have taken place in urban localities or areas characterized by high-population density where good access to food markets is likely (Santos et al. 2001; Bhandari et al. 2004; Penny et al. 2005; Zaman, Ashraf, and Martines 2008).

But poor access to foods is likely to be a limiting factor on the effectiveness of BCC to improve caregiver understanding of the importance of diet quality (Penny et al. 2005). This points to a second issue, the availability of a diverse set of foods for adults and children to consume. Sibhatu, Krishna, and Qaim (2015) report on a study conducted in four countries that shows that households with higher levels of diversity in food production exhibit higher levels of diversity in food consumption. Evidence from Ethiopia suggests that households with better access to markets consume more diverse diets (Stifel and Minten 2015) and their food consumption is less dependent on their own agricultural production (Hirvonen and Hoddinott 2014; Hoddinott, Headey, and Dereje 2015).

To this point, however, research into the role of caregiver knowledge and that of market access as determinants of diets, particularly child diets, has proceeded in parallel. In this paper, we bring these strands together by focusing on data from Ethiopia. Ethiopia provides a good study area for this topic for many reasons. Its rugged terrain and poor, though improving, infrastructure make transportation difficult and expensive. Chronic undernutrition is widespread and many children consume monotonous, undiversified diets (Central Statistical Agency and ICF International 2012; Headey 2014).

For our study, we use a novel data set from an area with a large variation in transportation costs over a relatively short distance but with similar agro-climatic conditions. Our survey data contain detailed information on the diets of pre-school children, their mothers' knowledge of good feeding and nutrition practices, and market access. Using instrumental variable techniques to address the endogeneity of household's nutrition knowledge, we find that nutrition knowledge leads to considerable improvements in children's diets – but only in areas with relatively good market access. Strikingly, improving nutrition knowledge in the most remote localities has no impact on the diversity of children's diets.

2. DATA

The data used in this analysis came from the second round of a household panel survey conducted in Alefa *woreda* (district) in the rugged terrain of northwestern Ethiopia. This area was chosen because the large variation in transportation costs over relatively short distances in the *woreda* allows us to carefully assess the impact of these varying costs by comparing it with a situation of similar physical and climatic conditions. The study site is an isolated area with little to no electricity or mobile phone access, and without any development or humanitarian assistance programs provided by non-governmental organizations. The starting point for the study area is the market town of Atsedemariam, which is connected to a major metropolitan area (Gonder) to the northeast by a gravel road that is passable year round.

Trucks regularly ply the road between Atsedemariam and the product markets in Gonder and beyond with goods originating from and destined for Atsedemariam. To the west of Atsedemariam there exist communities whose access to the outside markets is available for the most part only through Atsedemariam because of the difficult terrain. Further, access to Atsedemariam (and onward to Gonder) is limited to paths along the route that are mainly accessible only by foot, although motorcycles can pass along some portions. To transport agricultural produce to Atsedemariam and to transport agricultural inputs and consumer goods back from Atsedemariam, community members rely on donkeys.

Households were surveyed along a series of seven sub-districts (or sub-*kebeles*) along the route emanating from Atsedemariam. Households were divided in equal number into five different distance brackets (measured in travel time by donkey) from Atsedemariam. In each bracket, 170 households were interviewed, yielding a total of 850 households. Households were sampled equally from sub-districts within each category to assure a relatively homogenous spread of households over the space between Atsedemariam and the most remote households in Fantaye. The main objective from the sampling was to obtain a representation of households in the districts along the route from the market at Atsedemariam to Fantaye, and not to be representative of the population in the woreda. The first round of the survey took place shortly after the main season (*meher*) harvest over a five-week period in November and December 2011. The second round, which is used in this analysis, was conducted over a similar period in 2015, interviewing 775 of the original 850 households.

Transport costs were measured based on information collected in the household portion of the survey, which included the cost of renting a donkey for a round-trip to Atsedemariam and on how many kilograms a donkey can carry for such a trip. Using this information, we calculated the cost of transporting one quintal (100 kilograms) on a donkey to Atsedemariam. However, because farming households almost always take their own products to the market by donkey, rather than hiring porters, by including the opportunity cost of the farmers' time, this gives a more complete measure of transport costs. Thus our measure of transport cost is based on augmenting the cost of renting a donkey with the imputed value of the farmer's travel time. To determine the value of time, we use the median harvest-period wage in the village to assess the value of time for the return journey to Atsedemariam, as reported by households.[1] This is the measure of transport costs that we use throughout the analysis as a measure of remoteness.[2] On average, it takes households 4.6 (5.2) hours to travel one-way during the dry (wet) season to the market in Atsedemariam. Households incur an average cost of 75.3 Birr to transport a quintal to Atsedemariam. This varies from 25.6 Birr/quintal for the least remote household, to 109.2 Birr/quintal for the most remote.

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[1] Wage data was collected at the household level for three periods: (a) planting and preparation, (b) general cultivation, and (c) harvesting. The mean of the "average daily wage" reported in the sample was the same for all three periods (Birr 43).

[2] To minimize measurement errors in estimating travel times and costs, each household's transport cost is calculated as the average cost of the household's reported cost and the costs reported by its five nearest neighbors. The nearest neighbors are determined using the GPS coordinates for each household.

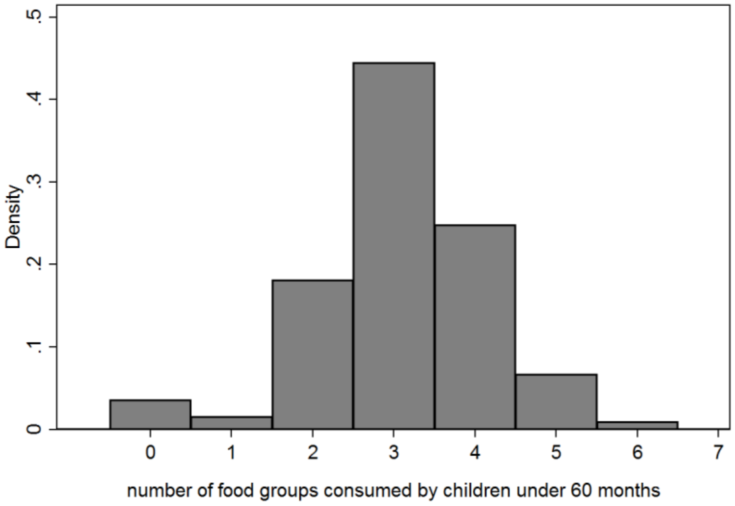
The survey instrument included a module on children's food consumption in the previous day. Mothers were asked a series of Yes/No questions about foods consumed by all children under 60 months who currently resided in the household.[3] Following the recommendations found in WHO (2008) for assessing infant and young child feeding (IYCF) practices, these foods were grouped into the following categories: grains, roots, and tubers (e.g. barley, maize, teff, and wheat); legumes and nuts; dairy products (milk, yogurt, cheese); flesh foods (meat, poultry, and fish products); eggs; vitamin A rich fruits and vegetables; and other fruits and vegetables. This yields a score ranging in value from zero to seven. A more diverse set of foods is necessary if children are to meet both energy and micronutrient needs. Moreover, children who consume from at least four groups during the previous day have a high likelihood of consuming animal-source foods, and at least one fruit or vegetable, as well as a staple food such as a grain, root, or tuber (WHO 2008).

This relatively simple indicator is a good proxy of diet quality and is found to be highly correlated with more detailed and complex measures of food intake, such as quantitative recall data of the quantity of all foods consumed by children. For example, Moursi et al. (2008) show that in Madagascar, this indicator is correlated with mean micronutrient density adequacy (MMDA). Using receiver-operator-curves, they show that a score of two or less food groups predicted low MMDA (less than 50 percent of children's daily requirements). Other studies that have shown that this dietary diversity score is correlated with micronutrient intake and density in developing countries include Daniels et al. (2009), Kennedy et al. (2007) and Steyn et al. (2006), and in the United States, Kant (1996, 2004). Building on earlier work by Arimond and Ruel (2004), this score has been shown to be correlated with longer term measures of children's nutritional status such as height in a variety of developing countries including Bangladesh, Ethiopia, India, and Zambia (Jones et al. 2014). Disha et al. (2012) also find evidence that the same indicator is correlated with child height in Ethiopia.

3. DESCRIPTIVE ANALYSIS

Figure 3.1 shows the distribution of the dietary diversity indicator for the 448 children less than 60 months of age in the survey sample. Children residing in the average household in the sample eat from 3 food groups. Only in 7.5 percent of the households do the children meet the WHO recommendation of eating from 4 or more food groups. There are a small number of children whose mothers reported that they consumed none of these foods during the previous day, either because they were ill or because they only consumed breastmilk.

Figure 3.1: Distribution of the dietary diversity indicator



Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Figure 3.2 shows the content of the children's diets. Nearly all children consume staple crops (grains, roots, and tubers) and legumes and nuts. About one third consume dairy products, but the consumption of other animal source foods (meat and eggs) is uncommon. Similarly, less than 10 percent of the children consume vegetables or fruits that are rich in

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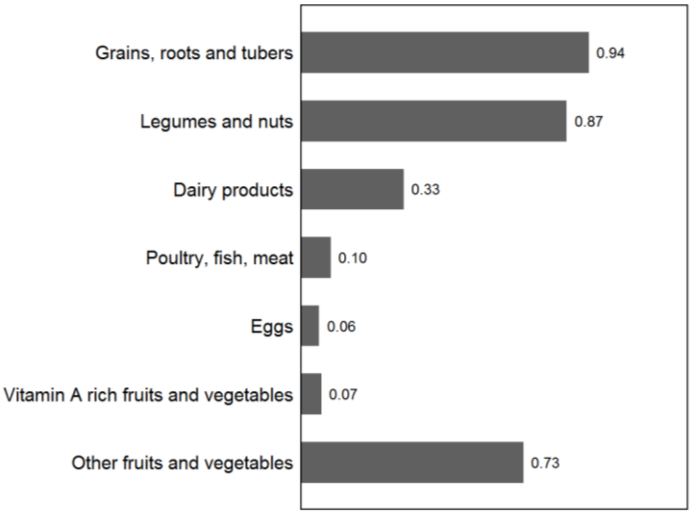
[3] Note that these questions were not asked at the individual level. Rather they were asked at the household level; about all children less than 60 months old currently residing in the household. As a result, we cannot study differences in diets of children who reside in the same household. This could be problematic if there were gender differences in infant and young child feeding practices. However, recent econometric studies using data from Ethiopia do not find evidence that supports this (Headey 2014; Hirvonen and Hoddinott 2014).

Vitamin A, but the consumption of other fruits and vegetables is relatively high. Results such as those shown in Figure 3.2 are not uncommon in Ethiopia; a similar pattern is found, for example, in Nguyen et al. (2013).

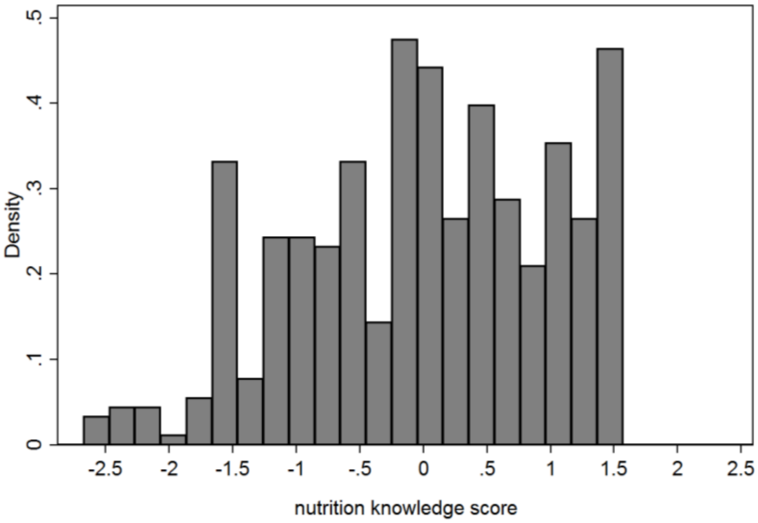
Figure 3.2: Diet content: share of children consuming from different food groups



Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Households' nutrition knowledge is captured in the data through seven statements about appropriate infant and young child feeding practises (Alive & Thrive 2014). The respondents were asked whether they agreed or disagreed with these statements. Table A1 of Appendix A provides an overview of the statements and the distribution of the responses to each. We reduce the household responses to these statements into one index using principal components analysis. The seven statement variables are highly correlated (average correlation coefficient is 0.330) and the principal components analysis attempts to find components that account for most of the variation among these variables. The end product is a single variable that we take to represent household's nutrition knowledge. Appendix A provides a more detailed description of the principal components analysis and the results. Moreover, to facilitate interpretation, household's nutrition knowledge is expressed in units of Z-scores.[4] Figure 3.3 shows how this nutrition knowledge score is distributed among the households. A higher number indicates better knowledge. We see that most observations lie within two standard deviations from zero.[5]

Figure 3.3: Distribution of household nutrition knowledge score



Source: Authors' calculation from the 2014/5 Rural Transport Survey.

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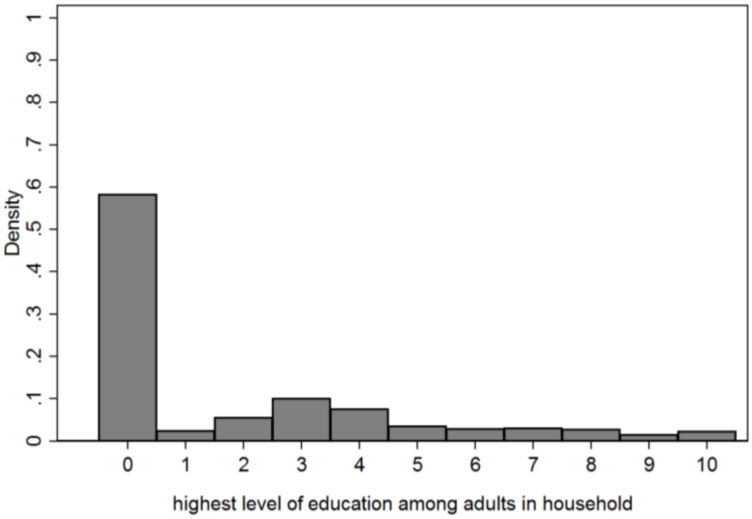
[4] The Z-scores are computed by subtracting the initial knowledge value from the sample mean and then dividing this with the standard deviation of the sample.

[5] We considered 5 households as outliers for which the nutrition knowledge score was less than -2.5. However, our results are not sensitive to these extreme values; including these 5 households to the final sample yields nearly identical coefficients in all regression models.

Since education, particularly among mothers, has been shown to matter significantly for nutritional outcomes, we look in more detail at this variable. Formal education levels are extremely low in the study area. Figure 3.4 shows the distribution of levels of education in our sample. The average level of education in these data is 2 years. More than 50 percent of the households do not have a single adult member who has attended school. Figure 3.5 estimates a locally weighted regression of the association between level of education and household's nutrition knowledge. The relationship is flat throughout the education distribution, implying that education does not explain differences in nutrition knowledge.

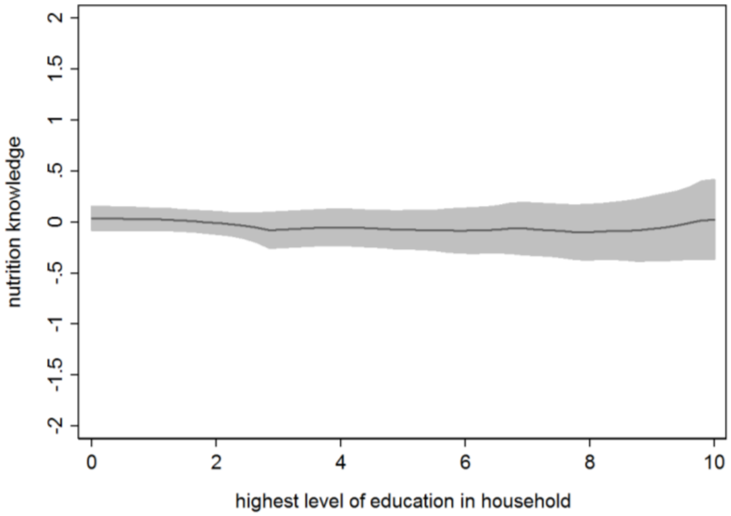
Figure 3.4: Distribution of education levels



Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Note: horizontal axis measures the highest level of education (in years) in the household among adult members (aged 15 or more).

Figure 3.5: Formal education and nutrition knowledge



Note: Local polynomial regression. Shaded area refers to 95%-confidence interval. Horizontal axis measures the highest level of education (in years) in the household among adult members (aged 15 or more).

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

In Figure 3.6 we examine whether formal education is correlated with children's dietary diversity. We do not find strong evidence to suggest that children originating from households exposed to more educated adult members enjoy better diets. There is some evidence of this at the top end of the schooling distribution, but the small number of households with higher levels of education renders the confidence intervals extremely wide.[6]

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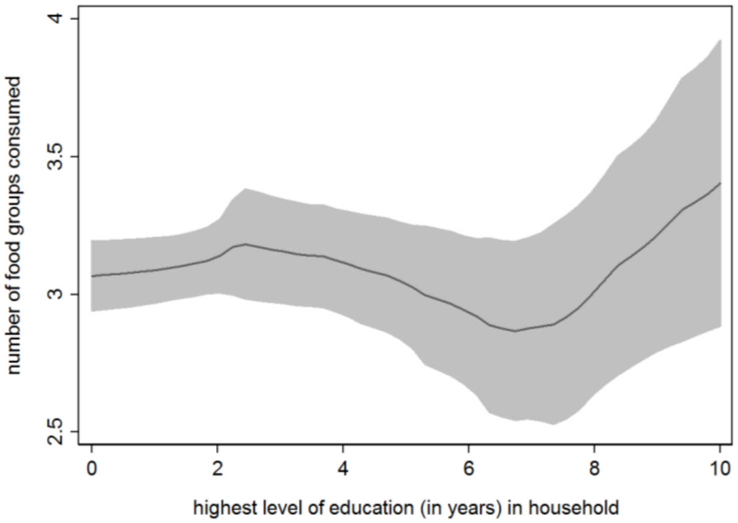
[6] This is consistent with results found in Alderman and Headey (2014) who study the role of (maternal and paternal) education on children's nutritional status. They find that while child nutrition status is positively correlated with parental education, the correlation gets stronger with secondary education.

Figure 3.6: Formal education and children's dietary diversity

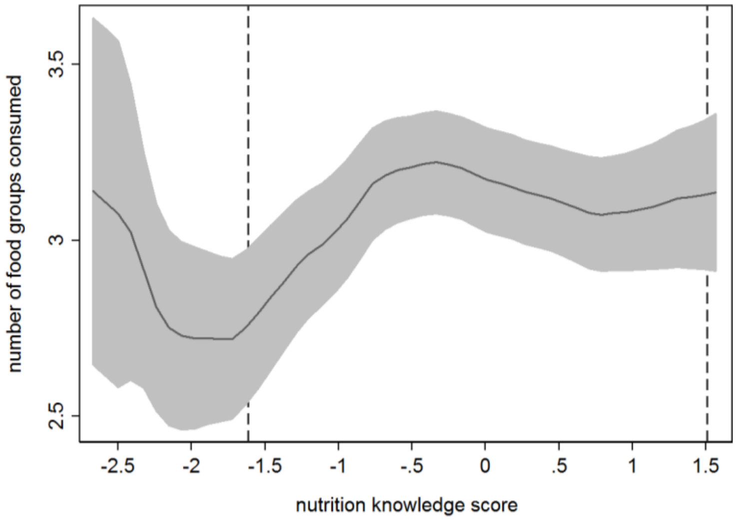


Note: Local polynomial regression. Shaded area refers to 95%-confidence interval. Horizontal axis measures the highest level of education (in years) in the household among adult members (aged 15 or more).

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Figure 3.7 shows the relationship between children's diets and household nutrition knowledge. In the lower half of the knowledge distribution, we see that dietary diversity is positively associated with nutrition knowledge. After a certain threshold, however, dietary diversity no longer increases with nutrition knowledge. The figure further shows that children's dietary diversity is still relatively low, even with good nutritional knowledge scores.

Figure 3.7: Nutrition knowledge and children's dietary diversity



Note: Local polynomial regression. Shaded area refers to 95%-confidence interval. Dashed lines represent the bottom and top 5% of the nutrition knowledge distribution.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

We then categorized households into low (lower half in the nutrition knowledge distribution) and high (upper half of the distribution) nutrition knowledge households. Figure 3.8 shows how children's dietary diversity varies across the transport cost gradient for both household types. We see that children in households with better nutrition knowledge enjoy more diverse diets across the remoteness gradient – except in the most remote localities.[7] However, the confidence intervals (not reported) are large and overlap across the two regression lines. The evidence is, at best, suggestive. This provokes the use of econometric techniques to further study this relationship.

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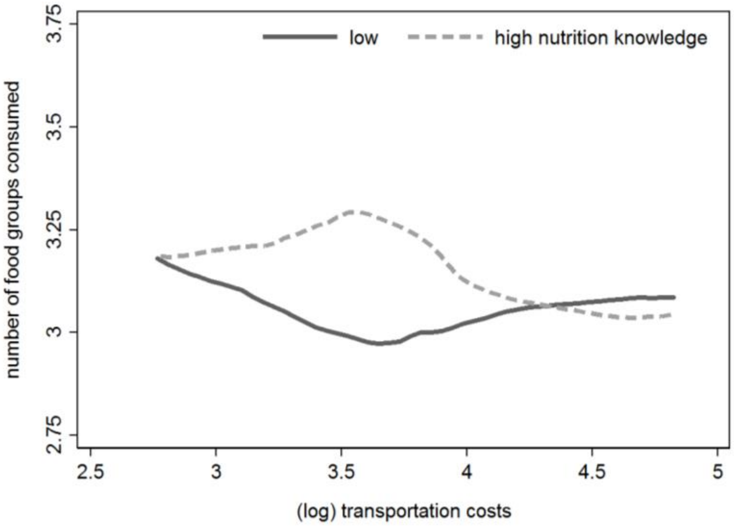
[7] Using data for the whole sample we find that dietary diversity decreases with transportation costs. This is in line with earlier research from this context, see Stifel and Minten (2015).

Figure 3.8: Remoteness and children's dietary diversity, by level of nutrition knowledge



Source: Authors' calculation from the 2014/5 Rural Transport Survey.

4. ECONOMETRIC APPROACH

We model the number of food groups consumed by children in household h (d_h) as a function of household nutrition knowledge (k_h):

$$d_{hv} = \beta k_h + \gamma r_h + x_h'\varphi + \varepsilon_h, \tag{1}$$

where r_h captures a household's remoteness. More specifically, r_h obtains a value of 1 if the household's transportation costs to the main market is in the top third of the transportation cost distribution for the sample households (zero otherwise).[8] The term $x_h{}'$ is a vector of household level characteristics, including household demographics (including representation of different age and gender groups) and household assets. Table 4.1 provides the summary statistics for all variables used in the analysis. The last term in the equation, ε_h, represents the error term.

A problem in estimating Equation (1) arises from the fact that the nutrition knowledge of a household cannot be directly observed. Here we proxy for household knowledge through the seven nutrition statements (see Section 3). However, this – as with any other attempt – to measure the 'true level of nutrition knowledge' will result in a variable that is measured with some degree of error (Variyam et al. 1999). Such measurement error in the independent variable, if randomly distributed with zero mean, typically leads to a lower-bound estimate (e.g. Deaton 1997). To address this issue, we opt for an Instrumental Variable (IV) strategy based on a household's access to health information. The IV strategy also addresses concerns that the estimated impact is driven by some unobserved household characteristics correlated with the knowledge variable.

The identification strategy is based on insights drawn from Ethiopia's strategy to combat undernutrition in the country. Since the start of the 2008 National Nutrition Programme, Ethiopia's nutrition strategy has followed a community based approach where the community (*kebele)* serves as a delivery platform for various health services (Lemma and Matji 2013). The community based approach is part of the national Health Extension Programme (HEP) initiated in 2003. The community based nutrition program is widespread, covering nearly all districts (*woredas*) of the country. Since its initiation, more than 30,000 Health Extension Workers (HEW) have been trained and placed into communities (White and Mason 2012). One of the key tasks of the HEWs is the provision of health education. This is done together with volunteers recruited from the communities (Wakabi 2008). The HEP typically deploys two HEWs per health post and together these government employees are expected to reach approximately 5,000 individuals.

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[8] All results are also robust to defining household remoteness as the top 4th and 5th quintile of the transportation cost distribution.

Table 4.1: Summary statistics

	Mean	Standard deviation
# of food groups consumed by children under 60 months	3.089	1.075
household nutrition knowledge (z-score)	0.000	1.000
remote household (*)	0.324	0.468
# of HH members less than 1 years old	0.161	0.380
# of HH members 1 years old	0.192	0.405
# of HH members 2 years old	0.315	0.474
# of HH members 3 years old	0.306	0.461
# of HH members 4 years old	0.395	0.489
# males 5-9 years of age in HH	0.746	0.764
# females 5-9 years of age in HH	0.701	0.730
# males 10-15 years of age in HH	0.634	0.803
# females 10-15 years of age in HH	0.547	0.725
# males 16 or more years of age in HH	1.355	0.737
# females 16 or more years of age in HH	1.257	0.582
mother's (head's spouse's) education	0.308	1.137
age of the head	38.230	10.080
HH has a safe drinking water source (*)	0.221	0.415
HH owns chicken (*)	0.931	0.254
HH owns sheep or goats (*)	0.623	0.485
HH owns calves, cows or heifer (*)	0.846	0.361
(log) value of productive assets owned	6.592	0.659
(log) land size (in acres)	3.398	0.881
Excluded instruments:		
household owns a radio (*)	0.248	0.432
HH was visited by a health worker (HEW/volunteer) (*)	0.795	0.404

Note: (*) indicates a dummy (0/1) variable. Household's location is considered remote if it belongs to top third in the transportation cost distribution.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

The National Nutrition Programme also provides nutrition information materials to radio and TV stations (GFDRE 2013). Radio and TV broadcasts contain nutrition related messages that promote dietary diversity and discuss the importance of micronutrients.

We use these insights to develop our identification strategy. Our first instrument is a dummy that obtains a value of one if the household owns a radio (enables access to radio broadcasted nutrition messages). The survey instrument also asked whether the household was visited by a HEW or a community health volunteer in the past 12 months. This variable is our second instrument: we hypothesize that these visits lead to improvements in households' nutrition knowledge. Given the central role of the health workers and the radio stations in delivering nutrition information, these two instruments should provide good predictors of household nutrition knowledge.

We can think of two potential concerns regarding the exclusion restriction. The first is that these variables are correlated with households' remoteness. Using a simple local polynomial regressions suggests that this concern is valid for the health extension visits (more remote households are less likely to be visited), but not for the radio ownership. However, we address this issue by including the remoteness variable into our specification with the community dummies. The second concern is that radio ownership captures some type of wealth effect. We address this issue by including controls for household wealth (livestock ownership, value of productive assets, and land size). Furthermore, it is worth noting that the cost of owning a radio is rather low. [9]

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[9] A recent paper by Pylypchuk and Norton (2014) also instrument knowledge using radio ownership to study the role of maternal knowledge on malaria prevention measures in Zambia. They make the same point about the relatively low cost of radios nowadays. They also point out that listening to the radio does not require literacy or schooling attainment.

Table 4.2 shows the first stage results for the two excluded instruments based on a two-step linear IV-GMM approach.[10] The excluded instruments appear with expected signs: both radio ownership and visits by a health worker are associated with better nutrition knowledge. Both coefficients appear positive and significant at least at the 5 percent level. The IV-diagnostics further show that the instruments are relevant (i.e. good predictors of nutrition knowledge); the Cragg-Donald test yields a value of 10.21 and the Angrist and Pischke (2009) test rejects the null hypothesis that endogenous regressor is weakly identified (p<0.001). Finally, according to the Hansen-Sargan test, we cannot reject the null of zero correlation between the instruments and the error term.

Table 4.2: First-stage regression results for the two excluded instruments

Outcome variable: nutrition knowledge	**(1)**
Household owns a radio	0.389***
	(0.105)
Household was visited by a health worker	0.296**
	(0.129)
Included instruments? [a)]	Yes
Weak Identification tests:	
Cragg-Donald Wald F statistic	10.21
Kleibergen-Paap rk Wald F statistic	10.58
Angrist-Pischke F-test – p-value	0.000***
Over-identification test:	
Hansen/Sargan test	1.324
p-value	0.250
Number of observations:	448

Note: Remoteness dummy obtains a value of one if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1.

[a)] Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

5. RESULTS

Table 5.1 shows the regression results based on the estimation of Equation (1). Column 1 provides the OLS result that treats nutrition knowledge as exogenous, while column 2 shows the IV-regression results. The coefficients on the control variables are *a priori* correct. Livestock ownership and other wealth factors are associated with better diversity of children's diets. Moreover, dietary diversity is lowered if infants are present, simply because these children are likely to be exclusively breastfed. The coefficient on the remoteness variable does not appear statistically significant, after controlling for wealth and education.

Household nutrition knowledge appears with a positive and statistically significant coefficient in both columns. According to the OLS model, nutrition knowledge has a modest impact on children's dietary diversity. In contrast, the instrumented coefficient in column 2 appears highly significant (p<0.01) and large. This difference between the OLS and IV-estimates is likely due to the measurement error in the nutrition knowledge variable.[11] According to the IV-estimate, a one standard deviation increase in household's nutrition knowledge score leads to 0.7 food group increase in children's diets, on average and *ceteris paribus*. The 95 percent confidence interval for this estimate is [0.20, 1.25]. An alternative way of interpreting this effect is as follows. The average household in the sample has a (standardized) nutrition knowledge score of 0.00 and their children consume from 3.08 food groups. Improving this household's nutrition knowledge to the level of the most knowledgeable household in the sample (knowledge score = 1.42) would result in a 1.03 food group increase in

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[10] The linear two-step GMM model implemented here is more efficient than the conventional two-stage least squares model when standard errors are heteroskedastic and the equation is over-identified (see e.g. Cameron and Trivedi 2005, p. 187-8). The two conditions are satisfied in our application. First, the number of instruments (2) exceeds the number of endogenous regressors (1). Second, the null of homoscedasticity is rejected in our application: the White (1980) test, less sensitive to departures from normality, yields 361.5, exceeding all the conventional critical values.

[11] The IV-strategy can be thought to correct this measurement error by 'forcing' the nutrition knowledge variable to respond to the BCC treatments received by the households. In other words, the identification in the IV-regression comes from households who respond to the changes triggered by the instruments. Therefore, our estimate, as with any IV-estimate, should be interpreted in terms of a Local Average Treatment Effect (LATE) (Angrist, Imbens, and Rubin 1996).

children's diets. As a result, children in this average household would consume from 4.1 food groups, thus satisfying the WHO (2008) guideline of having minimum of four food groups per day.

Table 5.1: Impact of household nutrition knowledge on children's dietary diversity

Dependent variable: number of food groups consumed	OLS (1)	IV (2)
Nutrition knowledge score	0.096**	0.724***
	(0.047)	(0.268)
Remoteness dummy	0.002	-0.183
	(0.104)	(0.148)
# of HH members less than 1 years old	-0.329**	-0.236
	(0.143)	(0.173)
# of HH members 1 years old	0.349***	0.204
	(0.133)	(0.179)
# of HH members 2 years old	0.683***	0.814***
	(0.129)	(0.166)
# of HH members 3 years old	0.628***	0.708***
	(0.142)	(0.174)
# of HH members 4 years old	0.551***	0.607***
	(0.131)	(0.152)
# males 5-9 years of age in HH	-0.081	-0.065
	(0.070)	(0.086)
# females 5-9 years of age in HH	0.005	0.012
	(0.077)	(0.087)
# males 10-15 years of age in HH	-0.008	0.040
	(0.073)	(0.092)
# females 10-15 years of age in HH	0.023	0.113
	(0.077)	(0.100)
# males 16 or more years of age in HH	-0.076	-0.063
	(0.076)	(0.088)
# females 16 or more years of age in HH	0.089	0.079
	(0.103)	(0.115)
Education of the spouse (years)	0.037	0.080**
	(0.033)	(0.041)
age of the head	-0.057*	-0.063*
	(0.030)	(0.037)
age of the head squared	0.001**	0.001**
	(0.000)	(0.000)
HH has a safe drinking water source	0.063	0.081
	(0.120)	(0.136)
HH owns chicken	0.430**	0.469*
	(0.196)	(0.246)
HH owns sheep or goats	-0.028	-0.111
	(0.098)	(0.118)
HH owns calves, cows or heifer	0.265*	0.383**
	(0.142)	(0.162)
(log) value of productive assets owned	0.279***	0.317***
	(0.084)	(0.108)
(log) land size (in acres)	0.072	-0.008
	(0.067)	(0.083)
R^2	0.151	-
Weak Identification tests:		
Cragg-Donald Wald F statistic	-	10.21
Angrist-Pischke F-test	-	10.58
p-value	-	0.000***
Over-identification test:		
Hansen/Sargan test	-	1.324
p-value	-	0.250
Number of observations	448	448

Note: Remoteness dummy obtains a value 1 if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1.

[a)] Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

We assessed the robustness of this finding in several ways. First, the nutrition statements displayed in Table A1 of Appendix A measure the general knowledge of households about feeding practises. One of the statements in the survey is directly linked to our outcome variable (dietary diversity): “Give a variety of foods to very young children (6-24 months)”. This alternative nutrition knowledge score obtains a value 0 if household strong disagrees, 1 if disagrees, 2 if neither agrees nor disagrees, 3 if agrees or 4 if strongly agrees with the following statement: "Give a variety of foods to very young children (6-24 months)". Households that agree with this statement should feed their children with a more diverse diet than other households. In order to conduct this check, we re-constructed the knowledge variable so that households that strongly agree with the statement receive 4 points while those who strongly disagree receive 0 points. The table in Appendix B re-runs Table 4.2 using this knowledge variable that runs from 0 to 4. The coefficient on the OLS model is statistically significant only at the 10 percent level, but the coefficient in the IV-model is statistically significant at the 5 percent level. As before, higher scores in this alternative knowledge variables lead to improvements in children’s dietary diversity. [12]

Second, our outcome variable is essentially a count (see Figure 3.1) so using the linear model may not be entirely appropriate. The advantage of using the linear model is that it provides a host of specification tests that we can use to assess the validity of our IV-approach. However, we also assessed the robustness of our findings using the Poisson model. Appendix C shows that the estimated coefficients (marginal effects) are very similar to the ones obtained using the linear models in Table 5.1. The results do not seem then to be driven by the non-linear nature of our left-hand side variable.

Third, our results are not driven by observed and unobserved community characteristics. Appendix D shows that including community (sub-kebele) dummies in the model results in similar coefficients on the nutrition knowledge variable as in Table 5.1. While these community dummies effectively control for various community characteristics, they come with a cost of absorbing a large amount of the variation in the remoteness data. This is the reason we prefer not to include them in the main specification (Equation 1). [13]

Fourth, it is reported that health workers may refer undernourished children to the health post for ‘therapeutic feeding’ (White and Mason 2012). While we believe such practice to be rare, this would obviously violate the exclusion restriction. To check that our results are not driven by this possibility, we re-ran Column 2 in Table 5.1 without the health worker visit instrument (Appendix E). The coefficient on the nutrition knowledge variable is nearly identical to the one observed in Column 2 in Table 5.1.

Finally, the nutrition literature recommends administering the dietary questions at the individual level (Ruel 2003). Another caveat in our data is that it covers a relatively small area, raising concerns about external validity. We addressed both of these concerns by replicating the analysis using the Feed-the-Future Midline Survey implemented in June and July in 2015.[14] While not nationally representative, the survey is widespread, being administered in 252 villages in 84 of the 670 rural districts (*woredas*) and in five regions of the country (Amhara, Oromia, Tigray, Somale and SNNP).[15] The sample consists of 4,107 children who are between 6 and 59 months of age. We added the same nutrition knowledge questions to this survey, but the dietary diversity questions were asked at the individual (child) level based on 24-hour recall. Using the same IV-strategy, we obtain coefficients that are similar in magnitude (see Appendix F). According to the IV-specification, increasing household nutrition knowledge by one standard deviation leads to a 0.75 food group increase in children’s dietary diversity. This implies that the results presented in Table 5.1 do not appear specific to this one *woreda* in the Amhara region. Furthermore, the use of household level dietary data does not seem to affect our findings.

Next we return to the transportation survey data that permits a precise measure of households’ market access (or remoteness).

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[12] Interpreting this coefficient is cumbersome due to the ordinal nature of the independent variable. For example, in column 2, increasing nutrition knowledge by one scale (e.g. from "neither agree nor disagree" to "agree") results in one food group increase in children's dietary diversity.

[13] Regressing the (linear) remoteness cost variable onto the sub-kebele dummies yields an R^2 value of 0.924. This means that the sub-kebele dummies alone account for 92 percent of the variation in the transportation cost (remoteness) data.

[14] The main purpose of the survey was to obtain post-intervention (midline) information in localities that were to receive investments to improve agricultural production and nutrition under the Feed the Future (FtF) program funded by the United States Agency for International Development (USAID), or in localities that were to act as comparison sites for the evaluation of FtF.

[15] For further information about this survey, including sampling, see Bachewe et al. (2014).

6. RESULTS BY MARKET ACCESS

The foregoing results show how improved nutrition knowledge leads to better diets. In this section, we study whether this relationship depends on households' access to markets. Specifically, we interact household nutrition knowledge (k_{hv}) in Equation (1) with the remoteness variable (r_h). The analysis is somewhat complicated by the fact that interacting the endogenous variable with an exogenous one results in two endogenous variables. To account for the possibility that the instruments work differently for remote and less-remote villages, we also interacted the two instruments with the remoteness variable. As a result, we now have four excluded instruments. Table 6.1 reports our results. Focusing on the IV-results in column 2, we see that for both variables, the Angrist and Pischke (2009, p. 217-218) F-statistic rejects the null that the endogenous regressor is weakly identified. The coefficient on the nutrition knowledge variable appears significant at the 1 percent level. For less remote households, improving household nutrition knowledge by one standard deviation increases children's dietary diversity by 1.5 food groups. The 95 percent confidence interval for this estimate is [0.44; 2.61]. The coefficient on the interaction term is negative and almost of the same magnitude in absolute terms as the coefficient on the non-interacted knowledge variable. This coefficient is statistically significant at the 5 percent level. Furthermore, the joint significance test implies that the knowledge variable coefficient for the children residing far from the markets is not statistically different from zero at conventional levels ((p=0.841).[16] This means that for remote households, improvements in nutrition knowledge do not lead to increases in children's dietary diversity.

Table 6.1: Impact of household nutrition knowledge on children's dietary diversity by remoteness

Dependent variable: number of food groups consumed	**OLS (1)**	**IV (2)**
nutrition knowledge (A)	0.106*	1.523***
	(0.062)	(0.553)
nutrition knowledge X remoteness (B)	-0.028	-1.468**
	(0.095)	(0.644)
remoteness dummy	0.005	-0.134
	(0.104)	(0.149)
Other controls? $^{a)}$	Yes	Yes
Sub-*kebele* dummies? $^{a)}$	Yes	Yes
χ^2-test: joint significance: (A)+(B) = 0	p = 0.284	p = 0.841
R^2	0.193	-
Weak Identification tests:		
Angrist-Pischke F-test: (A)	-	2.96
p-value	-	0.032*
Angrist-Pischke F-test: (B)	-	4.17
p-value	-	0.006***
Over-identification test:		
Hansen/Sargan test	-	1.573
p-value	-	0.455
Number of observations	448	448

Note: Remoteness dummy obtains a value 1 if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1.
$^{a)}$ Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

7. CONCLUSIONS

This paper studied the impact of improving the nutrition knowledge of households and its complementarity with market access. Using novel survey data that permits a careful measure of market access, we find that nutrition knowledge leads to

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[16] Adding the coefficient on the original nutrition knowledge score and the coefficient on the interaction term gives the effect of improving nutrition knowledge in the most remote communities. This gives a joint coefficient of 0.05 (standard error: 0.270) with 95 percent confidence interval at [-0.476, 0.584].

considerable improvements in children’s diets, but only in areas with relatively good market access. Improving nutrition knowledge in the most remote localities has no impact on children’s dietary diversity.

In light of these findings, in order to improve diets in Ethiopia, policy makers need to focus on solving both supply (access to foods) and demand side (knowledge) constraints. Behavioral Change Communication is an effective tool to tackle the demand side constraints to improving children’s diets, but only in areas characterized by good access to food markets. Tackling the supply side is more difficult. In the long run, access to foods should be mediated through food markets that are well-integrated within the country. In the short run, more remote households may have to be self-sufficient in producing the foods they want to consume (Hirvonen and Hoddinott 2014). But this may not be possible in all areas, as agro-climatic conditions impose constraints to farmers' food production choices. Moreover, encouraging households to diversify their food production is contrary to the basic economic notion of production based on comparative advantage.

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APPENDICES

Appendix A: Measuring nutrition knowledge

The survey instrument had seven nutrition statements to test households' nutrition knowledge. The statements are based on the "7 Excellent Feeding Actions" by promoted by the Alive & Thrive project in Ethiopia (Alive & Thrive 2014). Agreeing with the statement indicates that the respondent is knowledgeable about the proper infant and young child feeding practices. Table A1 shows these statements and the distribution of responses.

Table A1: Nutrition knowledge statements and the distribution of the responses, %

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Colostrum should be given to the baby	15.4	22.4	19.6	26.7	15.9
Give only breast milk for the first six months of life	2.2	4.1	13.3	46.3	34.1
Babies should eat thick porridge once they stop breastfeeding	2.7	6.2	18.7	43.1	29.3
Very young children (6-24 months) should eat eggs and meat	2.7	6.5	17.3	43.5	30.1
Porridge should be made by adding vegetables, eggs, milk	1.4	2.1	14.3	49.4	32.8
Give a variety of foods to very young children (6-24 months)	1.8	3.5	13.9	43.6	37.2
Give your sick children (6-24 months) more food than usual	2.8	9.6	18.8	43.2	25.6

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Table A2 shows the eigenvalues for each of the seven components. We see that the first two components explain 66 percent of the variation in the data. We follow the Kaiser-rule that states that only components that obtain an eigenvalue larger than one should be retained.

Table A2: Principal components and eigenvalues

	Eigenvalue	Proportion
component 1	3.57	0.51
component 2	1.04	0.15
component 3	0.75	0.11
component 4	0.56	0.08
component 5	0.48	0.07
component 6	0.33	0.05
component 7	0.27	0.04

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Columns 1 and 2 in Table A3 provide the principal component loadings based on the first two components. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy is displayed in column 3. We see that all KMO values are close to one, suggesting that the seven statement variables are indeed measuring a common component.

Table A3: Principal component loadings and sampling adequacy

Statement	1 Comp 1	2 Comp 2	3 Kaiser-Meyer-Olkin measure
Colostrum should be given to the baby	0.14	0.84	0.79
Give only breast milk for the first six months of life	0.32	0.40	0.87
Babies should eat thick porridge once they stop breastfeeding	0.40	-0.04	0.89
Very young children (6-24 months) should eat eggs and meat	0.44	-0.14	0.86
Porridge should be made by adding vegetables, eggs, milk	0.44	-0.02	0.88
Give a variety of foods to very young children (6-24 months)	0.46	-0.11	0.83
Give your sick children (6-24 months) more food than usual	0.35	-0.31	0.88
Overall			0.86

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Appendix B: Replicating Table 5.1 using an alternative measure of nutrition knowledge

Dependent variable: number of food groups consumed	OLS (1)	IV (2)
Nutrition knowledge score	0.096*	1.041**
	(0.058)	(0.413)
Remoteness dummy	0.018	-0.105
	(0.103)	(0.141)
Other control variables? [a)]	Yes	Yes
R^2	0.205	-
Weak Identification tests:		
Cragg-Donald Wald F statistic	-	6.97
Angrist-Pischke F-test	-	6.95
p-value	-	0.001***
Over-identification test:		
Hansen/Sargan test	-	1.496
p-value	-	0.221
Number of observations	448	448

Note: Nutrition knowledge score obtains a value 0 if household strong disagrees, 1 if disagrees, 2 if neither agrees nor disagrees, 3 if agrees and 4 if strongly agrees with the following statement: "Give a variety of foods to very young children (6-24 months)".
Remoteness dummy obtains a value of one if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1.
[a)] Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Appendix C: Replicating Table 5.1 using Poisson models

Dependent variable: number of food groups consumed	Poisson (1)	IV-Poisson (2)	IV-Poisson (3)
Error structure:	n/a	additive	multiplicative
Nutrition knowledge score	0.100**	0.691***	0.733**
	(0.047)	(0.256)	(0.305)
Remoteness dummy	0.014	-0.177	-0.168
	(0.101)	(0.147)	(0.164)
Other control variables? [a)]	Yes	Yes	Yes
Pearson goodness-of-fit test	146.5	-	-
--- p-value	1.000	-	-
Over-identification test:			
Hansen/Sargan test	-	0.845	0.949
p-value	-	0.358	0.330
Number of observations	448	448	448

Note: Remoteness dummy obtains a value of one if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1.
[a)] Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Appendix D: Replicating Table 5.1, but including sub-*kebele* dummies

Dependent variable: number of food groups consumed	**OLS** **(1)**	**IV** **(2)**
Nutrition knowledge	0.089*	0.809***
	(0.049)	(0.292)
Remoteness dummy	-0.177	-0.350*
	(0.151)	(0.197)
Other control variables? $^{a)}$	Yes	Yes
Sub-*kebele* dummies? $^{a)}$	Yes	Yes
R^2	0.193	-
Weak Identification tests:		
Cragg-Donald Wald F statistic	-	9.821
Angrist-Pischke F-test: (*A*)	-	9.996
p-value	-	0.0001***
Over-identification test:		
Hansen/Sargan test	-	0.921
p-value	-	0.337
Number of observations	448	448

Note: Remoteness dummy obtains a value of one if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1.

$^{a)}$ Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Appendix E: Replicating Table 5.1, but dropping the health-visit instrument

	IV **(1)**
Nutrition knowledge	0.939***
	(0.355)
Remoteness dummy	-0.247
	(0.171)
Other control variables? $^{a)}$	Yes
Weak Identification tests:	
Cragg-Donald Wald F statistic	13.97
Angrist-Pischke F-test	15.08
p-value	0.000***
Number of observations	448

Note: Remoteness dummy obtains a value of one if the household belongs to top third in the remoteness distribution, zero otherwise. Robust standard errors in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1. Hansen/Sargan test cannot be computed because the equation is exactly identified.

$^{a)}$ Coefficients omitted to preserve space.

Source: Authors' calculation from the 2014/5 Rural Transport Survey.

Appendix F: Replicating Table 5.1 using the Feed-the-Future midline (2015) data

Dependent variable: number of food groups consumed	**OLS** **(1)**	**IV** **(2)**
Nutrition knowledge score	0.049*	0.747**
	(0.029)	(0.376)
Other control variables? [a)]	Yes	Yes
R^2	0.163	-
Weak Identification tests:		
Cragg-Donald Wald F statistic	-	11.37
Angrist-Pischke F-test	-	4.28
p-value	-	0.017**
Over-identification test:		
Hansen/Sargan test	-	0.858
p-value	-	0.354
Number of observations	4,107	4,107

Note: Standard errors (clustered at the *woreda* level) in parentheses. Statistical significance denoted at *** p<0.01, ** p<0.05, * p<0.1. Unit of observation is a child 6 to 59 months of age. Child level controls include: sex and age of child. Household level controls include: assets (logged value of durable and productive assets), livestock ownership (in tropical livestock units), access to electricity, household demographics (including household size), head's age and highest level of education in the household. The community level controls include: distance to the nearest market town, access to health care, radio signal and electricity and dummies for each region.

[a)] Coefficients omitted to preserve space.

Source: Authors' calculation from the Feed the Future midline survey (2015), Ethiopia.

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