Diversion of Flashy Floods for Agricultural Use and its Effect on Nutrition in Ethiopia

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Abstract

The study examined whether access to spate irrigation leads to better nutrition outcomes. The results showed that there is an overall improvement in the study sites compared to the 2011 DHS study. As far as households with access to spate irrigation are concerned, weight-for-height z-scores indicated that 8.2% of the children had prevalence of global acute malnutrition; 8.2% of them had moderate acute malnutrition. None of the children had severe acute malnutrition. The weight-for-age results indicated that 27.5, 17.6 and 9.8% of the children showed prevalence of underweight, moderate underweight and severe underweight, respectively. The height-for-age z-scores showed 56.5, 30.8 and 21.7% of the children had prevalence of stunting, moderate stunting and severe stunting, respectively. On the other hand, households without access to spate irrigation indicated that as far as the weight-for-height z-scores of children are concerned, there were no children (boys and girls) with prevalence of global acute malnutrition; weight-for-age z-score showed that 13.6, 10.2 and 3.4% of the children had prevalence of underweight, moderate underweight and severe underweight, respectively. The height-for-age z-scores showed that 45.5, 25.5 and 20.0% of the children had prevalence of stunting, moderate stunting and severe stunting, respectively. The anthropometric measures, thus, showed the nutritional outcomes of users were worse-off than of nonusers of spate irrigation. This happens in the face of better income and consumption expenditures, mainly nonfood, for users compared to nonusers. This underlines the importance of nutrition education alongside efforts to improve access to irrigation. Moreover, multisectoral collaborations are needed between the health, agriculture, water, social protection, education, gender and other sectors to improve the nutrition outcome of children.

Key words: *Weight-for-age, height-for-age and weight-for-height z-scores, Ethiopia, Africa*

1. Background

Various studies indicated the positive impact of perennial irrigation systems on productivity and people's livelihood, measured in marginal factor productivity, poverty (income and expenditure) and food security in sub-Saharan Africa, particularly in Ethiopia (Hanjra and Gichuki 2008;

Hanjra et al. 2009; Namara et al. 2010; Hagos et al. 2012, 2013). As far as we could tell, however, there is no empirical evidence related to household's livelihood impact of diverting floods for crop production also known as spate irrigation (SI).

SI is a unique form of water resources management that has been practiced in arid and semiarid regions where evapotranspiration greatly exceeds rainfall (FAO 2010). It is a form of water management involving the diversion of flashy floods running off from mountainous catchments, using simple deflectors of bunds constructed from sand, stones and brushwood on the beds of normally dry wadis (Lawrence and Steenbergen 2005). Short-duration floods are diverted from riverbeds and spread over land – to cultivate crops, feed drinking water ponds, or irrigate pasture areas or forestlands (Van Steenbergen et al. 2011).

SI schemes can be classified as small, medium and large, depending on the area they irrigate and could be categorized into traditional and modern diversions (for details see Erkossa et al. 2013). Traditional diversions consist of deflecting spurs or, in flatter plains areas, bunds that are constructed across the flood channel and canals, which are usually short and rarely include a secondary distribution system. In improved traditional systems there are farmer-implemented (although government- or NGO-supported) improved diversion structures and rejection spillways near canal heads and drop structures and flow diversion structures in main canals. In modernized and new systems, numerous traditional intakes are replaced with concrete diversion weirs with sediment sluices as well as steep canals, and sediment management structures are provided to minimize sedimentation (Erkossa et al. 2013).

SI promotes higher productivity of farming systems by supplementing the low and erratic rainfall (Van Steenbergen et al. 2011). Since most farmers produce only once a year, a long dry spell or drought can lead to a chronic food shortage and poverty. The severity of such climate-related crop failures increases with decreasing altitude. Therefore, the Ethiopian government is convinced that full or supplementary irrigation is required to minimize the risk of crop failure. Since it is considered as an existing opportunity and perceived to have low investment cost, SI systems are considered as the option in vast areas of the lowlands to support the unreliable rain-fed cropping system. As a result, in Ethiopia spate irrigation is – as elsewhere in sub-Saharan Africa – on the increase (Van Steenbergen et al. 2011).

This form of water management system is practiced in Tigray, Amhara and Oromia regional states. It has also been practiced at Konso in Southern Nations, Nationalities and People's Region (SNNPR) since antiquity and in some places in the Afar Region (Alemayehu 2008). Alemayehu (2008) reported an estimated area under SI in year 2008 to be about 140,000 ha, with a very high annual increase.

SI is very common in the districts of Raya Azebo (Tigray), Kobo (in Amhara), Dedota and Arsi Negelle (in Oromia) and Omorita (in SNNPR). This study focused on two traditional and two modern SI schemes in Tigray and Oromia regions. The study covered 200 households from both sites, half of them with access to SI (intervention) and half of them without access (control).

The study aims, therefore, to explore if SI has a significant impact on improved growth and nutrition of children of smallholder farmers. A pertinent research question to examine is whether there are differences in nutritional outcomes of children under the age of 5 years between SI users' and nonusers' households. The study provides evidence that has an important policy implication.

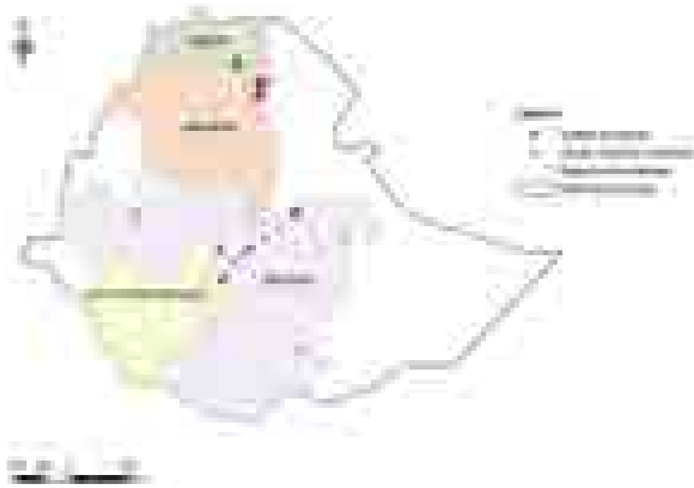
2. Methodology

Evaluation of nutritional status in this study is based on a comparison of height and weight for the children with data for child growth standards reference population of well-nourished children (WHO 2007). Height-for-age (HAZ) is the measure of linear growth. Children with HAZ below -2Z scores below the 5th percentile of the 2007 WHO standard population were classified as stunted. That is a child who is below -2Z from the reference mean for height-for-age is considered short for his/her age. Weight-for-height (WHZ) describes current nutritional status. A child who is below -2Z from the reference mean for WHZ is considered too thin for his/her height, or wasted, a condition reflecting acute or recent nutritional deficit. Weight-for-age (WAZ) is a composite index of WHZ and HAZ, and thus does not distinguish between acute malnutrition (wasting) and chronic malnutrition (stunting). A child can be underweight for his/her age because he or she is stunted, wasted, or both. WAZ, thus, is an overall indicator of a population's nutritional health. Children with HAZ and WAZ between <-2 z-score and >=-3 z-score were classified as moderately stunted and underweight, respectively. Children with HAZ and WAZ below < -3 z-scores were classified as severely stunted and underweight, respectively (Wang and Chen 2012). HAZ, WAZ and WHZ values below < -6 or > 6 were considered outliers. But none of the z-scores were out of range. In our data set for 12 cases, z-scores were not available (missing) and when we did range a plausibility check the observations were reduced by two or three units in the total sample. WHZ, WAZ and HAZ z-scores of children of households with access and with no access were reported to see the impact of access to spate irrigation. Gender disaggregated values for WHZ, WAZ and HAZ z-scores were reported to see if there were gender differences in nutritional outcomes. The z-scores were calculated using ENA (Emergency Nutrition Assessment) SMART. For similar approaches (see Mulugeta et al. 2009, 2010). But access to SI may not be the direct cause of malnutrition.

3. Study site and data sources

Two sites each in Tigray and Oromia, Fokisa, improved and Gereb Heshewa, traditional (both in Mehoni) and Dodota, improved (western Arsi) and Awadi (Arsi Negele) traditional, respectively, were purposively selected for the study. These sites were a subsample of samples (see Figure 4.1) used earlier in characterizing SI in Ethiopia (Erkosssa, et al. 2013). Fifty (50) households from each site, 25 with access and 25 without access, were selected using systematic sampling for the purpose of this study. Each selected household was interviewed, using a pretested questionnaire on access to services and infrastructure, demographic characteristics, access and use of spate irrigation, crop, livestock credit and off-farm income, food and nonfood expenditure, food security, and nutrition and health outcomes.

Figure 4.1. Location of the spate irrigation schemes and sites visited for this study.



4. Data management and statistical analysis

For this study, age, sex, weight and height of children under 5 years of age (122 children in total) were measured and recorded using locally made stadiometer with a sliding headpiece, and portable mechanical analogue-hanging scales, respectively. Height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg. Each subject was weighed with minimum clothing and no foot wear. The scales were carefully handled and periodically calibrated to ascertain accuracy. To avoid variability among the data collectors, the same measurers were employed for a given anthropometric measurement. Anthropometric measurements were converted to height for-age, weight-for-age and weight-for-height z-scores.

5. Results and discussion

5.1 Descriptive summary

The mean comparison test indicates that users are better off in terms of several livelihood indicators (see Table 4.1), like food expenditure, nonfood expenditure, primary education (complete), etc. SI users have a statistically higher livestock holding and family size (although insignificant in terms of female and male adults) compared to nonusers. This may imply that SI users are better-off in terms of major livelihood indicators compared to nonusers. But mean comparison test does not consider the effect of other covariates in the calculation of the mean and assessing the differences in livelihoods between groups. Thus we could not reach a final conclusion before we systematically analyze if access to SI has led to significant effects on nutrition outcomes.

Table 4.1. Mean comparison of spate users and nonusers.

Variable name	Mean of user of spate (n = 97)	Mean of nonusers of spate (n = 97)	t-test
Age of household head (in years)	43	42.1	0.445
Family size (in number)	5.361	4.814	-1.877*
Female adults (in number)	1.271	1.302	0.409
Male adults (in number)±	1.536	1.474	-0.411
Off-farm income (in ETB)	1490.88	1197.15	-0.568
Asset holding (in TLU)	1.845	1.281	-1.720*
Livestock income (in ETB)	783.21	1453.57	1.216
Credit income (in ETB)	740.38	753.51	0.075
Food expenditure during the last month (in ETB)	1951.46	1488.74	-2.330**
Nonfood expenditure during the last month (in ETB)	434.73	216.31	-2.625***
Total expenditure during the last month (in ETB)	2386.2	1705.057	-2.873*
Members' quantity completer primary education	2.1237	1.659	-1.905**
Members' quantity completer secondary education	0.773	0.659	-0.629

In some cases observations (n) are not similar in number: ┼= one obs. is missing; ±= users 84 and nonusers= 78. *, **, *** significant at 10, 5, 1%, respectively

Correlation coefficients indicate, however, that access to SI does not have significant impact on food shortage, food serving and effect and adaptation to food shortage.

5.2 Anthropometric results

As far as WAZ z-scores are concerned, the study showed that prevalence of underweight (<-2 z-score) was 19.1%, where about 21.1% of the boys and 17.0% girls were underweight. The study also showed a prevalence of moderate underweight (<-2 z-score and >=-3 z-score) 13.6% of the children, disaggregated into 12.3% boys and 15.1% girls. The study also shows a prevalence of severe underweight (<-3 z-score), where 5.5% of the children, disaggregated into 8.8% boys and 1.9% girls, had severe underweight implying the occurrence of both acute and chronic malnutrition in the study communities.

Looking into the results for HAZ z-scores, it shows the prevalence of stunting (<-2 z-score) where 50.0% of the children, i.e., 51.1% boys and 49.0% girls were stunted. About 30.0% of the children had moderate stunting (<-2 z-score and >=-3 z-score), with 32.7% of the boys and 27.5% of the girls. Of these 20.0% of the children, 18.4% of the boys and 21.6% of the girls had a prevalence of severe stunting (<-3 z-score). This implies that there is chronic malnutrition.

The WHZ results show that overall in the study sites 3.7% of all children have acute malnutrition (<-2 z-score) (see Table 4.2). When disaggregated, it was found that 5.4% of boys and 2.0% of girls have acute malnutrition. The study also shows 3.7% had moderate acute malnutrition (<-2 z-score and >=-3 z-score), disaggregated as 5.4% boys and 1.9% girls. None of the children had severe acute malnutrition (<-3 z-score). This implies that there was moderate but not severe acute malnutrition. The WAZ, WHZ and HAZ values for gender disaggregation are presented in the Appendix.

The 2011 DHS results indicated that overall, 29% of all children were underweight, and 9% of children were severely underweight. In rural areas, 42% of children were stunted (CSA 2012). The WHZ and WAZ indicators in the current survey show that the nutritional status of children has improved compared to the status in 2011; whether this is the result of SI use is a thing we will see below.

When we consider only households that use SI, the survey WHZ results indicated that 8.2% of the children had a prevalence of global acute malnutrition (<-2 z-score), where 11.1 and 4.5% constituted boys and girls, respectively. Of these 8.2% of the children had a prevalence of moderate acute malnutrition (<-2 z-score and >=-3 z-score), disaggregated into 11.1% of the boys and 4.5% of the girls. Prevalence of severe acute malnutrition (<-3 z-score) seems to affect none of the children.

Table 4.2. Anthropometric measures of children of users and nonusers.

Measures±	Overall sample (n= 111)	Users (n=49)	Nonusers (n=59)	Interpretation
Weight-for-height z-score (values in %)				
Below -2Z	3.7	8.2	0.0	Acute malnutrition
<-2 z-score and >=-3 z-scores	3.7	8.2	0.0	Moderate acute malnutrition
< -3 z-scores	0.0	0.0	0.0	Severe acute malnutrition
Weight-for-age z score				
Below -2Z	19.1	27.5	13.6	Underweight
<-2 z-score and >=-3 z-scores	13.6	17.6	10.2	Moderate underweight
< -3 z-scores	5.5	9.8	3.4	Severe underweighted
Height-for-Age z-score				
Below -2Z	50.0	56.5	45.5	Stunting
<-2 z-score and >=-3 z-scores	30.0	34.8	25.5	Moderate stunting
< -3 z-scores	5.5	21.7	20.0	Severe stunting

± Figures aggregated into boys and girls are given in the Appendix.

Source: Survey 2013.

The weight-for-age (WAZ) distribution results, in contrast to WHO standards, indicated that 27.5% of the children showed a prevalence of underweight (<-2 z-score), where 22.2% were boys and 33.3% were girls. Moreover, the result showed that 17.6% of the children, 11.1% boys and 25.0% girls showed a prevalence of moderate underweight (<-2 z-score and >=-3 z-score). Finally, 9.8% of the children, 11.7% of the boys and 8.3% of the girls showed a prevalence of severe underweight (<-3 z-score).

The distribution of height-for-age (HAZ) z-scores showed a prevalence of stunting (<-2 z-score) in 56.5% of the children, 65.4% boys and 45.0% girls. Of these 30.8% of the children, 34.8% of the boys and 30.0% of the girls showed a prevalence of moderate stunting (<-2 z-score and >=-3 z-score) and 21.7% of the children, 26.9% of the boys and 15.0% of the girls, showed a prevalence of severe stunting (<-3 z-score).

There was no prevalence of global acute malnutrition (<-2 z-score) in the children from the households without access to SI (see Table 4.2). But WAZ z-score showed that 13.6% of the children from the households without access to SI showed a prevalence of underweight (<-2 z-score). This constituted 20.7% of boys and 6.7% of girls. Nearly 10.2% of the children showed a prevalence of moderate underweight (<-2 z-score and >=-3 z-score), where 13.8% and 6.7% constituted boys and girls, respectively. The study showed a prevalence of severe underweight (<-3 z-score) in 3.4% of the children, where 6.9 and 0.0% constituted boys and girls, respectively.

The HAZ z-scores of children of households without access to SI showed that 45.5% of the children showed a prevalence of stunting (<-2 z-score). This constituted 37.5% of boys and 51.6% of girls. Of the children, 25.5% showed a prevalence of moderate stunting (<-2 z-score and >=-3 z-score), 25.57% boys and 25.0% girls. Prevalence of severe stunting (<-3 z-score) affected 20.0% of the children, 12.5% boys and 25.8% girls.

Spate does seem to have no significant impact, or does not lead to improvement, on anthropometric measures compared to households that did not use spate irrigation (Table 4.3). The study shows that spate irrigation reduces the absolute number but the relative number of the malnourished, underweight and stunted increases. Girls are not worse-off than boys. No comparable or more comprehensive study like DHS was available to see the effect of irrigation or SI on nutritional outcomes. The overall small sample size (and absence of comparable data) is an impediment to draw conclusive results.

Table 4.3. Anthropometric measures of children of traditional and improved SI.

Measures	Traditional SI (n= 21)	Improved SI (n= 33)
Weight-for-Height z scores (value in %)		
below -2Z	14.3	3.0
<-2 z-score and >=-3 z-scores	14.3	3.0
< -3 z-scores	0.0	0.0
Weight-for-Age z scores		
below -2Z	29.2	18.8
<-2 z-score and >=-3 z-scores	12.5	15.6
< -3 z-scores	16.7	3.1
Height-for-Age z scores		
below -2Z	50.0	60.0
<-2 z-score and >=-3 z-scores	40.9	26.7
< -3 z-scores	9.1	33.3

Source: Survey 2013.

When we examine households using improved SI (see Table 4.3), the WHZ z-score shows that 14.6% of the children showed acute malnutrition (<-2 z-score). This comprised 20.0% of boys and 9.1% of girls. Of the children, 14.3% showed moderate acute malnutrition (<-2 z-score and >=-3 z-score), where 20.0% and 9.1% constituted boys and girls, respectively. No children (0.0%) showed prevalence of severe acute malnutrition (<-3 z-score). The WAZ z-score shows that 29.2% of the children showed a prevalence of underweight (<-2 z-score). This comprised 33.3% of boys and 25.0% of girls. Of the children, 12.5% showed prevalence of moderate underweight (<-2 z-score and >=-3 z-score), where 8.3 and 16.7% constituted boys and girls, respectively. Of the children, 16.7% showed a prevalence of severe underweight (<-3 z-score), where 25.0% and 8.3% constituted boys and girls, respectively.

The HAZ z-score shows that 50.0% of the children showed a prevalence of stunting (<-2 z-score). This comprised 63.6% of boys and 36.4% of girls. Of the children, 40.9% showed a prevalence of moderate underweight (<-2 z-score and >=-3 z-score), where 63.6 and 18.2% constituted boys and girls, respectively. Of the children, 9.1% showed a prevalence of severe underweight (<-3 z-score), where 0.0 and 18.2% constituted boys and girls, respectively.

On the other hand, in households using traditional SI, the WHZ z-score shows that 3.0% of the children showed acute malnutrition (<-2 z-score). This comprised 5.3% of boys and 0.0 % of girls. Of the children, 3.0% showed moderate acute malnutrition (<-2 z-score and >=-3 z-score), where 5.3 and 0.0% constituted boys and girls, respectively. No children (0.0%) showed a prevalence of severe acute malnutrition (<-3 z-score).

The WAZ z-score shows that 18.8% of the children showed a prevalence of underweight (<-2 z-score). This comprised 11.1% of boys and 28.6% of girls. Of the children, 15.6% showed a prevalence of moderate underweight (<-2 z-score and >=-3 z-score), where 11.1 and 28.6% constituted boys and girls, respectively. Of the children 3.1% showed a prevalence of severe underweight (<-3 z-score), where 0.0 and 7.1% constituted boys and girls, respectively.

Finally, the HAZ z-score shows that 60.0% of the children showed a prevalence of stunting (<-2 z-score). This comprised 64.7% of boys and 53.8% of girls. Of the children, 26.7% showed a prevalence of moderate underweight (<-2 z-score and >=-3 z-score), where 23.5 and 30.9% constituted boys and girls, respectively. Of the children, 33.3% showed a prevalence of severe underweight (<-3 z-score), where 41.0 and 23.3% constituted boys and girls, respectively. Improved SI, thus, has led to improvement of acute malnutrition, underweight and moderate underweight, prevalence of stunting and severe stunting. On the other hand, traditional SI has led to improvements in moderate malnutrition, underweight, and severe underweight. To save space, the values of WHZ, WAZ and HAZ z-scores are not reported here.

Overall, having SI did not lead to significant improvement of nutritional outcomes when we compare users and nonusers; when we compare traditional and improved SI, the results are mixed. This may imply that using SI may not directly lead to improvement outcomes although it leads to increase of consumption expenditures, mainly nonfood. Our field observation seems to justify this fact: farmers use SI to grow cash crops (vegetable and fruits in Dadota and *chat* in Fokissa) which may increase household income and, hence, expenditure. Farmers grow cereals using rain-fed agriculture. Growing nutritious crops, accompanying access to SI with nutritional education, is necessary.

6. Conclusion and Recommendations

Access to SI is expected to increase crop productivity that, in turn, is expected to improve household nutrition. But the evidence from this study indicates that users do not have a better condition in nutrition outcomes compared to nonusers. The WHZ z-score results, compared to WHO standards, indicated that 8.2% of the children had moderate to acute malnutrition. WAZ z-scores indicated that 27.5% of the children showed a prevalence of underweight, 17.6% of the children showed prevalence of moderate underweight and 9.8% of the children showed a prevalence of severe underweight. According to the HAZ z-scores results 56.5% of the children showed a prevalence of stunting, 30.8% of the children showed a prevalence of moderate stunting and 21.7% of the children showed a prevalence of severe stunting. This implied that acute, both current and past, and chronic malnutrition was prevalent even in the presence of SI to the household. Access to SI, thus, did not lead to a significant difference in nutritional outcomes, although the average value of expenditure, food and nonfood was significant between the two groups. Increasing production, though a necessary condition, like irrigation, is not a guarantee for improved nutrition. Nutrition is a multidimensional problem that needs multisectoral collaborations between the health, agriculture, water, social protection, education, gender and other sectors. This study also underlines the importance of nutrition education as one of the entry points alongside improving access to SI. The importance of nutrition education is emphasized because better nutrition is important for the physical and mental growth of children under 5 years. The nutritional outcomes were not different among boys and girls, probably indicating the gender difference in rural Ethiopia is not prominent.

Overall wasting, underweight and stunting are serious compared to the WHO standard population. The country has a long way to go in improving nutrition outcomes.

Spate systems are risk-prone and are categorically different from perennial systems. The floods may be abundant or minimal and production varies from year to year. The fluctuation also brings along an unavoidable degree of inequity, with some lands always better served than others. Spate systems, moreover, have to deal with occasional high floods that – unless properly controlled – can cause damage to riverbeds and command areas (Van Steenbergen et al. 2011). Access to panel data could reflect these variations and can lead to a more realistic conclusion than one-period data.

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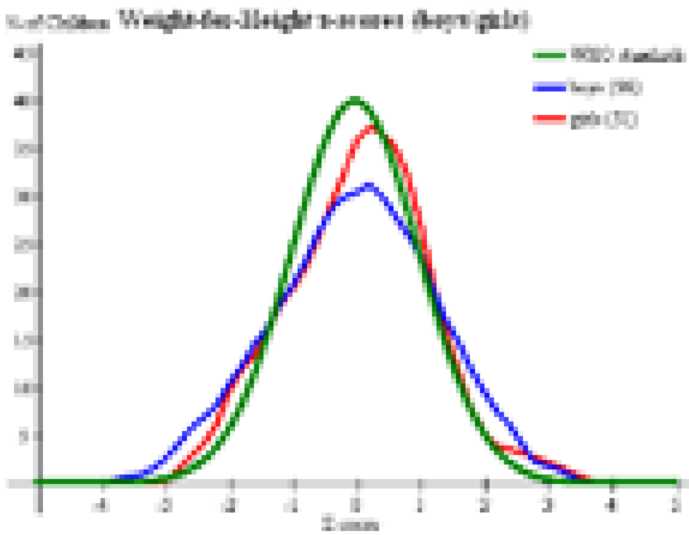
Appendix

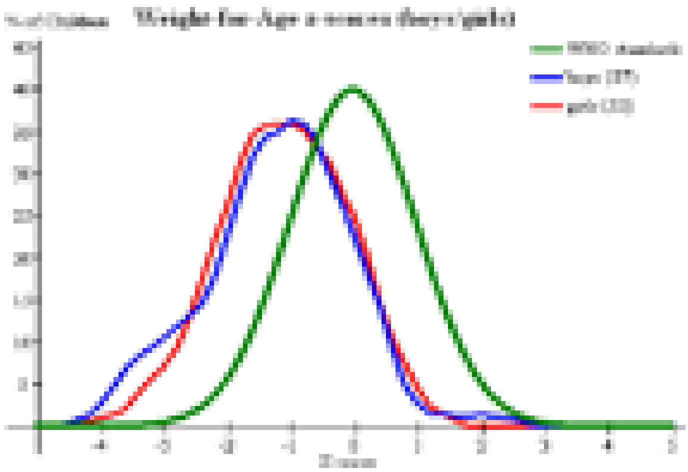
The appendix shows Figures A1 to A8.

Figure A1. WHZ z-score for the whole sample disaggregated by sex.



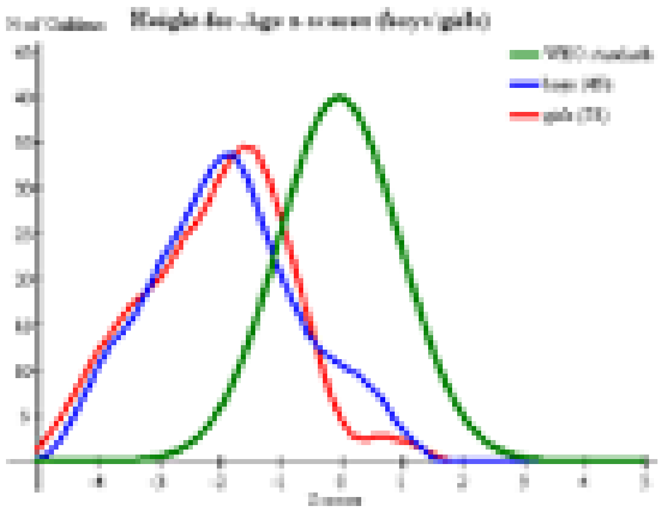
Source: Survey 2013.

Figure A2. WAZ z-score for the whole sample disaggregated by sex.



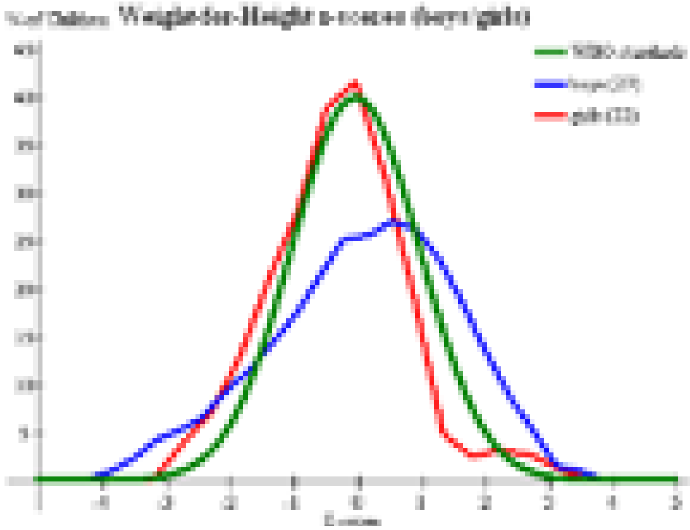
Source: Survey 2013.

Figure A3. HAZ z-score for the whole sample disaggregated by sex.



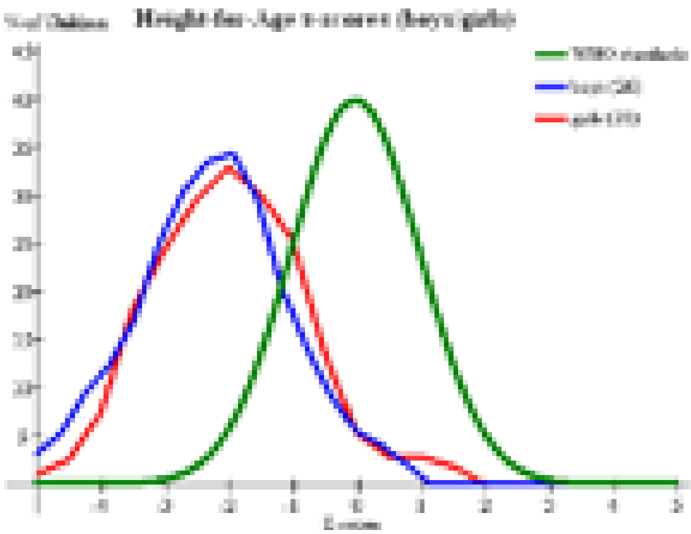
Source: Survey 2013.

Figure A4. WHZ z-scores for the sample with access to SI disaggregated by sex.



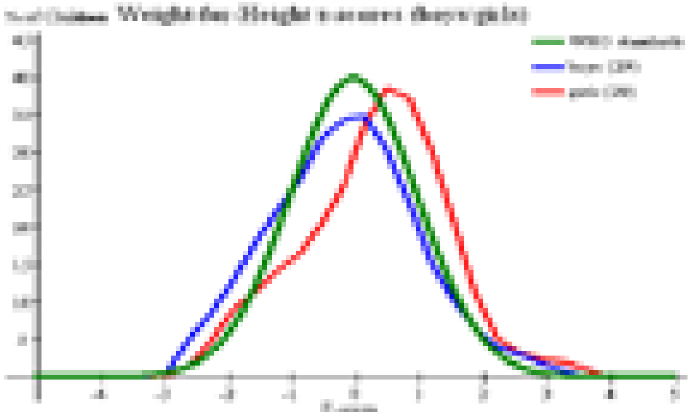
Source: Survey 2013.

Figure A5. HAZ disaggregated by sex for the sample with access to SI disaggregated by sex.



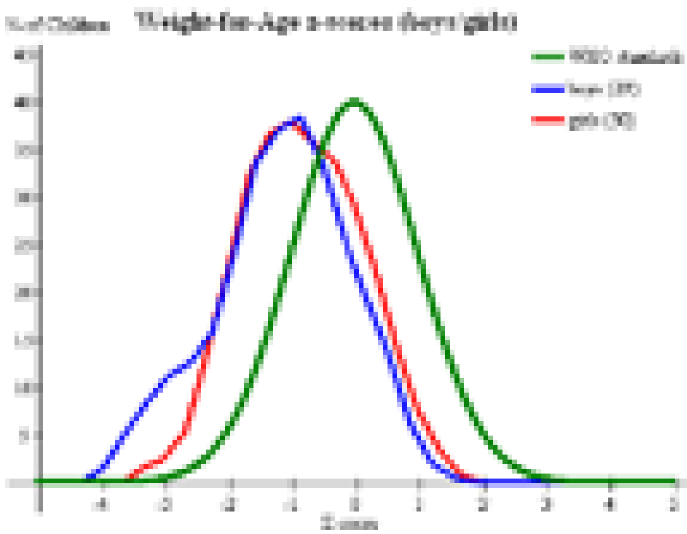
Source: Survey 2013.

Figure A6. WHZ z-scores for children of households without access to SI disaggregated by sex.



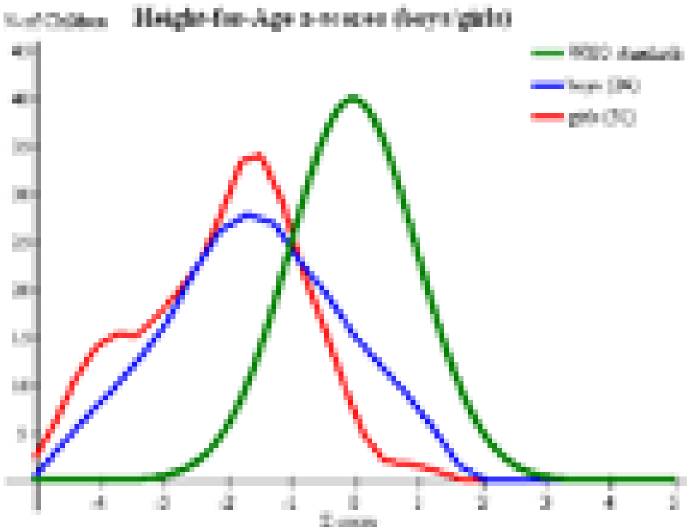
Source: Survey 2013.

Figure A7. WAZ z-scores for children of households without access to SI disaggregated by sex.



Source: Survey 2013.

Figure A8. HAZ z-scores for children of households without access to SI disaggregated by sex.



Source: Survey 2013.