South African Journal of Clinical Nutrition 2020; 33(4):152–157
https://doi.org/10.1080/16070658.2019.1612652

SAJCN
ISSN 1607-0658 EISSN 2221-1268

ARTICLE

Nutritional status of children aged 0–60 months in two drought-prone areas of Ethiopia

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Objectives: A study was undertaken to assess the prevalence of undernutrition and associated factors among children under five in two drought-prone areas in Ethiopia.
Study design and setting: Through a cross-sectional, mixed-methods approach, data were analysed using multistage random sampling methods.
Study subjects and outcome measures: Data were collected on socioeconomic factors, demographic characteristics and anthropometric measurements from 350 households. Height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) z-scores of 304 children, aged 0–60 months, were calculated using the WHO Anthro software. Children with z-scores of less than −2 standard deviations (SDs) for HAZ, WHZ and WAZ were classified as stunted, wasted and underweight respectively. Descriptive statistics, t-tests, correlation and regression analyses were used to assess the relationships between independent variables and stunting and underweight.
Results: Prevalence of stunting, wasting and underweight were 49.4%, 13.7% and 37.1% respectively. Among independent variables tested, agroecology was significantly associated with stunting ($p = 0.012$) and underweight ($p < 0.001$), while livestock holding was significantly correlated with stunting ($p = 0.008$) and underweight ($p = 0.012$). Access to irrigation was also significantly associated with stunting ($p = 0.028$) and underweight ($p = 0.016$). However, the prevalence of stunting, wasting and underweight was not significantly associated with household size, landholdings or frequency of sickness.
Conclusions: The prevalence of undernutrition within the study areas was higher than the national average for Ethiopia. Lowland areas exhibited the highest rates of undernutrition; consequently, interventions that include the enhancement of livestock holdings and access to irrigation should include agroecological factors in an effort to reduce childhood undernutrition.

Keywords: children, Ethiopia, stunting, under five, undernutrition

Introduction

Worldwide about 45% of deaths among children under five are attributed to undernutrition.[1] For those who survive, undernutrition is associated with negative health outcomes later in life.[2,3] Extreme poverty, food insecurity, inadequate nutritional intake, limited knowledge of nutrition and/or repeated infections are the major factors that affect child growth and development. Undernutrition, therefore, disproportionately affects children in middle- and low-income countries, especially in sub-Saharan Africa and South Asia, where about 250 million under-fives are at risk of growth retardation.[4]

Undernutrition among children results from the interactions of multi-level factors, including inadequate dietary intake, repeated and chronic infections, and compromised prenatal conditions.[1] Stunting (low height-for-age), the result of chronic undernutrition, is often associated with an increased risk of mortality and morbidity, poor cognitive and physical development, lower economic productivity and adverse maternal reproductive outcomes in adulthood.[1–3] Growth failure due to undernutrition during early childhood, especially in the first 1 000 days, can cause lasting damage, which may pass to the next generation.[5,6] Because childhood undernutrition can have significant individual, community and national-level impacts, it is considered one of the most important public health problems in developing countries such as Ethiopia. [1,3]

Ethiopia's children less than five years of age exhibit one of the highest rates of stunting in the world.[5] Such high undernutrition, defined as height-for-age (HAZ), weight-for-height (WHZ), and/or weight-for-age (WAZ) z-scores less than −2 standard deviations (SDs) has been persistent in Ethiopia.[5] The most recent assessment indicated that, nationwide, about 40% of children under five are stunted.[5] Recently, concerted efforts by the Ethiopian Government and its development partners have significantly improved nutrition and health for mothers and children, through nutrition-specific interventions, such as deworming, vitamins and other micronutrients supplementation.[7] The sustainability of these interventions, however, is problematic if they are implemented without simultaneously addressing the underlying factors, such as poverty and food security. The challenge of addressing the causal factors of undernutrition is highlighted by the fact that only about 12% of children under two years of age met the minimum acceptable level of dietary diversity,[8] indicating the urgent need to develop sustainable nutrition-sensitive interventions, such as increasing the production and cultivation of diversified crops.[9]

A multidisciplinary team of researchers from the USA and Ethiopia conducted a comprehensive survey and anthropometric assessment of populations in five districts from Amhara and Oromia Regional States to produce a baseline profile for the collaborative research programme entitled 'Farming, Food and Fitness' (3F). The programme was designed to enhance food and nutrition security through sustainable and nutrition-sensitive food production. Here, we present preliminary findings for one segment of the study population: children under the age of five. The objectives of this research were to: (a) determine the levels of undernutrition among children aged under five in the study districts, and (b) assess the potential factors that may correlate with children's nutritional status.

Methods

Study settings

This research was undertaken in the East Hararghe Zone of the Oromia Region and in the South Wollo Zone of the Amhara Region in Ethiopia (Figure 1). Each zone is drought-prone and among the most chronically food insecure areas of the country. Population sizes are comparable with about 2.7 million living in East Hararghe and 2.5 million in South Wollo.[10] However, the zones are ethnically different: East Hararghe is overwhelmingly (96.4%) Oromo, while in South Wollo, 98.6% of the population identify themselves as Amhara.[10] Two districts from East Hararghe, Fedis and Haramaya, and three districts from South Wollo, Dessie Zuria, Kalu and Tehuledere, were selected for this study. All households sampled for this study were involved in semi-subsistence farming, with about 30% of them having access to small-scale irrigation.

A smallholder subsistence, mixed farming system that integrates crop and livestock production characterises agriculture in both regions. Livestock provide nutrition, through meat and dairy, sources of income and social status as well. Livestock holdings were measured in tropical livestock units (TLU), an index that describes biomass across species with a single indicator.

Study design

A multistage sampling procedure was employed, stratified by major agroecological zones. Districts were purposively selected based on altitudinal variation that included lowland, midland and highland agroecological zones. Subdistricts within each district, and households within each subdistrict, were randomly selected using household lists provided by the district offices as a sample frame. One hundred households from each of the two districts in East Hararghe, and 50 households from each of the three districts in South Wollo, were selected for this study. Because detailed data collection within each household, including all household members, was critical to the research objectives, the total number of households sampled was primarily constrained by time.

Data collection

A cross-sectional, mixed-methods research project was conducted between June and July of 2010 and June and August of 2011. Eighteen enumerators, recruited from Haramaya and Wollo Universities, were trained by principal investigators to collect the data. The data-collection instruments were pretested in neighbouring villages, outside the target households.

The research was undertaken to collect baseline information on demographic, socioeconomic, agricultural and health-related factors that could inform future project designs for the 3F programme. However, this report focuses on data from the anthropometric assessment.

The Seca 869 (Seca®, Chino, USA) electronic scale was used to obtain body weight for individuals older than one year of age, and infants were weighed using the Doran DS4100 infant weight scale (Doran Scales, Inc., St Charles, IL, USA). The height/length of children was measured with the Perspective Enterprises Portable Adult/Infant Measuring stadiometer. Mid-upper arm circumference (MUAC) was measured using the Perspective Enterprises circumference measuring tapes (Perspective Enterprises, Portage, MI, USA). Standing height or recumbent length (for children under 24 months), MUAC, head circumference and arm-span were measured to the nearest 0.01 cm, while weight was measured to the nearest 0.01 kg. Each height and weight measurement was taken twice and the digital scale was recalibrated before each measure.

Ethics

The University of Nebraska Institutional Review Board reviewed and approved the study protocol and all supporting documents (IRB Approval #: 20100710992EP). The proposal was then approved by Haramaya University and Wollo University. Before the research was implemented in the field, the objectives of the study were explained to and permission was obtained

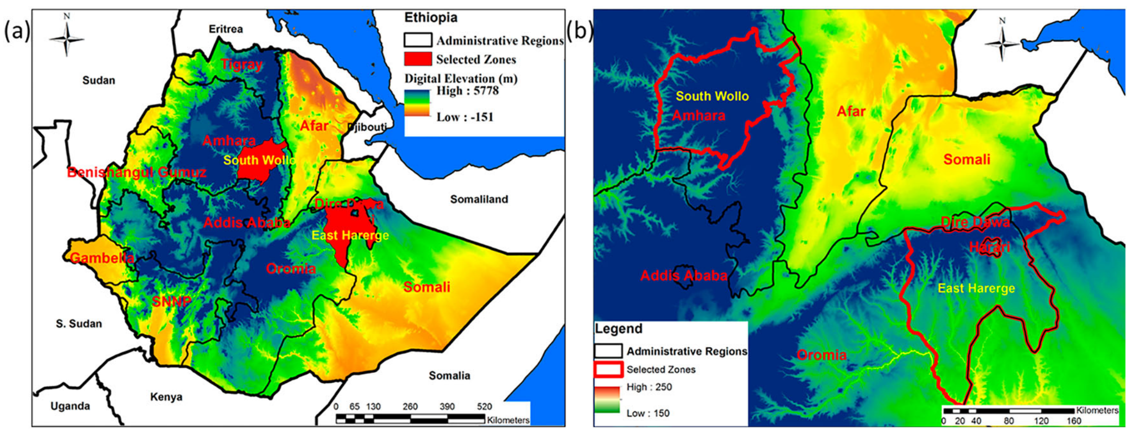

Figure 1: Map of Ethiopia showing (a) the study areas in red and (b) an enlarged drawing of the two study zones.

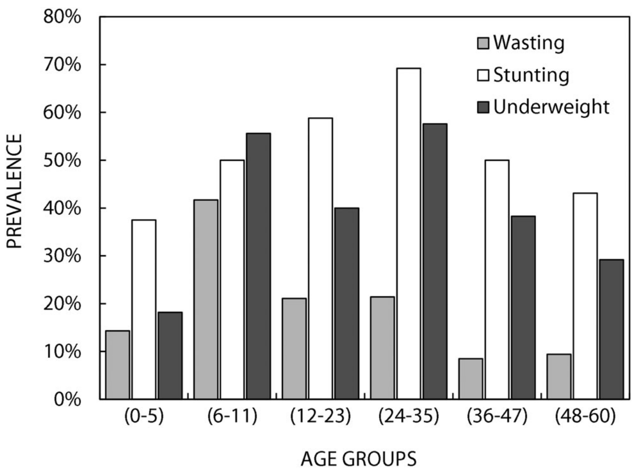

Figure 2: Prevalence of undernutrition (*z*-scores < −2 SDs) by age groups in the study areas.

from district and subdistrict officials. The purpose of the study, confidentiality of information and voluntariness of participation were explained to each household head and other members of the household, and verbal consent to participate was obtained from the household head before the interviews and anthropometric measurements were conducted.

Data analysis

Height/length-for-age z-scores (HAZ), weight-for-height/length z-scores (WHZ), and weight-for-age z-scores (WAZ) for children up to 60 months of age were generated using WHO Anthro Version 3.2.2.12 https://www.who.int/childgrowth/software/en/). Children with z-scores of less than −2 standard deviations (SDs) for HAZ, WHZ and WAZ were classified as stunted, wasted and underweight respectively.[11] Values of z-scores between −3 and −2 SDs were defined as moderate, and z-scores lower than −3 SDs were classified as severe.

T-tests, bivariate correlations, chi-square tests, multinomial and binary logistic regression were performed to assess the association between independent and dependent variables such as stunting, wasting and underweight. The independent variables tested included sex, region, district, agroecology, livestock holdings, irrigation, household size, farmland size and frequency of sickness. The regression analysis resulted in odds ratios (OR), generated with 95% confidence intervals (CI). A *p*-value of 0.05 or less was considered statistically significant. Data were analysed using SPSS (IBM SPSS Statistics for Windows, Version 25.0. IBM Corp, Armonk, NY, USA).

Results

The anthropometric indices of 304 children under five, 160 males and 144 females, were analysed for this study. The means and standard deviation of HAZ, WHZ and WAZ were −1.99 ± 1.89, −0.38 ± 1.63 and −1.56 ± 1.43 respectively. The overall prevalence of undernutrition in the two study areas, as determined by stunting (HAZ < −2 SDs), wasting (WHZ < −2 SDs) and underweight (WAZ < −2 SDs), was 49.4%, 13.7% and 37.1% respectively. Although the overall rate of undernutrition was high for the entire cohort, younger children within age ranges 6–12 and 24–35 months exhibited the highest rates of undernutrition (Figure 2). About half of the males and females, 50.4% and 48.4% respectively, were stunted in the study areas (Table 1). The prevalence of stunting varied between regions,

Table 1: Prevalence of wasting, stunting and underweight among children under five

Variable		Wasting (%)	Stunting (%)	Underweight (%)	*n*
Sex	Male	16.6	50.4	40.9	160
	Female	11.0	48.4	32.9	144
Region	Hararghe	15.5	51.1	40.5	222
	Wollo	10.3	45.3	28.0	82
District	Fedis (H)	14.0	62.5	51.1	133
	Haramaya (H)	17.5	36.6	24.7	89
	Dessie (W)	0.0	42.9	19.2	26
	Kalu (W)	15.9	45.5	35.6	45
	Tehuledere (W)	11.1	50.0	18.2	11
Agroecology	Highland	0.0	42.9	19.2	26
	Midland	16.9	38.0	24.0	100
	Lowland	14.6	57.4	47.2	178
Livestock holding	Low	14.5	58.4	44.4	153
	High	13.7	41.5	30.2	149
Irrigation	Yes	16.2	38.7	25.9	81
	No	13.1	53.8	41.2	223
Household size	Low	16.8	50.7	37.4	173
	High	10.6	47.9	36.6	131
	Three	0.0	50.0	28.6	14
Farmland size	Low	14.5	47.5	34.0	164
	High	13.4	51.6	40.7	140
Frequency of sickness	No	12.4	48.6	33.5	208
	Once	17.3	51.1	33.5	60
	Twice	28.6	40.9	59.1	22

(H) East Hararghe; (W) South Wollo.

Table 2: Factors significantly associated with childrens's' nutritional status

Independent variables		Stunting		Underweight	
		OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
District			0.012*		< 0.001*
	Dessie (H)	2.222 (0.858–5.752)	0.100	4.397 (1.564–12.362)	0.005*
	Haramaya (M)	2.889 (1.586–5.262)	0.001*	3.188 (1.766–5.757)	< 0.001*
	Tehuledere (M)	1.667 (0.453–6.125)	0.442	4.711 (0.980–22.644)	0.053
	Kalu (L)	2.000 (0.979–4.084)	0.057	1.899 (0.942–3.821)	0.073
	Fedis (L)				
Agroecology			0.012*		< 0.001*
	Highland	1.799 (0.714–4.531)	0.213	3.748 (1.353–10.387)	0.011*
	Midland	2.197 (1.290–3.742)	0.004*	2.826 (1.637–4.879)	< 0.001*
	Lowland				
Livestock holding	Low	0.511 (0.312–0.838)	0.008*	0.542 (0.337–0.872)	0.012*
	High				
Irrigation	Yes	1.844 (1.067–3.187)	0.028*	2.000 (1.137–3.517)	0.016*
	No				

**P*-values < 0.05; H = highland; M = midland, L = lowland.

among districts and agroecological zones, and by household access to irrigation (Table 1).

Overall, the proportion of stunted, wasted and underweight children was lower in South Wollo, compared with East Hararghe (Table 1). Boys were also more stunted, wasted and underweight than girls (Table 1), although these differences were not statistically significant. Although significant differences in the prevalence of stunting ($p = 0.012$) were observed between districts (Table 2), Fedis and Haramaya, both in East Hararghe, had the highest (62.5%) and lowest (36.6%) prevalence of stunting in this study (Table 1). The percentage of underweight children also differs significantly between study districts ($p < 0.001$) (Table 2). As was true for stunting, Fedis in Eastern Hararghe has the highest rate of underweight children, 51.1% (Table 1). The second highest proportion (35.6%) of underweight children is from the other lowland district, Kalu in South Wollo (Table 1). For the remaining districts, the underweight prevalence rate varies between 18.2% and 24.7% (Table 1).

There were significant differences in the prevalence of underweight between the three agroecological zones, highland, midland and lowland ($p < 0.001$) (Table 2). Children from the midland (OR 2.83; 95% CI 1.64–4.88) (Table 2) and the highland (OR 3.75) (Table 2) agroecological zones were more likely to be within the normal weight-for-age (WAZ > −2SDs) range compared with children from the lowland districts (Fedis and Kalu). Similarly, prevalence of stunting also varied by agroecology, such that the overall prevalence of stunting was significantly higher in lowland agroecological zones ($p = 0.012$) (Table 2). Here again, children from the midland agroecological zones are more likely to be within the normal height-for-age (HAZ > −2SDs) range compared with children from the lowland districts (Table 2). Although not statistically significant, children from highland areas are more likely to be in the normal height range compared with children from the lowlands (Table 2).

Livestock holdings, measured as total livestock unit per capita, were significantly associated with both HAZ and WAZ (Table 2). Children from households that own a TLU per capita below the median, 0.61 TLU per capita, are more likely to be stunted (OR 0.511) (Table 2) or underweight (OR 0.542), compared with those from households that have TLU per capita above the median.

The prevalence of stunting was significantly associated with lack of access to irrigation ($p = 0.028$). Children from households that have access to irrigation were less likely to be stunted (OR 0.542) (Table 2). Similarly, the prevalence of underweight was significantly associated with household access to irrigation ($p = 0.016$) (Table 2). In other words, children from households with access to irrigation were more likely to be within the normal weight-for-age range (OR 2.000) compared with children from households without access to irrigation (Table 2). Further analysis of the relationship between irrigation and under-five nutrition revealed a more complicated picture (Table 3). Access to irrigation was associated with severe stunting ($p = 0.010$) and severe underweight ($p = 0.003$); however, there did not seem

Table 3: Association between irrigation and children's nutritional status

Independent variables		Stunting		Underweight	
		OR (95% CI)*	*p*-value	OR (95% CI)*	*p*-value
Irrigation:					
Yes	Severely stunted	0.419 (0.215–0.814)	0.010	0.197 (0.068–0.573)	0.003
No					
Irrigation:					
Yes	Moderately stunted	0.793 (0.386–1.630)	0.528	0.784 (0.416–1.477)	0.451
No					

*Predicted probability is of membership for normal linear growth, HAZ equals to -2 SDs or above.

to be an association between access to irrigation on rates of moderate stunting ($p = 0.528$) and moderate underweight ($p = 0.451$) (Table 3).

Other factors that may affect child nutrition, such as household size, landholdings and frequency of reported sickness, were not significantly associated with prevalence of undernutrition in the study areas.

Discussion

Children from the study areas exhibited higher rates of undernutrition as compared with the country's national average.[12] Because the study districts are found in drought-prone areas, higher rates may be expected. However, the severity of undernutrition in the study areas, especially for stunting, is greater than the cut-off points considered 'very high prevalence' for public health or emergency interventions as defined by the WHO.[13] The long-term costs of such high stunting rates are enormous, and include increased risk of morbidity and mortality, reduced cognitive development and limited economic productivity for the affected individuals, their communities and society in general.[1,3,14,15]

The peaks of underweight prevalence occur at ages 6–11 months and 24–35 months, and coincide with the introduction of complementary foods and weaning from breast-feeding, respectively. Besides inadequate dietary consumption, the introduction of complementary and weaning foods may also enhance the risk of infection due to poor sanitation and hygiene conditions in rural Ethiopia.[12]

A distinctive pattern of undernutrition is present in the lowland districts. Both have similar agroecologies and dietary consumption patterns; more than 90% of households subsist primarily on a monotonous sorghum diet and consume almost no meat and limited vitamin-rich foods, such as fruits and vegetables.[16] Agroecology may be a more important factor in food insecurity and undernutrition than the characteristics of districts per se. For example, Fedis in East Hararghe and Kalu in South Wollo are located at lower altitudes than all the others. They also have high average temperatures and low annual rainfall,[17] and are dependent on low moisture-adapted crops such as sorghum. One major limiting factor for food production in the lowlands is moisture stress,[17] and as such this issue may account for the higher rates of undernutrition present at these lower altitudes. Thus, the prevalence of stunting and underweight in lowland areas suggests the need to consider local ecological contexts when addressing food and nutrition security.

Access to small-scale irrigation and prevalence of undernutrition

Children from households with irrigation were better off in their overall nutritional status than their counterparts. However, access to irrigation reduced *severe* undernutrition. The lack of significant association between moderate undernutrition and access to irrigation may be due to several factors, especially given that the link between irrigation and nutrition is complex.[9] The focus of small-scale irrigation on cash instead of food crops may have a negative impact on nutrition for a number of reasons.[18] These include the purchase of non-nutritious foods and increased risk of infection, especially from water-borne diseases, due to irrigation and inadequate child feeding practices,[1] but also insufficient farm plots.[19] Research indicates that while irrigation developments increase income, and to some extent access to food, very few studies actually measure the association between access to irrigation and nutritional status.[18] When the impact of irrigation on nutritional status of children is examined, results are often inconclusive.[9,18–21] However, a recent review by Ruel *et al.*[9] yielded an analytical caveat whereby programmes that explicitly aimed to increase household access to nutrient-rich foods, and carefully designed nutrition interventions, are more likely to achieve improved nutritional outcomes.[9] These observations suggest that there is a need to design nutrition-sensitive irrigation interventions.[18, 20] Despite the fact that households might generate income from irrigation to purchase additional foodstuffs, they may not have an adequate knowledge about which foods should be consumed to address macro- and micronutrient deficiencies for the life span, and hence underestimate what is needed for children.

Conclusions

Despite the cross-sectional nature of this study, and one that precludes a strong conclusion, our findings are congruent with other studies in Ethiopia and elsewhere. The local context, such as agroecology, had a significant association with the prevalence of child undernutrition, especially stunting. This relationship indicates a need to consider ecological contexts when designing programmes and policies designed to improve the nutritional status of children.

Although access to irrigation reduced the prevalence of severe forms of undernutrition among children, it did not significantly reduce the prevalence of either moderate stunting or moderate underweight. Although improving nutritional status requires a multisectoral (e.g. health and nutrition education for each life stage) approach, designing irrigation programmes with nutrition objectives can contribute to the improvement of nutritional status more than has been hitherto possible.

Acknowledgements – An International Seed Grant from the Institute of Agriculture and Natural Resources-Agricultural Research Division, and funding from the Robert B. Daugherty Water for Food Global Institute at the University of Nebraska-Lincoln, provided financial support for this project. The authors would like to thank their partners at Haramaya and Wollo Universities in Ethiopia for facilitating and participating in the fieldwork. They thank *Woreda* and *Kebele* officials for their time and commitment. They are also grateful for all the households who responded to the interviews and allowed anthropometric measurements. They thank three anonymous reviewers for their comments and suggestions an earlier draft of this manuscript.

Disclosure statement – No potential conflict of interest was reported by the authors.

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Received: 04-09-2018 Accepted: 24-04-2019