Original Article

Scale up of nutrition and health programs in Ethiopia and their overlap with reductions in child stunting

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Abstract

The prevalence of stunting in Sub-Saharan Africa has changed little since 2000, and the number of stunted children has increased. In contrast, Ethiopia is an example where the national stunting prevalence and number of stunted children have decreased consistently. We compare regional differences and temporal patterns in stunting with large-scale program coverage to identify where and when programs may have led to reductions in stunting. Data from three national demographic and health surveys and population statistics illustrate, at the regional level, where and when the prevalence and number of stunted children changed since 2000. Reports from large-scale nutrition and health programs were used to identify ecologic associations between geographic program coverage and reductions in stunting. From 2000 to 2005, the decline in the national stunting prevalence was mainly a result of reductions in Oromiya, SNNP and Tigray. Few nutrition programs had high coverage during this time, and economic growth may have contributed to stunting reduction by increasing household wealth and investments in sanitation. From 2005 to 2011, declines in stunting prevalence in Amhara, SNNP, Somali and Oromiya were largely responsible for national reductions. Numerous programs were implemented at scale and could have plausibly improved stunting. While ecologic relationships suggest that economic growth and large-scale programs may have contributed to the reduction in stunting in Ethiopia, stunting did not decrease in all regions despite increased program coverage expansion of the health system. Additional impact evaluations are needed identify the most effective programs to accelerate the reduction in the prevalence and number of stunted children. © 2016 John Wiley & Sons Ltd

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Introduction

Stunting, or chronic malnutrition, in children < 5 years of age, is associated with numerous health and development consequences in childhood and social and economic consequences in adolescence and adulthood (Black *et al.*, 2008). Stunting currently affects 58 million children in Africa, and the number of stunted children in Africa will likely increase because of population growth and a stagnating prevalence of stunting (de Onis *et al.*, 2013). Only a few African countries have successfully reduced the prevalence and number of stunted children in the past two decades.

Ethiopia provides one such example of a Sub-Saharan nation where stunting has decreased. From 1992 to 2011,

child stunting declined by 23 percentage points (from 67% to 44%) (UNICEF, 2013); ~14 percentage points of this decline was observed between 2000 and 2011, where the prevalence was measured by three Demographic and Health Surveys (DHS) with comparable designs and methodologies (CSA & ICF International, 2012; CSA & ORC Macro, 2006; CSA & ORC Macro, 2001). This reduction in the national prevalence of stunting occurred during a dynamic period with a significant increase in the total population and the expansion of large-scale health and nutrition programs.

In a separate study, we conducted an analysis to identify the risk factors of stunting and the factors associated with stunting reduction in Ethiopia between 2000 and 2011 using data from Ethiopia's 2000, 2005 and

2011 DHS (Woodruff *et al.*, 2016). As DHS lack detailed information on survey subjects' participation in many health and nutrition programs, our individual-level analysis of DHS data can unfortunately not investigate associations between program coverage and stunting reduction. We present here an ecologic analysis which aims to determine if the reduction in stunting can be – at least partly – ascribed to coverage of large-scale nutrition and health programs.

This paper has two objectives: (1) to present the national and regional stunting trends and identify which regions contributed most to national-level reductions in stunting from 2000 to 2011, and (2) to draw linkages between the reduction in stunting and health and nutrition programs in Ethiopia in the same time period. By understanding where and when program activities correlated with reductions in stunting, the authors hope to assist national and local authorities determine which programs are effective at reducing stunting.

Methods

Data from three national DHS surveys and national population figures were used to identify where and when stunting changed in Ethiopia between 2000–2005 and 2005–2011 and which regions contributed most to the changes in prevalence of stunting at the national level. Sub-national changes are investigated using two approaches. First, the prevalence of stunting nationally, by urban/rural status and by region was calculated using the World Health Organization's (WHO) Child Growth Standards (WHO, 2006). Stunting prevalence is defined as the weighted proportion of children 0–59 months of

age with height-for-age z scores (HAZ) below -2 SD; children with HAZ less than -6.0 or HAZ greater than $+6.0$ were excluded from analysis (SMART, 2006). Regional population statistics¹ from Ethiopia's Central Statistical Agency (CSA) (CSA, 2005; CSA, 2010; CSA, 2013) and regional prevalence from the three DHS were used to calculate the total number of stunted children by region and by year. Second, using the regional change in the number of stunted children for two different time periods, 2000–2005 and 2005–2011, the proportion of the national reduction in stunting was attributed to specific regions, accounting for both changes in stunting prevalence and population size.

An inventory of all large-scale health, nutrition and food security programs was conducted, and coverage and impact data were examined and overlaid against the reductions of stunting observed by the DHS. The evolution of the political, economic and demographic context in Ethiopia was also reviewed to further identify associations between secular trends and changes in stunting.

Results

Changes in prevalence and magnitude of stunting, 2000–2011

As shown in Figure 1, there has been a steady reduction in the prevalence of stunting when examined nationally and by urban and rural residence. Similar to national-level analysis, consistent decreases ≥ 2 percentage points between each DHS were observed in Southern

¹Specific figures used include total population by region by year, and the percent of children < 5 years old, by region by year.

Key messages

- Since 2000, Ethiopia's stunting prevalence decreased consistently at the national level but did not decline consistently at the regional level.
- The reduction in stunting only translates to relatively small reductions in the number of stunted children because of population growth.
- Few large-scale nutrition and health programs were at scale from 2000 to 2005, and stunting reductions correlate most directly with economic growth and improvements in household wealth.
- Many large-scale programs were implemented from 2005 to 2011, and the increased coverage of the HEP program and the CBN and CMAM programs show the strongest associations with reductions in stunting.

Fig. 1. Prevalence of stunting in children < 5 years of age in Ethiopia in 2000, 2005 and 2011 at the national level, by residency and by region.

Fig. 2. Number of children < 5 years of age with stunting in Ethiopia in 2000, 2005 and 2011 at the national level, by residency and by region.

Nations, Nationalities and Peoples' (SNNP) region, Oromiya, Gambela and Addis Ababa. The change in stunting prevalence in other regions, however, is less consistent. While the prevalence of stunting declined between 2000 and 2005 in Tigray, Afar and Benishangul-Gumuz, it increased from 2005 to 2011, albeit not to 2000 levels. In contrast, Amhara, Somali and Harari showed negligible changes or increases in the prevalence of stunting between 2000 and 2005, with reductions in prevalence between 2005 and 2011. Only in Dire Dawa did stunting increase consistently between 2000 and 2011, although this change is not statistically significant.

Even with a general decline in the prevalence of stunting, the prevalence of stunting measured in 2011 is considered 'very high' ($\geq 40\%$) in six of Ethiopia's 11 regions (Amhara, Tigray, SNNP, Oromiya, Afar and Benishangul-Gumuz) according to WHO (2010) classifications (2010). The prevalence of stunting is considered 'high' (30–39%) in Somali and Dire Dawa, and 'medium' (20–29%) in Addis Ababa, Gambela and Harari. In no region is stunting prevalence considered 'low' ($< 20\%$).

Figure 2 presents the total number of stunted children nationally, by urban/rural residence and by region in 2000, 2005 and 2011 (termed hereafter 'caseloads'). The overall national caseload has declined from 2000 to 2011; while a clear decline in rural children is observed, there was a small increase in caseloads in urban areas. According to population statistics, the number of children < 5 years of age increased by nearly 23% from 2000 and 2011, from 10.3 to 12.6 million. The number of stunted children declined from 5.8 to 5.5 million, a change of only 6%, over the same time period. At the regional level, the number of stunted children corresponds closely to regional populations, with the three most populous regions, Oromiya, Amhara and SNNP, containing the largest number of stunted children.

Tables 1 and 2 present the proportion of the national decrease in the stunting prevalence between two time periods (2000–2005 and 2005–2011) contributed by each region. Between 2000 and 2005 the 6.9 percentage point decrease in stunting nationally is attributed principally to reductions in the number of stunted children in Oromiya, SNNP and Tigray. Reductions in stunting in Afar and Addis Ababa also contributed to the national reduction in stunting, but to a smaller degree.

From 2005 to 2011, the 6.8 percentage point decrease in the national stunting prevalence is attributed to reductions in the number of stunted children in the Amhara, SNNP, Somali and Oromiya. The number of stunted children in Addis Ababa, Harari and Gambela also reduced and contributed to national reductions, but to a smaller extent. As the population of children < 5 years old increased in Somali and SNNP between 2005 and 2011, the reduction in the number of stunted children in these regions is due solely to reductions in the prevalence of stunting. In Amhara, however, a reduction in the prevalence of stunting by nearly 12 percentage points was accompanied by a large reduction in the total number of children < 5 years. According to Ethiopia's CSA, Amhara has the highest proportion of out-migration and the fastest decrease in the fertility rate (2013); thus, Amhara's contribution to the national reduction in stunting is likely caused both by improvements in child growth a reduced total number of children from migration and lower fertility.

Health, nutrition and food security strategies and program landscape

The number of national policies and large-scale health, nutrition and food security programs in Ethiopia has increased considerably in the past 20 years. Figure 3 presents the timeline of the various policies and programs implemented from 1995 to 2015.

Two national policy plans, (1) Ethiopia's Growth and Transformation Plans (GTPs) and (2) Health Sector Development Plans (HSDPs), have been used to launch and coordinate large-scale health-related programs and interventions. The GTPs are five-year development plans which cover multiple sectors, including health, and aim at improving general economic growth and achieving various millennium development goals (MDGs). The GTP 1 (2004/05–2009/10) and GTP 2 (2010/11–2014/15) called for improvements in health care infrastructure through the establishment of health posts and increased capacity of the health care system through training of more extension workers. The HSDP, on the other hand, is an umbrella strategy and planning document for health-related programs, including nutrition. In the first four HSDPs, nutrition has been considered a 'cross-cutting issue', first linked

Table 1. Change in stunting and the contribution to national stunting decrease, by region, 2000–2005

Region	Prevalence of stunting 2000	Prevalence of stunting 2005	Change (in percentage points)	Population of children < 5 years (2000)	Population of children < 5 years (2005)	Change in number of stunted children 2000–2005	Weighted decline in stunting prevalence (in percentage points)	Weighted contribution to stunting (as % of national decline)
Addis Ababa	33.8%	24.1%	-9.7	200 375	187 744	-22 480	-0.16	2.8%
Afar	53.5%	41.1%	-12.4	173 689	186 892	-16 111	-0.20	3.5%
Amhara	62.8%	63.7%	0.9	2 653 240	2 679 151	40 384	0.21	-3.7%
Benshangul-Gumuz	49.8%	44.3%	-5.5	84 915	105 485	4442	-0.05	0.9%
Dire Dawa	33.8%	33.7%	-0.1	41 971	51 493	3167	0.00	0.0%
Gambela	41.3%	38.9%	-2.4	31 877	34 949	430	-0.01	0.1%
Harari	42.0%	45.0%	3.0	23 843	26 149	1753	0.01	-0.1%
Oromiya	53.9%	44.2%	-9.7	3 904 349	4 348 448	-182 430	-3.73	64.0%
SNNP	59.4%	54.6%	-4.8	2 020 698	2 347 289	81 325	-1.00	17.1%
Somali	50.8%	50.2%	-0.6	547 285	678 679	62 676	-0.04	0.6%
Tigray	61.8%	47.1%	-14.7	609 269	659 554	-65 878	-0.86	14.7%
Total	57.7%	50.8%	-6.9	10 291 510	11 305 834	-92 721	-5.83	100.0%

Table 2. Change in stunting and the contribution to national stunting decrease, by region, 2005–2011

Region	Prevalence of stunting 2005	Prevalence of stunting 2011	Change (in percentage points)	Population of children < 5 years (2005)	Population of children < 5 years (2011)	Change in number of stunted children 2005–2011	Weighted decline in stunting prevalence (in percentage points)	Weighted contribution to stunting (as % of national decline)
Addis Ababa	24.1%	22.2%	-1.9	187 744	235 552	7046	-0.04	0.5%
Afar	41.1%	49.9%	8.8	186 892	269 958	57 897	0.21	-2.8%
Amhara	63.7%	51.8%	-11.9	2 679 151	2 470 549	-426 875	-2.60	35.1%
Benshangul-Gumuz	44.3%	48.1%	3.8	105 485	158 183	29 356	0.05	-0.7%
Dire Dawa	33.7%	35.1%	1.4	51 493	51 268	642	0.01	-0.1%
Gambela	38.9%	27.9%	-11.0	34 949	49 217	136	-0.05	0.6%
Harari	45.0%	29.1%	-15.9	26 149	28 305	-3530	-0.04	0.5%
Oromiya	44.2%	41.5%	-2.7	4 348 448	5 062 229	178 811	-1.21	16.3%
SNNP	54.6%	43.8%	-10.8	2 347 289	2 586 806	-148 599	-2.47	33.3%
Somali	50.2%	32.5%	-17.7	678 679	976 195	-23 434	-1.53	20.6%
Tigray	47.1%	51.0%	3.9	659 554	729 057	61 169	0.25	-3.4%
Total	57.7%	50.8%	-6.8	11 305 834	12 617 320	-267 380	-7.41	100.0%

Fig. 3. Ethiopia's nutrition strategies, programs and interventions—1995–2015.

CBN: Community Based Nutrition Program; CMAM: Community Management of Acute Malnutrition; DHS: Demographic and Health Survey; EOS: Enhanced Outreach Strategy; GTP: Growth and Transformation Plan; HEP: Health Extension Program; HSDP: Health Sector Development Plans; ICCM: Integrated Community Case Management; NNP: National Nutrition Program; OFSP: Other Food Security Program; PSNP: Productive Safety Net Program; UAP: Universal Access Program; TSF: Targeted Supplementary Food.

to the integrated management of childhood illnesses in the HSPD I (1997–2001) and then, as a separate package of Health Extension Program (HEP) in the HSDP II (2002–2004). The HSDP III (2005–2009) called for the development of a National Nutrition Strategy and Program (Federal Ministry of Health [Ethiopia], 2005) with centralized coordination, and HSDP IV (2010–2015) (Federal Ministry of Health [Ethiopia], 2010) has emphasized improving the coordination of nutrition programs. Stunting has been included as a key performance indicator in the HSDP III and IV. Stunting reduction targets were established in each plan; the stunting reduction targets for HSDP IV were to reduce the national stunting prevalence from 46% to 37%.

While numerous health and nutrition projects existed in Ethiopia in the 1990s and early 2000s, these programs were primarily classified as emergency responses and managed independently or in small partnerships by government ministries, UN agencies and non-governmental organizations. Large-scale health and nutrition programs only began in 2003 and 2004 with the commencement of the HEP, the Enhanced Outreach Strategy (EOS), Targeted Supplementary Food (TSF) and the Community Management of Acute Malnutrition (CMAM) programs.

Established in 2003 and operationalized in 2004 (Amare, 2013), Ethiopia's HEP has been designed to increase access to a universal set of health services, focusing predominantly on the prevention of illness and disease (Lemma & Matji, 2013). The HEP consists of 16 component activities spread across four thematic areas: disease prevention and control, family health, hygiene and environmental sanitation, and health education and communication. Nutrition is considered a component of the family health theme. The HEP delivers this set of health services in a decentralized manner; posting two female health extension workers to each of Ethiopia's approximately 15 000 kebeles (i.e. Ethiopia's smallest administrative unit, similar to ward). A year-long training is given to health extension workers prior to being posted, with refresher trainings on specific topics given on an on-going basis (Workie & Ramana, 2013).

The EOS program began in 2004. As part of child health days it provides semi-annual vitamin A supplementation to children 6–59 months and deworming to children 12–59 months in the vast majority of Ethiopia's woredas (i.e. districts). The EOS program was initially implemented in 325 drought-prone districts, and 305 non-drought-prone districts were included (under the moniker 'Extended EOS') in 2005. Children in

drought-prone areas are screened using mid-upper arm circumference on a semi-annual basis, and those identified with severe acute malnutrition were referred to a CMAM outpatient therapeutic program and those with moderate acute malnutrition were referred to the TSF program. Children in non-drought-prone districts were not screened by the EOS program (Fiedler & Chuko, 2008). The EOS program also provides support to pregnant and lactating women through nutrition screening and referral to for supplementary food distribution. In 2012, the EOS program transitioned to routine implementation via the HEP.

Large-scale nutrition programs (e.g. EOS, CMAM) were integrated into the HEP in 2008. In addition, the first ever National Nutrition Strategy was launched in February 2008, and aimed to ensure that all Ethiopians secure an adequate nutritional status. The National Nutrition Program (NNP) has been implemented in two phases, from 2008 to 2013 (NNP-1) and from 2013 to 2014 (NNP-2), and will continue in a third phase from 2015 to 2020. An extension of National Nutrition Strategy, the NNP aims to improve the coordination of nutrition approaches and programs (Lemma *et al.*, 2012; Federal Ministry of Health [Ethiopia], 2008). Improvements in service delivery have focused on four interventions: (1) sustaining EOS with TSF and transitioning of EOS into the HEP; (2) health facility nutrition services; (3)

Community-based nutrition program (CBN) and (4) micronutrient interventions (Lemma *et al.*, 2012).

Water, sanitation and hygiene activities are implemented both by the HEP, which focuses on promotion of sanitation and hygiene facilities, and the Universal Access Program, which focuses on infrastructure-related activities. Implemented by Ministry of Water Resources but in collaboration with the Ministry of Health, the Universal Access Program began in 2005 as part of the GTP 1, and initially aimed to achieve near universal access to water and sanitation by 2012.

Ethiopia's Productive Safety Net Program (PSNP) began in 2005 and is the largest food security and social protection program in Africa. Implemented in food-insecure woredas, the PSNP provides support to food-insecure households during the hunger gap seasons to prevent the sale of household assets and to stabilize consumption patterns (Berhane *et al.*, 2011). Specifically, support is provided in the form of (1) the provision of food for work via labor-intensive public works projects, and (2) direct support to households who cannot participate in public works projects. Since its creation, three separate rounds of the PSNP (2005–2006; 2007–2009; 2010–2014) have been implemented, and a new phase of PSNP is now planned for 2014 onwards.

Figure 4 illustrates the linkages between all large-scale nutrition, health and food security programs.

Fig. 4. The Health Extension Program as the main delivery platform for nutrition programs.

Multiple nutrition interventions are coordinated by the NNP and implemented by the HEP. Notably, water, sanitation and hygiene promotion and infrastructure activities are implemented separately. Food security programs are implemented separately from health and nutrition programs, and there are few direct linkages to the health extension program.

Coverage of health and nutrition programs

Health Extension Program

There has been a steady increase in the coverage of local health services since 2000. As detailed by UNICEF (2012a), the number of health posts constructed steadily increased from 1311 in 2001, 6191 in 2005, to 14 192 in 2011. This increase shows that Ethiopia's health sector steadily increased coverage of primary health care infrastructure and nearly met the HEP goal of 15 000 health posts operational and staffed by health extension workers by 2011. Citing data from the Federal Ministry of Health, Banteyerga (2011) states that primary health care coverage increased from 77% in 2005 to 90% in 2010.

An assessment of the HEP in Tigray found that increases in program coverage were associated with increased immunization rates in children (Amare, 2013). In addition, cross-sectional studies of the HEP program conducted in 2008 and 2010 in Tigray, Amhara, Oromiya and SNNP showed that the coverage and utilization of the HEP program, which was based on four measures of household health delivery, increased significantly (Karim *et al.*, 2013).

Community management of acute malnutrition

Ethiopia's CMAM program was established in response to a severe drought in Ethiopia in 2003, and was implemented as a stand-alone program from 2003 to 2007. The CMAM program was incorporated into the HEP in 2008, and scaled-up from 2008 to 2011 in Amhara, Oromiya, Tigray, Somali, SNNP, Afar and Gambela (Lemma *et al.*, 2012; Federal Ministry of Health [Ethiopia], 2013). The number of CMAM sites increased dramatically from 2008 and 2011, from 1240 to about 9000 sites (Lemma *et al.*, 2012). The number of sites increased further to approximately 14 000 sites in 2015; the number of sites corresponded with

increased numbers of admissions, however, regional admission estimates were not available (Salama & Matji, 2013). The CMAM program also focused heavily on community mobilization activities and *outpatient* therapeutic treatment, which enabled on-going identification and monitoring of children with severe acute malnutrition and treatment via ready-to-use therapeutic food (Mates, 2011).

The number of therapeutic feeding sites increased notably in 2008–2009, corresponding with the CMAM program's incorporation into the HEP's regular health services. At the same time, the CMAM and the Integrated Community Case Management² (ICCM) programs were linked to consolidate service delivery as part of the HEP's routine health services. Despite this increased coverage, an evaluation of the CMAM program (Federal Ministry of Health [Ethiopia], 2013) noted regional variations in the coverage of the Outpatient Therapeutic Programme and Stabilisation Centres, with Afar and Somali demonstrating weaker coverage compared to the other regions.

Enhanced outreach strategy and targeted supplementary feeding

The EOS was established in 2004 in 325 drought-prone woredas in all regions but Addis Ababa (Federal Ministry of Health [Ethiopia] & UNICEF [Ethiopia], 2004). The program was expanded in 2005 to 305 non-drought-prone woredas (630 in total),³ but the EOS in these locations does not include the nutrition screening component and referral to WFP-supported TSF (Negash, 2011).

Fiedler and Chuko (2008) present estimates of the coverage of the EOS program⁴ from 2004 to 2006. During rounds 1 and 2 of the EOS screening in 2004, approximately 1.3 to 2.5 million children 6–59 months received

²The ICCM program was initially referred to as Integrated Management of Childhood Illnesses.

³Due to the geographic variety in Ethiopia, many regions contain both 'drought-prone' and 'non-drought-prone' woredas. For example, while the majority of the Oromiya region is classified as non-drought-prone, several woredas in southern Oromiya are considered drought-prone.

⁴Estimates presented by Fiedler and Chuko include both the EOS and Extended-EOS (EEOS) programs which were implemented in 325 and 305 districts, respectively, between 2004 and 2006. While both the EOS and EEOS provided deworming and vitamin A supplementation, only the EOS included nutrition screening.

vitamin A supplements and 0.8 to 2.2 million children 12–59 months received anthelmintics. Three rounds of the EOS program were implemented prior to the 2005 DHS, and the program reached full scale by 2006, with approximately 9 and 10 million children receiving deworming medication and vitamin A supplements, respectively. Negash (2011) presents similar trends in the number of children covered from 2004 to 2009, yet Negash reported that the number of woredas providing nutrition screening and TSF was reduced in 2008 ‘from 325 to 167 because of resource constraints’. In 2008, EOS was transferred to the HEP into all regions except Afar, Somali, Gambella and Benishangul-Gumuz, where it continues (as of 2015) to be implemented independently of the HEP because of capacity constraints (UNICEF, 2012b). Based on the transition strategy of the Federal Ministry of Health, starting from June 2012, all woredas in agrarian regions had transited fully from EOS to Community health days (CHDs). Selected woredas are also transiting from CHD to routine Health Extension Program (HEP) integrating all intervention components into the routinely delivered HEP. In 2015, selected woredas in pastoralist regions of Somali, Afar, Gambella and Benshangul will transit from EOS to CHD.

Cross-sectional coverage data from the 2011 DHS reported that nationally, 53.1% of children received vitamin A supplements in the six months prior to data collection, ranging from 82.8% in Tigray to 26.3% in Somali. Among children aged 6–59 months, the national coverage of deworming medication was 21.0%, ranging from 6.0% in Somali to 26.6% in Benishangul-Gumuz (CSA & ICF International, 2012). Deworming in the EOS program is, however, only targeted at children 12–59 months old (Federal Ministry of Health [Ethiopia] & UNICEF [Ethiopia], 2004); thus, coverage estimates in the DHS for deworming are likely underestimates as they included children 6–11 months of age who are not eligible to receive deworming medicine.

Community-based nutrition program

Targeted to children <2 years of age and pregnant and lactating women, the CBN program is comprised of six interventions: (1) growth monitoring and promotion of essential nutrition actions (ENA) by behavior change communication (BCC); (2) pregnancy weight gain using ENA by BCC; (3) targeted food

supplementation; (4) micronutrient supplementation; (5) parasite control and (6) hygiene and sanitation (Federal Ministry of Health [Ethiopia], 2008).

The development of the CBN was a central component of the 2008 NNP. While implemented through the HEP, the CBN is delivered by Volunteer Community Health Workers who are supervised by health extension workers of the HEP. The CBN is implemented in Amhara, Oromiya, SNNP and Tigray regions. Starting in 2008, the CBN roll out was gradual in each region. Between 2008 and 2009, the CBN was implemented in 39 woredas, 94 woredas in 2010 and 170 woredas in 2011. By 2011, the CBN program was implemented in 47%, 27%, 48% and 94% of woredas in Amhara, Oromiya, SNNP and Tigray, respectively (UNICEF data, unpublished).

Integrated community case management

The ICCM program focuses on the treatment and management of pneumonia, diarrhea, malaria and severe acute malnutrition (Miller *et al.*, 2014). Health extension workers, working at the community level, are trained how to diagnose and treat children for these diseases.

The implementation of the ICCM program has changed over the years. Between 2002 and 2007, the Federal Ministry of Health implemented the ‘integrated management of childhood illness’ program on a pilot basis, focusing on child illness with little attention toward nutrition (Benson *et al.*, 2005). In 2008, nutrition components (e.g. screening and treatment of severe acute malnutrition) were added to the pilot program, and rebranded as the ICCM program, which was included into the HEP and was scaled up through the HEP in 2010 (Miller *et al.*, 2014). The ICCM was successfully scaled up in the health posts of most regions, however, Gambella, Afar and Somali are notable exceptions, where by 2013, only 69%, 47% and 9% of health posts had ‘regular ICCM capacity’, respectively (Alexander *et al.*, 2014).

In a process evaluation of the ICCM services in Oromiya in 2010, Miller *et al.* (2014) report that nearly all health extension workers were trained in ICCM, and 87% had received supervision in ICCM in the previous 3 months. Nearly 70% of health posts had all essential commodities for ICCM.

Productive safety net program

Launched in 2004, the PSNP is implemented in food insecure woredas in six regions: Afar, Amhara, Oromiya, SNNP, Somali and Tigray. The PSNP accelerated quickly, with nearly 5 million beneficiaries receiving either food or cash transfers in 2005, and the number of beneficiaries rose steadily to more than 7 million in 2009 and 2010 (UNICEF data, unpublished). The proportion of eligible beneficiaries covered cannot be easily calculated as the beneficiary targeting and selection processes vary by woreda. Using regional populations to estimate coverage, 4–14% of the population in Oromiya, SNNP and Amhara were eligible to participate in the PSNP (authors' calculations). In Tigray and Somali, the proportion of households receiving PSNP services from 2005 to 2011 fluctuated between 8% and 33% in Tigray and 4 and 23% in Somali. The PSNP in Afar – where all woredas were covered by the PSNP – consistently covered an average of 34% of the population from 2005 to 2011.

Universal access program

The government of Ethiopia launched the UAP in 2005, which defined coverage targets for access to a clean water source and adequate sanitation. Prior to the UAP, Ethiopia's government established two main policies related to water in 1999 and 2001 (Calow *et al.*, 2013) conceptualizing how the water-infrastructure projects should be managed and operated. DHS showed a steady improvement in water and sanitation coverage: the percentage of rural households with an improved source of drinking water increased from 14% in 2000 to 26% in 2005 and then to 42% in 2011 (Zachary *et al.*, 2013). On the other hand, the proportion of households with an improved sanitation source has stayed relatively low; in 2011, only 8% of households had an improved sanitation facility. Despite low coverage in improved sanitation, there has been notable increase in the use of unimproved facilities, such as pit latrines without slabs. As a result, the proportion of households with no access to a latrine facility decreased steadily from 82% in 2000 to 62% in 2005, and 38% in 2011. Improvement was most pronounced in rural areas, where the proportion of households without any

facility dropped from 92% to 45% from 2000 to 2011 (Zachary *et al.*, 2013).

Program impact on stunting and other indicators

There are only a few impact evaluations that examine the influence of Ethiopia's large-scale health and nutrition interventions on stunting, and these studies show mixed results. An evaluation of the EOS and TSF undertaken in Tigray, Amhara, Afar and Somali found a significantly greater increase in weight-for-height z-score in treatment children compared to control children, but there was a significant *decrease* in the HAZ in the treatment children (Skau *et al.*, 2009). Despite the improvements in wasting, the effect size was small. The authors attributed the small effect size on wasting to the impact of poor enrollment processes (about 50% of those screened and enrolled in TSF were not malnourished) and consumption of TSF food by household members other than the targeted child.

An evaluation of the CBN and TSF included multiple cross-sectional baseline, midline and endline surveys. Baseline surveys were implemented prior to commencement of the CBN, and intervention and control groups were established *de facto* based on the actual implementation of the program. Because of delayed implementation of the CBN program, areas that did not implement the CBN program during part of the evaluation were classified as the 'control' group. Between 2008 and 2010, intervention groups had increased contact with health workers, improved infant and young child feeding (e.g. dietary diversity, minimum acceptable diet), and a greater reduction in the prevalence of stunting compared to the control group (White & Mason, 2012). Reductions in stunting were found in intervention areas both with and without distribution of TSF regardless of the intensity of the CBN program at the community level. While this evaluation showed that the CBN program (implemented with and without TSF) was associated with stunting reduction, these results may be confounded by the fact that the initial woredas where CBN was launched in 2008 were classified as 'drought prone'; thus the EOS/TSF was implemented in the same locations.

A recent evaluation examined the nutritional impact of the PSNP and CBN. This report found 'no robust,

statistically significant associations between PSNP participation or the duration of presence of CBN and height-for-age *z* scores, stunting, weight-for-height *z* scores and wasting after controlling for child, maternal, household and location characteristics. This remains true if we use a different measure of PSNP participation or a different survey year (Berhane *et al.*, 2014).’ These recent results support earlier research related to the PSNP which showed that while some beneficiaries of the PSNP showed improvements in household food security, these improvements did not translate to improved health and nutrition status in children (Gilligan *et al.*, 2008).

Regarding overall delivery and intensity of the HEP, Karim *et al.* found a dose–response relationship between program intensity in the community – calculated using multiple measures of program outreach and coverage and the odds of receiving antenatal care and post-natal care practices (Karim *et al.*, 2013). Child growth, however, was not included as an outcome measure.

Secular trends

In addition to large-scale programs, secular trends may have contributed to improvements in nutritional status in children. Table 3 presents information related to Ethiopia’s political, economic, demographic and programmatic contexts over time. Over the past 20 years, Ethiopia has experienced strong GDP growth and marked reductions in the proportion of the population living in poverty (i.e. living on <\$1.25 per day). Particularly between 2000 and 2005, the proportion of individuals living in poverty decreased by 16% percentage points, from 54.6% to 38.9%, respectively (World Bank, 2014).

Economic growth has not, however, led to increased household wealth at the national level in Ethiopia (Woodruff *et al.*, 2016; Zachary *et al.*, 2013). While GDP could potentially have some positive spill-over effects, continued food crises suggest that economic growth has not increased food security in vulnerable populations. The 2002 and 2011 food crises were also not consistently associated with increased prevalence and caseloads of stunting in the three regions most affected: Afar, Oromiya and Somali. From 2000 and 2005, the prevalence of stunting decreased in these three regions, but caseloads increased in Somali.

Between 2005 and 2011, the stunting prevalence only increased in Afar, yet caseloads increased in Afar and Oromiya. Notably, despite a 17.7 percentage point reduction in stunting in Somali between 2005 and 2011, the caseloads only decreased slightly.

The dramatic increase in Ethiopia’s population with relatively slow urbanization may have ‘diluted’ any economic improvements experienced and may leave similar numbers of children vulnerable to malnutrition during food crises. Population growth also leads to additional demands on the health care system, which was only fully staffed in 2009. Changes in the fertility rate, however, may also reduce the number of young children in certain regions, such as Amhara. Internal migration within Ethiopia has also been noted, with predominant out-migration observed in Amhara, and in-migration in Addis Ababa, Dire Dawa and Gambela (CSA, 2013).

Discussion

Prevalence versus caseloads

Ethiopia’s stunting prevalence at the national and region levels decreased consistently from 2000 to 2011. This large prevalence reduction only translated to relatively small reductions in the number of stunted children in Ethiopia as the country’s population size increased by more than 18 million between 2000 and 2011 (CSA, 2005; CSA, 2010). The number of children <5 years old increased by approximately 2.3 million from 2000 to 2011, yet the number of stunted children decreased by only 360,000 in the same time period. Thus, substantial improvements to child health and nutrition have not likely reduced the caseloads of existing programs designed to reduce malnutrition in children. Additional resources and long-term efforts are required to further decrease the prevalence of stunting and number of stunted children.

Overlap of programs and stunting reduction: 2000–2005

Between 2000 and 2005, the majority of stunting reduction observed nationally occurred in two regions: Tigray and Oromiya. During this period, large-scale health and nutrition interventions were limited to the

Table 3. Ethiopia's political, economic and health background, 1995–2014

	1995–1999	2000–2004	2005–2009	2010–2014
Political background	Early years of democracy following transitional government from 1991 to 1994. Constitution established in 1994, with first multiparty elections in 1995 (Dercon, 2004) Intermittent fighting with Eritrea	Second multiparty elections held in 2000.	Widespread protests following general elections in 2005.	Following the death of Ethiopia's Prime Minister in 2012, succession of power implemented according to constitution. Multiparty elections subsequently conducted in 2013.
Economic background	Average annual GDP growth of about 5% (Ministry of Finance and Economic Development [Ethiopia], 2002). 63% of population living on less than \$1.25 per day in 2000 (World Bank, 2014)	Average annual GDP growth of about 4.5% (IMF) with growth between 2003 and 2004 of 12.3%. 55% of population living on less than \$1.25 per day in 2000 (World Bank, 2014)	Average annual GDP growth of 11% (World Bank, 2014). 39% of population living on less than \$1.25 per day in 2005 (World Bank, 2014)	High inflation in 2011; consistent growth in GDP 37% of population living on less than \$1.25 per day in 2011 (World Bank, 2014)
Demographic factors	Population in 1998 = 59.8 million (CSA, 2005). 86% rural population with density of 49 people per square km (1994 census cited by (CSA & ORC Macro, 2001)	Population in 2000 = 63.5 million (CSA, 2005)	Population in 2005 = 73.0 million (CSA, 2005). 84% rural population with density of 67 people per square km National census conducted in 2007.	Population in 2011 = 81.9 million (CSA, 2010) 80% rural population with density of 110 people per square km (CSA, 2010)
Food crises and displacement	Food crisis from 1999 to 2000 in Somali, Tigray, Amhara and Oromiya (Hammond & Maxwell, 2002)	Food crisis in 2002 in displaced households in Somali, Afar and Oromiya	Global food price crisis and drought in 2008 affected prices of staple foods throughout Ethiopia (Heady & Shenggen, 2008)	Food crisis in 2011 displaced households in Somali, Afar and Oromiya
Health systems	Integrated management of childhood illnesses noted as key strategy in HSDP-I.	Construction of health posts prioritized by HSDP-II. Establishment of the Health Extension Program in 2004	Expansion of HEP nationwide. Large-scale independent nutrition programs (e.g. EOS/TSF, CBN) integrated into HEP. Trained health extension workers placed in all kebeles by 2009.	Continuation of HEP
Large NNscale nutrition programs	No large-scale nutrition programs established at this time	CMAM begins in 2003 with limited coverage for first three years. EOS/TSF begins in 2004 with limited coverage in first year of operation.	NNP established in 2008, and nutrition programs incorporated into HEP. Increased coverage of CMAM, EOS and ICCM programs, and start of CBN program.	Consolidation of most nutrition programs under the Health Extension Program Second NNP established in 2013
Food security programs	No large-scale food security or safety net programs established at this time	No large-scale food security or safety net programs established at this time	PSNP commenced in food insecure woredas in 2005	Continuation of PSNP program

CMAM, HEP and EOS/TSF; however, the low coverage of CMAM and HEP during this period reduces the likelihood that a measurable impact on stunting from these programs would occur at the population level. While the coverage of the EOS/TSF program was increasing between 2004 and 2005, the authors

could not, unfortunately, identify figures detailing the *regional* coverage of the EOS program during its initial years of implementation. Notably, the program was only operating for approximately 1½ years and was not operating at full scale when the 2005 DHS was conducted (Fiedler & Chuko, 2008); only three rounds of

EOS were conducted prior to the 2005 DHS. As the coverage increased each round, only a small proportion of children would have received three rounds of vitamin A supplementation, deworming and TSF if warranted. Because of this relatively short period of partial implementation prior to the 2005 DHS, it is unlikely that the EOS program could have led to the stunting reduction observed between 2000 and 2005.

However, the EOS program may have contributed to improvements in diarrhea, a short-term indicator of health status and a risk factor of stunting in Ethiopia (Teshome *et al.*, 2009; Woodruff *et al.*, 2016). The prevalence of diarrhea in children <5 years has declined from 23.6% 2000 to 18.0% 2005 (CSA & ORC Macro, 2001; CSA & ORC Macro, 2006). This reduction in diarrhea may be attributable to the short implementation of the EOS program prior to the 2005 DHS. The use of anthelmintics has also been associated with reductions in the number of diarrheal episodes in India (Sur *et al.*, 2005), and vitamin A supplementation has been associated with reductions in the incidence of diarrhea (Mayo-Wilson *et al.*, 2011). Moreover, the evaluation of the EOS/TSF program (Skau *et al.*, 2009) identified that supplementary food improved wasting but not stunting. Thus, although the EOS with TSF can lead to biological improvements, it likely did not contribute to reductions in the prevalence of stunting between 2000 and 2005.

Contrarily, reductions in poverty and subsequent improvements in household wealth in some regions may have contributed to a reduction in stunting. Household wealth is significantly associated with child growth in Ethiopia (Gibson *et al.*, 2009; Woodruff *et al.*, 2016), and household wealth significantly increased in Tigray and Oromiya from 2000 to 2005. Increased household wealth may have also lead to improvements in the quality of households' water source and the use of latrines in these regions. Open defecation at the community level is significantly associated with growth in children 24–59 months and stunting reduction at the national level (Woodruff *et al.*, 2016).

Overlap of programs and stunting reduction: 2005–2011

Between 2005 and 2011, reductions in stunting prevalence in Amhara, SNNP and Somali contributed to

the majority of the decline in the national stunting prevalence. There were numerous large-scale programs implemented in the 2005–2011 period, including the EOS, ICCM, CBN, CMAM, UAP and PSNP. With the exception of the UAP and PSNP, all other large-scale programs were merged into the HEP service delivery package around 2008 when coverage increased further, albeit not uniformly.

Increased coverage of the HEP and its various nutrition interventions in Amhara, Oromiya and SNNP correlate with regional reductions in stunting. In the Somali region, the CBN program was not implemented, and thus reductions in stunting from 2005 to 2011 may be attributable to the coverage of the EOS and ICCM programs, and/or the general implementation of the HEP service package. As the 16 component activities of HEP were rolled out simultaneously, it is difficult to speculate which components could have resulted in reductions in stunting. Associations between increased coverage of HEP and improved antenatal and postnatal care practices (Karim *et al.*, 2013) may suggest that improvements to *in utero* growth and maternal nutrition status may have contributed to reductions in stunting. This contribution would likely be small, as optimal antenatal care practices increase from 12% to only 19% between 2005 and 2011 (Zachary *et al.*, 2013).

Sustained coverage of the EOS and ICCM potentially affected stunting by reducing the incidence of diarrhea in children <5 years old, which decreased from 18.0% to 13.7% from 2005 to 2011 (CSA & ICF International, 2012; CSA & ORC Macro, 2006). The CMAM program, which provided outpatient and inpatient therapeutic feeding (among other services) to children with severe acute malnutrition, may have helped to reduce stunting. Though the last of the large-scale nutrition programs to start, the CBN scaled up rapidly and documented a reduction in stunting and improved feeding practices in Amhara, Oromiya and SNNP (White & Mason, 2012).

Unlike Amhara, Oromiya and SNNP, no improvement in stunting from 2005 to 2011 in Tigray was observed by the DHS or the evaluation of the CBN (White & Mason, 2012). Low participation in the CBN and low coverage of CMAM may explain the lack of a reduction in the prevalence of stunting in Tigray. However, the EOS and ICCM programs and HEP service package were implemented in Tigray, suggesting

that stunting prevalence increased despite improvements in the health care system and greater access to supplementation, deworming and TSF. It is unclear why reductions in stunting were not observed in Tigray but were observed in Somali.

The sanitary situation also improved substantially from 2005 to 2011 and is associated with stunting reduction (Woodruff *et al.*, 2016); the proportion of households *without* a latrine (i.e. households practicing open defecation) decreased from 62% to 38% nationally and from 70% to 40% in rural areas (Zachary *et al.*, 2013). The increased use of latrines is characterized primarily by increased use of pit latrines without slabs which are considered an *unimproved sanitation facility* (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation, 2012). This increased coverage in sanitation facilities, although *unimproved*, is likely attributable, to expanded coverage of the UAP, CBN and HEP which all promoted improved sanitation practices.

Need of evidence documenting program impact on stunting

Despite the numerous large-scale nutrition programs, there is limited evidence documenting the extent to which health and nutrition programs reduce stunting in Ethiopia. Ecologic relationships suggest that large-scale programs are contributing to stunting reduction; however, further evaluations and studies can help to identify the most-effective programs. Because of the multiple programs currently implemented, studies comparing the effectiveness and cost of individual programs can provide useful information to policy makers and program planners. Because of Ethiopia's geographic diversity, however, studies comparing program interventions should be conducted in multiple settings as the determinants of stunting may vary by agro-ecologic zone. As the HEP is currently used as a delivery platform for multiple programs, 'implementation science' studies could also provide invaluable information about how to increase program delivery and coverage.

Limitations

This study has notable limitations. First, such an ecologic analysis cannot provide strong evidence of

causal relationships between stunting reduction and program implementation. To address this limitation, we have explored reports and studies examining the nutritional impact of large-scale studies. Second, our analysis focuses on *large-scale* health and nutrition programs only. There is a myriad of smaller-scale health and nutrition projects operating at the kebele and woredas levels, and regional reductions in stunting prevalence may have resulted from these projects. Including all small and medium-scale projects in such an analysis would not be feasible. Last, this review relies on available data of program coverage and impact which in many cases was not available or lacking. We also recognize that estimates of program coverage often do not reflect program 'intensity' or 'quality'.

Conclusion

The national stunting prevalence decreased consistently between 2000–2005 and 2005–2011, but these reductions occurred in two different programmatic environments. Whereas reductions in the 2000–2005 period correlate both with regional improvements in household wealth, reductions in 2005–2011 correlate with increased coverage the HEP program suite. From 2005 to 2011, the CBN and CMAM programs show the strongest ecologic associations and have supporting evidence from independent evaluations. The EOS interventions and the component activities of the HEP may also have contributed to reductions, but there is no clear evidence to support any impact on stunting reduction.

The large reduction in the national and regional stunting prevalence has only translated to relatively small reductions in the number of stunted children in Ethiopia. Thus, substantial improvements to child health and nutrition have not likely reduced the case-loads of existing programs designed to reduce malnutrition in children. Ecologic relationships suggest that large-scale programs are making an impact, however, and further impact evaluations can help to identify the most effective programs to help policy makers accelerate the reduction in the prevalence and number of stunted children in Ethiopia.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

JPW designed the study, and JPW and BAW conducted the trend analyses. JPW and FR drafted the first version of the manuscript and all authors thoroughly reviewed and contributed subsequent versions, including the final version.

Disclaimer

The authors alone are responsible for the views expressed in this publication, and they do not necessarily represent the decisions, policies or views of UNICEF.

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