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Do Social Safety Nets Buffer the Nutritional Effects of Drought? A Longitudinal Study of Children in Ethiopia

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Abstract:

Ethiopia is highly vulnerable to droughts due to its geographic features and the effects of climate change. Droughts contribute to child undernutrition by disrupting food security, yet little is known about the extent to which social protection systems can buffer these impacts. Using panel data from the Young Lives cohort study (2009–2017), we examined how drought exposure during early childhood influences adolescent nutritional outcomes and whether Ethiopia's Productive Safety Net Program (PSNP) mitigates these effects. The dataset includes information on children's anthropometric status, food aid participation, and historical community-level weather records. Droughts were defined using the Standardized Precipitation Index (SPI), with values below –1 indicating drought conditions. Associations were assessed using Generalized Linear Mixed-Effects Models (GLMMs), with bootstrapping to obtain robust standard errors.

Results indicate that exposure to a 24-month drought is associated with both chronic and acute undernutrition, while 12-month droughts were associated only with acute undernutrition. Six-month drought was not associated with either outcome. Participation in PSNP significantly reduced the likelihood of undernutrition among children affected by prolonged (12- and 24-month) droughts, suggesting a protective effect of sustained food assistance.

These findings highlight the critical role of long-term social protection and food aid programs in buffering children from the nutritional impacts of climate shocks. Strengthening and expanding such programs will be essential for safeguarding child health and resilience in drought-prone settings amid a changing climate.

Key Words: *drought, climate change, child undernutrition, food aid, Ethiopia*

1. Introduction

Climate change has increased the frequency and intensity of climate shocks worldwide. Climate shocks are extreme natural events that may occur rapidly, such as floods, or develop gradually over time, such as droughts. Droughts can be categorized into four broad types: *meteorological*, defined by a sustained period of below-average rainfall; *agricultural*, marked by insufficient soil moisture to support crop and pasture growth; *hydrological*, characterized by reduced surface and subsurface water resources; lastly, *socioeconomic*, occurring when water scarcity disrupts the supply of goods and services and altering livelihoods and economies (NOOA, n.d.; Wilhite et al., 2007; Wilhite et al., 2005). Ethiopia is highly vulnerable to droughts due to its geography, with the eastern regions receiving significantly less precipitation than the southern areas. During El Niño events, rainfall declines across the entire country (McSweeney et al., 2006). In Ethiopia, drought conditions are typically identified when seasonal precipitation decreases by 30% to 50% below normal levels (Mera, 2018). Such a decline in precipitation has significant implications for human health. Droughts undermine all dimensions of food security, including food production availability, utilization, and stability (FAO, IFAD, UNICEF, 2018). In 2016, during the main growing season, 75% of crops were lost due to drought, and 1 million livestock died (ACAPS, 2016). Disruptions to food security significantly increase the risk of undernutrition and associated health issues, especially amongst children.

Previous research shows that droughts can contribute to increased rates of child malnutrition. This health disturbance can impair children's growth, development, and even their future socio-economic status (Hirvonen et al., 2020). Undernutrition, a type of malnutrition, is the inadequate intake of nutrients, which can be manifested through chronic and acute forms. *Stunting*, a chronic form of undernutrition, results in low height-for-age and is typically caused by prolonged inadequate nutrition or recurrent illness. Acute forms of undernutrition typically result from sudden and severe weight loss, and are characterized by low weight-for-height (*wasting*) and low BMI (*thinness*) (DHS, 2021; UNICEF n.d.; Young Lives, 2018). As of 2022, 34.4 % of children under 5 years of age in Ethiopia experienced stunting (Ritchie, 2022), and in 2019, 7% experienced wasting (DHS, 2021). Important determinants of children's nutritional status identified in the literature include place of residence, mother's education level, household wealth, sex of child, and household size (Tekile, Woya, and Basha, 2019). Other causes for child

malnutrition are maternal malnutrition, limited access to clean water and sanitation, and food insecurity (UNICEF, n.d.). There is also growing recognition that climate change significantly affects child nutrition. In Ethiopia, an agriculturally dependent country, droughts directly impact food production and household wellbeing. Droughts can result in reduced dietary diversity, food quality, household incomes, and increased risk of infectious diseases due to deteriorating water quality (Dimitrova, 2021). Undernutrition remains a major threat to child health in Ethiopia. It has been estimated that one-third of child deaths in the country are due to undernutrition (Tekile et al., 2019). To address this issue, governments and humanitarian organizations have implemented food aid programs. In Ethiopia, the Productive Safety Net Program (PSNP) is a key initiative aimed at promoting child health by improving household food security and promoting child health during climate stress events.

The PSNP was launched in 2005 as a result of a government review of Ethiopia's emergency food aid system (IFPRI Ethiopia, 2021), and in its first year, it supported approximately 11% of the country's population (Sabates-Wheeler and Devereux, 2010). The program distributes aid through two methods. Assistance through public works, where beneficiaries provide labor in exchange for aid, or through direct support in cases where physical labor can't be provided. Additionally, the program is unique as it has different forms of food aid. It can provide aid in the form of cash transfer, direct food aid (grains and cooking oil), or a mix of both for every six months over five years (Debel et al., 2015; Sabates-Wheeler and Devereux, 2010). Understanding the benefits of programs like the PSNP for child nutrition is crucial, especially as recurrent droughts put them at higher risk of undernutrition.

This project will add to the existing literature on child undernutrition by exploring the contribution of climate shocks to nutritional health. More specifically, analyze how experiencing droughts in early life and adolescence impact child nutrition in Ethiopia and the extent aid programs, like PSNP, can mitigate these effects. The Young Lives dataset from the University of Oxford allows us to understand these relationships by tracking the same children over 15 years, collecting information on their health, household characteristics, PSNP participation, and community-specific weather data.

2. Methodology:

2.1. Data sources

a. Young Lives Data

The Young Lives Data is a longitudinal study by the University of Oxford aiming to understand the mechanisms driving poverty in low- and middle-income countries. The study began in 2002 and follows approximately 12,000 children through four countries: India, Ethiopia, Peru, and Vietnam. It collects basic information about the child participants, their household, and their community characteristics. The study has completed five waves, conducted every four years, with the most recent in 2016-17, and is working on publishing the data for the most recent wave. In each country, the children are grouped into the older cohort (starting average age of 8 years old) or the younger cohort (starting average age of 1 year old). Information on the older cohort was not included in the study as their starting age does not provide continuous data from their early childhood. This study focuses on Ethiopia's younger cohort, composed of approximately 2,000 children and whose information from all rounds is included in the constructed data file. Out of the 214 available variables in the data, 34 were selected for analysis, centering around the child's nutritional status, demographics, parental literacy, household wealth, and food aid, among others. The data was organized using the packages "tidyverse" in R. Through the organization process, rounds 1 and 2 were excluded from analysis, as they don't include information on food aid. Finally, the variable "*aid*" was created, which recorded if children received aid by identifying if children received aid through public works or direct support.

b. Matched Climate Series Data

The Young Lives database also provides a dataset with the weather information for all 26 communities included in the Ethiopian cohort. This dataset is derived from the Terrestrial Air Temperature and Precipitation Gridded Monthly Time Series from the University of Delaware (UDel). It combines the monthly precipitation and temperature data for each community from 1900 to 2017. An example for one community is provided in Appendix Figure A1. The precipitation data was used to calculate the Standard Precipitation Index (SPI) for each community over three different periods (6 months, 12 months, and 24 months) prior to the interview data. The "SPEI" package in R was applied to calculate the SPI values, which were linked to individual children based on their community ID to determine drought exposure. SPI

values below -1 were classified as drought events and coded as 1, and all other values were coded as 0 for no drought.

2.2 Data Analysis

a. Regression Model

To understand the relationship between drought, undernutrition, and food aid status, the Generalized Linear Mixed-Effect Model (GLMM) was used. This model extends the Generalized Linear Model (GLM) by incorporating both fixed and random effects, making it particularly useful for analyzing grouped data. The random effects account for unobserved heterogeneity at the child (*childid*) and community (*commid*) levels, reflecting repeated observations and clustering. The fixed effects include the primary variables of interest, drought exposure, child's nutritional status in the previous survey round, child's sex, religion, residence type (urban/rural), household size, sex of household head, parental literacy, and household wealth group. This model was conducted using the *"lme4"* package in R, and the resulting estimates represent the *prevalence ratio (PR)*. The PR is the extent to which the children exposed to each factor are associated with the likelihood of experiencing stunting or thinning.

b. Bootstrapping

Bootstrapping was used to calculate robust standard errors by repeatedly resampling the dataset with replacement and re-estimating the model across 1000 iterations. This procedure was implemented using the "boot" package in R. The variability in the resampled estimates was used to derive 95% confidence intervals, which were then visualized using coefficient plots. This approach enhances the reliability of the PR by relaxing standard parametric assumptions.

c. Assessing Heterogeneity Using the Wald Test

The regression model described above was estimated separately for children who received aid and those who did not. This step assesses whether aid impact of drought differed between the two groups. A Wald test was then conducted to evaluate whether the differences in the effect estimates were statistically significant. Specifically, the Wald test compares the coefficients across the two groups using the following formula:

Wald Test Equation:

1. $z = \frac{(\beta_1 - \beta_2)}{\sqrt{(SE_1)^2 + (SE_2)^2}}$

- β_1 = Coefficient for drought in the "Aid Received" model
- β_2 = Coefficient for drought in the "No Aid Received" model
- SE_1 = Standard error for β_1
- SE_2 = Standard error for β_2

2. $p - value = 2\left(pnorm\left(-abs(Z)\right)\right)$

A resulting p-value less than 0.05 indicates a statistically significant difference in the drought effect between the two groups.

3. Results:

There are a total of 9,995 data entries for the young cohort from rounds conducted between 2009 and 2017. Out of the total entries, 5,552 include complete information for stunting, and Table 1 summarizes them by child and household information. In rounds 3 to 5, there are a total of 1,405 observations of stunting in children. Round 4 recorded the highest stunting prevalence with 39% of the observations, followed by 33% and 28% from Rounds 5 and 3, respectively (Table 1). The child information in Table 1 indicates that 62% of observed cases were boys and only 38% were girls, and 80% belong to a Christian religious group. From the household information, it's shown that stunted children primarily live in rural areas (76%), have a male household head (76%), a household size of 6-10 people (59%), and are in the medium wealth group (46%). Additionally, 24% of stunted children had moms without literacy skills, and 54% had dads without literacy skills.

A similar trend is observed for the total of 5,532 cases with complete data for thinning. Table 1 shows that out of the total cases, 1,812 experienced thinness in rounds 3 to 5. Almost half the children were classified as thin in Round 4 (42%), while 36% and 22% were classified as thin during Rounds 5 and 3, respectively. More than half of the cases were boys (59%) from a Christian religious group (84%). Based on the household information, most of the children classified as thin live in a rural area (71%), in a household of 6 to 10 people (59%), belong to a medium wealth group (42%), and have a male-headed household (77%). The children also had 29% and 61% of moms and dads, respectively, without literacy skills.

Table 1. Prevalence of stunting and thinning in the Young Lives younger cohort (Rounds 3 to 5). Total cases are broken down by round, type of residence, child's sex, child's religion, parent's literacy status, household size, and the household's wealth index.

Characteristics	Stunting		Thinning	
	No N = 4,147[1]	Yes N = 1,405[1]	No N = 3,720[1]	Yes N = 1,812[1]
Round				
3	1,474 (36%)	403 (29%)	1,473 (40%)	395 (22%)
4	1,329 (32%)	542 (39%)	1,101 (30%)	764 (42%)
5	1,344 (32%)	460 (33%)	1,146 (31%)	653 (36%)
Residence Type				
Rural	2,473 (60%)	1,073 (76%)	2,253 (61%)	1,280 (71%)
Urban	1,668 (40%)	331 (24%)	1,462 (39%)	530 (29%)
Child's Sex				
Female	2,078 (50%)	537 (38%)	1,857 (50%)	751 (41%)
Male	2,069 (50%)	868 (62%)	1,863 (50%)	1,061 (59%)
Child's Religion				
Christian	3,441 (83%)	1,130 (80%)	3,031 (82%)	1,526 (84%)
Muslim	660 (16%)	257 (18%)	645 (17%)	265 (15%)
Other	40 (1.0%)	18 (1.3%)	39 (1.0%)	20 (1.1%)
Mom's Literacy Status				
No	1,514 (38%)	326 (24%)	1,319 (37%)	517 (29%)
Yes	2,509 (62%)	1,032 (76%)	2,271 (63%)	1,254 (71%)
Dad's Literacy Status				
No	2,432 (63%)	707 (54%)	2,106 (61%)	1,025 (61%)
Yes	1,426 (37%)	597 (46%)	1,345 (39%)	669 (39%)
Household's Head Sex				
Female	972 (23%)	339 (24%)	887 (24%)	421 (23%)
Male	3,169 (77%)	1,064 (76%)	2,827 (76%)	1,389 (77%)
Household Size				
1-5	1,795 (43%)	544 (39%)	1,613 (43%)	719 (40%)
6-10	2,290 (55%)	835 (59%)	2,047 (55%)	1,066 (59%)
11 +	56 (1.4%)	25 (1.8%)	55 (1.5%)	25 (1.4%)
Wealth Index				
Low	773 (19%)	400 (29%)	719 (19%)	449 (25%)
Medium	1,486 (36%)	640 (46%)	1,360 (37%)	756 (42%)
High	1,879 (45%)	362 (26%)	1,632 (44%)	604 (33%)

[1] n (%)

Data Source: Young Lives Data by University of Oxford

Table 2. Food aid status among Young Lives young cohort participants (Rounds 3 to 5). The table demonstrates the distribution of children who received support from the Productive Safety Net Program (PSNP), categorized into those who received any aid (left column), direct support only (middle column), and public works support only (right column). Rows indicate receipt of aid during different drought periods and the recipient's household characteristics

	Aid Received		Direct Support Aid		Public Works Aid	
Characteristics	No N = 3,951[1]	Yes N = 1,194[1]	No N = 4,940[1]	Yes N = 204[1]	No N = 4,082[1]	Yes N = 1,063[1]
Drought (6 months)	1,301 (33%)	185 (15%)	1,454 (29%)	32 (16%)	1,313 (32%)	173 (16%)
Drought (12 months)	938 (24%)	407 (34%)	1,283 (26%)	62 (30%)	973 (24%)	372 (35%)
Drought (24 months)	827 (21%)	167 (14%)	961 (19%)	33 (16%)	834 (20%)	160 (15%)
Children who are stunted						
No	3,026 (77%)	839 (70%)	3,727 (76%)	137 (67%)	3,110 (76%)	755 (71%)
Yes	917 (23%)	352 (30%)	1,202 (24%)	67 (33%)	964 (24%)	305 (29%)
Children experiencing thinness						
No	2,652 (68%)	773 (65%)	3,296 (67%)	128 (63%)	2,727 (67%)	698 (66%)
Yes	1,275 (32%)	417 (35%)	1,617 (33%)	75 (37%)	1,330 (33%)	362 (34%)
Mom's Literacy Status						
No	1,436 (37%)	198 (17%)	1,610 (33%)	24 (13%)	1,451 (37%)	183 (17%)
Yes	2,394 (63%)	973 (83%)	3,202 (67%)	164 (87%)	2,497 (63%)	870 (83%)
Dad's Literacy Status						
No	2,271 (61%)	604 (55%)	2,773 (60%)	102 (60%)	2,334 (61%)	541 (55%)
Yes	1,442 (39%)	486 (45%)	1,858 (40%)	69 (40%)	1,484 (39%)	444 (45%)
Residence Type						
Rural	2,382 (60%)	1,066 (89%)	3,271 (66%)	176 (86%)	2,492 (61%)	956 (90%)
Urban	1,569 (40%)	128 (11%)	1,669 (34%)	28 (14%)	1,590 (39%)	107 (10%)
Household Size						
1-5	1,617 (41%)	485 (41%)	1,999 (40%)	103 (50%)	1,692 (41%)	410 (39%)
6-10	2,272 (58%)	695 (58%)	2,868 (58%)	98 (48%)	2,326 (57%)	641 (60%)
11 +	62 (1.6%)	14 (1.2%)	73 (1.5%)	3 (1.5%)	64 (1.6%)	12 (1.1%)
Wealth Index						
Low	712 (18%)	420 (35%)	1,063 (22%)	69 (34%)	762 (19%)	370 (35%)
Medium	1,431 (36%)	593 (50%)	1,923 (39%)	100 (49%)	1,488 (36%)	536 (50%)
High	1,805 (46%)	180 (15%)	1,951 (40%)	34 (17%)	1,828 (45%)	157 (15%)

[1] n (%)

Data Source: Young Lives Data by University of Oxford

Table 2 describes the cases of children who received any form of food aid from PSNP. A total of 1,194 cases of children receiving aid either by direct support or public labor were recorded. Among these, 34% received aid during a 12-month drought period, followed by 15% during a 6-month drought, and 14% during a 24-month drought. A similar trend is observed for direct support and labor aid. Most of the direct support was distributed during a 12-month drought (30%), and 16% was distributed for both a 6-month and a 24-month drought. The distribution of aid through public works was 35%, 16%, and 15% for a 12, 6, and 24-month drought, respectively. The direct support program assisted 33% of children who were stunted, and 37% of children classified as thin. Overall, 30% of the children receiving any form of aid experienced stunting, and 35% thinness. A total of 89% of the children who received any form of aid resided in rural areas, compared to 11% in urban areas. Aid was more common among children from households with 6-10 members (58%) and those in the medium wealth group (50%). Additionally, children whose mothers were literate were more likely to receive aid as compared to children whose fathers were literate. For example, 83% of children who received any form of aid lived in households with moms who are literate, versus 45% of children in households with literate dads. This trend can also be observed in individuals across the different types of aid received. For direct support, maternal literacy was 87%, and paternal literacy was only 40%. While for public work aid, maternal literacy was 83%, and paternal literacy was 45%.

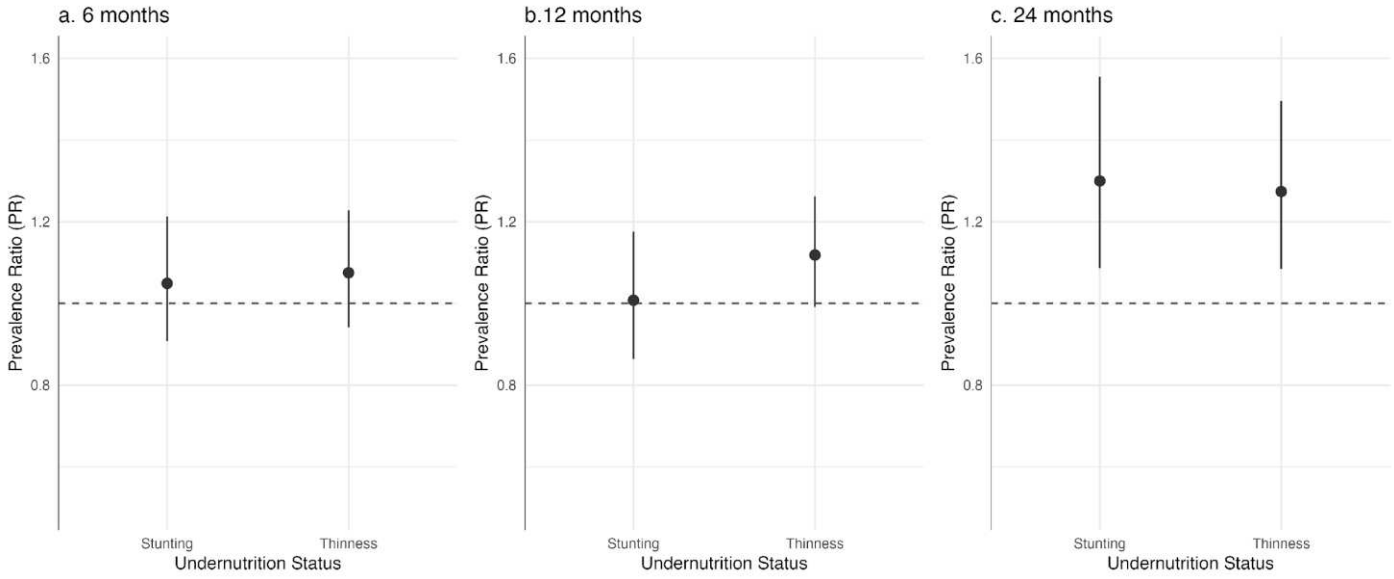


Figure 1. Associations between drought exposure and undernutrition outcomes (stunting and thinness). The y-axis shows the prevalence ratio and 95% confidence intervals. Each graph panel shows the results for a specific drought period: 6 months (left), 12 months (center), and 24 months (right).

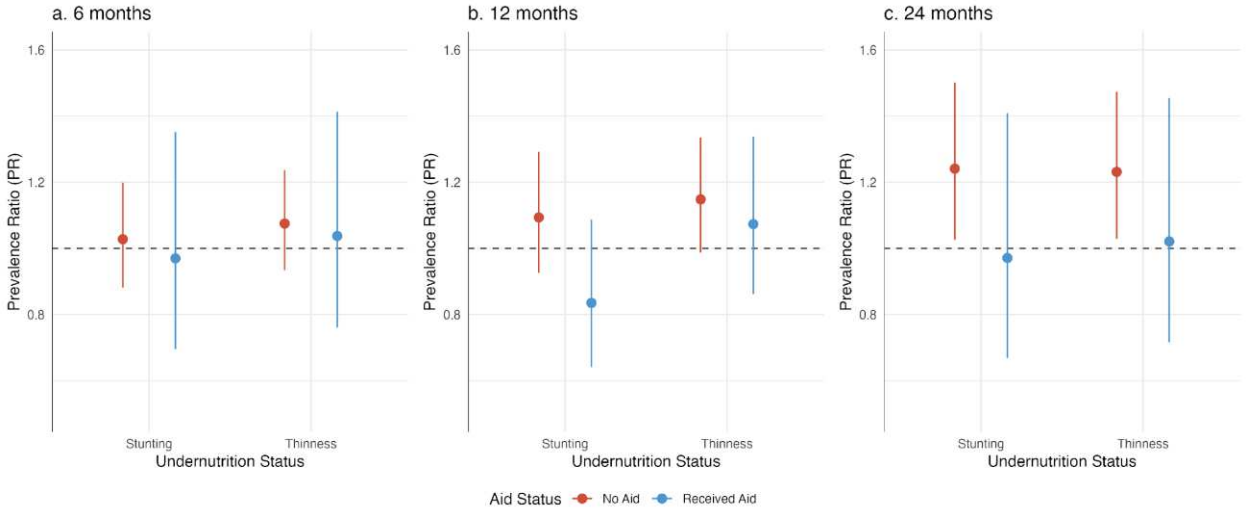


Figure 2. Associations between drought exposure and undernutrition outcomes (stunting and thinness), stratified by food aid status. The y-axis shows the prevalence ratio and 95% confidence intervals. Each panel shows the results for a specific drought period: 6 months (left), 12 months (center), and 24 months (right).

The results from the GMLER model and bootstrapping are shown in Figures 1 and 2. In Figure 1, exposure to a 6-month drought was associated with a 5% increase in the prevalence of stunting (PR = 1.05 with 95% CI: 0.908-1.213) and an 8% increase in the prevalence of thinness (PR = 1.08 with 95% CI: 0.942-1.227). A 12-month drought was not associated with an increase in the prevalence of stunting (PR = 1.00 with 95% CI: 0.863-1.176), but it was associated 12% increase in thinness prevalence (PR = 1.12 with 95% CI: 0.991-1.262). Lastly, exposure to a 24-month drought was associated with a 30% increase in the prevalence of stunting (PR = 1.30 with 95% CI: 1.086-1.555) and a 27% increase in the prevalence of thinness (PR = 1.27 with 95% CI: 1.084-1.496). The impacts of droughts on the prevalence of nutritional status were not

statistically significant for 6-month and 12-month droughts. The changes in prevalence during the 24-month drought are associated with high statistical significance.

In Figure 2, this same relationship is assessed by food aid status. Exposure to a 6-month drought among children who received aid did not affect the prevalence of stunting (PR = 0.970 with 95% CI: 0.696-1.352) or thinning (PR = 1.037 with 95% CI: 0.761-1.414). Similarly, exposure to a 6-month drought did not affect the prevalence of stunting and thinness among children who did not receive food aid (PR = 0.835 with 95% CI: 0.641-1.088 for stunting and PR = 1.074 with 95% CI: 0.861-1.338 for thinness). Exposure to a 12-month drought was not significantly associated with the prevalence of stunting or thinness among children who received food aid. Among children who did not receive food aid, exposure to a 12-month drought showed a positive association with thinness, however, this association did not reach statistical significance.

Lastly, exposure to a 24-month drought among children who received aid did not affect the prevalence of stunting (PR = 0.97 with 95% CI: 0.669-1.409) and thinness (PR = 1.02 with 95% CI: 0.716-1.455). However, among children who did not receive aid, exposure to a 24-month drought was associated with a substantial and statistically significant increase in stunting (24% increase; PR = 1.24, 95% CI: 1.026–1.501) and thinning (23% increase; PR = 1.23, 95% CI: 1.029–1.474). The Wald test did not indicate statistically significant differences between the aid and non-aid groups for any of the drought exposure periods (Table 4).

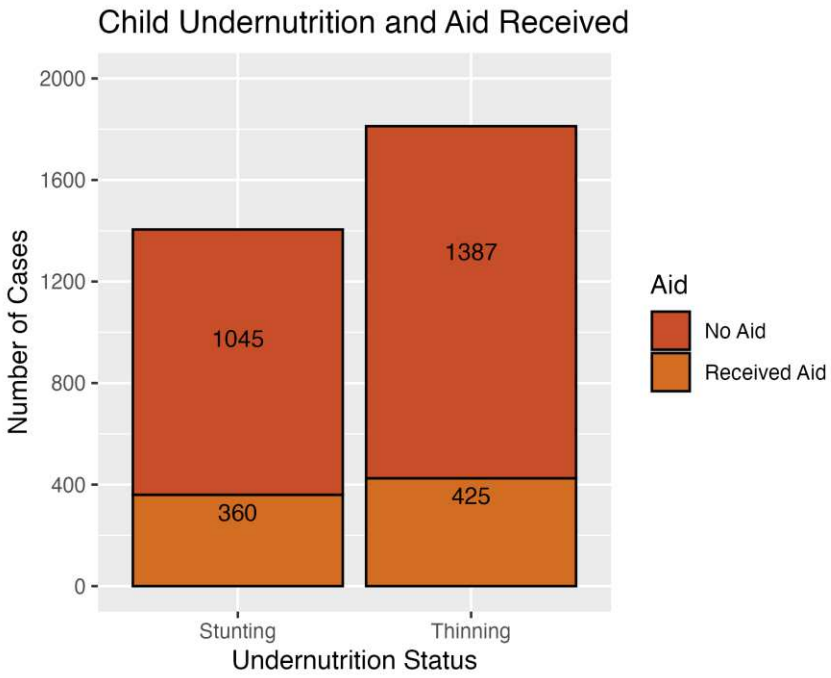


Figure 3. Total number of cases from rounds 3 to 5 of children experiencing stunting or thinness, grouped by food aid status from the Productive Safety Net Program (PSNP). The light orange section represents the cases that are aid recipients, while the dark orange section represents the cases that are not aid recipients.

Table 4. P-values from the Wald test assessing differences between aid and non-aid groups across the three drought durations (6 months, 12 months, and 24 months).

p-Values		
	Nutitional Status	
Drought Period	Stunting	Thinning
6	0.75585089	0.8371379
12	0.09069796	0.6212420
24	0.24957624	0.3548836

In Figure 3, the total number of cases of stunting and thinness is displayed based on food aid status. Through rounds 3 to 5, there were a total of 1,405 observations of stunted children. However, only 360 of those, around 26%, received food aid from the PSNP program. In the case of thinness, there were 1,812 observations of children classified as thin, and only 23% of those received aid.

4. Discussion:

4.1. Droughts and Child Nutrition

The most prevalent type of undernutrition among the study population is thinness. From Rounds 3 to 5, there are 1,812 cases of thinning compared to 1,405 stunting cases, as shown in Figure 3. Thinness is defined as low BMI for age, meaning droughts can have an acute effect on children's health by leading to a rapid weight loss. Stunting, by contrast, is a form of chronic undernutrition that affects a child's linear growth, and there could be a lag between the period of drought exposure and the growth deficit experienced by the child. This is further explained by analyzing child undernutrition through different drought durations. By analyzing the Young Lives data, the study explored the relationship between short and long-term droughts and child malnutrition. Short-term droughts were identified for the 6-month period prior to the interview date, while 12 and 24 months were used to identify longer-term droughts. Of the three drought periods, the 24-month drought increased the prevalence of stunting and thinning among the young cohort. During this long-term drought, stunting increased by 30% and thinning by 27%, compared to the 5% for stunting and 8% for thinning during a 6-month drought (Figure 1). This finding demonstrates that the longer the duration of the climate shock, the more chronic the effects are on nutritional status. In other words, the findings suggest that the accumulation of drought periods has a greater impact on child undernutrition than the initial months of drought, indicating that adverse nutritional effects may emerge only after prolonged exposure. This finding is consistent with previous research, suggesting that exposure to droughts in early life can have a lasting impact on child nutritional outcomes later in life. For example, exposure to drought at the ages of 5 and 8 years was associated with changes in height-for-age z-scores at the age of 12 years (Bahru et al., 2019). This means children are not vulnerable to climate shocks just in their early childhood, but also in their adolescence. Therefore, it's important to assist

children exposed to droughts beyond the first few months of exposure and the first 5 years of life.

4.2. Droughts, Child Nutrition, and Food Aid

This study shows evidence for the potential of food aid to mitigate the impacts of drought on child nutrition. Receiving aid was associated with a lower prevalence of stunting or thinness amongst children exposed to prolonged drought. In contrast, among children who did not receive aid, long-term drought was associated with a 24% increase in stunting and a 23% increase in thinness. This finding provides evidence that the PSNP program in Ethiopia helps mitigate the adverse effects of climate shocks, particularly droughts, on child nutritional outcomes, consistent with previous research (Bahru et al., 2019). Child undernutrition can be alleviated by access to resources such as food aid. However, not all children impacted by climate shocks have access to this type of assistance. Only 26% and 23% of children suffering from stunting and thinness, respectively, receive food aid through the PSNP program. These low percentages may be attributed to underlying determinants of child undernutrition, including place of residence, household size, and parental literacy. As shown in Table 2, 83% of cases of children who received aid had literate mothers, and 45% of cases had literate fathers. This suggests that children with literate parents are more likely to access food aid (Wake et al., 2023). In particular, paternal literacy may increase the likelihood of receiving food assistance during climate shocks by increasing access to information. Additionally, previous studies have shown that PSNP can be beneficial for child nutrition in the short term by increasing their weight-for-height z-scores, thus reducing the prevalence of acute undernutrition (Debela et al., 2015). It is important that policymakers establish and support food aid programs such as PSNP, as these can safeguard the health and development of the younger population.

4.3. Limitations and future work

This study uses longitudinal survey data and climate data matched to the location of survey participants shared by the Young Lives Cohort Study conducted by the University of Oxford. While the longitudinal nature of the study is a major advantage, there are only 26 communities included in the Ethiopian cohort, which may not be representative of the whole country. Additionally, some of the information was not collected in all survey rounds. For

example, underweight data for children was only available in rounds 1 to 3, while information about food aid status was only available in rounds 3 to 5. This data discontinuity led to dropping underweight as an undernutrition parameter, and the analysis was restricted to survey rounds that included information on food aid. A further limitation of this study is that the PSNP program offers food aid in the form of direct cash payments, food distribution, and a mix of both. However, the Young Lives study does not clarify this information. The study only identifies two ways in which aid can be obtained, either through direct support or through public labor.

Future research can expand this analysis by using the data collected by Young Lives in India, Peru, and Vietnam. This can provide important information on the variability of climate shocks' impacts on child undernutrition across countries. Additionally, future research can compare food aid programs and highlight characteristics that mitigate the relationship between climate shocks and child nutrition. In particular, the effectiveness of food aid delivered through cash payments, food distribution, or a mixture of both can be assessed. Such research can benefit policymakers by identifying strategies that maximize the benefits of food aid programs, such as the PSNP program in Ethiopia, during climate shocks. Future research could also focus on understanding the impacts of droughts on child nutrition during different seasons (e.g., agricultural and non-agricultural). This approach can help identify the most important mechanisms through which droughts impact child nutrition and inform the design of policies that are most effective in mitigating these impacts.

5. Conclusion:

As droughts increase in frequency and intensity, their impact on child nutrition is growing. Using Young Lives data for approximately 2,000 children from 2009 to 2017 in this study shows that long-term droughts lasting 24 months impact child undernutrition. This long-term drought is associated with increased prevalence of both stunting and thinness, whereas shorter droughts of 6 and 12 months show no associations with these outcomes. Results also show that receiving aid during the 24-month drought period mitigates the impact of droughts on both stunting and thinness. This implies that Ethiopia’s delivery of food aid through the Productive Safety Net Program should be expanded to all children experiencing a drought. In the study sample, only 26% of the stunted children and 23% of the children experiencing thinness received any form of aid through PSNP. This low number of aid distributions amongst children

experiencing undernutrition indicates that the food aid distribution can be expanded. By doing so, governments can improve the health of children. This can have significant implications, as good nutrition can improve the cognitive performance of children in school and hence the country's future economic development. Although the Young Lives data has some limitations, it offers a valuable opportunity to analyze the relationship between droughts, child undernutrition, and food aid. Therefore, it is important that the University of Oxford continues to conduct this survey and that similar research leveraging recent weather data is conducted in other countries.

6. Appendix:

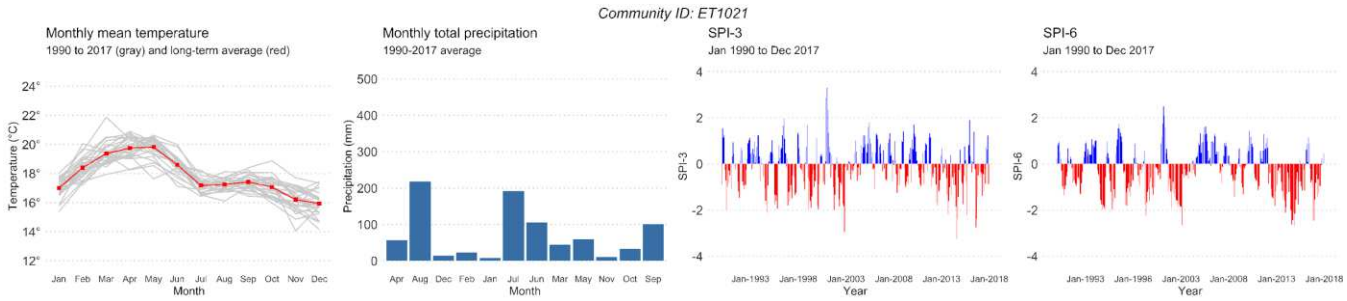


Figure A1. Weather plots showing the matched weather series for community ET10121. (Left) Monthly mean temperature, (middle) Monthly Total Precipitation, (middle) SPI-3, (right) SPI 6.

Table A1. Summary of the rounds from the Young Lives data organized by the year of the survey.

Characteristics	Year of Rounds		
	2009[1]	2013[1]	2016[1]
Children Present in Survey	1,885 (94%)	1,875 (94%)	1,812 (91%)
Children has Died	70 (3.5%)	78 (3.9%)	84 (4.2%)
Children who dropped out	44 (2.2%)	46 (2.3%)	104 (5.2%)
Region			
Addis Ababa City Administration	266 (14%)	267 (14%)	251 (14%)
Afar	0 (0%)	2 (0.1%)	0 (0%)
Amhara	381 (20%)	367 (20%)	356 (20%)
Benshangul Gumz	0 (0%)	1 (<0.1%)	0 (0%)
Oromiya	383 (20%)	392 (21%)	382 (21%)
SNNP	472 (25%)	463 (25%)	460 (25%)
Tigray	383 (20%)	382 (20%)	370 (20%)
Residence Type			
Rural	1,222 (65%)	1,187 (63%)	1,157 (64%)
Urban	663 (35%)	687 (37%)	662 (36%)

[1] n (%)

Data Source: Young Lives Data by University of Oxford

Table A2. Summary of the total cases from rounds 3 through 5 that experienced drought-based on the SPI value <-1 for each drought period of 6, 12, and 24 months.

Characteristics	6 months		12 months		24 months	
	No N = 3,659[1]	**Yes** N = 1,486[1]	**No** N = 3,800[1]	**Yes** N = 1,345[1]	**No** N = 4,151[1]	**Yes** N = 994[1]
Round						
3	1,777 (49%)	0 (0%)	1,479 (39%)	298 (22%)	1,777 (43%)	0 (0%)
4	1,030 (28%)	682 (46%)	1,064 (28%)	648 (48%)	1,052 (25%)	660 (66%)
5	852 (23%)	804 (54%)	1,257 (33%)	399 (30%)	1,322 (32%)	334 (34%)
Children who are stunted						
No	2,694 (74%)	1,171 (79%)	2,816 (74%)	1,049 (78%)	3,081 (74%)	784 (79%)
Yes	955 (26%)	314 (21%)	976 (26%)	293 (22%)	1,059 (26%)	210 (21%)
Children experiencing thinness						
No	2,427 (67%)	998 (67%)	2,538 (67%)	887 (66%)	2,728 (66%)	697 (70%)
Yes	1,209 (33%)	483 (33%)	1,237 (33%)	455 (34%)	1,397 (34%)	295 (30%)
Children who are underweight						
No	1,283 (73%)	0 (NA%)	1,081 (74%)	202 (68%)	1,283 (73%)	0 (NA%)
Yes	482 (27%)	0 (NA%)	387 (26%)	95 (32%)	482 (27%)	0 (NA%)
Residence Type						
Rural	2,548 (70%)	900 (61%)	2,525 (66%)	923 (69%)	2,847 (69%)	601 (60%)
Urban	1,111 (30%)	586 (39%)	1,275 (34%)	422 (31%)	1,304 (31%)	393 (40%)

[1] n (%)

Data Source: Young Lives Data by University of Oxford

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