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Malnutrition and Climate Patterns in the ASALs of Kenya: A Resilience Analysis based on a Pseudo-panel Dataset

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technical consortium
Building Resilience in the Horn of Africa

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1 Introduction

Although the arid and semi-arid lands (ASAL) of East Africa are traditionally home to pastoralists, declining rangeland, tenuous land rights, and increasing sedentarization have encouraged agro-pastoralism or a complete switch to agriculture. Most agro-pastoralists depend on rainfed agriculture, which is prone to high production risks that plunge communities into dire food shortages following drought or dry spells (Speranza, Kiteme & Wiesmann, 2008). Farmers in this region have developed a number of coping strategies for dealing with these conditions (Ngugi & Nyariki, 2005). However, new challenges are putting pressure on their coping strategies, which is especially troublesome since many of them are facing a period of transition from traditional livelihoods to agriculture. Those pastoralists who have sedentarized rapidly typically have low levels of resilience – defined as the ability of individual(s) to avoid or escape from chronic poverty over time when faced with a number of shocks and stressors (Barrett & Constas, 2014).

The 4th assessment of the Intergovernmental Panel on Climate Change (IPCC) forecasts a significant reduction in growing seasons all over Africa in the coming decades. The IPCC estimates that reduction in yields could reach 20% by 2050 (Boko et al., 2007), further increasing the vulnerability of farmers who depend on rainfed agriculture. Land degradation is one of the most important factors for the relatively low resilience of farmers in rainfed production systems, exacerbated by the adverse impact of climate change in already arid conditions. This dependence on rainfall leaves households vulnerable to hunger when extreme weather events occur (Fox, Rockstrom & Barron, 2005). For example, using longitudinal data, Kristjanson, Mango, Krishna, Radeny and Johnson (2010) in Kenya and Krishna et al. (2006) in Uganda observe that reduced soil fertility caused households to fall into poverty.

In this paper we examine resilience of food security in arid and semi-arid lowlands (ASAL) in Kenya, using repeated cross-sectional data (collected in 1993, 1998, 2003 and 2008). We measure short and long-term food security in response to changing agro-climatic conditions, using indicators of children's (0-59 months) and women's (15-49 years) nutritional status. Since measurements over time on the same units of analysis are not available, synthetic cohorts of individuals (children and women) having similar characteristics have been reconstructed, resulted in a pseudo-panel dataset (see below for details) The dataset is used to observe resilience to agro-climatic shocks, including temperature increases, drought, and changes in vegetation cover.

Overall, Kenya faces high and widespread vulnerability to hunger (Alinovi, D'Errico, Mane & Romano, 2010). Climatic (especially droughts) and political shocks are the substantial causes of food insecurity in the country. A significant portion of arable land is arid or semi-arid. While pastoralists and agro-pastoralists in Kenya have been more affected by previous droughts than other groups, those who have kept their pastoral practices have adapted to shocks more readily than those who have sedentarized rapidly. The latter often have little access to land and insufficient resources to irrigate their crops. Because they have moved swiftly into an unfamiliar mix of livelihood strategies, they rely on a much smaller and less flexible set of coping mechanisms, while earlier they had several from which to choose (Smucker & Wisner, 2007).

2 Resilience: some theory

Resilience, a concept developed in the study of ecology (Holling, 1973), is now used in many disciplines, including psychology and economics. It refers to the ability of a system to adjust to outside influences without becoming qualitatively different, and regain the status attained before the shock occurs. Not to be confused with stability, the tendency of a system to return to some equilibrium, resilience is characterized by adaptability. IFAD (2015) defines household resilience as the ability of households to "maintain, recover, and improve their integrity and functionality when subject to a disturbance." A similar concept is proposed by Barrett and Constas (2014), who relate resilience to the "stochastic dynamics of individual and collective human well-being, especially on the avoidance of and escape from chronic poverty over time in the face of myriad stressors and shocks".

Multiple studies find that resilient systems have several characteristics in common: they tend to have strong asset bases, which can be deployed in case of a shock. They also tend to have redundant systems in place to respond to change, which allows parts of the system to fail without a total breakdown. Resilient households also exhibit diversity in their livelihood strategies, with a propensity to innovate in the wake a disturbances. The institutional context in which they operate is usually characterized by relatively high access to assets, enhancing resilience. This institutional support is in line with other characteristics of resilient households, including connectivity to other individuals, households and institutions, along with generally elevated access to information (IFAD, 2015).

More resilient households are also more able to mobilize resources to react to shocks without losing their ability to access and consume adequately nutritious food (Alinovi et al., 2010; USAID, 1992). The food security measures considered in this paper are child and woman anthropometric measures. Height and weight for children under five years and women of reproductive age provide evidence of both acute (short-term, severe) and chronic (long-term) malnutrition. This malnutrition can be due to undernutrition, overnutrition, or an imbalance of macro- and micronutrients, or their combination thereof. It is important to note that nutrient deficiencies can persist even when individuals consume an adequate amount of food. While wasting is a sign of acute undernutrition, which makes children more vulnerable to infections, stunting is evidence of chronic, long-term undernutrition. Stunted children face significant physical and cognitive challenges, as well as an increased probability of early death (Ruel & Hoddinott, 2008; Wood, 2013).

Food security is significantly affected by the livelihood strategies households pursue. Livelihoods in the ASAL areas of the Horn of Africa are largely characterized by pastoralism, with some urban dwellers and gatherers (Headey & Kennedy, 2011). Although herds are declining, land grazing is becoming increasingly scarce, leaving pastoralists exposed to climatic shocks and stresses. However, pastoralists are well-placed to minimize negative effects of climatic events through mobility and trade. In fact, current pastoralists and agro-pastoralists fare better against shocks than their counterparts who have been forced into full sedentarization (Headey, Taffesse & You, 2012).

3 Data

In order to study the link between individual nutrition status and climatic conditions we construct a database combining household survey data with remote sensing information on biophysical variables. At the micro-level individual modules of the latest four Demographic and Health Surveys (DHS)[1] waves of survey data available for Kenya (1993, 1998, 2003, 2008) are used. The DHS are nationally-representative household surveys that provide data on a wide range of indicators on population, health, and nutrition. In particular, each wave contains anthropometric measures for both children (0-59 months) and women of reproductive age (15-49 years), which we will use as outcome variables in our analysis. Biophysical variables measured through satellites are then associated to each DHS household at the district level in each wave. In particular, climate-related characteristics, such as mean temperature and rainfall, Palmer Drought Severity Index (PDSI)[2] and Normalized Difference Vegetation Index (NDVI)[3] are used.

The incidence of stunting and underweight among children has been decreasing over time in almost every region, with the incidence of wasting following an opposite trend (Table 1). Overall, annual temperatures seem to be gradually rising, while 1993 appears to have been the driest of the four years in our dataset. In the case of anthropometric measurements for women, underweight rates have improved recently in Nairobi and Nyanza, but worsened in every other region. The average BMI has slightly increased overall.

[1] http://www.dhsprogram.com/

[2] The Palmer Drought Index is based on a supply-and-demand model of soil moisture approximated using an algorithm with temperature and rainfall as inputs. The index has proven most effective in determining long-term drought (several months) rather than short lived events, thus it is especially useful to compare the dryness level across years.

[3] It is a variable assessing the degree of live green vegetation in the observed area. Negative values of NDVI (approaching -1) correspond to water. Values close to zero (-0.1 to 0.1) generally correspond to barren areas of rock, sand, or snow. Lastly, low, positive values represent shrub and grassland (approximately 0.2 to 0.4), while high values indicate temperate and tropical rainforests (values approaching 1).

Table 1: Distribution of the Main Variables of Interest by Region and Year

REGION	YEAR	CHILD: MODERATE STUNTING RATE	CHILD: MODERATE UNDERWEIGHT RATE	CHILD: MODERATE WASTING RATE	WOMAN: UNDERWEIGHT RATE	WOMAN: AVERAGE BMI	RAINFALL (mm)	TEMPERATURE (CELSIUS)	DROUGHT (INVERSE PDSI)	NDVI
Central	1993	37.3%	15.2%	5.3%	7.5%	22.4	1296	17.0	1.4	0.60
	1998	33.6%	12.4%	7.7%	8.7%	22.9	1744	17.5	-0.3	0.64
	2003	31.8%	11.2%	5.0%	7.1%	23.8	1574	18.1	-2.5	0.63
	2008	33.5%	13.3%	5.3%	10.0%	23.9	1268	17.4	-2.4	0.63
Coast	1993	48.3%	31.9%	11.9%	14.6%	21.6	695	26.1	1.4	0.46
	1998	43.2%	23.2%	5.9%	14.7%	21.9	1331	25.4	-0.2	0.49
	2003	41.2%	19.4%	5.6%	13.1%	23.0	1018	26.6	-0.2	0.49
	2008	39.9%	24.1%	11.1%	15.8%	23.5	788	26.4	-1.2	0.49
Eastern	1993	48.0%	24.6%	8.4%	12.1%	21.6	873	21.6	1.4	0.50
	1998	43.7%	22.4%	5.5%	15.4%	21.4	1714	21.1	-0.3	0.55
	2003	41.0%	17.5%	4.4%	12.8%	22.2	1043	23.8	-2.0	0.51
	2008	42.0%	20.6%	7.1%	16.8%	22.2	824	23.3	-2.2	0.51
Nairobi	1993	35.9%	8.4%	1.7%	3.5%	23.7	1001	18.6	1.4	0.46
	1998	30.0%	8.4%	11.9%	4.6%	23.5	1088	19.1	-0.3	0.47
	2003	23.5%	5.1%	4.5%	4.5%	24.6	1117	19.9	-2.5	0.43
	2008	28.9%	8.3%	4.3%	3.1%	24.9	891	19.4	-2.4	0.43
North Eastern	2003	27.8%	33.4%	27.5%	27.0%	20.1	493	27.8	-2.5	0.39
	2008	37.9%	25.4%	20.4%	27.5%	20.8	464	27.6	-2.4	0.39
Nyanza	1993	39.8%	18.1%	6.2%	9.6%	21.9	1233	21.3	1.8	0.60
	1998	36.1%	18.7%	8.5%	11.0%	21.7	1781	21.6	0.5	0.64
	2003	35.5%	11.7%	3.1%	10.5%	22.2	1547	22.8	-0.1	0.63
	2008	30.9%	11.0%	4.1%	8.8%	23.0	1565	22.3	-1.2	0.63
Rift Valley	1993	36.2%	21.9%	8.7%	13.7%	22.2	1045	18.7	1.9	0.58
	1998	36.9%	19.4%	8.6%	15.0%	22.0	1230	19.3	-0.2	0.62
	2003	37.6%	19.9%	8.3%	18.5%	22.1	1102	20.8	-0.3	0.59
	2008	36.1%	18.6%	8.6%	14.4%	22.5	1250	20.1	-1.1	0.59
Western	1993	36.9%	14.0%	4.5%	4.4%	22.2	1407	21.1	4.3	0.67
	1998	40.0%	16.2%	5.4%	6.1%	22.1	1574	21.7	-0.9	0.68
	2003	35.7%	16.8%	6.4%	11.8%	22.2	1548	22.6	-0.7	0.68
	2008	32.2%	10.6%	2.3%	9.5%	22.6	1746	22.3	-1.4	0.67

Looking at differences in the distribution of nutritional outcomes by agro-ecological zone (Figure 1a) in arid and semi-arid areas of Kenya (focus of our analysis), child undernourishment rates in 2008 appear to be correlated with climatic variables across regions (Figure 1b, Figure 1c and Figure 1d). The same is true for women underweight rate and BMI (Figure 1e, Figure 1f).

Figure 1a: Agro-Ecological Zones

Figure 1b: Child Stunting

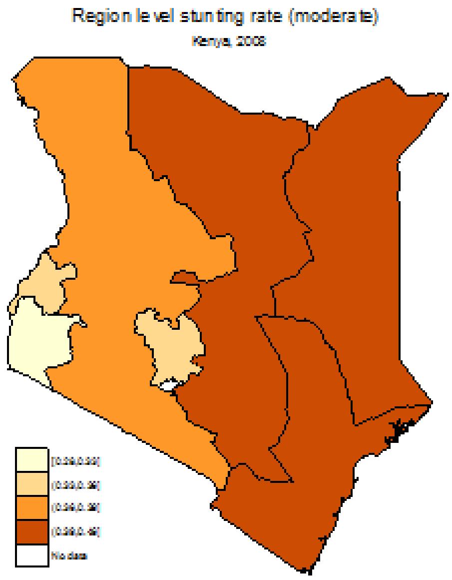


Figure 1c: Child Underweight

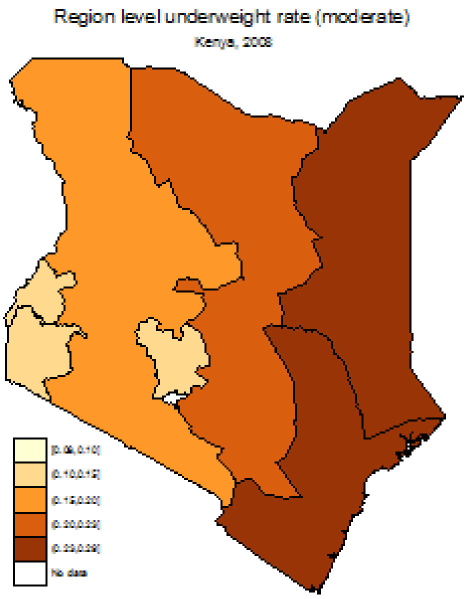


Figure 1d: Child Wasting

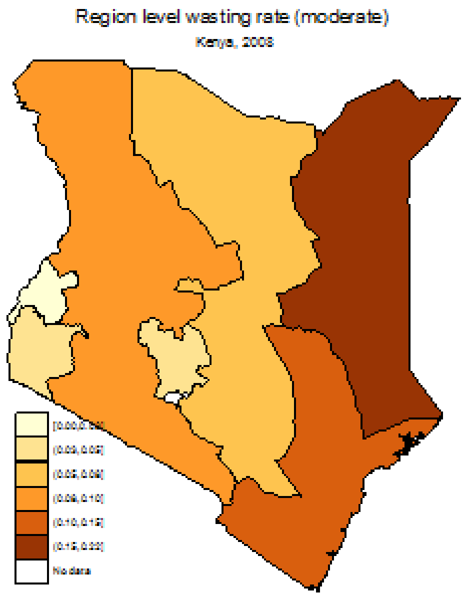


Figure 1e: Women Underweight

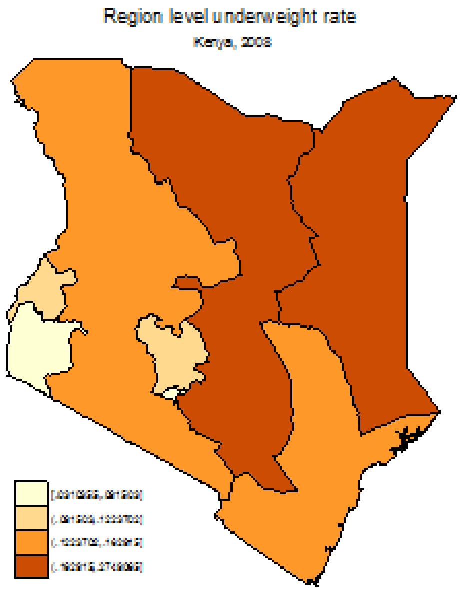


Figure 1f: Women BMI

While incidence of all three child nutritional indicators have been decreasing in non-arid counties, child wasting and woman underweight rates have increased drastically over the observed period.

Figure 2a: Child Stunting Trends

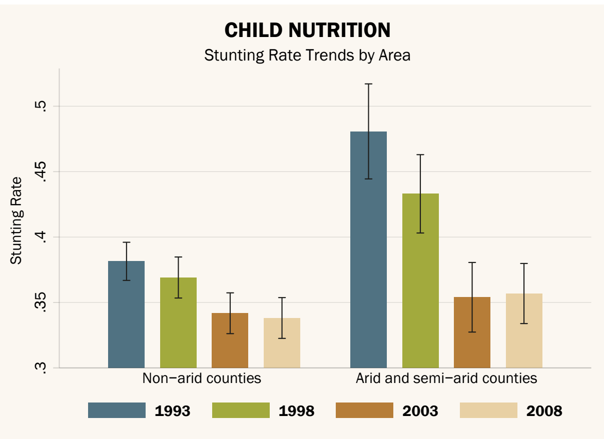


Figure 2b: Child Underweight Trends

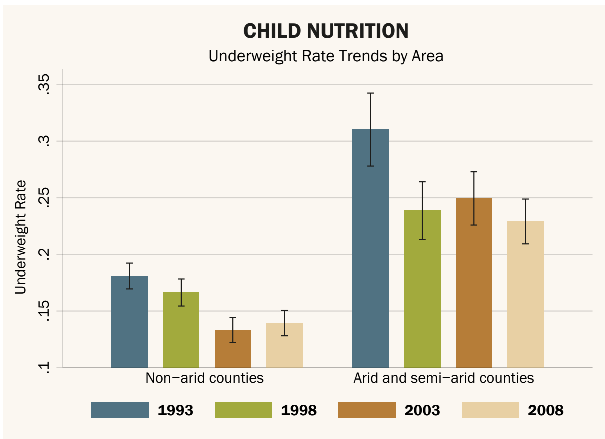


Figure 2c: Child Wasting Trends

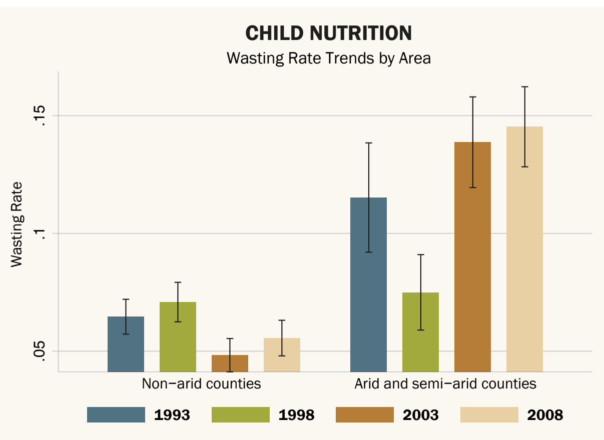
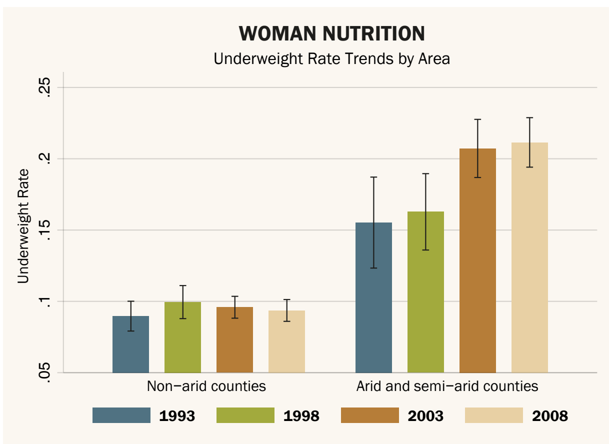


Figure 2d: Woman Underweight Trends



4 Methodology

To analyze how households and individuals dynamically react to shocks, nationally-representative data on a panel of individuals or households which are monitored over time would be ideal. Nonetheless, since the DHS is a series of repeated cross sectional data, construction of a synthetic panel based on individual propensity of being undernourished can provide a valid alternative. Specifically, in the first stage the following probit model is estimated for each year:

Specifically, in the first stage the following probit model is estimated separately for each year (1993, 1998, 2003, 2008):

$$1) \qquad P(Z_i = 1) = \alpha X_i + r_i + \varepsilon_i$$

where $\boldsymbol{Z_i}$ represent the nutritional outcome indicators (stunting, underweight and wasting for children; and underweight for women); $\boldsymbol{X_i}$ is a matrix of control variables (age in months, sex, age of the mother at birth, years of education of the mother, rural/urban location of the household, presence of a female head and availability of a radio in the household for the child-level regressions; education level, age, marital status, number of children and working status of the woman, rural/urban location and radio ownership of the household in the woman-level regressions). $\boldsymbol{r_i}$ captures region fixed effects and $\boldsymbol{\varepsilon_i}$ is a vector of error terms assumed idiosyncratic.

Predicted probability of being malnourished given $\boldsymbol{X_i}$ are computed, separately by quantile as follows:

$$2) \qquad \begin{cases} Q_{Z_1} = E(Z_i \mid X_i, r_i) < s_1 \\ Q_{Z_2} = s_1 < E(Z_i \mid X_i, r_i) < s_2 \\ Q_{Z_3} = s_2 < E(Z_i \mid X_i, r_i) < s_3 \\ Q_{Z_4} = s_3 < E(Z_i \mid X_i, r_i) < s_4 \\ Q_{Z_5} = s_4 < E(Z_i \mid X_i, r_i) \end{cases}$$

where (s_1, s_4) express the four thresholds defining the five quintiles. The quintiles are estimated separately for each year and then combined to create a pseudo panel of individuals belonging to the same quintiles over time (separately for children under five and women and specific to each anthropometric variable).[4]

In the second stage, the following probit model is estimated:

$$3) \qquad P(Z_{it} = 1) = Qz_i + \beta BIO_{dt} + \gamma_t + \varepsilon_i$$

[4] The child sample size is almost 5,000 observations in each year. Thus the propensity score, based on quintiles identifying the synthetic cohorts of children, is calculated using almost 1,000 observations each year. The same model is also estimated using the restricted sample of ASAL areas of Kenya, on a more limited number of observations per year per quintile (about 100).

where Qz_i captures the panel fixed effects, γ_t captures year fixed effects and BIO_{dt} is a matrix of time-varying biophysical variables at the district level (including temperature, drought index and NDVI) and ε_i is a vector of error terms. β constitutes our main parameter of interest, which measures the impact of the climatic variation on the probability of being malnourished. As before, the same regression is estimated for the entire country, adding a dummy identifying arid and semi-arid areas, as well as for the ASAL areas only. Similar regressions are estimated taking continuous variables as left-hand side regressands (such as the distribution of the z-scores of height for age, weight for age and weight for height for children and body mass index for women) using OLS instead of a limited dependent variable model.

Finally, a different specification of equation (3) is estimated in order to look at the interaction between biophysical variables and a) a dummy identifying whether the head or the spouse has a job in the non-agricultural sector and b) a variable capturing years of education of the woman. The estimated model is:

$$4) \qquad P(Z_{it} = 1) = Qz_i + \beta_1 BIO_{dt} + \beta_2 BIO_{dt} RES_{it} + RES_{it} + \gamma_t + \varepsilon_i$$

where RES_{it} is a matrix containing the two expected resilience-enhancing strategies: non-agricultural job participation and woman's education.

Once parameter estimates are obtained, simulations are performed by artificially introducing a shock in temperature and drought distribution. Specifically, an increase in the average temperature of two degrees Celsius, in the drought index by 50%, and the combination of both have been simulated.

A. ANTHROPOMETRIC MEASUREMENTS FOR CHILDREN

Table 2 reports parameter estimates of equation 1 for the entire Kenya, used to construct the synthetic cohorts of the main regressions. Results show that the older the child (in months, until age five), the higher the probability of being stunted and underweight, but the lower the probability of being wasted. Girls are less likely to be undernourished than boys. Age of the mother at child birth has a positive effect on stunting rates, while it does not seem relevant on the other anthropometric measures. On the contrary, mother's education significantly decreases the likelihood of any type of child undernutrition. Radio ownership, used as a proxy for wealth, is associated with lower undernutrition rates, while rural location seems to be associated with higher stunting rates but not with underweight and wasting. Similar trends occur when the analysis is restricted to the ASAL areas (Table A1 in the appendix).

Table 2: Regressions results to define synthetic cohorts of children (whole country)

VARIABLES	ALL KENYA											
	P (stunting)				P (underweight)				P (wasting)			
	Year 1993	Year 1998	Year 2003	Year 2008	Year 1993	Year 1998	Year 2003	Year 2008	Year 1993	Year 1998	Year 2003	Year 2008
Age of child in months	0.00796***	0.00960***	0.00637***	0.00285	0.00256*	0.00530***	0.00308**	0.00681***	-0.00897***	-0.00888***	-0.0107***	-0.00653***
	(0.00127)	(0.00129)	(0.00121)	(0.00205)	(0.00138)	(0.00138)	(0.00138)	(0.00166)	(0.00216)	(0.00204)	(0.00213)	(0.00234)
Child is female	-0.199***	-0.171***	-0.220***	-0.108**	-0.169***	-0.0700	-0.268***	-0.0619	-0.0894	0.0316	-0.236***	-0.149*
	(0.0435)	(0.0423)	(0.0402)	(0.0477)	(0.0503)	(0.0471)	(0.0558)	(0.0634)	(0.0660)	(0.0617)	(0.0704)	(0.0806)
Age of mother (years)	-0.0101***	-0.0114***	-0.00634*	0.00158	-0.00831**	-0.00698	-0.00198	0.00412	-0.00199	-0.00312	-0.00540	0.00397
	(0.00366)	(0.00374)	(0.00325)	(0.00460)	(0.00406)	(0.00440)	(0.00394)	(0.00431)	(0.00486)	(0.00491)	(0.00488)	(0.00533)
Mother's education in single years	-0.0399***	-0.0529***	-0.0492***	-0.0240***	-0.0521***	-0.0683***	-0.0533***	-0.0487***	-0.0431***	-0.0339***	-0.0488***	-0.0401***
	(0.00750)	(0.00664)	(0.00738)	(0.00737)	(0.00789)	(0.00820)	(0.00895)	(0.00915)	(0.0112)	(0.00912)	(0.0132)	(0.0114)
Female head	0.0233	-0.0586	-0.0265	0.0782	0.00774	-0.0258	-0.0290	-0.0915	-0.150*	0.0422	-0.0251	-0.176**
	(0.0536)	(0.0520)	(0.0527)	(0.0642)	(0.0579)	(0.0553)	(0.0716)	(0.0723)	(0.0790)	(0.0735)	(0.0899)	(0.0771)
Rural area	0.289***	0.175*	0.0360	0.305***	0.238**	0.157	0.0973	0.175	-0.0642	0.0719	0.112	0.0555
	(0.106)	(0.0909)	(0.0723)	(0.0980)	(0.104)	(0.107)	(0.0735)	(0.111)	(0.134)	(0.105)	(0.118)	(0.107)
Household owns a radio	-0.199***	-0.220***	-0.145***	-0.138**	-0.184***	-0.150**	-0.229***	-0.247***	-0.0980	0.0329	-0.162*	-0.177**
	(0.0503)	(0.0492)	(0.0543)	(0.0593)	(0.0500)	(0.0609)	(0.0661)	(0.0661)	(0.0692)	(0.0682)	(0.0844)	(0.0858)
Constant	-0.123	0.248	-0.456***	-0.617***	-0.679***	-0.486***	-0.323*	-0.956***	-0.968***	-1.181***	-0.113	-0.561***
	(0.181)	(0.157)	(0.151)	(0.171)	(0.200)	(0.186)	(0.167)	(0.169)	(0.242)	(0.221)	(0.205)	(0.216)
Observations	4,980	4,667	4,791	5,207	5,148	4,801	4,940	5,363	4,951	4,617	4,771	5,178

Region fixed effects omitted
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3a reports the main regressions of child undernutrition, separately for the whole country and the ASAL areas only. Overall, the higher the temperature the higher the undernutrition rate, especially for stunting in ASAL areas. Drought, as measured by the inverse of the PDSI index, and NDVI have very little effect on anthropometric measurements for children. The same is true for the availability of a non-agricultural job within the household (Table 3b), although it significantly decreases the incidence of wasted children in ASAL areas. However, having a non-agricultural job in these high temperature areas would end up being detrimental for resilience. Woman's education significantly decreases underweight probability in ASAL counties but could be detrimental for underweight resilience in case of high temperature shocks. Nevertheless, high education seems to help wasting resilience to droughts in ASAL counties. Further research on this is required to disentangle the reasons for these effects. Finally, similar regressions are estimated on severe undernutrition (based on z-scores under -3) and are reported in Table A2 of the appendix. The results on severe undernutrition are similar to the ones obtained for moderate levels reported in Table 3a.

Table 3a: Regression results: probability of stunting, underweight and wasting on biophysical variables

	P(STUNTING) ON BIOPHYSICAL VARIABLES		P(UNDERWEIGHT) ON BIOPHYSICAL VARIABLES		P(WASTING) ON BIOPHYSICAL VARIABLES	
VARIABLES	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**
Arid_area	-0.126***		0.0188		0.108**	
	(0.0366)		(0.0411)		(0.0504)	
Mean annual temperature	0.00565	0.0172*	0.0153**	0.0234**	0.0143**	0.0174
	(0.00536)	(0.00890)	(0.00637)	(0.0102)	(0.00655)	(0.0109)
Drought	0.0143*	0.0220	0.00401	0.0322	-0.00987	0.0330
	(0.00759)	(0.0146)	(0.00969)	(0.0212)	(0.0138)	(0.0285)
NDVI	0.0693	0.751**	0.185	0.0136	-0.0135	-0.0951
	(0.148)	(0.311)	(0.160)	(0.353)	(0.189)	(0.443)
Year 1998	0.0439	-0.0429	0.0271	-0.0555	0.0455	-0.0258
	(0.0383)	(0.0784)	(0.0446)	(0.0850)	(0.0553)	(0.127)
Year 2003	-0.0144	-0.196**	-0.0643	-0.163	-0.0818	-0.0250
	(0.0433)	(0.0849)	(0.0535)	(0.114)	(0.0738)	(0.145)
Year 2008	-0.00739	-0.153*	-0.0437	-0.116	-0.00406	0.201
	(0.0534)	(0.0904)	(0.0659)	(0.112)	(0.0694)	(0.133)
Constant	-0.935***	-1.472***	-1.867***	-1.584***	-2.231***	-2.132***
	(0.153)	(0.308)	(0.178)	(0.366)	(0.208)	(0.432)
Observations	19,365	4,684	19,966	4,901	19,236	4,648

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 3b: Regression results: probability of stunting, underweight and wasting on biophysical variables with interactions

	NON-AGRICULTURAL LABOR INTERACTIONS						WOMAN EDUCATION INTERACTIONS					
	P(stunting) on biophysical variables		P(underweight) on biophysical variables		P(wasting) on biophysical variables		P(stunting) on biophysical variables		P(underweight) on biophysical variables		P(wasting) on biophysical variables	
VARIABLES	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**
Arid_area	-0.132***		0.00907		0.100**		-0.136***		0.0189		0.104**	
	(0.0371)		(0.0410)		(0.0497)		(0.0373)		(0.0409)		(0.0494)	
Mean annual temperature	0.00805	0.0209*	0.0192*	0.0252*	0.0197*	0.00336	0.00831	0.0106	0.00739	0.00816	0.0103	0.0100
	(0.00740)	(0.0115)	(0.0103)	(0.0132)	(0.0104)	(0.0148)	(0.00857)	(0.0121)	(0.00939)	(0.0136)	(0.00990)	(0.0142)
Drought	0.0173*	0.0264	0.0138	0.0695**	0.00190	0.0554	0.0203	0.0174	0.00777	0.0479*	0.00593	0.0654*
	(0.0105)	(0.0237)	(0.0145)	(0.0328)	(0.0202)	(0.0384)	(0.0125)	(0.0235)	(0.0161)	(0.0270)	(0.0239)	(0.0339)
NDVI	0.0530	0.783**	0.103	-0.00875	-0.0971	-0.215	0.0655	0.792**	0.155	-0.145	-0.0483	-0.377
	(0.150)	(0.312)	(0.160)	(0.356)	(0.190)	(0.420)	(0.148)	(0.332)	(0.162)	(0.366)	(0.191)	(0.447)
Tempxnagri	-0.00141	-0.00347	-0.00158	0.00671	-0.00763	0.0352*						
	(0.00867)	(0.0152)	(0.0104)	(0.0157)	(0.0120)	(0.0208)						
Droughtxnagri	-0.00470	-0.00950	-0.0137	-0.0569	-0.0193	-0.0325						
	(0.0119)	(0.0288)	(0.0138)	(0.0364)	(0.0197)	(0.0423)						
Nonagri job	-0.0132	0.0301	-0.123	-0.349	0.0433	-0.978**						
	(0.185)	(0.368)	(0.226)	(0.377)	(0.259)	(0.497)						
Tempxedu							-0.000578	0.00177	0.00131	0.00416*	0.000786	0.00225
							(0.00108)	(0.00247)	(0.00112)	(0.00245)	(0.00137)	(0.00244)
Droughtxedu							-0.00104	0.000823	-0.000763	-0.00515	-0.00285	-0.0100**
							(0.00150)	(0.00426)	(0.00193)	(0.00414)	(0.00274)	(0.00512)
Woman's years of education							0.00467	-0.0462	-0.0381	-0.108*	-0.0197	-0.0565
							(0.0238)	(0.0598)	(0.0251)	(0.0595)	(0.0305)	(0.0597)
Year 1998	0.0460	-0.0451	0.0149	-0.0721	0.0315	-0.0409	0.0479	-0.0375	0.0314	-0.0318	0.0535	-0.00874
	(0.0390)	(0.0788)	(0.0441)	(0.0830)	(0.0555)	(0.125)	(0.0387)	(0.0823)	(0.0451)	(0.0890)	(0.0573)	(0.128)
Year 2003	-0.0130	-0.199**	-0.0760	-0.182*	-0.0982	-0.0456	-0.0128	-0.195**	-0.0604	-0.160	-0.0771	-0.0316
	(0.0441)	(0.0845)	(0.0517)	(0.103)	(0.0716)	(0.138)	(0.0436)	(0.0841)	(0.0539)	(0.114)	(0.0738)	(0.142)
Year 2008	-0.00366	-0.154*	-0.0470	-0.127	-0.0155	0.182	-0.00405	-0.151*	-0.0364	-0.115	0.00229	0.194
	(0.0538)	(0.0909)	(0.0647)	(0.105)	(0.0683)	(0.129)	(0.0538)	(0.0899)	(0.0667)	(0.110)	(0.0705)	(0.131)
Constant	-0.944***	-1.547***	-1.766***	-1.451***	-2.191***	-1.622***	-0.922***	-1.291***	-1.577***	-1.054**	-2.109***	-1.825***
	(0.192)	(0.356)	(0.263)	(0.433)	(0.278)	(0.455)	(0.222)	(0.364)	(0.255)	(0.441)	(0.284)	(0.514)
Observations	19,133	4,655	19,727	4,870	19,006	4,619	19,365	4,684	19,966	4,901	19,236	4,648

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 4, 5 and 6 report regression results based on z-score as dependent variable, both using OLS and quantile regression to look at different points along the z-score distribution. Presence of a drought shows a strong negative effect on height for age, with the impact fairly homogeneous across distribution quartiles. Contrarily to expectations, high levels of NDVI are also negatively correlated with height for age, and this is particularly true in ASAL areas.

Table4: Regression results of stunting z-score

	HEIGHT FOR AGE SCORE (HAZ)							
VARIABLES	**All Kenya**				**Arid and semi-arid zones**			
	Tot	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**
Arid_area	0.0978*	0.111**	0.116***	0.214***				
	(0.0587)	(0.0487)	(0.0429)	(0.0589)				
Mean annual temperature	0.00169	0.00203	-0.00406	0.00367	0.000442	-0.0126	-0.0208*	-0.00426
	(0.00837)	(0.00662)	(0.00582)	(0.00774)	(0.0150)	(0.0131)	(0.0117)	(0.0134)
Inverse PDSI	-0.0204	-0.0235**	-0.0173**	-0.0290**	-0.0839***	-0.0359	-0.0705***	-0.0684***
	(0.0128)	(0.0108)	(0.00858)	(0.0129)	(0.0283)	(0.0229)	(0.0203)	(0.0207)
NDVI	-0.391*	-0.0297	-0.416***	-0.269	-1.376***	-0.784*	-1.255***	-1.510***
	(0.223)	(0.181)	(0.158)	(0.199)	(0.496)	(0.452)	(0.390)	(0.496)
Year 1998	0.102	-0.123**	-0.0128	0.0505	0.138	0.0511	-0.0816	0.156
	(0.0632)	(0.0524)	(0.0466)	(0.0607)	(0.136)	(0.125)	(0.105)	(0.131)
Year 2003	0.168**	0.0249	0.0661	0.0830	0.415***	0.324***	0.272***	0.378***
	(0.0752)	(0.0577)	(0.0487)	(0.0676)	(0.129)	(0.119)	(0.101)	(0.120)
Year 2008	0.131*	0.00446	0.0438	0.0320	0.240*	0.263**	0.0900	0.153
	(0.0704)	(0.0646)	(0.0543)	(0.0767)	(0.135)	(0.124)	(0.110)	(0.126)
Constant	-0.662***	-1.861***	-0.571***	0.217	-0.451	-1.333***	0.00282	0.748
	(0.241)	(0.189)	(0.169)	(0.217)	(0.521)	(0.458)	(0.402)	(0.477)
Observations	19,816	19,816	19,816	19,816	4,822	4,822	4,822	4,822
R-squared	0.046				0.066			

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Temperature has a highly negative effect on the distribution of weight for age, and this is especially true in ASAL areas and for higher quartiles of the z-score distribution. Drought appears to be detrimental only in ASAL areas, affecting children in the last two quartiles the most.

Table 5: Regression results of underweight z-score

VARIABLES	WEIGHT FOR AGE SCORE (WAZ)							
	All Kenya				Arid and semi-arid zones			
	Tot	p25	p50	p75	Tot	p25	p50	p75
Arid_area	0.0882	0.0105	0.0158	0.0486				
	(0.0701)	(0.0373)	(0.0366)	(0.0355)				
Mean annual temperature	-0.0296***	-0.0146***	-0.0108**	-0.0146***	-0.0620***	-0.0281***	-0.0346***	-0.0431***
	(0.00980)	(0.00491)	(0.00488)	(0.00481)	(0.0236)	(0.00943)	(0.00911)	(0.00991)
Inverse PDSI	-0.0108	-0.00104	-0.00620	-0.00617	-0.0702**	-0.0237	-0.0381***	-0.0460**
	(0.0101)	(0.00802)	(0.00724)	(0.00732)	(0.0340)	(0.0185)	(0.0147)	(0.0209)
NDVI	-0.280	-0.169	-0.0175	-0.174	-0.201	-0.323	-0.194	-0.605*
	(0.173)	(0.140)	(0.136)	(0.133)	(0.410)	(0.305)	(0.314)	(0.327)
Year 1998	-0.0628	-0.0183	-0.0131	-0.0505	-0.162	0.168*	0.0291	-0.0585
	(0.0598)	(0.0440)	(0.0382)	(0.0398)	(0.155)	(0.0951)	(0.0924)	(0.0959)
Year 2003	-0.00254	0.0605	0.0118	0.0105	0.147	0.291***	0.159*	0.130
	(0.0721)	(0.0451)	(0.0414)	(0.0412)	(0.190)	(0.100)	(0.0860)	(0.103)
Year 2008	-0.0833	0.0463	-0.0428	-0.0397	-0.122	0.233**	0.0357	-0.0630
	(0.0689)	(0.0494)	(0.0456)	(0.0469)	(0.156)	(0.0956)	(0.0958)	(0.103)
Constant	0.541**	-0.731***	-0.0549	0.920***	0.990	-0.737**	0.303	1.514***
	(0.219)	(0.142)	(0.141)	(0.138)	(0.622)	(0.330)	(0.328)	(0.349)
Observations	20,015	20,015	20,015	20,015	4,916	4,916	4,916	4,916
R-squared	0.034				0.023			

*Panel fixed effects not reported
Robust standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1

Finally, temperature is negatively associated to wasting z-score. The effect is similar in ASAL areas and for the entire country, and children in the bottom of the distribution seem the most affected, making them extremely vulnerable to this type of shocks. NDVI has again a surprising negative effect but only when the entire country is considered. In the case of ASAL areas, more greenness is associated to higher wasting z-score. Regression results with interaction between availability of a job in the non–agricultural sector and woman's education on the z-score are reported in Table A3, A4, A5 in the appendix. The resilience interactions play a more important role in the ASAL counties than for the entire country. Table A5 shows how both the availability of a non-agricultural job and the level of education of the woman are associated with higher wasting z-score overall and higher resilience in case of droughts in ASAL counties. On the other hand, if a temperature peak had to occur, those same measures predict lower resilience in arid and semi-arid areas.

Table 6: Regression results of wasting z-score

	WEIGHT FOR HEIGHT SCORE (WHZ)							
VARIABLES	**All Kenya**				**Arid and semi-arid zones**			
	Tot	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**
Arid_area	-0.215***	-0.185***	-0.261***	-0.264***				
	(0.0650)	(0.0468)	(0.0354)	(0.0437)				
Mean annual temperature	-0.0404***	-0.0180***	-0.0168***	-0.0249***	-0.0478***	-0.0227**	-0.0209**	-0.0261**
	(0.00841)	(0.00610)	(0.00485)	(0.00631)	(0.0170)	(0.0108)	(0.00881)	(0.0115)
Inverse PDSI	0.0140	0.0159*	0.00649	0.00384	-0.0221	-0.00532	0.0121	-0.0188
	(0.0109)	(0.00883)	(0.00785)	(0.00987)	(0.0301)	(0.0214)	(0.0160)	(0.0209)
NDVI	-0.460**	0.152	-0.0591	-0.374**	0.547	0.870**	0.837***	0.309
	(0.226)	(0.159)	(0.127)	(0.163)	(0.462)	(0.434)	(0.317)	(0.429)
Year 1998	0.00733	-0.0759	-0.0314	0.0389	-0.0685	-0.112	-0.00662	-0.0642
	(0.0763)	(0.0464)	(0.0407)	(0.0487)	(0.189)	(0.111)	(0.0945)	(0.107)
Year 2003	0.0307	0.0615	0.0561	0.0281	-0.0759	0.0129	0.0722	-0.211**
	(0.0758)	(0.0503)	(0.0430)	(0.0531)	(0.194)	(0.114)	(0.0933)	(0.106)
Year 2008	-0.0572	-0.0240	-0.0225	-0.0777	-0.238	-0.221*	-0.0530	-0.243**
	(0.0825)	(0.0574)	(0.0483)	(0.0613)	(0.186)	(0.119)	(0.100)	(0.119)
Constant	1.349***	-0.213	0.537***	1.631***	0.793	-0.681*	-0.0830	1.246***
	(0.253)	(0.168)	(0.139)	(0.179)	(0.562)	(0.408)	(0.326)	(0.420)
Observations	19,617	19,617	19,617	19,617	4,766	4,766	4,766	4,766
R-squared	0.012				0.020			

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Finally, table 7 performs some simulations to predict the potential impact of climate change on child nutritional outcomes. Temperature shocks are the biggest threat to child nutrition, especially for stunting and wasting, and particularly in ASAL areas. This effect is likely to be reinforced if temperature peaks occur at the same time of a severe drought, which is likely to be the case given the correlation of the two events.

Table 7: Simulation results of climate change impact

SIMULATION WITH ALL KENYA

Year	Actual stunting (moderate)	Predicted stunting (moderate)	Predicted stunting (moderate) with simulation (+2 degrees temp)	Predicted stunting (moderate) with simulation (+50% drought index)	Predicted stunting (moderate) with simulation (+2 degrees and +50% drought index)
1993	0.396	0.408	0.412	0.414	0.418
1998	0.383	0.387	0.391	0.387	0.391
2003	0.345	0.349	0.353	0.346	0.350
2008	0.344	0.351	0.355	0.347	0.351
Total	**0.367**	**0.374**	**0.378**	**0.373**	**0.377**

Year	Actual underweight (moderate)	Predicted underweight (moderate)	Predicted underweight (moderate) with simulation (+2 degrees temp)	Predicted underweight (moderate) with simulation (+50% drought index)	Predicted underweight (moderate) with simulation (+2 degrees and +50% drought index)
1993	0.201	0.199	0.207	0.200	0.208
1998	0.183	0.188	0.196	0.188	0.196
2003	0.164	0.167	0.174	0.166	0.174
2008	0.168	0.174	0.182	0.173	0.181
Total	**0.179**	**0.182**	**0.190**	**0.182**	**0.190**

Year	Actual wasting (moderate)	Predicted wasting (moderate)	Predicted wasting (moderate) with simulation (+2 degrees temp)	Predicted wasting (moderate) with simulation (+50% drought index)	Predicted wasting (moderate) with simulation (+2 degrees and +50% drought index)
1993	0.072	0.069	0.073	0.068	0.072
1998	0.072	0.074	0.078	0.074	0.078
2003	0.072	0.066	0.070	0.067	0.071
2008	0.084	0.080	0.084	0.081	0.085
Total	**0.075**	**0.072**	**0.076**	**0.073**	**0.076**

SIMULATION WITH ARID AND SEMI ARID AREAS IN KENYA

Year	Actual stunting (moderate)	Predicted stunting (moderate)	Predicted stunting (moderate) with simulation (+2 degrees temp)	Predicted stunting (moderate) with simulation (+50% drought index)	Predicted stunting (moderate) with simulation (+2 degrees and +50% drought index)
1993	0.481	0.485	0.498	0.490	0.503
1998	0.433	0.431	0.444	0.430	0.443
2003	0.354	0.352	0.364	0.349	0.361
2008	0.357	0.370	0.382	0.363	0.375
Total	**0.392**	**0.398**	**0.410**	**0.395**	**0.408**

Year	Actual underweight (moderate)	Predicted underweight (moderate)	Predicted underweight (moderate) with simulation (+2 degrees temp)	Predicted underweight (moderate) with simulation (+50% drought index)	Predicted underweight (moderate) with simulation (+2 degrees and +50% drought index)
1993	0.310	0.314	0.330	0.321	0.337
1998	0.239	0.246	0.260	0.244	0.258
2003	0.249	0.255	0.270	0.251	0.265
2008	0.229	0.246	0.260	0.238	0.252
Total	**0.250**	**0.260**	**0.274**	**0.257**	**0.271**

Year	Actual wasting (moderate)	Predicted wasting (moderate)	Predicted wasting (moderate) with simulation (+2 degrees temp)	Predicted wasting (moderate) with simulation (+50% drought index)	Predicted wasting (moderate) with simulation (+2 degrees and +50% drought index)
1993	0.115	0.115	0.121	0.119	0.126
1998	0.075	0.075	0.080	0.074	0.079
2003	0.139	0.124	0.131	0.121	0.128
2008	0.145	0.153	0.161	0.147	0.155
Total	**0.123**	**0.122**	**0.128**	**0.119**	**0.126**

B. ANTHROPOMETRIC MEASUREMENTS FOR WOMEN

Parameter estimates used to create synthetic cohorts of women are reported in appendix Table A6. As expected, female education is positively correlated with BMI and negatively with underweight, and so are female age and radio ownership. On the other hand, women in rural households are significantly more undernourished, especially more recently, and so are unemployed women. Regression results of women underweight are reported in Table 8.

Table 8: Regression results of the probability of underweight

	P(UNDERWEIGHT) ON BIOPHYSICAL		P(UNDERWEIGHT) ON BIOPHYSICAL WITH NON-AGRI LABOR CONTROL		P(UNDERWEIGHT) ON BIOPHYSICAL WITH NON-AGRI LABOR CONTROL	
VARIABLES	**All Kenya**	**Arid semi-arid**	**All Kenya**	**Arid semi-arid**	**All Kenya**	**Arid semi-arid**
Arid_area	0.0252 (0.0438)		0.0337 (0.0441)		0.0212 (0.0443)	
Mean annual temperature	0.0117** (0.00586)	0.0280*** (0.0105)	0.00246 (0.00915)	0.00789 (0.0128)	0.0158* (0.00953)	-0.00578 (0.0126)
Drought	0.00588 (0.0106)	0.0250 (0.0215)	-0.00193 (0.0139)	0.0299 (0.0240)	0.00297 (0.0202)	0.0406 (0.0294)
NDVI	-0.314* (0.172)	-0.451 (0.388)	-0.362** (0.175)	-0.530 (0.393)	-0.298* (0.170)	-0.825** (0.393)
Tempxnagri			0.0207* (0.0112)	0.0460*** (0.0147)		
Droughtxnagri			0.0204 (0.0152)	-0.00810 (0.0270)		
Nonagri_job			-0.556** (0.256)	-1.186*** (0.359)		
Tempxedu					-0.000888 (0.00131)	0.00750*** (0.00224)
Droughtxedu					0.000435 (0.00241)	-0.00573 (0.00420)
Woman's years of education					0.0128 (0.0300)	-0.185*** (0.0543)
Year 1998	0.165** (0.0652)	0.125 (0.124)	0.159** (0.0648)	0.144 (0.124)	0.170** (0.0664)	0.169 (0.126)
Year 2003	0.219*** (0.0722)	0.0925 (0.138)	0.199*** (0.0713)	0.104 (0.137)	0.223*** (0.0727)	0.124 (0.134)
Year 2008	0.275*** (0.0739)	0.181 (0.134)	0.256*** (0.0733)	0.185 (0.134)	0.281*** (0.0737)	0.200 (0.134)
Constant	-1.990*** (0.175)	-2.131*** (0.406)	-1.639*** (0.245)	-1.549*** (0.458)	-2.026*** (0.258)	-1.098** (0.444)
Observations	19,825	4,573	19,825	4,573	19,825	4,573

*Panel fixed effects not reported
Robust standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1

Underweight probability increases with temperature, especially in ASAL areas, which confirms the higher vulnerability of individuals in these area (already observed among children). NDVI is negatively correlated with women underweight across Kenya, with the effect not significant if only rural areas are considered. Finally, drought index does seem to play a role on women underweight.

As observed in the case of child malnutrition, availability of a non-agricultural job and a woman's education generally improve woman nutritional status, but they also cause a larger drop in case of temperature peaks. Similar trends appear when looking at the entire BMI distribution (Table 9a and 9b). Temperature has the strongest negative impact at the top of the BMI distribution, while NDVI negatively related to BMI in ASAL areas. Having a non-agricultural job is positively associated with BMI especially at lower quartiles. Women's education is positively associated with BMI in the ASAL counties but negatively in the whole Kenya. As previously observed, in arid and semi-arid areas both a job other than agriculture and education levels are detrimental to resilience in temperature peaks but education becomes helpful when a drought hits.

Table 9a: Regression results of BMI on biophysical variables

	BMI ON BIOPHYSICAL VARIABLES							
VARIABLES	**All Kenya**				**Arid Semi-Arid**			
	Average	**p25**	**p50**	**p75**	**Average**	**p25**	**p50**	**p75**
Arid_area	-0.0722	-0.400***	-0.326***	0.0101				
	(0.156)	(0.0886)	(0.0925)	(0.115)				
Mean annual temperature	-0.0583***	-0.0401***	-0.0550***	-0.0940***	-0.115***	-0.0291	-0.0587***	-0.162***
	(0.0199)	(0.0141)	(0.0133)	(0.0178)	(0.0360)	(0.0225)	(0.0217)	(0.0286)
Drought	-0.0228	-0.000236	-0.00891	-0.0168	0.0130	-0.00978	-0.0145	0.0420
	(0.0270)	(0.0217)	(0.0193)	(0.0273)	(0.0621)	(0.0371)	(0.0379)	(0.0452)
NDVI	-0.361	0.209	0.112	-0.0934	1.680	2.892***	2.559***	-0.126
	(0.513)	(0.357)	(0.347)	(0.435)	(1.231)	(0.693)	(0.744)	(0.857)
Year 1998	-0.442***	-0.296**	-0.372***	-0.460***	-0.570*	-0.352	-0.748***	-0.312
	(0.127)	(0.132)	(0.126)	(0.135)	(0.321)	(0.262)	(0.241)	(0.427)
Year 2003	0.0553	-0.210	0.00260	0.304**	0.206	-0.0563	-0.00176	0.591
	(0.157)	(0.136)	(0.128)	(0.152)	(0.383)	(0.269)	(0.238)	(0.439)
Year 2008	0.156	-0.134	0.0910	0.346**	0.246	-0.162	-0.122	0.568
	(0.169)	(0.156)	(0.144)	(0.174)	(0.364)	(0.274)	(0.246)	(0.457)
Constant	22.20***	19.93***	21.72***	24.21***	21.64***	17.58***	19.87***	24.82***
	(0.494)	(0.421)	(0.397)	(0.513)	(1.274)	(0.808)	(0.795)	(1.060)
Observations	21,551	21,551	21,551	21,551	5,038	5,038	5,038	5,038
R-squared	0.155				0.192			

*Panel fixed effects not reported
Robust standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1

Table 9b: Regression results of BMI on biophysical variables with interactions

VARIABLES	BMI ON BIOPHYSICAL VARIABLES WITH NON-AGRI LABOR INTERACTIONS								BMI ON BIOPHYSICAL VARIABLES WITH WOMAN EDUCATION INTERACTIONS							
	All Kenya				Arid Semi-Arid				All Kenya				Arid Semi-Arid			
	Average	p25	p50	p75	Average	p25	p50	p75	Average	p25	p50	p75	Average	p25	p50	p75
Arid_area	-0.0810	-0.328***	-0.261***	0.0313					0.0198	-0.240***	-0.175*	0.150				
	(0.157)	(0.0774)	(0.0874)	(0.121)					(0.154)	(0.0806)	(0.0941)	(0.125)				
Mean annual temperature	-0.0557***	-0.0221	-0.0329**	-0.0677***	-0.0893*	0.0206	-0.0337	-0.110**	-0.169***	-0.0737***	-0.127***	-0.265***	-0.0667	0.0452*	-0.0115	-0.0963**
	(0.0204)	(0.0157)	(0.0168)	(0.0232)	(0.0453)	(0.0264)	(0.0297)	(0.0428)	(0.0323)	(0.0180)	(0.0225)	(0.0297)	(0.0435)	(0.0272)	(0.0313)	(0.0434)
Drought	0.0231	0.000510	0.0411*	0.0236	-0.0530	-0.0589	-0.0442	-0.00314	0.0627	0.0228	0.0227	0.0890**	-0.0102	-0.0564	-0.141**	0.0409
	(0.0318)	(0.0245)	(0.0225)	(0.0339)	(0.0708)	(0.0531)	(0.0540)	(0.0663)	(0.0450)	(0.0273)	(0.0346)	(0.0438)	(0.0734)	(0.0501)	(0.0572)	(0.0685)
NDVI	-0.284	0.632*	0.344	0.215	1.928	3.450***	2.512***	0.444	-0.580	0.0688	-0.115	-0.572	2.113*	3.624***	3.141***	0.428
	(0.517)	(0.336)	(0.350)	(0.467)	(1.205)	(0.704)	(0.733)	(0.975)	(0.488)	(0.322)	(0.345)	(0.465)	(1.252)	(0.741)	(0.796)	(0.926)
TempXnagri	-0.0174	-0.0531***	-0.0550**	-0.0453	-0.0713	-0.113***	-0.0501	-0.104*								
	(0.0257)	(0.0200)	(0.0216)	(0.0305)	(0.0769)	(0.0379)	(0.0400)	(0.0590)								
DroughtXnagri	-0.0909***	-0.0189	-0.111***	-0.0850**	0.120	0.0736	0.0452	0.0782								
	(0.0330)	(0.0310)	(0.0292)	(0.0427)	(0.0995)	(0.0749)	(0.0697)	(0.0974)								
Non-agri job	0.728	1.538***	1.385***	1.294*	2.247	3.049***	1.549	2.885*								
	(0.563)	(0.452)	(0.483)	(0.677)	(1.890)	(0.926)	(0.983)	(1.472)								
TempXedu									0.0166***	0.00701***	0.0126***	0.0241***	-0.00764*	-0.0103**	-0.00606	-0.0124*
									(0.00348)	(0.00257)	(0.00273)	(0.00364)	(0.00460)	(0.00453)	(0.00469)	(0.00650)
DroughtXedu									-0.0120**	-0.00399	-0.00501	-0.0128***	0.00705	0.0188**	0.0245***	-0.00191
									(0.00503)	(0.00406)	(0.00423)	(0.00494)	(0.00887)	(0.00822)	(0.00814)	(0.00999)
Woman's years of education									-0.349***	-0.0754	-0.224***	-0.530***	0.222*	0.345***	0.236**	0.299*
									(0.0787)	(0.0578)	(0.0617)	(0.0819)	(0.116)	(0.110)	(0.113)	(0.161)
Year 1998	-0.415***	-0.254**	-0.394***	-0.419***	-0.477	-0.287	-0.552**	-0.0826	-0.410***	-0.336***	-0.379***	-0.326**	-0.610*	-0.631***	-0.583**	-0.379
	(0.129)	(0.128)	(0.123)	(0.143)	(0.321)	(0.298)	(0.257)	(0.410)	(0.126)	(0.118)	(0.113)	(0.138)	(0.316)	(0.222)	(0.233)	(0.344)
Year 2003	0.114	-0.0716	0.0397	0.332**	0.353	-0.0484	0.118	0.861**	0.106	-0.249**	0.00527	0.508***	0.193	-0.284	0.121	0.549
	(0.162)	(0.129)	(0.122)	(0.165)	(0.395)	(0.317)	(0.248)	(0.402)	(0.156)	(0.122)	(0.117)	(0.149)	(0.371)	(0.219)	(0.227)	(0.360)
Year 2008	0.206	0.00795	0.0817	0.388**	0.413	-0.0864	0.0308	0.764*	0.201	-0.212	0.0499	0.543***	0.234	-0.380*	0.00674	0.518
	(0.173)	(0.144)	(0.141)	(0.190)	(0.365)	(0.316)	(0.259)	(0.416)	(0.166)	(0.137)	(0.134)	(0.172)	(0.357)	(0.226)	(0.237)	(0.378)
Constant	21.99***	19.04***	21.06***	23.33***	20.60***	15.95***	18.99***	22.90***	24.70***	20.40***	23.19***	28.15***	20.22***	15.45***	18.07***	22.95***
	(0.549)	(0.459)	(0.474)	(0.634)	(1.311)	(0.893)	(0.955)	(1.372)	(0.827)	(0.485)	(0.605)	(0.802)	(1.471)	(0.883)	(1.003)	(1.374)
Observations	21,551	21,551	21,551	21,551	5,038	5,038	5,038	5,038	21,551	21,551	21,551	21,551	5,038	5,038	5,038	5,038
R-squared	0.157				0.195				0.158				0.193			

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

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Conclusions

This study showed how arid and semi-arid areas of Kenya are particularly affected by undernutrition in women and children. Despite undernutrition improving in the rest of the country, in the ASAL areas the trends appear to be negative, particularly with respect to wasting in children and women being underweight. Temperature shocks emerge as the most detrimental factor for nutrition, again especially in ASAL areas. Droughts, on the other hand, seem to play a significant role only in affecting stunting, while NDVI plays a mixed role, with some cases where more vegetation is associated with higher levels of undernutrition. Overall, the availability of a non-agricultural job within the household is positively associated with nutritional outcomes, as is women's education, especially in ASAL counties. However, they are also associated with bigger losses in the event of temperature shocks, which raises a query on the role of non–agricultural activities in increasing resilience. Results show that expected climate change bears the potential to greatly harm the Kenyan population living in ASAL areas, and that what is currently believed to be viable solutions to increase resilience may not deliver the results promised. More investigation and research is needed to identify programming strategies to implement, which will enable populations to better cope with climate change and the associated challenges ahead.

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Appendix Tables

Table A1: Regressions results to define synthetic cohorts of children (ASAL areas only)

	ARID AND SEMI-ARID AREAS OF KENYA											
VARIABLES	**Stunting (Moderate)**				**Underweight (Moderate)**				**Wasting (Moderate)**			
	Year 1993	**Year 1998**	**Year 2003**	**Year 2008**	**Year 1993**	**Year 1998**	**Year 2003**	**Year 2008**	**Year 1993**	**Year 1998**	**Year 2003**	**Year 2008**
Age of child in months	0.0156***	0.0119***	0.00960***	0.00837***	0.00540*	0.00803***	0.00800***	0.0124***	-0.0163***	-0.00788*	-0.00451	-0.00160
	(0.00338)	(0.00291)	(0.00269)	(0.00273)	(0.00305)	(0.00302)	(0.00278)	(0.00187)	(0.00571)	(0.00464)	(0.00409)	(0.00278)
Child is female	-0.146	-0.223***	-0.216**	-0.109	-0.159	-0.129	-0.390***	-0.115	-0.101	0.0120	-0.420***	-0.169
	(0.104)	(0.0844)	(0.0895)	(0.0743)	(0.131)	(0.0984)	(0.127)	(0.105)	(0.169)	(0.134)	(0.142)	(0.133)
Age of mother (years)	-0.0109	-0.0157*	-0.0134**	0.0160**	-0.00483	-0.00996	-0.00798	0.00170	-1.92e-05	0.00653	-0.00510	-0.00331
	(0.00867)	(0.00843)	(0.00641)	(0.00627)	(0.00808)	(0.00820)	(0.00709)	(0.00656)	(0.0103)	(0.00908)	(0.00915)	(0.00715)
Mother's education in single years	-0.0206	-0.0656***	-0.0479***	-0.0362***	-0.0456**	-0.0663***	-0.0482***	-0.0288*	-0.0265	-0.0334*	-0.0356	-0.0110
	(0.0251)	(0.0132)	(0.0133)	(0.0130)	(0.0200)	(0.0166)	(0.0166)	(0.0154)	(0.0237)	(0.0182)	(0.0241)	(0.0144)
Female head	0.0444	-0.0203	-0.0476	0.0362	0.106	-0.103	0.156	-0.0610	-0.177	-0.0567	-0.0227	-0.168*
	(0.159)	(0.104)	(0.131)	(0.108)	(0.116)	(0.0907)	(0.135)	(0.0972)	(0.159)	(0.176)	(0.189)	(0.0996)
Rural area	0.529	0.327	-0.0269	0.389***	0.0149	0.195	0.134	0.474***	-0.0719	0.165	0.0399	0.0719
	(0.351)	(0.203)	(0.0991)	(0.118)	(0.321)	(0.163)	(0.169)	(0.163)	(0.398)	(0.209)	(0.192)	(0.124)
Household owns a radio	-0.240	-0.133	-0.183*	-0.00864	-0.127	-0.194	-0.198	-0.289***	0.213	0.0505	-0.308**	-0.298***
	(0.175)	(0.0949)	(0.103)	(0.109)	(0.122)	(0.128)	(0.127)	(0.106)	(0.174)	(0.138)	(0.133)	(0.112)
Constant	-0.709	-0.155	-0.301	-1.248***	-0.342	-0.441	-0.306	-1.331***	-0.597	-1.139***	-0.114	-0.518**
	(0.477)	(0.315)	(0.253)	(0.230)	(0.396)	(0.290)	(0.271)	(0.255)	(0.551)	(0.347)	(0.324)	(0.225)
Observations	725	1,047	1,239	1,673	790	1,079	1,299	1,733	726	1,034	1,236	1,652

Region fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A2: Regressions results on severe child undernutrition

	P(SEVERE STUNTING) ON BIOPHYSICAL VARIABLES		P(SEVERE UNDERWEIGHT) ON BIOPHYSICAL VARIABLES		P(SEVERE WASTING) ON BIOPHYSICAL VARIABLES	
VARIABLES	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**	**All Kenya**	**Arid, semi-arid areas**
Arid_area	-0.0402 (0.0406)		0.0490 (0.0607)		0.103* (0.0624)	
Mean annual temperature	0.00646 (0.00583)	0.0242** (0.0106)	0.0245*** (0.00805)	0.0145 (0.0140)	0.0179** (0.00908)	0.0246 (0.0159)
Drought	0.0150* (0.00835)	0.0287 (0.0198)	0.000745 (0.0141)	0.0330 (0.0335)	-0.0178 (0.0136)	-0.0165 (0.0202)
NDVI	0.299** (0.146)	0.592* (0.319)	0.288 (0.206)	-0.165 (0.421)	-0.0110 (0.258)	-0.517 (0.467)
Year 1998	0.0984** (0.0394)	0.0274 (0.0768)	-0.0726 (0.0599)	-0.0568 (0.131)	0.0764 (0.0770)	-0.223 (0.176)
Year 2003	-0.0344 (0.0494)	-0.168* (0.101)	-0.145* (0.0809)	-0.108 (0.170)	-0.0757 (0.0807)	-0.327** (0.157)
Year 2008	-0.0225 (0.0541)	-0.221** (0.101)	-0.258*** (0.0762)	-0.207 (0.151)	-0.111 (0.0876)	-0.186 (0.160)
Constant	-1.748*** (0.168)	-2.015*** (0.344)	-2.567*** (0.230)	-1.845*** (0.450)	-2.713*** (0.280)	-2.337*** (0.554)
Observations	19,365	4,684	19,966	4,901	19,236	4,648

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A3: Regressions results on child stunting z-score and resilience interactions

	HEIGHT FOR AGE SCORE WITH NON-AGRICULTURAL JOB INTERACTIONS								HEIGHT FOR AGE SCORE WITH WOMAN EDUCATION INTERACTIONS							
VARIABLES	**All Kenya**				**Arid and semi-arid areas**				**All Kenya**				**Arid and semi-arid areas**			
	Tot	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**
Arid_area	0.121**	0.122**	0.117***	0.225***					0.0807	0.134***	0.124***	0.180***				
	(0.0557)	(0.0503)	(0.0422)	(0.0582)					(0.0586)	(0.0454)	(0.0445)	(0.0578)				
Mean annual temperature	-0.00303	0.00194	-0.00796	0.00669	-0.0125	-0.00591	-0.0247	0.0134	-0.00368	-0.00289	-0.0107	-0.00543	0.00105	-0.00843	-0.0235	0.0201
	(0.0135)	(0.0102)	(0.00921)	(0.0116)	(0.0183)	(0.0189)	(0.0166)	(0.0187)	(0.0144)	(0.0103)	(0.0100)	(0.0136)	(0.0193)	(0.0194)	(0.0146)	(0.0189)
Drought	-0.0240	-0.0308**	-0.0161	-0.0125	-0.0613*	-0.0664*	-0.0884***	-0.0924***	-0.0640***	-0.0345**	-0.0302**	-0.0424**	-0.113**	-0.0644**	-0.0851***	-0.0930***
	(0.0159)	(0.0154)	(0.0142)	(0.0167)	(0.0353)	(0.0354)	(0.0295)	(0.0331)	(0.0242)	(0.0164)	(0.0145)	(0.0214)	(0.0487)	(0.0316)	(0.0260)	(0.0318)
NDVI	-0.385*	-0.0273	-0.450***	-0.320	-1.361***	-0.767*	-1.222***	-1.156**	-0.386*	-0.0365	-0.384**	-0.413**	-1.086**	-1.306***	-1.206***	-1.002*
	(0.229)	(0.190)	(0.160)	(0.201)	(0.507)	(0.466)	(0.398)	(0.493)	(0.222)	(0.186)	(0.161)	(0.195)	(0.533)	(0.442)	(0.409)	(0.523)
TempXnagri	0.00432	-0.00333	0.00502	-0.00604	0.0212	-0.0188	0.00592	-0.0199								
	(0.0143)	(0.0120)	(0.0103)	(0.0133)	(0.0204)	(0.0234)	(0.0207)	(0.0219)								
DroughtXnagri	0.00850	0.0177	0.000245	-0.0227	-0.0197	0.0381	0.0401	0.0346								
	(0.0195)	(0.0169)	(0.0149)	(0.0183)	(0.0530)	(0.0417)	(0.0364)	(0.0390)								
Non-agri job	-0.109	0.144	-0.129	0.000854	-0.586	0.554	-0.0983	0.300								
	(0.310)	(0.252)	(0.221)	(0.282)	(0.483)	(0.567)	(0.498)	(0.514)								
TempXedu									0.000450	0.00125	0.00106	0.000763	1.29e-05	-0.000854	0.000806	-0.00469*
									(0.00177)	(0.00137)	(0.00128)	(0.00166)	(0.00375)	(0.00248)	(0.00254)	(0.00274)
DroughtXedu									0.00644**	0.00312	0.00212	0.00139	0.00699	0.00508	0.00530	0.00627
									(0.00307)	(0.00205)	(0.00175)	(0.00241)	(0.00789)	(0.00361)	(0.00445)	(0.00472)
Woman's years of education									-0.0215	0.00180	-0.0149	-0.0457	-0.00789	0.0667	-0.0138	0.0928
									(0.0401)	(0.0301)	(0.0281)	(0.0365)	(0.0922)	(0.0602)	(0.0620)	(0.0649)
Year 1998	0.0969	-0.121**	-0.0263	0.0547	0.0842	0.00505	-0.107	0.105	0.0969	-0.109**	-0.0262	0.0757	0.130	0.102	-0.0926	0.164
	(0.0638)	(0.0539)	(0.0471)	(0.0598)	(0.131)	(0.131)	(0.108)	(0.122)	(0.0632)	(0.0519)	(0.0459)	(0.0607)	(0.146)	(0.113)	(0.109)	(0.135)
Year 2003	0.168**	0.0340	0.0552	0.0920	0.375***	0.306**	0.257**	0.397***	0.168**	0.0414	0.0542	0.104*	0.413***	0.364***	0.289***	0.427***
	(0.0761)	(0.0606)	(0.0487)	(0.0640)	(0.131)	(0.126)	(0.106)	(0.118)	(0.0742)	(0.0583)	(0.0473)	(0.0629)	(0.129)	(0.109)	(0.106)	(0.132)
Year 2008	0.133*	0.0119	0.0363	0.0361	0.208	0.236*	0.109	0.183	0.133*	0.00822	0.0380	0.0509	0.242*	0.294***	0.0903	0.205
	(0.0707)	(0.0669)	(0.0538)	(0.0730)	(0.134)	(0.130)	(0.115)	(0.123)	(0.0702)	(0.0642)	(0.0533)	(0.0741)	(0.135)	(0.110)	(0.112)	(0.139)
Constant	-0.549	-1.919***	-0.434*	0.298	-0.0414	-1.595***	0.0890	0.333	-0.415	-2.033***	-0.500*	0.763**	-0.541	-1.573***	0.0442	0.0476
	(0.344)	(0.252)	(0.231)	(0.285)	(0.601)	(0.584)	(0.491)	(0.571)	(0.375)	(0.276)	(0.265)	(0.340)	(0.612)	(0.595)	(0.458)	(0.599)
Observations	19,581	19,581	19,581	19,581	4,791	4,791	4,791	4,791	19,816	19,816	19,816	19,816	4,822	4,822	4,822	4,822
R-squared	0.046				0.066				0.047				0.067			

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A4: Regressions results on child underweight z-score and resilience interactions

	WEIGHT FOR AGE SCORE WITH NON-AGRICULTURAL JOB INTERACTIONS								WEIGHT FOR AGE SCORE WITH WOMAN EDUCATION INTERACTIONS							
VARIABLES	All Kenya				Arid and semi-arid areas				All Kenya				Arid and semi-arid areas			
	Tot	p25	p50	p75	Tot	p25	p50	p75	Tot	p25	p50	p75	Tot	p25	p50	p75
Arid_area	0.0694	-0.000948	0.0168	0.0557					0.0894	-0.00233	0.0179	0.0459				
	(0.0669)	(0.0361)	(0.0371)	(0.0374)					(0.0720)	(0.0382)	(0.0353)	(0.0337)				
Mean annual temperature	-0.0445***	-0.0289***	-0.0191**	-0.0173**	-0.0745*	-0.0369***	-0.0299**	-0.0207*	-0.0357	0.000506	-0.000805	-0.00945	-0.0585	-0.0143	-0.0198*	-0.0215*
	(0.0169)	(0.00782)	(0.00799)	(0.00734)	(0.0389)	(0.0142)	(0.0120)	(0.0117)	(0.0231)	(0.00812)	(0.00845)	(0.00812)	(0.0398)	(0.0118)	(0.0119)	(0.0126)
Drought	-0.0173	-0.00765	-0.0118	-0.00107	-0.141**	-0.0801***	-0.0742***	-0.0529**	-0.0271	0.00822	0.0136	0.00982	-0.121**	-0.0277	-0.0468**	-0.0572**
	(0.0208)	(0.0134)	(0.0115)	(0.0103)	(0.0680)	(0.0298)	(0.0230)	(0.0247)	(0.0271)	(0.0136)	(0.0126)	(0.0130)	(0.0610)	(0.0248)	(0.0182)	(0.0255)
NDVI	-0.281*	-0.0604	-0.00161	-0.123	-0.253	-0.220	-0.358	-0.580**	-0.281*	-0.118	0.00710	-0.177	0.204	-0.194	-0.173	-0.196
	(0.169)	(0.135)	(0.142)	(0.141)	(0.417)	(0.344)	(0.303)	(0.267)	(0.169)	(0.140)	(0.136)	(0.133)	(0.507)	(0.331)	(0.327)	(0.327)
TempXnagri	0.0219	0.0166*	0.0104	0.00302	0.0246	0.00569	-0.0288*	-0.0501***								
	(0.0134)	(0.00844)	(0.00906)	(0.00871)	(0.0355)	(0.0190)	(0.0158)	(0.0145)								
DroughtXnagri	0.0107	0.0105	0.00727	-0.00457	0.117	0.0873**	0.0408	0.0263								
	(0.0217)	(0.0141)	(0.0122)	(0.0116)	(0.0747)	(0.0349)	(0.0274)	(0.0289)								
Nonagri_job	-0.401	-0.202	-0.152	-0.0277	-0.453	0.0938	0.868**	1.316***								
	(0.297)	(0.188)	(0.193)	(0.183)	(0.873)	(0.463)	(0.373)	(0.346)								
TempXedu									0.000954	-0.00232**	-0.00160	-0.000984	-0.000952	-0.00396**	-0.00392**	-0.00494**
									(0.00241)	(0.00104)	(0.00106)	(0.000995)	(0.00475)	(0.00188)	(0.00190)	(0.00194)
DroughtXedu									0.00248	-0.00104	-0.00278*	-0.00251*	0.0124	0.00175	0.00218	0.00493
									(0.00318)	(0.00154)	(0.00147)	(0.00142)	(0.00787)	(0.00353)	(0.00298)	(0.00362)
Woman's years of education									-0.0196	0.0646***	0.0311	0.0164	0.0162	0.111**	0.0919**	0.115**
									(0.0544)	(0.0230)	(0.0234)	(0.0221)	(0.122)	(0.0448)	(0.0452)	(0.0473)
Year 1998	-0.0471	-0.0190	-0.0161	-0.0455	-0.0873	0.217**	-0.00751	-0.00590	-0.0665	-0.0223	-0.00786	-0.0408	-0.182	0.133	0.0284	-0.0597
	(0.0603)	(0.0433)	(0.0376)	(0.0412)	(0.149)	(0.106)	(0.0856)	(0.0899)	(0.0597)	(0.0426)	(0.0371)	(0.0393)	(0.154)	(0.0908)	(0.0882)	(0.0942)
Year 2003	0.0126	0.0813*	0.0179	0.0138	0.213	0.348***	0.125	0.121	-0.00291	0.0618	0.0158	0.0194	0.145	0.304***	0.173**	0.136
	(0.0729)	(0.0459)	(0.0404)	(0.0418)	(0.184)	(0.107)	(0.0821)	(0.0926)	(0.0723)	(0.0431)	(0.0395)	(0.0394)	(0.189)	(0.0993)	(0.0788)	(0.0976)
Year 2008	-0.0697	0.0607	-0.0336	-0.0328	-0.0540	0.273**	-0.00541	-0.0110	-0.0838	0.0555	-0.0351	-0.0315	-0.119	0.202**	0.0266	-0.0420
	(0.0694)	(0.0494)	(0.0467)	(0.0477)	(0.147)	(0.107)	(0.0894)	(0.0906)	(0.0680)	(0.0481)	(0.0441)	(0.0453)	(0.154)	(0.0940)	(0.0905)	(0.0976)
Constant	0.803**	-0.609***	0.0538	0.918***	1.163	-0.807*	0.174	0.908***	0.677	-1.238***	-0.271	0.840***	0.775	-1.272***	-0.0662	0.825**
	(0.374)	(0.206)	(0.198)	(0.181)	(0.987)	(0.446)	(0.356)	(0.342)	(0.523)	(0.218)	(0.222)	(0.211)	(1.022)	(0.388)	(0.393)	(0.390)
Observations	19,775	19,775	19,775	19,775	4,884	4,884	4,884	4,884	20,015	20,015	20,015	20,015	4,916	4,916	4,916	4,916
R-squared	0.035				0.025				0.034				0.024			

*Panel fixed effects not reported
Robust standard errors in parentheses *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table A5: Regressions results on child wasting z-score and resilience interactions

	WEIGHT FOR AGE SCORE WITH NON-AGRICULTURAL JOB INTERACTIONS								WEIGHT FOR AGE SCORE WITH WOMAN EDUCATION INTERACTIONS							
VARIABLES	**All Kenya**				**Arid and semi-arid areas**				**All Kenya**				**Arid and semi-arid areas**			
	Tot	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**	**Tot**	**p25**	**p50**	**p75**
Arid_area	-0.202***	-0.173***	-0.240***	-0.259***					-0.170***	-0.169***	-0.219***	-0.222***				
	(0.0627)	(0.0462)	(0.0351)	(0.0437)					(0.0629)	(0.0489)	(0.0380)	(0.0494)				
Mean annual temperature	-0.0489***	-0.0251**	-0.0237***	-0.0235**	-0.0537*	-0.00426	-0.00964	-0.00208	-0.0267	-0.00528	0.00508	0.00882	-0.0449	-0.0172	0.00266	0.0102
	(0.0154)	(0.0102)	(0.00786)	(0.00931)	(0.0314)	(0.0167)	(0.0123)	(0.0151)	(0.0169)	(0.0110)	(0.00852)	(0.0112)	(0.0304)	(0.0142)	(0.0116)	(0.0171)
Drought	-0.000281	-0.00541	-0.00171	-0.0145	-0.0669	-0.0517	-0.0645***	-0.0713**	0.0275	0.0349**	0.0458***	0.0343**	-0.0636*	-0.0705**	-0.0207	-0.0527*
	(0.0187)	(0.0159)	(0.00957)	(0.0123)	(0.0468)	(0.0359)	(0.0225)	(0.0287)	(0.0212)	(0.0161)	(0.0122)	(0.0153)	(0.0366)	(0.0300)	(0.0234)	(0.0281)
NDVI	-0.346	0.243	0.0274	-0.242	0.623	1.117***	0.903***	0.532	-0.347	0.167	0.108	-0.0966	0.766	1.228***	1.246***	0.780*
	(0.220)	(0.164)	(0.130)	(0.162)	(0.466)	(0.411)	(0.302)	(0.447)	(0.215)	(0.162)	(0.128)	(0.169)	(0.485)	(0.440)	(0.332)	(0.446)
TempXnagri	0.0113	0.0127	0.00632	-0.00347	0.00293	-0.0354*	-0.0191	-0.0416*								
	(0.0152)	(0.0116)	(0.00876)	(0.0106)	(0.0330)	(0.0197)	(0.0154)	(0.0215)								
DroughtXnagri	0.0189	0.0242	0.0157	0.0287**	0.0692	0.0641	0.0902***	0.0776**								
	(0.0191)	(0.0163)	(0.0112)	(0.0138)	(0.0576)	(0.0401)	(0.0269)	(0.0367)								
Nonagri_job	-0.0512	-0.0468	0.0373	0.239	0.154	1.068**	0.690*	1.175**								
	(0.339)	(0.245)	(0.187)	(0.234)	(0.813)	(0.465)	(0.370)	(0.530)								
TempXedu									-0.000682	-0.000969	-0.00194*	-0.00308**	0.000405	-0.000767	-0.00367*	-0.00576**
									(0.00184)	(0.00135)	(0.00105)	(0.00140)	(0.00387)	(0.00221)	(0.00207)	(0.00276)
DroughtXedu									-0.00164	-0.00274	-0.00512***	-0.00347*	0.00992*	0.0121***	0.00733**	0.00682
									(0.00245)	(0.00177)	(0.00149)	(0.00191)	(0.00517)	(0.00314)	(0.00367)	(0.00447)
Woman's years of education									0.0513	0.0397	0.0726***	0.113***	0.0193	0.0419	0.119**	0.186***
									(0.0425)	(0.0294)	(0.0229)	(0.0307)	(0.0949)	(0.0512)	(0.0496)	(0.0670)
Year 1998	0.00832	-0.0683	-0.0425	0.0383	-0.0583	-0.0639	-0.0977	-0.0299	-0.0327	-0.0937**	-0.0584	0.00719	-0.120	-0.123	-0.133	-0.113
	(0.0778)	(0.0462)	(0.0408)	(0.0481)	(0.191)	(0.131)	(0.0900)	(0.108)	(0.0742)	(0.0470)	(0.0387)	(0.0526)	(0.175)	(0.110)	(0.0928)	(0.111)
Year 2003	0.0306	0.0702	0.0540	0.0432	-0.0639	0.0899	-0.0410	-0.212*	-0.00141	0.0432	0.0279	-0.00296	-0.0953	0.0224	-0.00894	-0.303***
	(0.0766)	(0.0543)	(0.0397)	(0.0493)	(0.192)	(0.125)	(0.0822)	(0.110)	(0.0761)	(0.0523)	(0.0432)	(0.0536)	(0.189)	(0.109)	(0.0935)	(0.108)
Year 2008	-0.0649	-0.0308	-0.0291	-0.0733	-0.228	-0.183	-0.177**	-0.229*	-0.0935	-0.0405	-0.0538	-0.0993	-0.253	-0.213*	-0.118	-0.308***
	(0.0831)	(0.0611)	(0.0457)	(0.0583)	(0.187)	(0.131)	(0.0900)	(0.119)	(0.0812)	(0.0569)	(0.0475)	(0.0629)	(0.181)	(0.114)	(0.0980)	(0.118)
Constant	1.318***	-0.306	0.503***	1.395***	0.725	-1.486***	-0.469	0.415	0.675	-0.659**	-0.310	0.322	0.459	-1.151**	-1.015***	-0.185
	(0.377)	(0.248)	(0.194)	(0.238)	(0.917)	(0.521)	(0.384)	(0.500)	(0.423)	(0.278)	(0.218)	(0.285)	(0.920)	(0.465)	(0.385)	(0.550)
Observations	19,384	19,384	19,384	19,384	4,737	4,737	4,737	4,737	19,617	19,617	19,617	19,617	4,766	4,766	4,766	4,766
R-squared	0.014				0.023				0.015				0.022			

*Panel fixed effects not reported
Robust standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1

Table A6: Regressions results to define synthetic cohorts of women

	P(UNDERWEIGHT)								BMI (OLS REG)							
VARIABLES	**All Kenya**				**Arid and semi-arid areas**				**All Kenya**				**Arid and semi-arid areas**			
	1993	**1998**	**2003**	**2008**	**1993**	**1998**	**2003**	**2008**	**1993**	**1998**	**2003**	**2008**	**1993**	**1998**	**2003**	**2008**
Rural	0.262	0.159	0.391***	0.177**		0.371	0.169	0.194*	-1.488***	-1.155***	-1.681***	-1.369***	-1.649	-1.570**	-1.623***	-2.207***
	(0.261)	(0.117)	(0.0849)	(0.0741)		(0.281)	(0.165)	(0.118)	(0.403)	(0.240)	(0.243)	(0.309)	(1.033)	(0.713)	(0.557)	(0.474)
Woman's education in single years	-0.0731***	-0.0523***	-0.0669***	-0.0565***	-0.0876***	-0.0681***	-0.0782***	-0.0659***	0.0820***	0.140***	0.146***	0.140***	0.123*	0.172***	0.227***	0.207***
	(0.0147)	(0.0118)	(0.00808)	(0.00835)	(0.0281)	(0.0209)	(0.0152)	(0.0140)	(0.0285)	(0.0243)	(0.0173)	(0.0225)	(0.0640)	(0.0390)	(0.0288)	(0.0374)
Age of woman (years)	0.00415	-0.00341	-0.0150***	-0.0112**	-0.00771	-0.0183	-0.0238***	-0.0209***	0.0714***	0.0684***	0.154***	0.141***	0.0419	0.0707*	0.135***	0.160***
	(0.0112)	(0.00849)	(0.00421)	(0.00525)	(0.0233)	(0.0188)	(0.00862)	(0.00680)	(0.0212)	(0.0163)	(0.0104)	(0.0139)	(0.0512)	(0.0426)	(0.0199)	(0.0236)
Woman is currently married	-0.0965	0.105	-0.133**	-0.188***	-0.146	0.430**	-0.136	-0.236**	0.0356	0.403**	0.757***	0.960***	-0.751	0.0678	1.061***	1.018***
	(0.119)	(0.0930)	(0.0544)	(0.0546)	(0.364)	(0.198)	(0.114)	(0.0958)	(0.192)	(0.163)	(0.111)	(0.150)	(0.779)	(0.420)	(0.236)	(0.379)
Total number of children ever born	-0.0218	-0.0273	-0.0146	0.00731	-0.0324	0.0184	0.0151	0.0593**	-0.0299	0.0146	-0.171***	-0.183***	-0.0371	-0.0187	-0.193***	-0.256***
	(0.0302)	(0.0239)	(0.0138)	(0.0165)	(0.0710)	(0.0573)	(0.0238)	(0.0242)	(0.0592)	(0.0534)	(0.0368)	(0.0454)	(0.179)	(0.153)	(0.0597)	(0.0934)
Woman is not working		0.0312	0.220***	0.234***		-0.0910	0.161	0.208**		-0.266	-0.644***	-0.381*		-0.916**	-0.562*	-0.545
		(0.0907)	(0.0596)	(0.0698)		(0.200)	(0.123)	(0.101)		(0.171)	(0.129)	(0.198)		(0.428)	(0.314)	(0.353)
Woman is working in agriculture	0.120	0.0692	0.139**	0.164	0.273	0.0532	0.293*	0.0207	-0.319**	-0.507***	-0.849***	-0.638***	0.738	-0.926*	-0.764*	-0.375
	(0.105)	(0.100)	(0.0687)	(0.107)	(0.251)	(0.207)	(0.154)	(0.137)	(0.162)	(0.175)	(0.152)	(0.210)	(0.545)	(0.512)	(0.427)	(0.374)
Household owns a radio	0.104	-0.0840	-0.168***	-0.222***	0.633***	-0.0921	-0.159*	-0.243**	0.556***	0.602***	0.797***	0.876***	0.731*	0.642*	0.861***	0.898**
	(0.0961)	(0.0757)	(0.0612)	(0.0860)	(0.195)	(0.156)	(0.0887)	(0.102)	(0.162)	(0.133)	(0.134)	(0.186)	(0.395)	(0.332)	(0.208)	(0.384)
Constant	-1.577***	-1.186***	-0.436**	-0.363*	-0.444	-0.638	-0.0964	-0.213	20.24***	19.65***	18.42***	17.68***	21.11***	20.03***	17.71***	18.12***
	(0.392)	(0.283)	(0.179)	(0.191)	(0.625)	(0.516)	(0.275)	(0.200)	(0.691)	(0.537)	(0.372)	(0.498)	(1.639)	(1.149)	(0.878)	(0.802)
Observations	1,878	3,275	7,164	7,672	212	726	1,513	2,122	2,091	3,667	7,684	8,287	250	810	1,656	2,322
R-squared									0.081	0.094	0.218	0.164	0.067	0.112	0.258	0.223

*Panel fixed effects not reported
Robust standard errors in parentheses *** p < 0.01, ** p < 0.05, * p < 0.1

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