Tulane University

Department of International Health and Development

Impact of Drought and HIV on Child Nutrition in Eastern and Southern Africa

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Working Papers in
International Health and Development

No. 07-03

November 2007

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The Working Papers in International Health and Development Series

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Suggested Citation Format

Mason, John B. and the Tulane/UNICEF Team. 2007. Impact of Drought on HIV and Nutrition in Eastern and Southern Africa. Working Papers in International Health and Development, No.07-03. New Orleans: Department of International Health and Development, Tulane University.

Acknowledgements

This work was supported through by UNICEF through a Cooperative Agreement between Tulane University School of Public Health and Tropical Medicine and UNICEF, Eastern and Southern Africa Regional Office (1 August 2006; Tulane Project 545338).

Impact of drought and HIV on child nutrition in Eastern and Southern Africa.

John B Mason and Tulane/UNICEF team[1]

ABSTRACT

Objective: To determine short- and long-term trends in child malnutrition and how these are affected by drought and HIV.

Design: Secondary epidemiological analysis of area-level data derived from national surveys, generally from mid-1990s to mid-2000s.

Setting: Data from countries in the Horn of Africa (Ethiopia, Kenya, Uganda) and southern Africa (Lesotho, Malawi, Mozambique, Swaziland, Zambia, and Zimbabwe), compiled and analyzed under UNICEF auspices.

Subjects: Secondary data: children 0-5 years for weight-for-age; HIV prevalence data from antenatal clinic surveillance; food security data from UN sources (FAO, ILO, others).

Results: Overall trends in child nutrition are improving as national averages, slowed but not stopped by the effects of intermittent droughts. In southern Africa underweight prevalences show signs of recovery from the 2001-3 crisis. Food security early warnings tend to be confirmed by subsequent food production and price indicators, and these relate as expected (if weakly) to malnutrition changes: real time warnings are useful. Areas of higher HIV have *better* nutrition (in both country groups), but this counter-intuitive association is removed controlling for environment and SES. In non-drought periods (in the Horn countries) underweight improves by 0.8 ppts/year. In low HIV areas in Eastern Africa nutrition deteriorates during drought, with underweight prevalences 5-12 percentage points (ppts) higher than in non-drought periods, with less difference in high HIV areas, in contrast to southern Africa where drought and HIV together were previously found to interact.

Conclusions: Despite severe intermittent droughts and the HIV/AIDS epidemic (now declining but still with very high prevalences), underlying trends in child underweight are improving when drought is absent: resilience may be better than feared. Preventing effects of drought and HIV could release potential for improvement, and supported by national nutrition programs – generally lacking but developing in places, e.g. Ethiopia – could accelerate rates of underweight reduction (now generally averaging 0.3 ppts/year or less) to those needed to meet MDG goals (0.4—0.9 ppts/year).

[1] Many people contributed to the analyses used here, and to conceptualizing, writing and editing earlier reports on which much of this paper is based. These include (approximately in time sequence): from Tulane: Adam Bailes, Karen Mason, Sophie Chotard, Nick Oliphant, Jon Rivers, Ryan Matthews, Nick Nelson, Tina Lloren, Eden Hegwood, Megan Dieterich; from UNICEF, Claudia Hudspeth, Olivia Yambi, Urban Jonsson, Saba Mebrahtu, Peter Hailey.

Impact of drought and HIV on child nutrition in Eastern and Southern Africa.

INTRODUCTION.

Intermittent food insecurity from drought and the impact of HIV/AIDS threaten nutritional status in Sub-Saharan Africa. The direction and size of underlying trends and of the effects of drought and disease are sometimes overlooked in the stream of urgent warnings and appeals. Such humanitarian alerts may come from intergovernmental bodies (e.g. UN: OCHA, ReliefWeb [2] European Community, ECHO[3]), government agencies (e.g. USAID, FEWSNET[4]; DfID); and non-governmental sources (e.g. Interaction [5]; DEC[6]; Epicentre[7]). Since around 1990 several episodes of severe drought have undermined progress, and the HIV/AIDS epidemic has evolved. Broad estimates of nutritional status (using child underweight as the most common indicator of malnutrition) indicated virtually no change from 1990-2005 in prevalences in Africa overall (UN-SCN, 2004; UNICEF, 2006, 1997) and possible increases in Eastern Africa (about 0.3 ppts/yr, 1990-2005); this contrasts with all other developing regions where malnutrition prevalences are falling, by an average of around 0.5 ppts/year. However, better economic circumstances in Africa are creating a public impression of progress at last – for example to quote the lead editorial in the New York Times[8]: ‘Nobody can know for certain whether Africa south of the Sahara might be at the cusp of shaking its endemic destitution and starting up the ladder of development. But it has its best chance in decades, and it would be a crime not to grasp the opportunity.’

Assessments of the effects of drought in southern Africa in 2001-3 led at first to some uncertainty as to trends in malnutrition; subsequent research initiated by UNICEF (Mason et al, 2005) found that drought, amplified by HIV/AIDS, caused substantial increases in underweight (but not in wasting) particularly in previously better-off areas. This covered Lesotho, Malawi, Mozambique, Swaziland, Zambia, and Zimbabwe. The research reported here, also sponsored by UNICEF in its coordinating role for nutrition, extends the scope to include data from Ethiopia, Kenya and Uganda (in the Greater Horn of Africa, referred to as ‘Horn countries’), and compares these with the southern African countries, for which the data have also been updated.

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[2] E.g ‘Drought, disaster looming in East Africa’, Reliefweb, 21 March 2006. http://wwwnotes.reliefweb.int/w/rwb.nsf/480fa8736b88bbc3c12564f6004c8ad5/ba7856cc1ccfa63d4925713a00070aa6?OpenDocument

[3] E.g. Horn of Africa: European Commission earmarks further €10 million to improve drought preparedness. http://www.europa-eu-un.org/articles/en/article_6032_en.htm

[4] http://www.fews.net/

[5] Interaction – the American Council for Voluntary International Action – is a coordinating agency for US-based NGOs.

[6] Disaster Emergency Committee, UK – coordinates 12 UK-based NGOs involved in humanitarian assistance.

[7] Epicentre is a non-profit organization based in Paris, originally created by Medecins sans Frontieres, specializing in public health and epidemiology.

[8] NYT, Friday 2 November 2007, p A22. Africa’s chance.

In southern Africa *higher* prevalences of HIV were associated by area with *lower* malnutrition prevalences (and lower child mortality rates), and this was hypothesized to be due to higher HIV prevalences in areas that were better off socio-economically (Mason et al, 2005). The association of HIV with higher SES was recently shown at household level in DHS in Kenya (Mishra et al, 2005; Silvestre, 2007), lending credence to the explanation. The association of HIV with underweight prevalences has now been examined further, in southern Africa and in the Horn countries, taking account of SES and related variables, as reported here.

A concern has been that the HIV/AIDS epidemic is weakening the resilience of households to survive and recover from income and production losses due to drought, leading perhaps to what has been termed a 'new variant famine' (de Waal and Whiteside, 2003), likely to persist after drought recedes. Results from the previous study on southern Africa indicated that drought and HIV interacted such that nutrition deteriorated much faster in areas where the two were combined than with either alone: this is also examined here for the Horn countries. At the same time, more recent survey results from southern Africa can indicate if recovery in nutrition has occurred after the 2001-3 drought.

This paper aims to provide estimates of the underlying trends in child nutrition[9] – as a general measure of human progress and one specifically chosen to monitor international goals[10] – to assess the size of the effects of drought, food insecurity, and HIV, in selected countries in Eastern and Southern Africa. Associations of HIV and malnutrition are investigated taking account of SES.

METHODS

Data Sources and Datasets

The two geographical regions studied are southern Africa (Lesotho, Malawi, Mozambique, Swaziland, Zambia, and Zimbabwe) and the Greater Horn of Africa (Kenya, Ethiopia, Eritrea, Somalia, Sudan and Uganda); only limited data were available on Eritrea, Sudan, and Swaziland. The studies concern trends in child malnutrition in relation to drought and HIV, taking account of possible confounding by SES and environmental health factors. All data used were at the area (typically province) level. The first step was to update the previously constructed datasets for southern Africa (see Mason et al, 2005) and extend these for the Horn countries. These are described at the end of this section. Key variables used in analysis are listed in table 1.

< table 1 near here>

[9] Full reports are at http://www.tulane.edu/~internut/New_Folder/index.htm, reference reports, Niphorn and Nipsa2. Chotard et al, 2006 has the Horn results.

[10] Millenium Development Goals: http://www.un.org/millenniumgoals/ .

Nutritional data

Anthropometric data were obtained from the surveys shown in table2, standardized as the prevalence of underweight children (<-2SDs by WHO/NCHS standards – the indicators reported at the time – for children 6-59 months), defined by province (or equivalent) and year. The main sources of these data were: Demographic and Health Surveys (DHS); Multiple Indicator Cluster Surveys (MICS, sponsored by UNICEF); governmental national surveys, either primarily for nutrition (e.g. Zimbabwe) or including nutrition in broader surveys (e.g. Welfare Monitoring Surveys, Ethiopia); Non-Government Organizational (NGO) district surveys (Zambia).

< table 2 near here>

Underweight prevalence data were accessed from the datasets themselves in most cases; where not available, data from the published reports or WHO (http://www.who.int/nutgrowthdb/database/en/) were used, adjusted to 5-59 months where needed as described in Mason et al, 2005. DHS datasets and reports were downloaded from the Measure/DHS website [11]. MICS datasets and reports were provided by UNICEF[12] . For Ethiopia, the national Central Statistical Authority Welfare Monitoring Surveys were the primary source, considered comparable through time (Oliphant, 2005); DHS surveys (2000, 2005) were also considered. In general, the national surveys used a two-stage cluster sampling method representative at the provincial level. District level surveys conducted by NGO's for Malawi and Zambia typically used 30x30 cluster sampling methodology and are representative at the area level.

HIV Data

Prevalence data for HIV was taken from the HIV/AIDS Surveillance Data Base [13], and from UNAIDS reports (http://www.who.int/GlobalAtlas/predefinedReports/EFS2006/index.asp). The information in the database contains the sentinel surveillance site information from ante-natal clinics, as well as data from national reports and scientific publications. The search criteria used in the database was for pregnant women aged 15 – 49 years of age. For Zambia, HIV prevalence data was also found in the DHS 2001/2 survey. Malawi had data available from the National AIDS Control Programme, via The POLICY Project[14]. Adjustments of HIV data from ante-natal clinics was not attempted here. However,

[11] http://www.measuredhs.com

[12] http://www.childinfo.org

[13] http://www.census.gov/ipc/www/hivaidsd.html

[14] The National AIDS Control Programme, The POLICY Project. Estimating National HIV Prevalence in Malawi from Sentinel Surveillance Data [Online]. 2001 [access 2003 March]. Available from http://www.policyproject.com/pubs/countryreports/MalSS.pdf

considerations are put forward by WHO could be investigated further for application in future analyses[15].

HIV prevalence data were not available for every area and time where there was nutritional data. To match HIV prevalence data in these cases, a set of rules was used to provide the best estimate, as follows: (a) if data existed for the same area, but before and after in time, then the HIV prevalence was linearly interpolated; (b) if before and after points were not available, the nearest prevalence point in time was used; (c) if a district did not have any data at all, the nearest available regional/provincial estimate was used.

In every case, the data points were examined as a time series within the respective area and in relation to the region to make extrapolation was as plausible as possible. In the actual analysis, categories derived from the data were generally used, reducing the effect of inaccuracies in the estimates.

SES and related variables

A number of SES and related variables were compiled, to characterize areas with respect to malnutrition, and to control for potential confounding. A list of the variables used in the analyses reported here is in table 1, discussed under 'datasets'. The majority of these variables came from DHS data . Some indicators already existed by area and were taken directly from reports or data provided; others had to be derived from the survey datasets. In some instances, DHS was not available for a particular country, in which case, MICS data were used. The Zimbabwe National Nutrition Survey 2003 Report was consulted for relevant variables (e.g. measles immunization coverage). The SES variables were usually chosen as those that tend to change only slowly over time (e.g. education levels), so that typically there was at least a valid DHS or MICS survey for the time period being analyzed.

Additional details of the more important variables used here were as follows. Variables compiled that did not have to be derived were % of area with electricity (*electric*) and % of area that is *urban*. Population data was taken from LandScan 2002 Oak Ridge University and FAO-GIS. Access to a safe water source (*safewatr*) was calculated as a water source other than surface water. The values from this derivation were tested against the DHS reports and were defined similarly. Likewise, access to a safe means of excreta disposal (*safexcrt*) was defined as those with a facility and not having to use a bush/field. Again, this was similar to the definition DHS used to derive their variable. Another useful variable, especially as a proxy for socio-economic status, was the % of head of household with more than a primary education (*primedfi*). This was also derived from DHS survey data. *Measles* immunization coverage was used as a measure of access to health care, and was derived for children older than 11 months of age.

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[15] WHO and UNAIDS, 2003. Reconciling Antenatal Clinic-based Surveillance and Population-based Survey Estimates of HIV Prevalence in Sub-Saharan Africa. WHO, Geneva.

Food prices

The food security indicator used was the ratio of the cost of food, or the food price index (FPI), to the consumer price index (CPI). This ratio (FPI/CPI) was found in preliminary analyses to predict changes in malnutrition (Nipsa 2 report); and had been associated in earlier work (SCN News, 19XX). The FPI and CPI values (as indices, 1990 = 100) were extracted from the ILO database (http://laborsta.ilo.org) for Ethiopia, Kenya and Uganda in the Horn (they were not available for Eritrea), and for Malawi, Mozambique, Zambia and Zimbabwe. The data were also available for Malawi and Zimbabwe elsewhere[16 17], while the consumer price index for Zambia was found in a report from the Central Statistical Office [18]. However while these were used for initial analyses they have been replaced by the ILO-derived data here for consistency. When the ratio of the indices goes above one, that is when the FPI exceeds the CPI, then the relative cost of food is increasing in relation to the cost of other goods on the market, providing an indication of increasing difficulty in access to food.

Drought

In the early investigations in this study, several indicators were used to assess the extent and localization of drought. Subsequently, estimates of food and agricultural production became available, usually a year or two after the end of the crop year, from FAO's FAOStat. Indicators based on these retrospective production estimates were used in the analyses reported here; however, comparison with the earlier available indicators was of some interest and this was briefly examined for Ethiopia, Kenya and Uganda for 2000-5. The early indicators were taken from rainfall and from FAO reports.

First, estimates of the Water Requirement Satisfaction Index (WRSI), available for 2000 through 2005, derive from rainfall data for the crop pattern of the areas monitored; these were kindly provided through FEWS NET by the USGS[19]. They are available as maps, showing the WRSI by area on a scale centred around 100. An estimate was made by inspection as to the approximate average WRSI for each country-year (for Ethiopia, Kenya, and Uganda, 2000-2005).

A second accessible source of reports on drought is from the FAO Global Information and Early Warning System (GIEWS) (http://www.fao.org/giews/english/fs/index.htm), which categorizes countries as 'normal', 'unfavourable prospects for current crops', 'food supply shortfall in current marketing year requiring exceptional assistance', and both of these latter. These reports are issued three to six times per year. Extracting from the 41 reports from 1999 through 2005 allows an estimate (from the unfavourable crop prospects category) of timing of drought. For coding, 'unfavorable prospects' was scored 1, 'food supply shortfall' 2, and both 3; normal was 0; these were averaged for each country-year. The reports gave Kenya as clearly affected by drought in 1999, 2000, 2004

16 http://www.nso.malawi.net/data_on_line/economics/prices/urgan_cpi.htm [access 2004 February]

17 http://www.icaz.org.zw/CPI/cpi.htm [access 2004 February]

18 Republic of Zambia, Central Statistical Office, Consumer Price Index, August 2003 Release.

19 http://igskmncnwb015.cr.usgs.gov/adds/index.php

and 2005; Ethiopia in 1999 and 2000; Somalia in 2000 and 2001; Eritrea in 2000 and 2001; and Sudan in 2001-02 and 2004. Uganda was only occasionally reported as having unfavourable crop conditions in this period. These two contemporary estimates were compared with production (for Ethiopia, Kenya, and Uganda, 2000-5, see figure 1, discussed under 'Results'.

< figure 1 near here>

Estimates of agricultural production produced in retrospect, as provided by FAO, give a more quantitative assessment of drought effects. Food production indices (FProdI), measures of net annual national agricultural food production for a given country, were obtained from the Food and Agricultural Organization (FAO) for each country for years 1988-2006 (as available) at http://faostat.fao.org/site/499/default.aspx. Since these production estimates were standardized with reference to the average of 1999-2001, which included drought years, the indices were recalibrated to non-drought (or anyway high production) years, as follows: Kenya, 1994, index 124.9; Ethiopia, 1996, index 106.8; Sudan, 1994, index 136.6. This was so that the indices shown approximated to production as a % of a non-drought year.

A variable representing *changes* in food production by year was created. Plotted against time a substantial secular trend in FProdI was seen; the residual (the difference between observed and predicted values of the dependent variable for each case, unstandardized) was derived from the regression of *year* (independent variable) with *food production index* (dependent variable). This variable was created for *each* country separately (i.e. was different for Ethiopia, Kenya, and Uganda). Yearly values of each country variable were combined into a single variable ('resall2') for each year for all three countries. The resulting FprodI residual variable could only be applied at national level (since FprodI is only national), thus it took the same value for each region within a country in any one year. The variable gives the annual deviation from the long-term trend and is taken as a measure of drought; its value in practice was from -8 (drought) to +8 (bumper crop).

Time Periods for Trend Analysis

To analyze the *changes* in underweight in nutrition, child underweight prevalence estimates in pairs of surveys in different years were compared (see change dataset description, below). Time periods were established defining whether the periods between two surveys represented: no drought i.e. neither survey in drought period); entering drought (i.e. from before to during drought); during drought (both surveys in drought years); or coming out of drought (i.e. first survey during drought, second survey no drought). For southern Africa this was defined in the previously published analyses (Mason et al, 2005, figure 5), where the focus was on the effects of the 2001-3 drought, as before, or during this drought period. For the Horn countries the timing of drought was more variable. From the FProdI variable, the periods of reduced food production were approximately as follows: Kenya, 1995-8, 2000, 2004-5; Ethiopia, 1995, 1998-2000, (2003-4 had slightly low production but no reports of drought from FAO/GIEWS), 2005; Uganda, 1996-9, 2005. Matching these periods to pairs of surveys led to defining the periods as follows: Kenya, 1993-4, out of drought; 1994-8, into drought; 1998-2000, during drought; 2000-3, out of drought; Ethiopia, 1996-8, into drought; 1998-2000, during drought; 2000-5, no drought[20]; Uganda, 1988-95, none; 1995-2001, none.

Datasets

Three types of datasets were used:

- 'survey' datasets, in which a case was a nutritional survey result, defined by area (province or equivalent) and month/year, with other variables matched to this area and time; separate datasets were created for southern Africa[21] (based on that used for the analyses given in Mason et al, 2005) and the Horn countries[22];
- 'change' datasets, in which a case was defined as two consecutive nutritional surveys by area, allowing calculation of rate of change of underweight prevalences (as ppts/year), with other variables matched to the first and second surveys as needed, again as separate datasets for southern Africa[23] and the Horn countries[24];
- An aggregated dataset, with country-year as the case (n=161), for variables only available at national level, such as FPI/CPI[25].

The datasets were not merged between the regions, as the results were sufficiently different (e.g. underweight and HIV prevalences) that no analyses used the combined data. However the variables were equivalent and identical analyses were run on the two regions. Variables used in the analyses reported here are defined in table 1.

RESULTS

National underweight trends.

Trends in prevalences of underweight children estimated at national level, by year, are shown in figures 2 and 3. In most countries, up to about 2000, trends were of slow improvement at about 0.5 ppts/year. Around 2000, underweight prevalences increased in southern Africa, with drought and economic recession (as described in Mason et al, 2005), then showing some signs of recovery. In Ethiopia, Kenya and Uganda (referred to as Horn countries) the trends were more consistent, with an overall trend of improvement in the last ten years at national level. The apparent substantial improvement in Ethiopia from 2000-5, from WMS results was also seen in the DHS national estimates (2000: 42.0%; 2005: 34.6%, from WHO database); although these surveys were repeated at different seasons (both WMS and DHS), it seems likely that the improvement estimated

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20 Scored as no drought as 2000-5 predominantly good production.
21 Filename: Survey II AB-EH Jul 07.sav.
22 Filename: Survey II eh-jm 2oct.sav
23 Filename: Change II AB_11May.sav.
24 Filename: eden-ch.sav.
25 Filename: aggr.sav

reflects genuine change. The underweight prevalences in the southern African countries show some recovery after the 2001-3 drought, except in Mozambique (where food production was lower again in 2005, see below).

< figures 2 and 3 near here>

Drought and HIV/AIDS are two factors likely to cause substantial year-to-year changes in child nutrition. Estimates of HIV/AIDS prevalences are taken from ante-natal clinic surveillance, applied at country-year level. In southern Africa (see figure 4) the pattern has been of rapid spread of HIV during the 1990's, with probable leveling off around 2000 and possible falls in prevalence in Malawi and Zambia. The overall levels in the 2000's are among the highest in the world, of 25-35% in Lesotho, Swaziland, and Zimbabwe. In the Horn, Uganda's high HIV prevalences (20-25%) were reported in the early 1990's (see figure 5), since then falling steadily to a reported level of less than 10% in the last ten years. In Ethiopia the peak was reported in 1995, at 20-25%, since apparently falling to less than 10% -- however HIV data only cover limited areas, and these estimates depend considerably on urban estimates, especially in Addis Ababa. Kenya reported a slower increase in the 1990's reaching about 20% in 2000, since also falling to less than 10%.

< figures 4 and 5 near here>

Assessing food security and drought.

Drought is estimated in real time from rainfall and crop reports; for retrospective analyses the published agricultural production indices compiled by FAO give an accessible quantitative estimate, available at country-year level. The deviations in food production index (FProdI) from the trend, calculated separately for each country, are shown in figures 6 and 7. The FProdI was chosen rather than crop production or total agricultural production, as likely to reflect changes in food availability; in any event all three were highly correlated. The trend through time of the FProdI was strongly positive, in part (but not only) because of population growth. Deriving the residual from the regression of FProdI against year gives an estimate of deviations from the long term trend and thus a convenient indicator of variations in food production.

< figures 6 and 7 near here>

Not all year-to-year variations are due to agricultural conditions. The plunge in production in Malawi in 2002 was considered largely economic. The war between Ethiopia and Eritrea in 1998-2000 no doubt contributed to low production at that time.

Reports from FAO's Global Information and Early Warning System (GIEWS), usually about quarterly, were retrieved and coded to reflect reports of unfavourable crop conditions or shortages as assessed at the time, for Ethiopia, Kenya and Uganda. The estimates were generally consistent with the FProdI-derived indicator for Kenya (see figure 1), with 2000, 2004 and 2005 as drought years. For Ethiopia the consistency was less: 2000 had lower production compared to 2001 and 2002, and GIEWS reported drought; however in 2003-4 GIEWS was not reporting unfavourable conditions, but the FProdI indicator was lower; 2005 was reported as unfavourable, and the FProdI was down. Uganda had unfavourable crop conditions in 2005, from both sources.

Food purchasing power may also be tracked using the indicator of the ratio of the Food Price Index to the Consumer (General) Price Index (CPI) – FPI/CPI – which is available via ILO (http://laborsta.ilo.org/ (yearly statistics)). The calculated ratios are shown in figure 8, by country and year.

< figure 8 near here>

The production indicator in most countries is associated with the current FPI/CPI, more so with the FPI/CPI in the *following* year – e.g. the production indicator in 2000 with FPI/CPI in 2001. For the nine countries, the regression coefficient for FPI/CPI (next year) with production indicator (as independent variable) was -0.27 (p=0.018, n=101); this can be compared with an insignificant association (p=0.32) using FPI/CPI for the same year. The association was stronger in the Horn countries, for FPI/CPI (next year) the coefficient was -0.54 (p=0.014, n=45); it was also associated, less strongly, with FPI/CPI in the same year (coefficient = -0.42, p=0.04, n=46). This lagged effect can be illustrated in the Ethiopia data (figure 9): the production increase in 1996 precedes the FPI/CPI fall in 1997, while these changes are in the same year in 2000-2003.

< figure 9 near here>

Food prices and underweight.

The relative price of food (FPI/CPI) appears to predict changes in underweight prevalences – by inspection of graphs such as for Ethiopia (see previous section) and during the southern Africa drought[26]. The association of underweight with FPI/CPI was tested by regression for the national data from the nine countries. The association of FPI/CPI with underweight in the following year (e.g. FPI/CPI in 2000 with underweight 2001) was weakly positive (as expected) where these data were available; more so when the underweight prevalence was standardized as a proportion to the average underweight for the country. The results were, for unstandardized prevalence, underweight (next year) = -5.0 + 0.306 FPI/CPI (coefficient p=0.16, n= 34); for standardized prevalence (next year), coefficient = 0.0040 (p=0.13, n=31).

The southern African countries had considerably higher rates of general price index increases – inflation – starting in 1990: for example the CPI's for 1990, 2000 (base year) and 2006 for Malawi were 7, 100, and 226; for Zambia 1, 100, 251; and Zimbabwe 6, 100, 34688. In the Horn countries, these were, for Ethiopia, 136 (1991), 100, 106; Kenya, 24, 100, 178; Uganda, 32, 100, 133. It is likely that the high rate of general price inflation diluted the effect of the relative price of food.

[26] See Nipsa 2 report, figs 3.1-1 to 3.1-6.

Testing for effects of season (using dummy variables for post-harvest, moderate hunger, and hungry season) gave no significant associations. However, the likely size of the effect of season on underweight prevalence was about 2 ppts, between surveys conducted post-harvest and in moderate hungry season (p=0.3, n=19).

Drought years.

The years of better and worse food security can be seen from these indicators. In the Horn, Ethiopia had good production in 1996-7, below average in 1998-2000, high again in 2001-2, down somewhat in 2004-5 (figure 6). In contrast, Kenya and Uganda had severe shortfalls in 1996-98, better harvests 2001-3, and shortfalls again in 2004-5. The FPI-CPI (figure 8) generally confirms this pattern, but in addition there has been a rapid rise in this indicator in Kenya, also to a lesser extent in Uganda, from 2003 on.

In the Southern African countries previous analyses had shown the interaction of drought and HIV (Mason et al, 2005). The droughts around 2000 are seen in some countries in the changes in the production indices (figure 3), although Malawi is anomalous – this food crisis was known at the time to be related to economic problems rather than agricultural conditions.

How good are early warnings?

A comparison of the drought indicators available in real time with subsequent food production estimates is shown in figure 1 for Ethiopia and Kenya, 2000-5. Those available at the time are: reports from FAO's early warning system, GIEWS; water requirement satisfaction index (WRSI); and relative price of food (FPI/CPI); in the plots the FProdI indicator is reversed in sign, so that high values correspond to likely drought, and indicators are expected to go in the same direction. For Ethiopia, these results show that 2000 had relatively low food production, and this was in line with FAO and WRSI reports at the time. 2001-2 had good production, and relative food prices fell; WRSI however indicated some drought, but FAO issued no warnings (correctly judging by subsequent food production estimates). In 2003-4 food prices remained lower, and production was only slightly down. In 2005 there was some drought, but prices are not available. Changes in child underweight in 2000-5 are consistent with this favourable food security picture.

In Kenya the pattern was similar to Ethiopia for 2000-2, but then in 2003 food prices rose even though production was good; in 2004-5 production was down somewhat, drought was reported by FAO, and food prices rose substantially. These indicators would predict that child underweight in Kenya may have risen after 2003 (data are not available on this at present).

Useful implications of these data are, first, that contemporary alerts from FAO/GIEWS do seem to warn of subsequent production shortfalls and food price increases. Second, relative prices of food (as shown above) increase subsequently, and provide additional warnings of threats to food security and nutrition.

Area-level trends in underweight.

Data for child underweight prevalences and HIV are available at province (or equivalent) level. In general, these do not show a clear association between changes in HIV and changes in underweight. Moreover, in the Horn unlike in southern Africa (as reported in Mason et al, 2005), there is less tendency for better-off areas (in nutritional terms) to increase in prevalence, and to cross-over with the worse-off areas decreasing (province/regional level trends are in Chotard et al, 2006, Figs 2.8, 2.13, and Annexes 2-4; and Hegwood, 2007). Nonetheless, some convergence occurs. In Uganda, Central and Eastern regions had the lowest prevalences in 1988, had increased underweight by 1995 and 2001, while Northern and Western improved: as a result the range of prevalences went from 17 ppts to 5 ppts between regions (1988-2001). In Kenya the range between provinces went from 26 ppts in 1998 (Western to Central) to 12 ppts in 2000 (Rift valley to Central) and 10 ppts in 2003 (Coast to Central). In Ethiopia, where HIV is lower in most regions, underweight prevalence changes by region are more parallel with less convergence (ranges by region, 30 ppts in 1996, 26 ppts in 2000, 22 ppts in 2005).

In Ethiopia, Kenya and Uganda provincial/regional underweight trends have no obvious relation to HIV levels or trends. For example, the peaking of HIV prevalences in Uganda, especially noticeable in North and West regions in the early 1990's, is at the same time as some reduction in the underweight prevalence. Central and Eastern regions do not show an improvement in underweight along with lower HIV prevalences. Similar considerations apply in Kenya.

Area-level associations cross-sectionally of HIV and underweight.

The association of HIV prevalences at area level with prevalences of underweight was previously shown, in Southern Africa, to be significantly in the direction of *higher* HIV associated with *lower* child underweight. The suggestion that this was due to confounding, because HIV is higher in better-SES areas, and SES is associated with better nutrition, is now largely confirmed in the analyses reported here, which bring in new variables of SES for the southern African countries, and add in data from Ethiopia, Kenya, and Uganda. A number of socio-economic (SES) indicators were created mainly from data in the DHS and MICS surveys (see methods section); these were tested for their impact on the association of underweight with HIV based on their being associated with both these – HIV was significantly positively correlated with education and safe water access in both southern African and Horn countries; underweight was significantly negatively correlated with these variables.

The regression coefficients for HIV prevalence with child underweight prevalences ('underweight') as the dependent variable became smaller (less negative) and less significant when progressively controlling for SES (see table 3). Note the coefficient starts significantly negative, becoming less so. In the southern African countries (model 1) the coefficient of -0.543 (p=0.000, n=55) is analogous to that in previously-published results (Mason et al, 2005, Fig 3: -0.520, p=0.000, n=32), with some recent datapoints added. The coefficient decreases to -0.292 then -0.198 (p=0.078) when a set of SES variables are entered (models 2 and 3). For the Horn countries, the bivariate coefficient is similar, -0.632 (p=0.001, n=50: model 4 in the table). This becomes quite insignificant (p=0.337) controlling for SES variables. The results support the view that the negative association of HIV with child underweight is due to confounding (as suggested above), although it should be noted that some degree of negative association remains for southern Africa, and indeed this persisted when other available SES variables were used (results not shown here).

< table 3 near here>

The influence of drought on underweight allowing for HIV.

Drought (implying increased food insecurity) assessed either by the food production change variable or by FPI/CPI is only quantified at national level: production estimates are made nationally (at the end of the crop year), and price indices for the most part are reported nationally, although also available by month. HIV can be assessed with reference to areas (provinces or equivalent), although this relates to surveillance clinics in the area rather than deriving from population assessments. Underweight prevalences can be estimated at area level from representative surveys, but these are not available every year. Assembling these data (see methods section) allows examination of associations of underweight (as the outcome variable) with HIV and drought, at area level (see table 4). Note that drought and HIV are not related (and correlations are insignificant), but may interact with each other rather than confound, as shown before in southern Africa in relation to changes in underweight (Mason et al, 2005, Fig 5).

< table 4 near here>

In the southern African countries, underweight prevalences are on average 4.9 ppts higher in drought than non-drought years (p=0.00); in the Horn countries the difference is less, 1.7 ppts on average (not significant). The confounding effect of HIV is seen within drought categories, where underweight prevalence is lower in the high HIV areas (reading the table vertically – except for Horn-no drought, which is not significant). The effect of drought is generally as expected *within* HIV categories, except for Horn countries, high HIV group, where the difference is in the unexpected direction (lower prevalence in drought) but this is not significant (p=0.27).

The counter-intuitive underweight differences between high and low HIV areas have been shown to be largely due to association of HIV with better SES, urbanization, and similar variables, in the results given earlier in table 3. The interaction implied between HIV and drought for the Horn countries in table 4 is highly significant (p=0.004, n=80), but this becomes insignificant (p=0.49) controlling for education, urbanization, and water/sanitation. In other words the anomalous differences in effect of drought by HIV category are again probably due to differences in socio-economic and environmental factors.

How improvement rates are affected by drought.

Average rates of change in underweight in relation to drought (see table 6) were as follows (negative is improvement): no drought, -0.82; before drought to drought, -0.08; during drought, -0.13; in drought to after drought, -1.07. (Disaggregating by HIV level did not show any consistent pattern.) This is important for quantifying the impact of drought on nutritional improvement. Without drought, the rate of -0.8 ppts/year is substantial; with drought it almost ceases; and recovery is seen emerging from drought.

< table 5 near here>

The number of area-year estimates of underweight was fewer in the Horn countries than for southern Africa, and deriving and testing a measure of change in underweight (ppts/year) as the dependent variable, with HIV and drought (as previously found to be significant and interacting in southern Africa) did not yield any significant associations.

DISCUSSION

National trends in child underweight prevalences showed long-term improvement in the four Horn countries assessed, with Ethiopia decreasing prevalence at about 0.9 ppts/year from 1996-2005. Eritrea reported improvement at a similar rate. Kenya and Uganda showed slower progress, at around 0.1-0.3 ppts/year, but with prevalences about half those of Ethiopia. The countries of southern Africa showed indications of recovery in underweight prevalences after the severe conditions of the early 2000's, except Mozambique. However, the longer term trend (1990's to 2000's), as far as it can be discerned taking into account the drought of 2001-3, is probably similar to Kenya and Uganda, about 0.1-0.3 ppts/year. The exception is Malawi (where the problem 2000-1 was economic and food security management rather than drought) which had a rate of about 0.9 ppts/year.

The differences in underweight prevalences associated with drought – averaging across areas more and less affected – was around 5 ppts in southern Africa, but less (1.7 ppts, not significant by itself) in the three Horn countries. The rates of change in underweight in the Horn countries indicated that drought was substantially reducing the underlying improving trend, and this was clearly also the case in the southern Africa countries (Mason et al, 2005).

Early warnings of likely food production shortfalls (e.g. from FAO/GIEWS) are usually subsequently seen to be correct from national data. Moreover, it can be seen in retrospect that the food production indicator (FProdI) was significantly associated with the relative price of food (FPI/CPI). The FPI/CPI was weakly associated with underweight prevalence. Thus the expected sequence of drought reducing production, leading to raised food prices, and thence to increased child malnutrition, appears to hold. Relevant to policy are the findings that, first, this can be assessed in real time, moreover with lags such that timely intervention should be feasible. Second, the size of the overall effect of intermittent drought is modest at national level.

It is crucial to note that these connections of food production through to malnutrition here refer to short-term changes. The importance of health and care as determinants of child nutrition (UNICEF, 1990) is well established, and in the short term these are considered as (mainly) held constant. Even if they were not, their effect – for instance increased poverty associated with production shortfalls – would act in the same direction. Thus there is nothing contradictory in expecting this pathway to operate; where caution is needed is in interpreting the relation of (say) food production to nutrition as implying that direct intervention on food is needed – often the issue may be poverty, income, and indeed addressing health and care.

The trends in child malnutrition for the Horn countries have been of improvement despite periodic droughts. (The effects are more extensive in highly vulnerable populations – especially pastoralists in the semi-arid areas – as shown in other analyses reported elsewhere[27].) Approximately, drought brings the underlying improvement rate (around

[27] Niphorn report, section 3; results in preparation for publication.

0.8 ppts/year) to a halt, but this appears to bounce back with a transient faster rate (e.g. 1.1 ppts/year) when normal conditions return. This implies, first, that food security stabilization efforts during drought are useful to protect continued progress: e.g. the slope for Kenya in figure 2 could have been for more improvement if drought effects had been mitigated. But second, this stresses the concern that more frequent and prolonged droughts unless effectively mitigated will reverse the current (slow) improving trend. But at least, despite frequent alarms, this has not happened at national levels yet.

Higher HIV prevalences by area are associated with *lower* underweight prevalences. This counter-intuitive result from area-level analysis was seen in the southern African countries previously (Mason et al, 2005). The correlation is similar in the Horn countries, and confirmed with additional newer data points in southern Africa. The likely explanation was that higher SES areas had higher HIV, *and* (as yet) lower child malnutrition, i.e. underweight. This is supported by correlations, in both groups of countries. Further, recent household estimates in Kenya by DHS of HIV status have demonstrated higher percentages of HIV-positive adults in higher SES households (Mishra et al, 2005, p 10; Silvestre, 2007). The strong negative bivariate association of child underweight with HIV (at area level) was found to be reduced substantially (but still with p=0.08) in southern Africa, and eliminated in the Horn countries, confirming that the bivariate association is indeed due to confounding (table 4). The relation is still important for targeting – it remains that high HIV areas should be targeted for intervention to protect child nutrition – but in no way suggests that higher HIV is causally associated with better child nutrition.

Nonetheless, in this context it should be noted that despite extensive in-depth analyses of African datasets, no worsening of child nutrition with orphanhood has been generally established (Rivers et al, 2007), and indeed recent analyses of the Kenyan DHS data do not show that children of HIV positive parents are more underweight[28] (Silvestre, 2007). It may be – hopefully is – that resilience and protection of child nutrition is more than expected. On the other hand, the most affected children may be increasing (e.g. street children) and not included in the survey samples[29].

Taking account of the confounding effect of HIV status clarifies the relation of drought with underweight. In the Horn countries underweight prevalences are only slightly higher in times of drought (31.7% vs 30.0%, NS), but breaking this down by high-low HIV areas, the difference is seen to be much greater in low HIV areas (40.3% vs 27.8%, p=0.002). This reflects the fact that HIV affects the more modern areas, and drought vulnerability is in the more remote, and lower HIV, areas. Thus interventions to mitigate drought should be focused on these vulnerable areas, which tend to be the opposite of those where HIV interventions are priority. In southern African countries this increase in underweight cross-sectionally with drought is significant in both high and low HIV areas.

[28] The pattern is mysterious – by wealth quintile, the richest two show no difference in child growth by parents' HIV status; the middle quintile does show children of HIV positive parents more underweight; but then those in the lowest two quintiles are somewhat less underweight. Whether this is due to differential child mortality by HIV and wealth status could not be ascertained from the data.

[29] J Rivers – pers comm..

Finally, these results have implications for assessing progress towards the Millennium Development Goal (1), eradication of extreme hunger and poverty. One of the four indicators is prevalence of underweight children under 5 years of age[30] (http://unstats.un.org/unsd/mdg/Host.aspx?Content=Indicators/OfficialList.htm) , with the target of reducing the prevalence by half between 1990 and 2015. This approximates to a rate of 0.9 ppts/year starting in 1990 at around 45% (e.g. Eritrea, Ethiopia); 0.4 ppts/year starting around 15-20% (Lesotho, Zimbabwe); and 0.6 ppts/year starting around 25-30% (Kenya, Malawi, Mozambique, Uganda, Zambia). These figures provide some guidance in interpreting the trends observed and suggesting policy implications. The current underweight change rates and, for comparison, HDI and GDP growth rates are shown in table 6.

< table 6 near here>

The substantially improving trend in Ethiopia 2000-5, whose magnitude is somewhat uncertain in terms of whether it is long term (some drought in 2000[31]; surveys not matched seasonally) may be expected to continue if there is no severe drought (or the effects are contained), and if current programmes are sustained and evolve. In this context the Extended Outreach Strategy (UNICEF, 2005)[32], which aims to identify and feed severely malnourished children (seven million were screened annually in recent years) is highly relevant, and may well have contributed to the reduction in underweight prevalence. This strategy is planned to evolve into a national nutrition programme[33] for non-emergency and emergency needs, and the success of this could be expected to maintain or accelerate progress to the MDG – towards which Ethiopia is already approximately on track from recent data, with the required and actual estimated rates being 0.9 ppts/year. Undoubtedly the underlying trend has been helped by a strong growth in national GDP, which with education contributes to an improving trend in HDI[34].

Kenya and Uganda have recent rates of underweight improvement of only 0.1-0.3 ppts/year, compared with a rate of 0.6 ppts/year needed to meet the MDG target. Part of this slow rate is no doubt due to drought, which has been intermittently serious in the last ten years, particularly affecting the semi-arid areas and pastoralist populations – these are however a minority and would not account for much of the rate. HIV prevalences falling in the 2000's probably contributed less to malnutrition than before. In Kenya food prices have been rising, in part associated with lowered production. However, progress measured by HDI has been negative in Kenya, and thus socio-economic performance probably accounts for part of the poor nutritional progress. Added to this there are no national programmes in Kenya aimed at protecting and improving child health and

[30] Note that estimates here are standardized to 6-59 months, which gives slightly higher prevalences than 0-59 months (0-6 month children have lower underweight); however this does not affect the interpretation.
[31] E.g. food aid needs estimated as 10 million in 2000, 5 million in 2005 (UNICEF, 2006 – ppt)
[32] Guideline for the EOS, MOH/UNICEF/MOST, July 2005.
[33] Ref to NNP/Ethiopia.
[34] Human Development Index, from UNDP: life expectancy, adult literacy, and GDP per caput (PPP).

nutrition, equivalent to EOS in Ethiopia. In Uganda programmes cover significant proportions of the country (e.g. Uphold[35]), plus the HDI is showing a positive direction; these factors are likely to account for the better nutritional performance. Nonetheless, in both countries new efforts beyond dealing with intermittent drought crises are need to at least double the underlying rate of improvement in child underweight (e.g. to meet the MDG target). High among the priorities to achieve this would seem to be developing national programmes aimed at protecting and improving child nutrition.

In the southern African countries HIV prevalences are higher and only recently starting to fall; moreover the drought in 2001-3 was severe across the region. As described previously (Mason et al, 2005), drought and HIV interacted to cause rapid deterioration, particularly in areas previously better off. The underlying (non-drought) trend, despite HIV, appears to be improving in Malawi, and possibly slightly in Mozambique (assuming drought caused recent underweight increases), and Lesotho. Zambia lacks recent data.

In Zimbabwe, despite massive price inflation and food shortages, data seem to show that underweight prevalences have risen only slightly, and remain the lowest in the countries studied – presumably due to continued protection of children by the high education levels, and remaining coping capacity. This includes a continuing capacity of the health system to, for example, maintain immunization rates. In a recent evaluation we found[36] that immunization coverage had been maintained at (>90%), in part through effective linkage with community-based programmes.

Thus the prospects for attaining MDG targets in the southern African countries seem to depend partly on overcoming current constraints, both in terms of drought and controlling HIV/AIDS, and economic and political problems. In the southern African countries much of the attention in health is focused on HIV/AIDS. To maintain a long-term improvement in child nutrition more investment in community-based health and nutrition programmes is likely to be needed.

In general, African countries have not had a focus on the type of community-based health and nutrition programmes that have been associated with long-term improvements in child nutrition in other parts of the world (Mason et al, 2006). The main exceptions have been in Tanzania in the 1980's and 90's with the Iringa project then the Child Survival and Development projects, and the Supplementary Feeding Programme in post-independence Zimbabwe. This is changing with the expansion of EOS and related programmes in Ethiopia into a National Nutrition Programme. Similar initiatives should follow elsewhere. However, it has been shown that drought (especially in combination with HIV) can bring national improvement to a halt – so better prevention and mitigation of the effects of drought are crucial to protecting long-term improving trends and allowing these to become established.

Put the other way, remarkably enough the underlying trends may still be (just) positive: this implies that the benefits of successfully controlling drought and disease will be to

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[35] http://uphold.jsi.com/Docs/ResourceDocs/UPHOLD_AR_PY2006.pdf

[36] REACH Evaluation: Oliphant, Doherty … Mason, Chopra: in preparation.

unmask potential for establishing sustainable improvement. Economic growth has been strong and crucial determinants such as education, especially for girls, are moving ahead[37]. These provide essential context for sustained progress. With additional programmes of national coverage, rates of improvement in child growth could be achieved and maintained to reach the MDG target of halving child malnutrition by 2015.

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List of tables and figures.

Tables and Figures (for sources see methods section)

Table 1. List of key variables used in the analyses.

Variable definition	Variable name/dataset				
	Survey, southern	Survey, Horn	Change, southern	Change, Horn	Aggregated
Underweight prevalence: 6-59 mo, <-2SDs WHO/NCHS	Uwfin	Uwfin	Uw1, uw2	Uw, uw2_b	Uw4
Change in underweight prevalence: ppts/year, between consecutive surveys	NA	NA	chuwy	chuwy	NA
HIV Prevalence	Hivfin	Hivfin	Hivprev3	hivprev	NA
Education: % head of hhd with primary or more	Primedfi	Primedfi	NA	NA	NA
Urban: % of area's population urban	Urban	Urban	Urban	Urban	NA
Electricity: % hhds with electricity	Electric	Electric	Electric	Electric	NA
Measles: % children >= 12 months immunized	Measles	NA	Measles	NA	NA
Safe water: % hhds with some improved water supply	Safewatr	Safewatr	Safewatr	Safewatr	NA
Safe excreta: % hhds not using fields/bush	Safexctr	Safexctr	Safexctr	Safexctr	NA
Standardized Food Production Index (FProdI): annual deviations (residuals) from trend by country	Resfin	Resfin	NA	Resfin	Resfin
Relative price of food (FPI/CPI): ratio of general to food price index	NA	NA	NA	NA	Fpicpi Fpicpi2 (next yr)
Area: province or region	Region	Region	Region	Region	NA

Table 2. List of surveys used.

	Year	Timing (Season)	By/source
Eritrea	1995		DHS
	2002	Mar-July	DHS
	1993-2002		MOH
Ethiopia	1996	Jun-Jul (Mod/Hunger)	CSA/WMS (1)
	1998	Jun-Jul (Mod/Hunger)	CSA/WMS (1)
	2000	Jun-Jul (Mod/Hunger)	CSA/WMS (1)
	2000	Feb-Jun (Post-hvst/Mod)	DHS
	2004/5	Jan-Feb 05 (Post-hvst)	CSA/WMS (1)
	2005	Apr-Aug (Mod/Hunger)	DHS
Kenya	1998	Mar-May (Mod)	DHS
	2000	Sept-Oct (Hunger)	MICS
	2003	May-July(Mod/Hunger)	DHS
S Sudan	2000	July-Aug (Hunger)	MICS II
Uganda	1995	Mar-Aug (Mod)	DHS
	2000/1	Sept-Feb (Post-hvst)	DHS
Lesotho	2000	Mar- May (Hunger)	UNICEF/MICS
	2002	Oct (Mod)	NNEPI (2)
	2004-2005	Sep-Jan (Mod)	DHS
Malawi	1992	Sep-Nov (Mod)	DHS
	1995	Oct (Mod)	UNICEF/MICS
	2000	Jun-Nov (Post-hvst)	DHS
	2002	Jul-Aug (Post-hvst)	District surveys: round 1 (2)
	2002-2003	Dec-Feb (Mod)	District surveys: round 2 (2)
	2003	Apr-May (Post-hvst)	District surveys: round 3 (2)
	2004-2005	Oct-Jan (Mod)	DHS
	2006	Jul-Nov (Post-hvst)	DHS
Mozambique	1997	Mar-Jun (Hung/post-hvst)	DHS
	2000-2001	Oct-May (All)	QUIBB (3)
	2002	Dec (Mod)	VAC2 (3)
	2003	May-Jun (Post-hvst)	VAC3 (3)
	2003-2004	Jul-Sep (Post-hvst)	DHS
Swaziland	2000	Aug (Post-hvst)	UNICEF/MICS
Zambia	1992	March (Hunger)	DHS
	1996-1997	Jul-Jan (Post-h/mod)	DHS
	1999	Oct (Mod)	UNICEF/MICS
	1999	Oct (Mod)	UNICEF/MICS
	2001-2002	Nov-May (Mod-hunger)	DHS
	2002	Jan-May (Hunger)	DHS
	2002	Sep-May (Mod-hunger)	District surveys: round 1 (2)
	2002-2003	Nov-Mar (Mod)	District surveys: round 2 (2)
Zimbabwe	1994	Sep (Post-hvst)	DHS
	1999	Aug-Nov (Post-hvst)	DHS
	2002	May (Post-hvst)	National Nutr Survey (2)
	2003	Jan (Mod)	National Nutr Survey (2)
	2004-5	March, November	National Surveillance System

Notes: (1) Welfare Monitoring Survey, by Central Statistics Authority. (2) See Mason et al, 2005.

Table 3 Regression analysis: decrease in coefficient for HIV on underweight prevalence, when controlling for socioeconomic variables

Dependent variable = underweight, (uwfin). In cells: coefficient (B), t, p.

	Srn African countries			Horn countries		
Variable \ Models	1	2	3	4	5	6
HIV prevalence (%) (hivfin)	-0.543 -6.358 0.000	-0.292 -2.789 0.007	-0.198 -1.804 0.078	-0.632 -3.484 0.001	-0.314 -1.733 0.090	-0.163 -0.971 0.337
% head of hh with > primary education (primedfi)	-	-0.190 -3.170 0.003	-0.218 -2.760 0.009	-	-0.164 -2.550 0.014	-0.183 -3.232 0.002
% urban population (urban)	-	-0.025 -0.839 0.405	-0.04358 -0.932 0.357	-	-0.124 -3.394 0.001	-0.134 -4.019 0.000
% hhs with electricity (electric)	-	-	0.06598 0.658 0.514	-	-	0.0199 0.489 0.627
% children >= 12 mo measles immunized (measles)	-	-	0.06633 1.126 0.267	-	-	-
% hhs with safe water (safewatr)	-	-	-0.01724 -0.415 0.680	-	-	0.0904 1.751 0.087
% hhs with safe excreta disposal (safexcrt)	-	-	0.05414 1.295 0.202	-	-	-0.155 -4.568 0.000
Constant	35.786	35.243	25.719	31.393	19.508	19.217
N	55	55	50	50	50	50
Adj R squ	0.422	0.551	0.563	0.185	0.436	0.607

Table 4. Prevalences (%) of underweight by drought and HIV prevalence category, aggregated by region (n) within southern African and Horn countries.
(Significance of comparisons is given in the lower table.)

	Southern Africa		Horn countries	
HIV	No drought	Drought	No drought	Drought
Low	22.6% (71)	27.4% (86)	27.8% (15)	40.3% (17)
High	19.0% (114)	22.3% (60)	32.9% (11)	27.8% (37)
Total	20.4% (185)	25.3% (146)	30.0% (26)	31.7% (54)

	Southern Africa		Horn countries	
HIV	No drought	Drought	No drought	Drought
Low	← F=13.5, P=0.000 →		← F=12.0, P=0.002 →	
Low/High	↑ F=11.3, P=0.001 ↓	↑ F=17.9, P=0.000 ↓	↑ (F=0.9, P=0.35) ↓	↑ F=13.5, P=0.001 ↓
High	← F=12.5, P=0.001 →		← (F=1.24, P=0.27) →	
Total	← F=36.7, P=0.000 →		← (F=0.325, P=0.57) →	

Note: Srn Africa, drought defined as food production indicator (rescat2, from *res_all2*), as <0; HIV category (hivcatj, from *hivprev4)* >20%. For Horn countries, drought is food production indicator (rescat, from resall2) as <0; HIV category (hivicat, from hivint) as > 10%.

Table 5. Average rates of change in underweight prevalences between consecutive surveys by region, for periods defined by drought, for Horn countries.

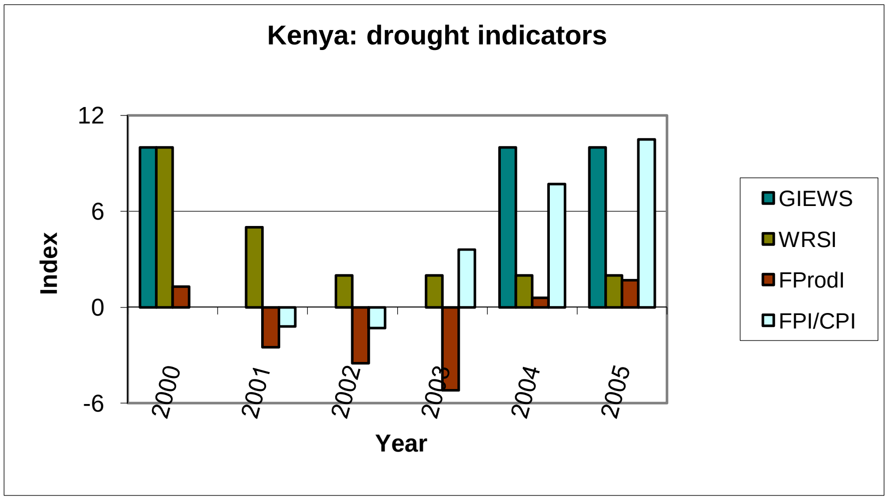
Period	Change in underweight (ppts/yr)
No drought	-0.82 (15)
Before to during drought	-0.08 (16)
During drought	-0.13 (17)
During to after drought	-1.07 (16)

Table 6. Values of selected national indicators (HDI, GDP growth) and MDG hunger target (child underweight)

	Uwt rate 00-05 (underlying) ppts/year	Rate for MDG ppts/year	HDI 05 (*100) index	HDI (*100) rate 00-05 ppts/year	GDP rate (real: %/year)
Ethiopia	-0.9	-0.9	37.1	0.44	10.6%
Kenya	-0.1	-0.6	49.1	-0.26	6.1%
Uganda	-0.3	-0.6	50.2	0.56	5.3%
Lesotho	-	-0.4	49.4	-0.60	6.2%
Malawi	-1.3	-0.6	40.0	0.04	8.5%
Mozambique	-0.1	-0.6	39.0	0.52	9.4%
Zambia	-	-0.6	40.7	-0.04	5.8%
Zimbabwe	+0.3	-0.4	49.1	-0.66	-4.1%

Lesotho, Zambia, insufficient data.

Figure 1. Drought and food security indicators, from FAO (GIEWS), rainfall (WRSI), food production indices (FProdI, standardized) and relative food price (FPI/CPI) (Note: all indicators organized so increase vertically implies drought and/or lower food security)



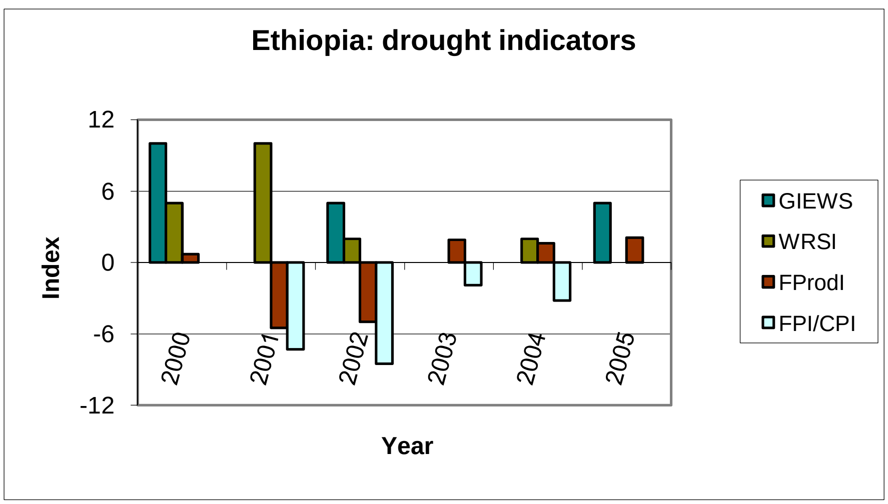


Figure 2. Trends in national underweight prevalences, Horn countries

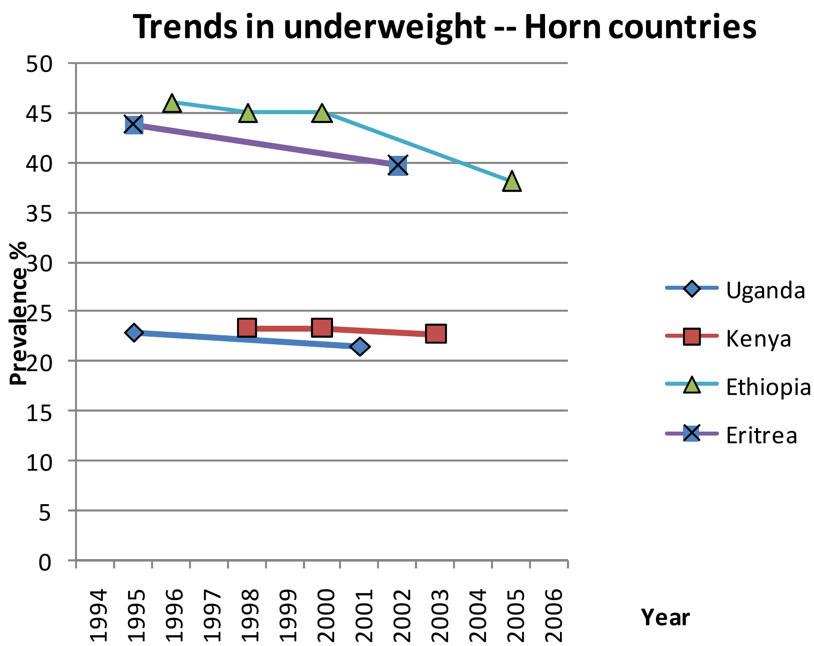


Figure 3. Trends in national underweight prevalences, southern African countries

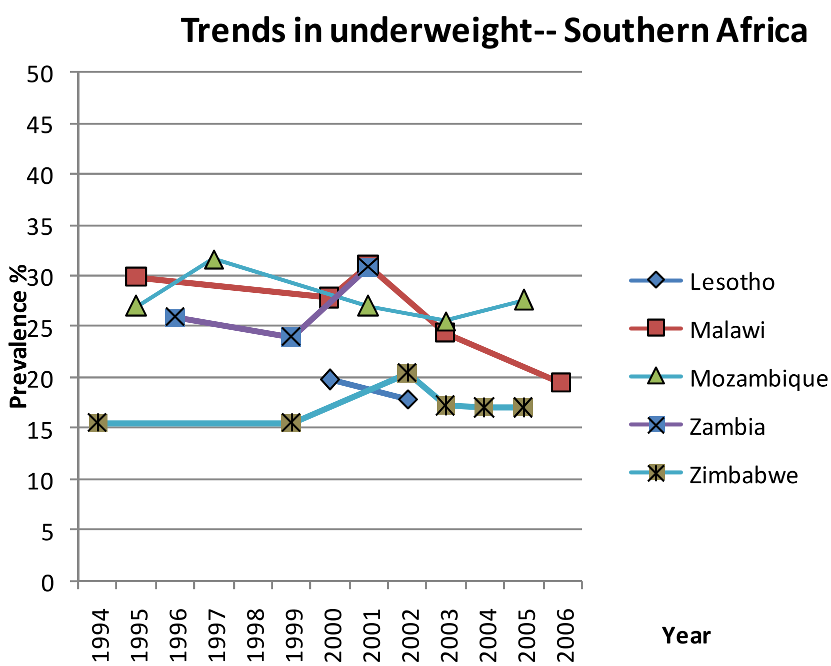


Figure 4 Trends in HIV prevalences, southern African countries

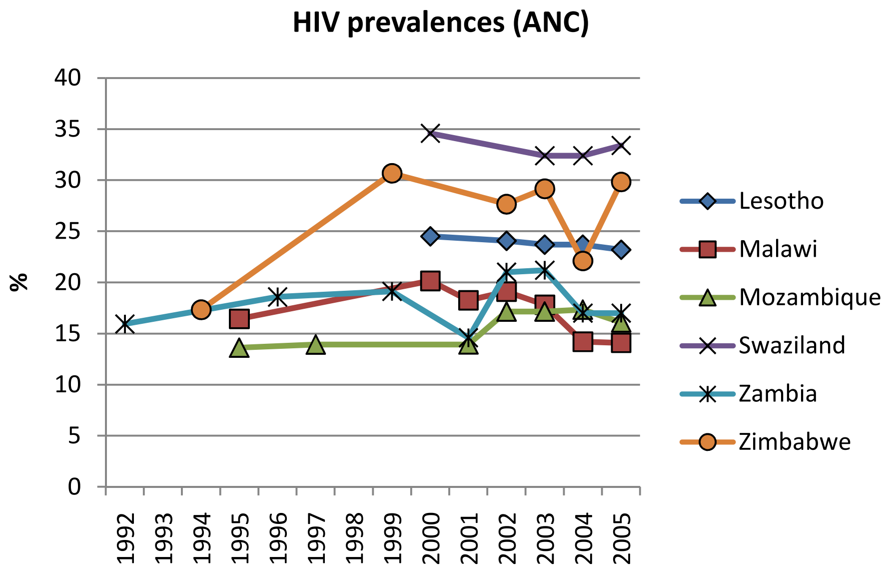


Figure 5. Trends in HIV prevalences, Horn countries

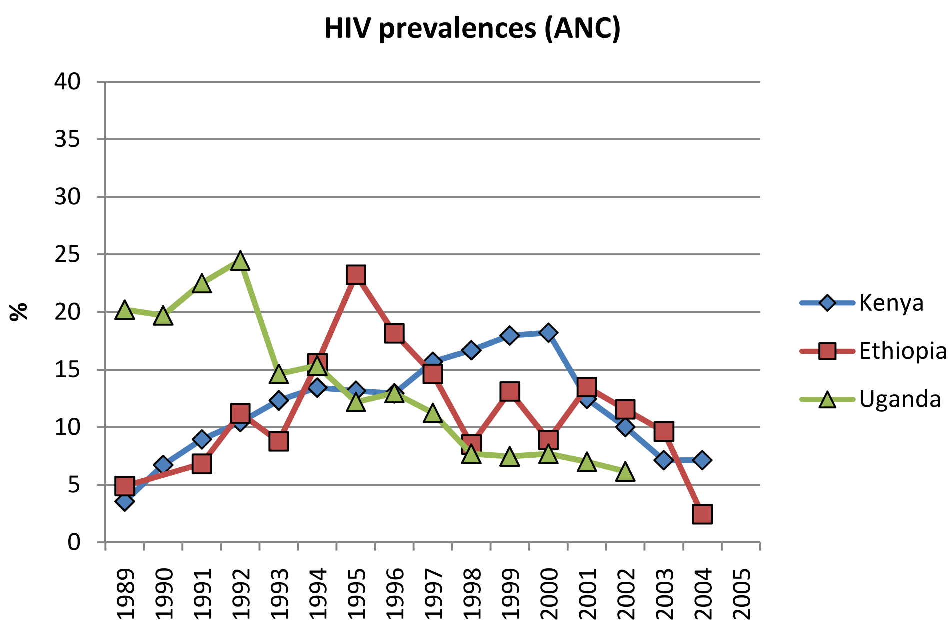


Figure 6. Trends in Food Production Indices (standardized), Horn countries

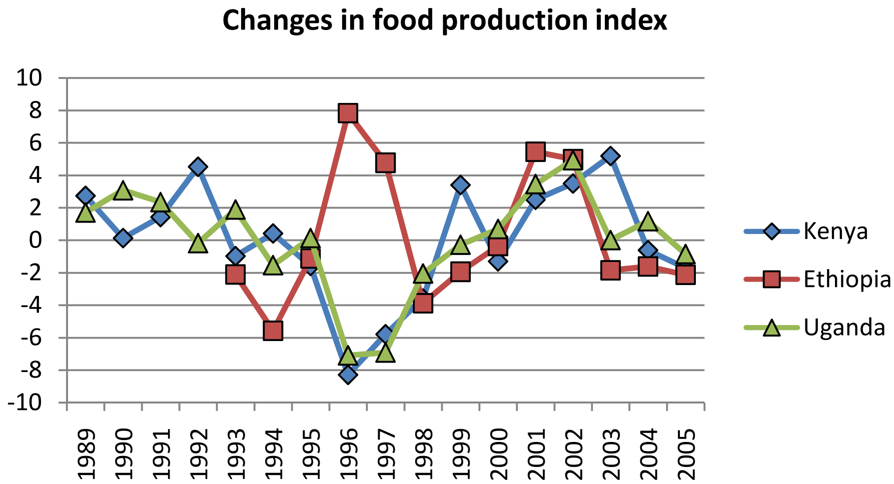
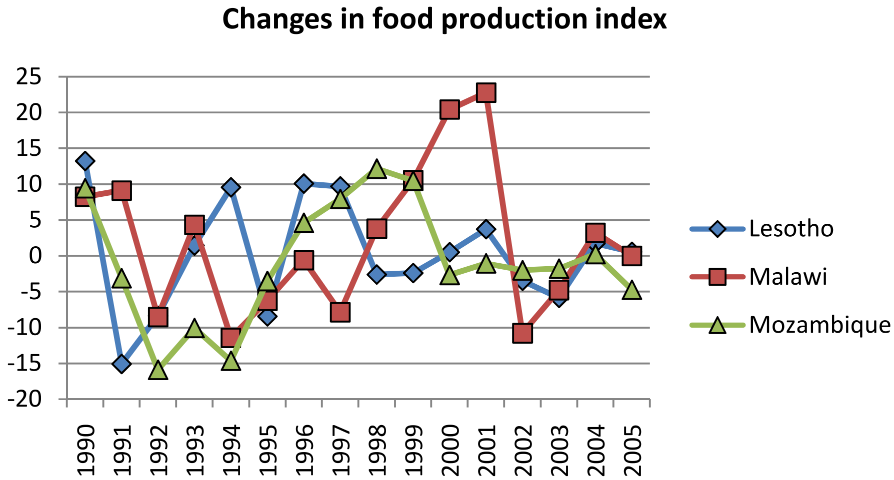


Figure 7. Trends in Food Production Indices (standardized), southern African countries



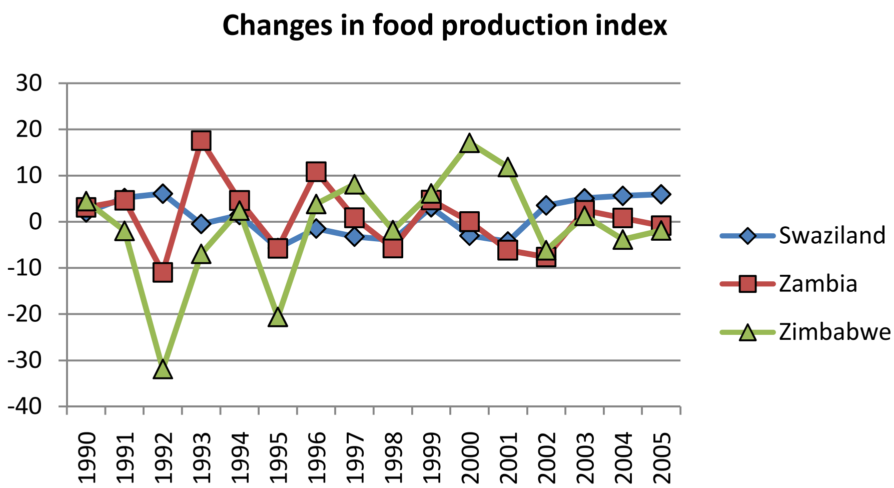
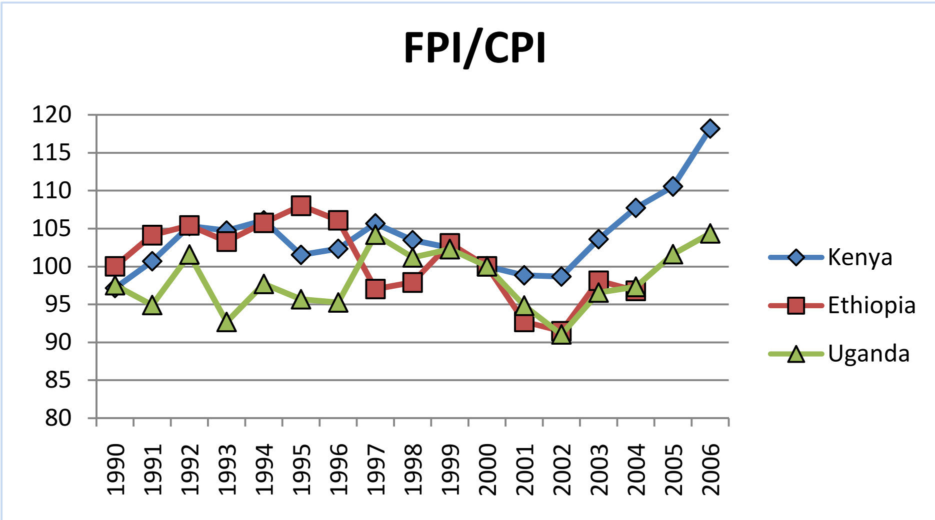


Figure 8. Relative price of food (FPI/CPI), Horn and southern African countries.



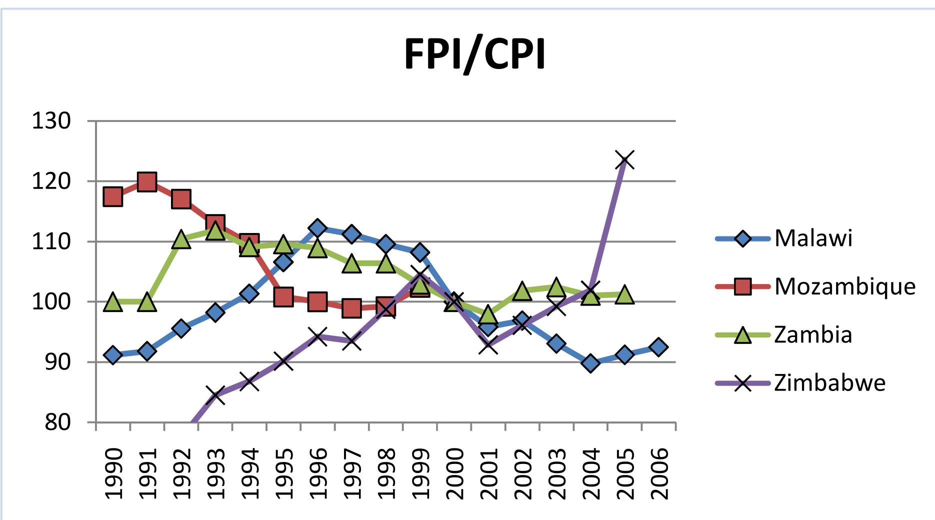


Figure 9. Multiple indicators of food security and child nutrition, Ethiopia.