Redefining "Vulnerable Child" in the Context of HIV/AIDS

Authors:

Priscilla A. Idele, *United Nations Children's Fund (UNICEF)*
Livia Montana, *University of North Carolina*
Chiho Suzuki, *United Nations Children's Fund (UNICEF)*
Upjeet Chandan, *Consultant*
Patricia Lim Ah Ken, *United Nations Children's Fund (UNICEF)*
Turgay Unalan, *United Nations Children's Fund (UNICEF)*
Luong Y Nguyen, *United Nations Children's Fund (UNICEF)*
Attila Hancioglu, *United Nations Children's Fund (UNICEF)*
Rachel Yates, *United Nations Children's Fund (UNICEF)*

ABSTRACT

Recent evidence indicates that global indicators (UNICEF and UNAIDS 2005) used to identify the most vulnerable children in the context of HIV do not consistently identify children with poor outcomes (Akwara et al 2010). To identify key variables more consistently associated with child vulnerability, the most recent household survey data sets (2005-2008) from 11 countries – Central African Republic, Malawi, Sierra Leone, Haiti, Rwanda, Swaziland, United Republic of Tanzania, Ugandan, Zambia, Zimbabwe, and Cambodia - were pooled and analysed utilizing multivariate logistic regression.

Outcome measures utilized varied according to age. For young children aged 0-4, the following outcomes were assessed: received fever treatment; slept under insecticide-treated mosquito nets (ITNs), and if the child's birth was registered. For older children, outcomes included were school attendance (aged 7–17) and child labour (aged 5–14), and for female adolescents (aged 15-17), early sexual debut and early marriage.

Analytical variables included were: sex of the child; age of the child; household wealth status; presence of an adult member in the household who has been sick for three or more months in the past year; highest education level of any adult in the household; household dependency ratio;

orphanhood status; child's living arrangements; and community characteristics (urban/rural). Multivariate logistic regression models were fitted to assess the strength of the associations between each outcome and analytical variable and results were pooled for all countries.

Results indicate that household wealth status, a child's living arrangements, and household adult education level, are the most powerful and consistent factors associated with key outcomes of child vulnerability. In addition, orphanhood is significant for schooling, child labour, and birth registration. The presence of a chronically ill adult in the household was significant only for school attendance and child labour.

Based on the results of the analysis, it is proposed that child vulnerability in the context of HIV be re-defined at the global level according to three key categories, each of which encompasses household wealth status. Vulnerable children are those who live in a household ranked in the bottom two wealth quintiles who: (1) are not living with either parent; or (2) have lost one or both parents; or (3) are living in a household with adults with no education.

The recommended definition of child vulnerability differs markedly from the 2005 UNICEF and UNAIDS global definition in that it now excludes variables associated with chronic illness among adults in the household, as this variable does not have consistently strong associations with developmental outcomes for children. Importantly, the evidence presented here can help to inform the dialogue on global monitoring and resource estimates for vulnerable children affected by AIDS.

INTRODUCTION

Despite significant achievements in the global AIDS response over the past decade – declining new infections, decreased AIDS-related mortality, and the increased scale-up and availability of antiretroviral therapy – HIV and AIDS continue to have adverse impacts on the lives of children and families worldwide (UNAIDS 2012). As of 2011, an estimated 17.3 million children had lost one or both parents to AIDS globally[1] and millions more have been affected by living in households and communities severely impacted by the epidemic. At the family and household

[1] UNAIDS unpublished HIV estimates, 2012

level, commonly reported impacts on children affected by HIV and AIDS include the loss of parental care and protection, decreased access to schooling and healthcare, increased child labour, increased risk of abuse and exploitation, psychosocial distress, stigma and discrimination and impoverishment (Nyberg et al 2012). Among orphaned youth, an increased risk of HIV infection has also been documented (Birdthistle 2008; Operario et al 2011). Importantly, impacts tend to accumulate and can intensify the vulnerability of children, families, and households over time.

Within this context, identifying and monitoring a core set of global indicators of child vulnerability has been essential for monitoring progress in service coverage, assessing global resource needs and ensuring resources are reaching the most vulnerable children. However, because impacts vary and not all children affected by AIDS are necessarily vulnerable, identifying indicators which apply globally has been challenging.

Existing definitions of child vulnerability within the context of HIV and AIDS have largely been shaped by indicators developed in conjunction with the Declaration of Commitment on HIV and AIDS adopted by the United Nations General Assembly Special Session (UNGASS) on HIV and AIDS in 2001 as well as the UNAIDS Monitoring and Evaluation Reference Group's (MERG) working definition of a 'vulnerable child' (UNICEF and UNAIDS 2005). The indicators set out by UNGASS to identify the most vulnerable children affected by HIV and AIDS included 1) the ratio of school attendance between orphans and non-orphans aged 10–14 and 2) the percentage of orphaned and vulnerable children under 18 whose households received free, basic external support in caring for the child. The first indicator, which is also being tracked globally in conjunction with Millennium Development Goal (MDG) 6, was developed on the assumption that AIDS would lead to an increased number of orphans who would be less likely to attend school than non-orphans. The second indicator (external support) was intended to measure progress in meeting the care and support needs of children affected by HIV and AIDS. This indicator, however, has been revised due to a lack of clarity and agreement on how to define a vulnerable child, and on the need to narrow the components of external support that need to be measured. This revised indicator, which is one of the core indicators used to monitor the 2011 Political Declaration on HIV/AIDS, now measures external economic support to the poorest households affected by HIV and AIDS (UNAIDS 2012).

According to the 2005 UNICEF and UNAIDS definition, a child made vulnerable by HIV and AIDS is below the age of 18 and:

- Has lost one or both parents, or
- Has a chronically ill parent (regardless of whether the parent lives in the same household as the child), or
- Lives in a household where in the past 12 months at least one adult died and was sick for 3 of the 12 months before he/she died, or
- Lives in a household where at least one adult was seriously ill for at least 3 months in the past 12 months, or
- Lives outside of family care (i.e., lives in an institution or on the streets)

Recent evidence however indicates that global indicators used to identify the most vulnerable children in the context of HIV do not consistently identify children with poor outcomes. An analysis of 2008-2009 DHS and MICS household survey data undertaken by Akwara et al (2010) for example concluded that orphanhood or co-residence with a chronically ill or HIV-infected adult did not consistently identify the most vulnerable children when examining three age-disaggregated outcomes: wasting among children aged 0 to 4; school attendance among children aged 10 to 14 and; early sexual debut among adolescents aged 15 to 17.

Rather other factors such as the wealth status of the household (as measured by household asset-based wealth quintiles), the relationship of the child to the caregiver, and the education level of adults in the household had stronger associations with outcomes for children. Moreover, household wealth status was the only consistent predictive factor across age-disaggregated outcomes.

The results of the Akwara et al. analysis are consistent with other research which has found varying effects associated with orphanhood status, as a key marker of vulnerability utilized within the context of HIV and AIDS (Sherr 2008). Much of the literature focuses on educational outcomes among orphaned children (cf. Bicego, Rutstein & Johnson. 2003; Ainsworth & Filmer, 2006; Case, Paxson & Ableidinger 2004; Parikh et al 2007) and to a lesser extent health and

nutritional outcomes (Lindblade, Odhiambo, Rosen & DeCock, 2003; Monasch and Boerma 2004; Johnson, Padmadas, and Smith 2010; de Silva 2012). The effect of orphanhood on schooling varies, depending upon context and outcomes measured, and as suggested by Gin, Li, and Sherr (2012) in a critical examination of the literature is likely moderated or mediated by other factors such as the child's gender, pattern of parental loss (e.g. maternal, paternal, or double), a child's living arrangements, and household poverty (ibid). In addition, there is increasing evidence that many negative impacts experienced by some children affected by HIV/AIDS are poverty-related and the most efficient means of reaching children in greatest need may be through targeting the poorest households (Richter and Desmond 2008; JLICA 2008; Robertson et al 2012).

The impacts on children of living with a chronically ill adult has been less studied (see Gray 2008 however), although there is a growing body of literature on how living in households affected by HIV and AIDS impacts child and adolescent outcomes, relating to education, nutrition, abuse and transactional sex (Bele, Valsangkar and Bodhare 2011; Cluver et al 2011; Magadi 2011; Ndirangu et al 2011; Cluver et al 2012).

From an aid effectiveness and equity perspective, it is critical that global and national resources for children affected by AIDS are reaching those in greatest need. In addition, consistent monitoring at the global and national levels is needed to assess the extent to which the most vulnerable children are being reached with a range of health, education, child and social protection interventions.

With this objective in mind, this study builds on Akwara et al's 2010 work and aims to answer the following research question: What are the consistent factors associated with selected poor developmental outcomes for children, including those affected by HIV and AIDS, that can be used to identify vulnerable children? Similar to the 2010 analysis, of the five criteria identified by the UNICEF and UNAIDS 2005 (above), orphanhood status and whether an adult in the household was sick for three of the past twelve months were included as analytical variables. The current analysis, however, differs from the original 2010 analysis in two fundamental ways. Firstly it examines a broader set of child- and adolescent-level outcomes, including measures not previously studied. Secondly, orphanhood and living arrangements are analysed independently in

the current analysis, so that both the independent and combined effects can be quantified. In the 2010 analysis, guardianship and orphanhood status were intertwined.

The results of the study will inform the development of an improved global measure of the most vulnerable children affected by AIDS, which can be used for monitoring global coverage of social protection, care and support services to children affected by HIV and assessing progress and identify gaps in the HIV response; providing evidence to inform the targeting of programmes for external support to households with vulnerable children, including children affected by HIV and; generating a global denominator for resource estimates of an 'HIV-sensitive' social protection, care and support programmes for vulnerable children including those affected by HIV.

METHODS

Data source

Data used in this analysis are derived from household surveys collected from 11 countries through the Multiple Indicator Cluster Survey (MICS), the Demographic and Health Survey (DHS) and AIDS Indicator Survey (AIS) (see Table 1). The data sets were selected to represent a range of HIV prevalence rates and geographic areas, as well as to contain the key analytic and outcome variables of interest for this study. The most recent surveys available at the time the analysis was undertaken were chosen. Surveys were carried out between 2005 and 2008.

Table 1. Survey data sets included in this analysis

Data source	Country	Survey year	HIV prevalence*
MICS	Central African Republic	2006	4.7
MICS	Malawi	2006	11.0
MICS	Sierra Leone	2005	1.6
DHS	Haiti	2005–06	1.9
DHS	Rwanda	2005	2.9
DHS	Swaziland	2006–07	25.9
AIS	United Republic of Tanzania	2007–08	5.6
DHS	Uganda	2006	6.5
DHS	Zambia	2007	13.5
DHS	Zimbabwe	2005–06	14.3
DHS	Cambodia	2005	0.5

*Adults aged 15–49 years old, Joint United Nations Programme on HIV/AIDS (2010).

MICS

UNICEF assists countries in the collection and analysis of data to fill data gaps in monitoring the status of women and children through its international household survey initiative, the MICS. Now in its fourth round, more than 200 MICS have been conducted in more than 100 countries since the mid 1990s. MICS data are utilized to produce local estimates on a wide range of health, education, child protection, water and sanitation, and HIV and AIDS indicators that are internationally comparable.

DHS/AIS

The USAID-supported DHS programme collects a wide range of data on women, men and children in developing countries in the areas of population, health, and nutrition. The household surveys are nationally and regionally representative. Modules on HIV and AIDS knowledge and awareness are included in most surveys, and HIV testing has been included in more than 50 surveys to date. Similar to DHS, AIS is a nationally representative household survey; however, AIS specifically allows measurement of indicators for monitoring national HIV/AIDS programmes.

Key measures of vulnerability

Several indicators for children and adolescents are used in this analysis to reflect outcomes associated with vulnerability which extend beyond the 2005 UNICEF/UNAIDS definition of a vulnerable child. Table 2 illustrates the key outcomes used in this analysis for children under 5 years, 5–14-year-olds, 7–17-year-olds and 15–17-year-olds. These measures were selected because they reflect key outcomes along a child's developmental lifecycle (first and second decades of life), taking into account data availability. All outcome measures utilized in the analysis are dichotomous (indicating either the presence or absence of a given outcome).

Table 2. Outcome measures

Children age 0–4	Children age 5–17	Adolescents age 15–17
Fever treatment	School attendance (7-17 years)	Early sexual debut
Slept under insecticide-treated nets	Child labour (5-14 years)	Early marriage
Birth registration		

Child-level outcomes

Children under the age of 5 are of particular importance, because poor health outcomes in early childhood can hinder children's growth and development with lasting negative impacts (e.g., Victora et al. 2008).

Fever Treatment

Fever treatment reflects whether a child who had a fever in the two weeks prior to the survey was treated at a health facility or by a health provider.

Slept under insecticide-treated nets (ITNs)

Whether a child slept under an ITN the night before the survey was completed reflects a reduced risk of illness. ITNs are an important component of malaria prevention and can reduce the number of deaths among young children by 20 per cent (Lengeler 2009).

Birth registration

Birth registration measures whether a child's birth is registered with a civil authority. Birth serves as the foundation for safeguarding a child's rights vis-a-vis the State. A child whose birth is not registered may not be able to claim services (e.g. health and education) and protections afforded by the State.

Child- and adolescent-level outcomes

School attendance

This indicator measures whether a child (7-17 years) has ever attended school in the past year. School attendance is associated with poverty reduction, gender equality and lower child mortality rates (UNICEF 2004)

Child Labour

This indicator reflects whether a child has done any kind of work for someone who is not a member of the household in the past week. Child labour is both a cause and consequence of social inequities and may reinforce intergenerational poverty cycles.

Sexual Debut

Early sexual debut refers to sexual debut before the age of 15. Early sexual debut among 15–17-year-olds puts female adolescents at risk for teen pregnancy and both males and females at risk for sexually transmitted infections.

Early Marriage

Early marriage refers to marriage or union before the age of 18. Early marriage is a violation of human rights and disproportionately affects girls, with adverse impacts. It can lead to early pregnancy, social isolation, and poor future health outcomes. It is also linked to not attending school, and to higher maternal and child mortality rates (UNICEF 2009).

Analytical variables

The analytical (background) variables used in the regression analyses include age, sex, wealth quintile ranking of the household, adult chronic illness in the household, household dependency ratio, living arrangements, education level of any adult in the household, orphanhood status, and community characteristics. The analytical variables are defined in Table 3.

Table 3. Definitions of analytical variables

Variable Name	Variable Definition
CHILD VARIABLES	
Age	Age of child at time of survey (completed years)
Sex	
Male	Relative to female
HOUSEHOLD-LEVEL VARIABLES	
Household wealth quintiles	
Wealth Quintile 1 (reference)	Household is in the lowest wealth quintile.
Wealth Quintile 2	Household is in the second lowest wealth quintile.
Wealth Quintile 3	Household is in the middle wealth quintile.
Wealth Quintile 4	Household is in the second highest wealth quintile.
Wealth Quintile 5	Household is in the highest wealth quintile.
Household Dependency Ratio	
Low household dependency ratio <1 (reference)	Household dependency ratio is greater than one. The household dependency ratio is adults over age 64 and children under age 15 to adults age 15–64.
High household dependency ratio or no household member aged 15-64	Household dependency ratio is greater than one or there are no adults of working age in the household.
Household Health	
No adult sick (reference)	No adults in the household have been sick for three or more months in the past 12 months.
Adult sick in household	An adult in the household was sick for three or more months in the past 12 months.
Household Education	
At least one adult in household had primary level education (reference)	At least one adult (18 years and older) in the household has received some education.
No education is highest level of education among all adults in household	None of the adults (18 years and older) living in the household has received any education.

ORPHANING VARIABLE	
Both parents alive (reference)	Both parents are alive.
Single orphan	One parent is dead and one parent is alive.
Double orphan	Both parents are dead.
LIVING ARRANGEMENTS VARIABLE	
Lives with one or both parents (reference)	The child lives with one or both parents.
Lives with other relatives or with no relatives	The child lives with other relatives or no relatives.
COMMUNITYVARIABLE	
Urban	Relative to rural.

Descriptive statistics indicate the unadjusted averages for each outcome and analytical variables, by country. The descriptive estimates were generated using the survey commands *svy* in Stata 12 (StataCorp 2011), which account for the multi-stage survey designs and produce weighted percentages using the sample weights provided in each dataset.

Data were pooled for 11 countries and were analyzed using bivariate and multivariate methods. The number of countries with available data varies by outcome measure. The inclusion of countries in the pooled analysis was determined by whether a given outcome variable was measured in the country's survey for this analysis. For example, whether a child slept under an ITN was not measured in Haiti's 2005-2006 DHS, and therefore Haiti could not be included in the pooled analysis for this outcome measure. In the bivariate analysis, key measures of vulnerability for children were compared by key background characteristics (i.e., analytical variables) described in Table 3 above. Assessments of statistically significant differences (at the $p<0.05$ level) were made using chi-squared tests (results not included here). Multivariate analysis using logistic regression containing nine sets of analytical variables was undertaken to provide controls that allow for the quantification of the strength of associations between analytical and outcome variables, while controlling for other characteristics.

The regression results are presented as odds ratios (OR) with standard errors and p-values. Country variables were included in all models as fixed effects, in order to control for country-specific unobserved effects. Region and country fixed effects were included in earlier versions of the models, and there was little difference in the overall fit of the model, or in the coefficient

sizes and significance, as compared with models with only country fixed effects. Therefore the final models include only country fixed effects. Standard errors are clustered at the primary sampling unit level in order to account for the multi-stage survey designs. Assessments of statistical significance were made at 0.05 level and better.

The analyses presented in this paper are based on an analytical sample. Children for whom data was missing for any of the independent or dependent variables were not included in the models.

LIMITATIONS OF THE ANALYSIS

Although both MICS and DHS are widely considered to be reliable and high-quality sources of population and health information, there are also limitations associated with these data sources. A major limitation is the surveys do not capture any children who live outside households. MICS and DHS therefore do not provide representative estimates for all orphans; they provide estimates for orphans in a population-based representative sample of all households. Some of the most vulnerable children are those living outside the family environment, which will not be captured in these surveys. This is an important distinction when considering targeting of new programmes.

Moreover, HIV status was not available in all of the surveys selected for this report, and where it was, the sample size was not always large enough for the purposes of this study. HIV status of the parent(s) and of the children is not accounted for, and this may be a severe limitation. There is a strong likelihood that some children who have lost one or both parents, due to AIDS-related illnesses, are HIV-positive themselves. The HIV status of these children can affect their physical health and cognitive development, yet it is not possible to show associations between HIV status and dimensions of vulnerability.

Another limitation is the use of the wealth index to classify relative wealth of the survey populations. The wealth indices are survey-specific, relative indicators of overall asset ownership, which serves as a proxy for wealth or poverty. However, the index is often biased towards urban areas (which may appear to be wealthier or better off than rural areas) and may not correlate precisely with poverty as measured from consumption or expenditures. Despite

these limitations, the assets index has been proven to be a highly useful proxy of wealth (Filmer and Scott 2012).

In addition, though they were selected for comparability and they represent a range of measures throughout the life course, the outcomes selected for this analysis are confined to those available in the DHS and MICS data sets and cannot represent all important outcomes.

Furthermore, the role of social norms and socio-economic determinants of child outcomes, including those that shape gender roles, local understandings of childhood, as well as discrimination based on gender, ethnicity, religion, etc., cannot be measured in a survey instrument such as the MICS, DHS, or AIS. These may have important influences on both the outcomes and determinants of vulnerability.

Finally, while household survey data provide rich and extensive data on households, the survey data used are cross-sectional for each country. It is not known, for example, the age at which a child was orphaned, or the previous household living conditions of the orphan. Orphanhood status and living arrangements may have changed before – or after – the critical period of the outcomes analysed in this study. It is not known whether the orphan status preceded the malnutrition, or occurred afterwards. The duration of the current living arrangement is not known, nor is the timing of the acquisition of assets of the household. And though the directly measured indicator was not used for this analysis, HIV status itself cannot be situated in the life history of children or their parents, or household members, as there is no way to know when the virus was contracted among those who are HIV-positive. Therefore, assumptions are made, and the results presented here can only inform us of the associations between these outcomes and selected determinants, regardless of timing of events.

Despite these limitations, the high-quality population-based data provide insights into the associations between indicators of vulnerability (including vulnerability due to HIV) and health and well-being outcomes.

FINDINGS

Descriptive results

The distributions of variables for each outcome in the pooled analysis are presented in Table 4. Samples are broadly divided into four age bands: under 5 years; 15-14 years; 7-17 years; and 15-17 years. In a number of countries for which HIV testing was included in the survey from a sub-sample of households, a variable was created to indicate the presence of at least one HIV positive adult in the household. This variable however was not included in the multivariate regression, because this measurement is not available for all countries. With regard to orphan status, Table 4 presents the distribution by three categories (both parents alive; one parent alive; both parents dead). Given the small percentage of children falling into the category of having both parents dead, single and double orphanhood were combined into one category for the multivariate analysis.

For children under 5 years of age, about 50% had their births registered. Among children who had fever in the two weeks prior to the survey, less than 50% were treated at a health facility or by a health provider. Less than 20% of children under age 5 had slept under an ITN the night before.

Among children aged 5-14, one out of five had worked for someone outside the household in the last week, and among school aged children aged 7-17, the majority (80%) had attended school in the past year.

With regard to adolescent boys and girls (aged 15- 17) slightly more than ten per cent had sex before age 15. In terms of early marriage, more than 10% of girls and less than 1% of boys had married before the age of 18.

Table 4. Descriptive statistics of outcome and analytical variables for pooled data from 11 countries in the study

Outcome variables		**Birth registration Age <5**	**Fever treatment Age <5**	**Slept under ITN Age <5**	**Child labour Age 5 - 14**	**Ever attended school in the last year Age 7-17**	**Sex before age 15 Age 15-17**		**Married before age 18 Age 15-17**	
							Male	**Female**	**Male**	**Female**
Percent		49.8	44.0	16.4	20.0	80.1	12.9	10.1	0.01	10.7
Analytical variables (in %)										
Child characteristics										
Sex	Female	50.1	50.4	50.2	50.6	50.0	N/A	N/A	N/A	N/A
Age	<1	21.1	22.5	21.4						
	1	20.0	25.9	20.4						
	2	19.9	21.8	20.4						
	3	19.9	17.2	19.8						
	4	19.1	12.6	18.0						
	5-9				55.1					
	7-9					30.8				
	10-14				44.9	48.4				
	15-17					20.8				
	15							35.9		35.9
	16							34.6		34.6
	17							29.4		29.4
Household characteristics										
Wealth	Lowest quintile	24.1	24.7	23.4	21.0	21.0		17.1		17.1
	Second quintile	21.9	22.2	21.7	20.3	19.8		17.4		17.4
	Third quintile	20.3	21.1	20.5	19.9	20.1		18.9		18.9
	Fourth quintile	18.8	18.8	18.9	19.9	20.0		22.0		22.0
	Highest quintile	15.0	13.2	15.5	18.9	19.1		24.5		24.5
Adult sick in household for three+ months in past year	Adult sick in household	6.3	7.7	5.5	7.0	7.0		6.5		6.5
HIV positive adult in household*	At least one adult HIV positive	19.3 (n=25214)	15.6 (n=4935)	21.2 (n=22844)	N/A	19.4 (n=48190)		17.5 (n=6188)		17.5 (n=6192)
Sex of household head	Female	23.2	20.9	20.8	24.4	29.5		30.9		30.9
Highest education level of any adult in household	No adult age 18 and over had education	13.9	13..4	12.1	22.4	15.5		11.8		11.8
	Highest education is primary level+	86.1	86.6	87.9	77.6	84.5		88.2		88.2
Household dependency ratio	Dependency ratio greater than 1 or No adult age 15-64 in HH	56.2	52.9	54.7	67.1	56.0		25.1		25.1
*Number of adults over age 64 and children under age 15 to adults age 15-64	Dependency ratio less than 1	43.8	47.1	45.3	32.9	44.0		74.9		74.9
Orphan status	Both biological parents alive	95.6	96.6	95.7	85.1	79.4		74.1		74.2
	Only one parent alive	4.0	3.2	3.9	11.9	16.2		19.8		19.8
	Both biological parents dead	0.4	0.2	0.4	3.0	4.4		6.0		6.0
Living arrangement	Lives with one or both parents	92.3	96.2	93.3	78.4	75.3		65.8		65.9
	Lives with other relatives or with no relatives	7.7	3.8	6.7	21.6	24.7		34.2		34.1
Community characteristics										
Place of residence	Urban	27.3	21.7	22.1	27.2	25.1		28.8		28.8
Number of observations		**67527**	**23322**	**84761**	**66559**	**166290**		**16213**		**16186**

Note: For the variable "HIV positive adult in household," the denominators are different because HIV testing was undertaken on a sub-sample of respondents, and are shown in parentheses below the percentages.

Logistic regression results

Pooled logistic regression results for the outcomes in the study are presented in Table 5, and the associations between the outcomes and the key analytical variables are described below.

Determinants of birth registration

Among children under 5, those living in a household with no educated adults were about 30 per cent less likely to be registered (OR 0.7). The effect of wealth on birth registration indicates that children living in the wealthiest households were almost three times more likely to have been registered (OR 2.8). Children under 5 were less likely to be registered if they lived with anyone other than their parents (OR 0.7) compared with living with one or both parents.

Determinants of fever treatment

Children who lived in households where no adult in the household was educated were less likely to have been taken for fever treatment (OR 0.8). The association of wealth quintile and fever treatment did not vary significantly, except among the top two wealth quintiles (fourth quintile OR 1.4; highest quintile OR 1.6) as compared with children in the poorest households.

Determinants of sleeping under ITNs

Children who lived in households where no adult was educated were about 20 per cent less likely to have slept under an ITN compared with children who lived in households where at least one adult had some education (OR 0.8). Children living with anyone other than their parents were about 30 per cent less likely than those living with one or both parents to be sleeping under an ITN (OR 0.7). The likelihood of sleeping under an ITN increases with household wealth quintile. Children living in the wealthiest households experienced nearly three times greater odds of sleeping under at ITN than children in the poorest households (OR 2.8).

Table 5. Multivariate logistic regression odds ratios for pooled country data, by outcome (standard errors in parentheses)

Variables		Birth registered *Age 0-4*	Child taken to health facility follow-ing fever *Age 0-4*	Slept under ITN last night *Age 0-4*	Child labour *Age 5-14*	Ever attended school in past year *Age 7-17*	Had sex before age 15 among females *Age 15-17*	Married or in union before age 18 among females *Age 15-17*
Child characteristics								
Sex	Male	0.9 (0.02)	1.0 (0.04)	1.0 (0.02)	0.9*** (0.02)	1.2*** (0.02)		
Child age	Age 1 (ref=<1)	1.9*** (0.08)	0.9 (0.04)	0.9* (0.03)				
	Age 2	2.2*** (0.09)	0.9 (0.06)	0.8*** (0.02)				
	Age 3	2.2*** (0.10)	0.8*** (0.03)	0.8*** (0.02)				
	Age 4	2.4*** (0.11)	0.7*** (0.04)	0.7*** (0.02)				
	Age 10-14 (ref= Age 5-9)				1.7*** (0.04)			
	Age 10-14 (ref= Age 7-9)					1.8*** (0.03)		
	Age 15-17					0.5*** (0.01)		
	Age 16 (ref= Age 15)						0.9* (0.06)	2.3*** (0.20)
	Age 17						0.8** (0.06)	6.0*** (0.50)
Household characteristics								
Wealth	Second quintile (ref=lowest quintile)	1.2*** (0.05)	0.9 (0.05)	1.3*** (0.06)	1.1* (0.06)	1.4*** (0.04)	1.1 (0.09)	0.8* (0.08)
	Third quintile	1.4*** (0.07)	1.1 (0.05)	1.5*** (0.08)	1.2** (0.06)	1.8*** (0.5)	0.9 (0.09)	0.6*** (0.06)
	Fourth quintile	1.7*** (0.10)	1.4*** (0.09)	1.7*** (0.09)	1.0 (0.06)	2.5*** (0.08)	0.8* (0.08)	0.4*** (0.04)
	Highest quintile	2.8*** (0.22)	1.6*** (0.10)	2.8*** (0.16)	0.7*** (0.05)	3.9*** (0.15)	0.6*** (0.06)	0.1*** (0.02)
At least one adult sick in HH for three+ months in past year	Adult sick in household	0.9 (0.07)	0.9 (0.60)	0.9 (0.06)	1.1* (0.07)	0.9* (0.03)	1.2 (0.13)	1.0 (0.13)
Sex of household head	Female	0.9 (0.04)	1.1 (0.05)	0.8*** (0.03)	1.1 (0.04)	1.3*** (0.03)	0.9 (0.06)	0.5*** (0.04)
Education level of any adult in HH	No adult age 18 and over had education (ref=At least one adult in HH had primary level education)	0.7*** (0.04)	0.8*** (0.04)	0.8** (0.05)	0.8*** (0.04)	0.4*** (0.01)	1.1 (0.09)	1.0 (0.10)
Household dependency ratio	Dependency ratio greater than 1 (ref= <1 or no adult age 15-64 in HH)	0.9* (0.03)	0.8*** (0.03)	0.9*** (0.02)	0.9 (0.03)	1.0 (0.02)	0.9 (0.06)	0.7*** (0.05)
Orphan status	Only one parent alive or both parents dead (ref= not orphan)	0.9* (0.06)	0.9 (0.08)	0.9 (0.06)	1.2*** (0.05)	0.9*** (0.02)	1.1 (0.07)	0.8*** (0.06)
Living arrangement	Lives with anyone other than parents (i.e., other relatives or non-relatives) (ref= lives with parents)	0.7*** (0.04)	0.9 (0.07)	0.7*** (0.04)	0.9* (0.03)	0.7*** (0.01)	1.8*** (0.11)	7.2*** (0.53)
Community characteristics								
Place of residence	Urban	1.3** (0.08)	1.3*** (0.10)	1.3*** (0.07)	0.9* (0.06)	1.0 (0.03)	1.1 (0.08)	1.3** (0.11)
Observations		**67527**	**23322**	**84761**	**66559**	**166290**	**16213**	**16186**

Standard errors in parentheses; , * p<0.05, ** p<0.01, *** p<0.0001

Determinants of child labour

Males were significantly less likely to work than females (OR 0.9) and older children were more likely to have worked than younger children (OR 1.7). Controlling for other factors, children between the ages of 5 and 14 were about 20 per cent less likely to work if they lived in a household where no adults in the household were educated (OR 0.8). But, if an adult in the household was sick for three or more months of the past year, a child aged 5–14 was more likely to be working compared with a child living in a house with no sick adult (OR 1.1). Children in the wealthiest households were less likely to be working compared with children living in the poorest households (OR 0.7). Orphans, single and double, are more likely to work outside the home compared with non-orphans (OR 1.2). Children living with those other than their parents are slightly less likely to work than those living with one or both parents (OR 0.9).

Determinants of school attendance

If no adults in the household are educated, children are about 60 per cent less likely to attend school compared with counterparts living in households where at least one adult has some education (OR 0.4) Controlling for other factors in the model, the odds for males attending school are about 20 per cent higher than the odds for females (OR 1.2). Those 7–17-year-olds living in a household where an adult was sick for more than three months in the past year were less likely to have attended school in the past year, compared with children who lived in households where an adult was not sick (OR 0.9). The wealthier the household, the greater the odds that the child attended school in the past year. Controlling for all other factors in the model, the odds of attending school were nearly four times greater for those living in the wealthiest households as compared with those in the poorest (OR 3.9).

Orphans, single and double, were less likely to have attended school compared with children whose parents are alive (OR 0.9). Children living with anyone besides their parents experience lower odds of having attended school compared with children living with one or both parents (OR 0.7).

Determinants of early sexual debut

Female adolescents living in the wealthiest households were less likely to have experienced sexual debut before age 15 compared with the poorest (OR 0.6). Female adolescents living with other relatives or no relatives had increased odds of experiencing sex before age 15 compared with adolescents who lived with one or both parents (OR 1.8).

Determinants of early marriage

Across all quintiles, the odds of early marriage among female adolescents were significantly lower compared with the poorest group. Those living in the wealthiest households were less likely than those living in poorest households to be married before age 18 (OR 0.1).

The odds of early marriage were more than seven times greater for adolescents living with other relatives or no relatives compared with those living with one or both parents (OR 7.2). Orphans, single and double, were less likely to marry early compared with non-orphans (OR 0.8).

Main findings by background characteristics

Household characteristics

Education of Adults

Lack of education of adults in the household is significantly associated with lower odds of attending school (OR 0.4), child labour (OR 0.8), birth registration (OR 0.7), fever treatment (OR 0.8) and sleeping under ITNs (OR 0.8). There was no significant association between the lack of education amongst adults in the household and early marriage or early sex among female adolescents.

Adult Chronic Illness

Living with an adult who had been sick for three or more months in the past year was significantly associated only with lower odds of school attendance (OR 0.9) and higher odds of child labour (OR 1.1).

Wealth

Household asset index ranking (relative for each country) is significantly associated with greater odds of attending school, birth registration, and sleeping under an ITN. Household asset ranking is significantly associated with fever treatment for children among the top two wealth quintiles (fourth quintile OR 1.4; highest quintile OR 1.6). Children living in the wealthiest households are significantly less likely to be engaged in child labour as compared with children in the poorest households (OR 0.7). Only in the top two wealth quintiles are female adolescents significantly less likely to engage in early sex (fourth quintile OR 0.8; highest quintile OR 0.6)) when compared with female adolescents in the poorest households. The odds of marrying before age 18 drops with each increase in wealth ranking compared with the poorest households.

Living arrangements and orphanhood status

Those living with anybody other than parents have significantly lower odds of school attendance (OR 0.7), child labour (OR 0.9), birth registration (OR 0.7), sleeping under at ITN (OR 0.7).

Orphans, single and double, are less likely to attend school (OR 0.9)) and more likely to be engaged in child labour compared with non-orphans (OR 1.2). Orphans are slightly less likely to have their births registered (OR 0.9).

The odds of early sexual debut and early marriage are greater for female adolescents living with those other than their parents (sexual debut OR 1.8; early marriage OR 7.2) as compared with those living with one or both parents. Orphans have no different odds of early sexual debut compared with non-orphans; yet, orphans are less likely to be married or in union before age 18 compared with non-orphans (OR 0.8).

DISCUSSION

The results of this study further validate the results of the 2010 Akwara et al. study by using a new set of country data, as well as by using alternative robust statistical techniques, including pooling data sets with fixed country effects, separating orphanhood status from living arrangements and clustering the standard errors of model estimates to account for the survey designs. These results indicate that household wealth, a child's living arrangements, and household adult education are the most powerful and consistent factors associated with key outcomes of vulnerability. Orphanhood status is also significant for some outcomes. Orphanhood matters for schooling, child labour, and birth registration. The presence of a chronically ill adult in the household was significant for school attendance (lower) and child labour (higher), but not a consistent predictor of poor outcomes, after controlling for all other main analytical variables. These findings reinforce and build on the previous work by Akwara et al., and can contribute to the evidence to be used to propose a set of recommended indicators best-suited to differentiate vulnerable children and adolescents.

Household wealth

Household wealth, measured in quintile ranking within each survey, is consistently and significantly associated with every outcome for children and adolescents. Those living in the wealthiest quintile, as compared with the poorest, fare better in school attendance, child labour, birth registration, early marriage and sexual debut, fever treatment and ITN use. Household wealth, therefore, is an important marker of health and development outcomes.

A child's living arrangements

Living arrangements can vary whether or not a child is an orphan. Children living with those other than their parents fare significantly worse on birth registration, sleeping under an ITN, school attendance and have greater odds of early sexual debut and early marriage. Independent of orphanhood status, household living arrangement is an important marker of well-being.

The education level of the adults in the household

The education level of any adult in the household, defined as no education or any education, is significantly associated with many outcomes for children. The lack of education of adults in the

household is significantly associated with lower odds of attending school, birth registration, fever treatment, and sleeping under ITNs.

Orphanhood

The results show that orphanhood status is independently associated with some key outcomes, and the effect is distinct from living arrangements. Orphans are less likely than non-orphans to attend school, more likely to work compared with non-orphans, and less likely to have their births registered. Orphanhood status however is not consistently associated with child vulnerability across all developmental outcomes. They are no different from non-orphans in the likelihood of early sexual debut, treatment for fever, and ITN use.

Plausible scenarios could explain the lack of consistent associations among orphanhood status and health outcomes. Firstly, it is well known that MICS, DHS, and AIS represent the household population, and by definition only orphans who live in households would be included in the survey. Orphans who live in institutional or non-household settings will not be represented in these results. Furthermore, many programmes focused on HIV and AIDS and orphans and vulnerable children were not specifically targeting children living in the poorest households, and in many cases financial support may have followed orphans, including in wealthier households. Conversely, the significant association between orphanhood and child labour and school attendance may be explained by the death of parents affecting economic activity of the household (leading to child labour and less frequent school attendance). Additional qualitative analysis of how orphaning affects household dynamics is needed to elucidate the quantitative results presented here.

RECOMMENDATIONS AND CONCLUSIONS

Child vulnerability is an issue that cuts across development programming and planning in the sectors of HIV and AIDS, health, child protection and social protection. Based on the results of the analysis, it is proposed to redefine child vulnerability in general and in the context of HIV and AIDS. For overall child vulnerability, we recommend a broader definition which is HIV-sensitive (in that it is inclusive of HIV-affected children), but is also inclusive of other equally

vulnerable children who are not presently affected by HIV. The broader definition takes into account orphanhood and the other two categories (a child's living arrangements and the lack of education of adults in the household) in conjunction with household wealth ranking. Therefore vulnerable children are those who live in a household ranked in the bottom two wealth quintiles and who: (1) are not living with either parent; or (2) have lost one or both parents; or (3) are living in a household with adults with no education. This wider definition will be useful for broader developmental responses in health, child and social protection and education programmes.

As detailed above, one category of child vulnerability is being an orphan (lost one or both parents) and living in a household ranked in the bottom two wealth quintiles. This relates closely to child vulnerability in the context of HIV and AIDS. HIV is one of the main drivers of parental death, particularly in high prevalence contexts and settings, and poor households are least resilient to the economic impacts of increased morbidity and mortality. For HIV and AIDS global programme monitoring purposes, we recommend using this as a denominator for tracking coverage and assessing resource needs for the protection, care and support of children affected by AIDS, including educational and economic assistance to households.

The recommended definition of child vulnerability differs in several ways from the 2005 UNICEF and UNAIDS global definition in that it now excludes variables associated with chronic illness among adults in the household, as these variables do not have consistently strong associations with developmental outcomes for children. Instead, the definition now focuses on the following four variables: household wealth status, orphanhood status, a child's living arrangements, and the education level of adults in the household. To varying degrees, these indicators are significantly associated with key health and social outcomes among children across selected countries and HIV epidemic contexts, and are readily collected in household surveys and censuses with high temporal frequency, which is crucial for global monitoring.

This set of analytical variables can be used to identify vulnerable children both for determining a global denominator and for informing targeting. However, it is recommended that additional contextual national and sub-national vulnerability analysis is needed to inform programmatic targeting. The indicators and the outcomes are mostly not HIV-specific, yet in the case of orphaning status we can see this as a useful proxy of HIV affectedness, particularly in high HIV

prevalence settings. Using these four indicators, estimates of the number of children who fall into each of the defined measures of vulnerability, as well as those who fall into the combinations of these measures, can be calculated. Monitoring these indicators over time will help to ensure that progress continues to be made in reaching the most vulnerable children worldwide and responding to their needs. As next steps, it is recommended that the *Guide to Monitoring and Evaluation of the National Response for Children Orphaned and Made Vulnerable by HIV/AIDS* (2005) and that questionnaire modules for household surveys be reviewed and revised in light of the current analysis and that resource estimates for social protection, care and support programmes for children affected by HIV and AIDS be undertaken based on the new denominator.

REFERENCES

Ainsworth M., & Filmer, D. (2006). Inequalities in children's schooling: AIDS, orphanhood, poverty, and gender. *World Development*, 34: 1099-1128.

Akwara, Priscilla A., et al. (2010). "Who is the Vulnerable Child? Using survey data to identify children at risk in the era of HIV and AIDS," *AIDS Care*, 22, 9, September 2010, 1066–1085.

Barnett, T., & Whiteside, A. (2002). Poverty and HIV/AIDS: Impact, coping, and mitigation policy. In *AIDS, public policy, and child well-being.* (Chap. 11). Florence, Italy: UNICEF.

Behrman, J.R., Alderman, H., Hoddinott, F. (2004). Malnutrition and hunger. In B. Lomborg (Ed.), *Global Crises, Global Solutions* (pp. 363-420). Cambridge, UK: Cambridge University Press.

Bele, Samir D., Valsangkar, S., and Bodhare, T. (2011). Impairment of nutritional, educational status, and quality of life among children infected with and belonging to families affected by human immunodeficiency virus/acquired immune deficiency syndrome. *Vulnerable Children and Youth Studies* 6(4): 284

Belsey, M.A. and Sherr, L. (2011). 'The definition of true orphan prevalence: trends, contexts, and implications for policies and programmes. *Vulnerable Children and Youth* 6(3): 185-200.

Bicego, G., Rutstein, S. and Johnson, K. (2003). Dimensions of the emerging orphan crises in sub-Saharan Africa. *Social Science and Medicine* 56: 1235-1247.

Campbell, P., Moroni, M., & Webb, D. (2008). A review of monitoring and evaluation in support of orphans and vulnerable children in east and southern Africa. *Vulnerable Children and Youth Studies*, 3(3), 159 -173.

Case A., Paxson,C., & Ableidinger, J. (2004). Orphans in Africa. *Demography*, 41(3), 483-508.

Clark, S. (2004). Early marriage and HIV risks in Sub-Saharan Africa. *Studies in Family Planning*, 35(3), 149-160.

Cluver, L., Orkin, M, Boyes, M,, Gardener, F. and Meinch, F. (2011). 'Transactional Sex among AIDS-Orphaned and AIDS-Affected Adolescent Predicted by Abuse and Extreme Poverty' *JAIDS* 58(3): 336-339

Cluver, L., Operario, D., Lane, T., and Kganakga (2012) "I can't go to school and leave her in so much pain" Educational shortfalls among adolescent 'young carers' in the South Africa AIDS Epidemic. *Journal of Adolescent Research* 27(5): 581-605.

Crampin, A.C., Floyd, S., Glynn, J.R., Madise,N., Nyondo, A., Khondwe,M.M., Njoka,C.L., Kanyongoloka, H., Ngwira, B., Zaba, B., & Fine, P.E. (2003). The long-term impact of HIV and orphanhood on the mortality and physical well-being of children in rural Malawi. *AIDS*, 17, 389-397.

DeSilva MB, Skalicky A, Beard J, Cakwe M, Zhuwau T, Quinlan T and Simon J (2012). Early impacts of orphaning: Health, nutrition, and food insecurity in a cohort of school-going adolescents in South Africa, *Vulnerable Children and Youth Studies: An International Interdisciplinary Journal for Research, Policy and Care*, 7:1, 75-87.

Filmer, Deon, and Kinnon Scott, "Assessing Asset Indices," *Demography*, vol. 49, no. 1, February 2012, pp. 359–392.

Franco, L.M., Burkhalter, B., de Wagt, A., Jennings, L., Gamble Kelly, A., & Hammink, M.E. (2009). Evidence base for children affected by HIV and AIDS in low prevalence and concentrated epidemic countries: Applicability to programming guidance from high prevalence countries, *AIDS Care*, 21 (S1), 49-59.

Grantham-McGregor, S., Cheung, Y.B., Cueto, S., Glewwe, P., Richter, L., & Strupp, B. (2007). Developmental potential in the first 5 years for children in developing countries. *Lancet*, 369(9555), 60-70.

Gray, G.E., Van Niekerk, R., Struthers, H., Violari, A., Martinson, N., McIntyre, J., & Naidu, V. (2006). The effects of adult morbidity and mortality on household welfare and the well-being of children in Soweto. *Vulnerable Children and Youth Studies: An International Interdisciplinary Journal for Research, Policy and Care*, 1(1): 17-30.

Guo Y, Li X, Sherr L. (2012). The impact of HIV/AIDS on children's educational outcomes: A critical review of the global literature. *AIDS Care* 24 (8): 993 – 1012.

Jain, S and K Kurz (2007) "New Insights on Preventing Child Marriage: A Global Analysis of Factors and Programs," USAID, ICRW, Pact and IGWG Publication: Washington, DC.

Jensen R and R Thornton (2003) "Early Female Marriage in the Developing World," *Gender and Development*, 11(2):9-19.

Johnson, Fiifi A. (2010) Orphanhood and vulnerability: A conduit to poor child health outcomes in Rwanda. *AIDS Care* 22(3): 314.

JLICA (2008) *Home truths. Facing the facts on children, AIDS, and poverty*. Technical report, Joint Learning Initiative on Children and HIV/AIDS (JLICA).

Lengeler, Christian, 'Insecticide-Treated Bed Nets and Curtains for Preventing Malaria (Review)', John Wiley & Sons, 2009.

Lindblade, K.A., Odhiambo,F., Rosen, D.H., & DeCock, K.M. (2003). Health and nutritional status of orphans <6 years old cared for by relatives in western Kenya. *Tropical Medicine and International Health*, 8(1), 67-72.

Madise N., Zulu, E., & Ciera J. (2007). Is poverty a driver for risky sexual behaviour? Evidence from national surveys of adolescents in four African countries. *African Journal of Reproductive Health*, 11(3), 83–98.

Magadi, Monica A. (2011). Household and community HIV/AIDS status and child malnutrition in sub-Saharan Africa: Evidence from demographic and health surveys. *Social Science and Medicine*, 73(3): 436-446.

Monasch R and Boerma JT (2004) Orphanhood and childcare patterns in sub-Saharan Africa: An analysis of national surveys from 40 countries. *AIDS*, 18 (Suppl. 2), S55-S65.

Ndirangu M, Wariero JO Sachs SE, Masibo P, Deckelbaum RJ (2011). Nutritional status of under-five children in HIV-affected households in western Kenya *Food and Nutrition Bulletin,* 32 (2): 159-167.

Nyberg BJ, Yates DD, Lovich R, Coulibaly-Traore D, Sherr L, Thurman TR, Sampson A, and Howard B. (2012). Saving Lives for a Lifetime: Supporting Orphans and Vulnerable Youth Impacted by HIV/AIDS. *JAIDS* 60(3): S127-S135.

Nour, N.M. (2006). Health consequences of child marriage in Africa. *Emerging Infectious Diseases*, 12(11), 1644-1650.

Palermo, T. & Peterman, A. (2008). Orphanhood as a risk factor for child marriage and early sexual debut: Evidence from sub-Saharan Africa," mimeo, Chapel Hill, NC: Dept. of Public Policy, UNC/ Chapel Hill.

Parikh A., Desilva, M.B., Cakwe, M., Quinlan, T., Simon, J.L., Skalicky, A., & Zhuwau, T. (2007). Exploring the Cinderella myth: intrahousehold differences in child wellbeing between orphans and non-orphans in Amajuba District, South Africa. AIDS 21 (suppl.7), s95-s103.

Radcliff, E. (2012). 'Association between Family Composition and the Well-being of Vulnerable Children in Nairobi, Kenya' *Maternal and Child Health Journal* 16(6): 1232-40.

Richter L and Desmond, C. (2008). Targeting AIDS orphans and child-headeade households? A perspective fron national surveys in South Africa, 1995-2005. *AIDS Care* 20, 9, 1019-1028.

Roberston, L. (2010) Sexual risk among orphaned adolescents: Is country-level HIV prevalence an important factor? *AIDS Care* 22(8): 927.

Robertson, L. et al (2012). Household-based cash transfer targeting strategies in Zimbabwe: Are we reaching the most vulnerable children? *Social Science and Medicine* 75: 2502-2508.

Rutstein, Shea O., and Kiersten Johnson, 'The DHS Wealth Index', *DHS Comparative Reports*, no. 6, ORC Macro, Calverton, Maryland, 2004.

Schenk, K. Ndhlovu, L., Tembo, S. Nsune, A., Nkhata, C. Walusiku, B. & Watts, C. (2008). Supporting orphans and vulnerable children affected by AIDS: Using community-generated definitions to explore patterns of children's vulnerability in Zambia. *AIDS Care*, 20 (8), 894 – 903.

Sherr, L., Varrall, R., Mueller, J., Richter, L., Wakhwega, A., Adato, M., Belsey, M., Chandan,U., Drimie, S., Hosegood, V., Kimou, J., Madhavan, S., Mathambo, V., & Desmond, C. (2008). A systematic review on the meaning of the concept 'AIDS Orphan': confusion over definitions and implications for care, *AIDS Care*, 20 (5), 527-536.

Thielman, N. et al (2012). Correlates of poor health among orphans and abandoned children in less wealthy countries; the importance of caregiver health. PLoS One 7, 6, e38109

UNAIDS. Gobal AIDS Response Progress Reporting 2012. Guidelines. Construction of core indicators for monitoring the 2011 Political Declaration on HIV/AIDS.

UNICEF (2005) State of the World's Children. New York: Author

UNICEF (2009). State of the World's Children. New York: Author.

UNICEF and UNAIDS. (2005). Guide to monitoring and evaluation of the national response for children orphaned and made vulnerable by HIV/AIDS. New York: UNICEF.

United Nations General Assembly (2001). Declaration of Commitment on HIV/AIDS, United Nations, New York.

Victora, C.G., Adair, L., Fall, C., Hallal, P.C., Martorell, R., Richter, L., & Sachdev, H.S. (2008). Maternal and child undernutrition: consequences for adult health and human capital. *Lancet* 371(9609), 340-357.

WHO. (2006). WHO child growth standards: length/height-for-age, weight for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. Geneva: Author.