The World Bank Group

Progress and challenges for improving child & maternal health in a post-conflict setting: the case of South Sudan

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A. INTRODUCTION

The Republic of South Sudan is emerging from a prolonged civil conflict and faces immense social, economic and political challenges, including: high morbidity and mortality from preventable disease, increasing inter and intra-tribal tensions over resources and political space (Schomerus and Allen 2010), absence of functional physical infrastructure, high unemployment, a large but sparse rural population that is not well connected to population centers (83% of the population lives in rural areas), pressures from returnees, the emergency assistance requirements of those displaced by conflict in the border areas (Medecins Sans Frontieres 2011), high rates of poverty (50% of the population is under the poverty line) and extremely low levels of education (75% of heads of households have not completed any level of education) (World Bank 2010).

In 2005, the Comprehensive Peace Agreement (CPA) signed by the Sudanese People's Liberation Army (SPLA) and the Government of Sudan (GoS) ended 22 years of civil war, in which an estimated 2 million people died, and established the Government of National Unity (GONU) and the Government of South Sudan (GoSS). Guided by the CPA and supported by donors, GoSS set out to create accountable government structures, reliable service delivery, civic education, security and coordination between development agencies. However, given the complexity of these objectives and the lack of a clear implementation road map, much of the political effort placed emphasis on achieving the much clearer CPA technical milestones: the census, elections and the referendum for independence– held in January 2011. Currently, domestic and international stakeholders face the broader project of stabilization, reconstruction, and institution building as efforts move away from meeting immediate needs through emergency humanitarian assistance towards laying the foundation for sustainable self-governance through long term development.

The legacy of war, the implementation of the CPA and independence has shaped the opportunities and challenges for health systems building in South Sudan. During the war, existing public health infrastructure collapsed and health services in non-garrison towns (controlled by the government of Sudan (GoS)) were delivered primarily by NGOs and UN agencies operating emergency relief programs at the local level (USAID 2007). What emerges is a sparse, fragmented and independent group of vertically run programs relying on external financing and management structures amidst a population exposed to a large number of health risks. To a large degree - with the proliferation of aid that accompanied the signing of the CPA, short-term funding cycles, and poor coordination between donors – fragmentation persists (Cometto, Fritsche et al. 2010).

While the CPA provided a broad framework for peace and institution building, it also created an expectation among the population of tangible benefits, primarily personal security and access to resources and services. In South Sudan, whether these expectations can be met will depend to a large degree on the ability of the young bureaucracy to strengthen its capacity to deliver core functions of government. Going forward there will be growing pressure on GoSS, including the Ministry of Health (MoH) to bring tangible benefits to the population to establish credibility. In addition, decentralization and the devolution of power to states and counties - a key provision of the CPA – has had destabilizing effects brought about by lack of accountability and authority among government structures at the local level (Schomerus and Allen 2010). A focus on decentralization influenced the creation of State Ministries of Health (SMoH) responsible for the overall management of county health services.

Decentralization poses challenges in the areas of budgeting and access to resources, planning, coordination, communication and ensuring sufficient managerial capacity exists at the local level.

While significant progress has been made in strengthening the health system in South Sudan since the CPA, in particular the creation and staffing of the central and state MoH, the development of overarching sector policies (including the Southern Sudan Interim Health Policy and Basic Package of Health Services that provide the vision and values underpinning the health system and the norms to guide service providers) and the prioritization of data collection through national household surveys, much work remains to ensure the ministries can effectively manage its multiple functions and partnerships effectively. Key challenges include low government capacity, leveraging aid financing for capacity building and long-term development, and coordinating efforts effectively between all stakeholders.

South Sudan's health system plays two key roles within the broader objectives of the emerging state: (1) Meeting immediate population health needs by providing essential services that reduce excess mortality and morbidity and (2) strengthening the legitimacy of the government by building social institutions and cohesion among the population (Kruk, Freedman et al. 2010).

South Sudan's population health status reflects the long-term effects of prolonged violent conflict, the destruction of basic health services and sustained exposure to multiple health risks. Vulnerable populations – particularly women and children – are at greatest risk of premature death and disability. The reasons are manifold: food insecurity, malnutrition, early and frequent pregnancy, inadequate access to water and sanitation. In addition, collapsed physical infrastructure and constrained financial and human resources limits the ability of the health system to treat preventable conditions such as malaria, diarrhea and pneumonia. Other challenges facing the health system include responding to the needs of those internally displaced by conflict, responding to outbreaks of neglected infectious diseases – such as the major outbreak of leishmaniasis (Kala Azar) in the Upper Nile region in 2010 (Medicins Sans Frontieres 2011), the threat of increased incidence of HIV/AIDS, and management of endemic diseases such as tuberculosis, malaria and pneumonia.

A separate role of the health system involves fostering social cohesion through signaling values (such as equality and social solidarity) and building trust in the government more broadly. Given growing perceptions of government ineffectiveness, unequal distribution of resources between rural and urban areas, and an expectation of improvement after independence – the tangible benefits of a well-functioning health system can be an important tool to provide the population with a sense of security and protection.

The WHO defines good health services as those which deliver effective, safe, quality personal and non-personal health interventions to those who need them, when and where needed, with minimum waste of resources. This implies platforms and systems of delivery that provides evidence-based and cost-effective interventions, training institutions creating knowledgeable health workers with the skill and motivation to provide those services, quality management and logistics systems and consistent and adequate financing – these are systems which are currently in development by the Government of South Sudan (GoSS) in partnership with civil society and international donors.

One objective of this report is to provide a reference on the levels and trends in under-five mortality, the coverage of evidence-based child and maternal survival interventions for individuals in need and the

characteristics of health financing in South Sudan using relevant, population representative data sources. In addition, this paper examines patterns in access to health services associated with socio-demographic characteristics in order to help identify where gaps exist and where progress has been made. Table A1 provides an overview of the data sources available to generate population based health indicators for South Sudan. This report draws primarily from the 1989-1990 Sudan Demographic and Health Survey (DHS), the 2006 and 2010 Sudan Household Health Survey (SHHS), the 2008 Census and the 2008 National Baseline Household Survey (NBHS). Due to two prolonged civil wars (the first, from 1955-1972 and the second, from 1983-2005) the population-based health surveys used to measure fertility, mortality, life expectancy, health system indicators and the epidemiology of disease in Sudan have historically excluded the south making a proper assessment of the health status of the region difficult. The SHHS completed in 2006 was the first household survey effort to systematically collect health-related data for the population of South Sudan, which was followed up with a second health survey in 2010 – both provide an important evidence-base to guide health policy and resource allocation for the sector.

Table A1. Data sources for population based measures of health in Sudan

Year	Census/ Survey	Sample Size (households)	Coverage	Micro-Data Publicly Available
1973	Sudan Census	NA	North & South	No
1978-79	Sudan Fertility Survey (SFS)	12,000	North	The Office of Population Based Research at Princeton University: http://opr.princeton.edu/archive/wfs/SD.asp
1983	Sudan Census	NA	North & South	No
1989-1990	Sudan Demographic & Health Survey (SDHS)	6,891	North	Measure DHS (with approval): http://www.measuredhs.com/accesssurveys/
1992-1993	Pan Arab Project for Child and Mother Health (PAPCHILD)	6,940	North, South	No
1993	Sudan Census	NA	North	No
1999	Safe Motherhood Survey (SMS)	16,075	North, 3 southern urban centers	No
2000	Multiple Indicator Cluster Survey II (MICS II)	North: 23,192 South: 1,551	North, 3 southern urban centers	UNICEF MICS program (with approval): http://www.childinfo.org/mics2_datasets.html
2006	Sudan Household Health Survey (SHHS)	North: 14,970 South: 9,557	North & South	South Sudan Center for Census, Statistics and Evaluation (with approval): http://www.ssccse.org/
2008	Sudan Census (Long Form)	North: 922,816 South: 92,592	North & South	Minnesota Population Center - IPUMS http://www.ipums.org/
2008	National Baseline Household Survey (NBHS)	North: *7,913* South: *4,969*	North & South	No
2009/2010	Sudan Household Health Survey	North: 14,778 South: 9,369	North & South	In progress

Source: Adapted from the International Monetary Fund's General Data Dissemination System (http://dsbb.imf.org/pages/gdds)

Figure A1. Map of South Sudan

Source: United Nations Mission Office in Sudan

B. MATERNAL AND CHILD SURVIVAL

Levels and trends in under-five and infant mortality

Key findings and discussion

- The variation of under-five mortality estimates for South Sudan derived from multiple household surveys and alternative demographic methods during overlapping periods of exposure reduces confidence in any single estimate. This variation reflects the difficulties (past and present) faced by families in the region (with conflict provoking elevated levels of adult mortality and migration) that inevitably result in selection biases and reduced accuracy of recalled events.

- Specifically, the survey data from which mortality estimates are derived excludes the mortality experiences of children whose mother's did not survive the war. These children are more likely to have died compared to the children of mothers who survived the war, thus creating the potential for significantly underestimating older mortality estimates. In addition, many of the mothers present in 2006, and especially those present in 2010, may have been abroad or in the North at the time of war. Therefore, many of the long-ago births are those that took place out of South Sudan, in better conditions than those during the civil war. This would result in lower mortality figures than one would get if it were possible to only consider births that took place within South Sudan.

- Available evidence suggests that survival conditions for children in South Sudan improved substantially – with under-five mortality falling by 48 percent (representing an average rate of decline of 3 percent per year) between 1984 and 2008 - from 203 to 105 deaths per 1000 live births.

- Under-five mortality levels for South Sudan are 25 percent higher than those in Sudan (North); 15 percent lower than the average for Africa and 78 percent higher than the global average.

- While a causal analysis of the drivers of declines in under-five mortality is not within the scope of this study, child survival likely improved as the direct effects of war and violence (compounded by famine and drought) fell towards the approach of the CPA. The indirect-effects of conflict, however, linger (as evident by the excess mortality of children in the South versus the North - which serves as a crude counterfactual).

- Mortality among children is heavily concentrated during their first year. An estimated 68 percent of deaths occurring before the age of five, happen during infancy (before children reach one year of age) and approximately 34 percent of deaths occurring before the age of five happen during the neonatal period (in the first 30 days after birth).

- By comparison, in Sudan (North), under-five mortality declined by 39 percent (on average, 1.3 percent per year) between 1965 and 2008 - from 145 to 89 deaths per 1000 live births. Improvements in under-five mortality during this period were driven primarily by reductions in child mortality (deaths among children aged 1-5). Progress in reducing infant mortality was much slower by contrast.

Data and methods

Under five mortality – the probability of dying between birth and exact age five (5q0) - can be measured using census, vital registration or survey data. While the most precise estimates of under-five mortality are obtained from vital registration systems that capture all births and deaths, in their absence, measurement of under-five mortality relies on surveys that retrospectively ask women to report on the births and deaths of their children. The assessment of the levels and trends in under-five mortality presented here draws from three household surveys and a census: the 2006 and 2010 Sudan Household Health Survey (SHHS), the 1999-2000 Demographic Health survey (DHS) and the 2008 Census Long Form. The SHHS and Census cover all states and are representative at the state level. The DHS only covers states in Sudan (North) and is representative at the regional level. In 2008, South Sudan conducted its first Census as part of the Comprehensive Peace Agreement (CPA). In addition to the full enumeration of the population, a 10% random sample of households completed a more detailed questionnaire – the long form - on household characteristics and included questions on vital events (such as births and deaths). The analysis conducted here was limited to this sample. Table B1 summarizes the key characteristics of each data source. Sample weights from the 2006 SHHS were adjusted to take into account population counts from the 2008 population census – these adjustments are explained in Annex 1.

Table B1. Data sources for analyses of under-five mortality

	Demographic Health Survey (DHS)	Sudan Household Health Survey (SHHS)	Census (Long Form)	Sudan Household Health Survey (SHHS)
Year	1989/1990	2006	2008	2010
Number of households interviewed				
Sudan (North)	6,891	14,826	922,816	14,778
South Sudan	0	9,220	92,592	9,369
Number of women (of reproductive age 15-49) interviewed				
Sudan (North)	5,860	18,186	1,196,309	17,174
South Sudan	0	8,737	129,802	9,077
Number of live births recorded				
Sudan (North)	25,805	47,120	2,810,651	47,092
South Sudan	0	30,499	339,200	28,720
Number of live births per women (overall)				
Sudan (North)	4.40	2.59	2.35	2.74
South Sudan	--	3.49	2.61	3.16
Geographic coverage	North	North & South	North & South	North & South
Sub-Nationally Representative?	By region	By state	By county	By state

Source: Author's calculations from DHS, SHHS and CENSUS

When using survey data to measure under-five mortality, two methods are available: the complete birth history (or direct) method and the summary birth history (or indirect) method. The direct method uses data from several questions asked to mothers of reproductive age regarding each birth, including the child's date of birth, sex, survival status, current age, or if deceased - the age at death. Data from these questions enable the direct estimation of probabilities of survival and death at different ages. Details of the methodology used to estimate under-five mortality using the direct method are provided in Annex 2.

The indirect method by contrast, requires answers to only two questions: the total number of live births and surviving children per mother. The proportion of children ever born who have died by five-year age groups of mothers is then used to obtain estimates of under-five mortality (displayed in Table B8). This technique was originally developed based on observations of a strong relationship between these proportions and population-level child mortality rates (Brass and Coale 1968). Subsequent refinements enabled the estimated rates of mortality to be localized in time (Feeney 1980).

Two indirect methods were used: the Standard Indirect (Brass) Method described in United Nations' Manual X and incorporated in the software package QFIVE (United Nations 1983); and the Maternal Age Cohort-Derived Method (MAC) developed by the Institute for Health Metrics and Evaluation (IHME) and described in a recent paper (Rajaratnam, Tran et al. 2010). Only MAC estimates are presented in the results below. In addition, under-five mortality estimates using the indirect method from mothers between the ages of 15-19 are not used because adolescent births tend to occur among poor women and are disproportionately first births they are not comparable to births from other age cohorts.

Estimates of under-five mortality obtained from the direct and indirect methods from each data source were synthesized using a locally weighted scatterplot smoothing (lowess) procedure to obtain a single trend. Given the low level of the estimates for South Sudan derived from the 2006 SHHS (mostly concerning estimates prior to 2003) relative to estimates produced from the 2010 SHHS and 2008 Census (on average, – the 2006 SHHS mortality estimates are not taken into consideration in the lowess procedure for South Sudan. In the absence of objective criteria and additional detail about the data collection process for each survey, the lowess procedure used here gives equal weight to all estimates, regardless of the data source or method of estimation. Estimates of infant mortality – the probability of dying between birth and exact age one - were obtained by using direct estimates of infant and under-5 mortality to compute the share of under-five deaths occurring before the first year of life and applying these shares to the lowess estimates of under-five mortality. Where available, estimates from other studies and surveys were used to validate the estimates produced here.

Sources of error in mortality measurement

The degree of accuracy of mortality estimates depends on sampling variability and on non-sampling errors. Non-sampling errors depend on the extent to which information provided by mothers is accurate and complete and the extent to which the mothers interviewed are representative of the general population of mothers in South Sudan. One important drawback of the direct approach is that it places high demand on the respondent to recall dates of birth and deaths (Rajaratnam, Tran et al. 2010). In South Sudan – where literacy and numeracy is low, fertility rates are high and decades of violent conflict have displaced large populations – the risk of recall bias is high. Omission of births and deaths affects mortality levels, misreporting of birth and death dates impacts mortality trends, and misreporting of age at death may distort the age pattern of mortality (DHS 1991).

Both direct and indirect estimates will be affected by the composition of women interviewed at the time of the survey. If interviewed women are systematically different from women who are not interviewed (for various reasons discussed below), selection bias will introduce error in mortality estimates. One important source of selection error is associated with the fact that as only surviving women are interviewed, no information is collected on the mortality conditions of children who have been orphaned (Preston, Heuveline et al. 2001) - in

populations severely affected by conflict and elevated adult mortality, such as South Sudan, historical under-five mortality estimates (during periods of intense conflict in the 1980's for example) based on interviews of surviving women in the 2000s will likely be underestimated. A related issue is that the household surveys exclude women who have emigrated and include women who have returned to South Sudan and whose children were born elsewhere.

Another potential source of selection error that affects both direct and indirect estimates, stems from low response rates to the SHHS individual women's questionnaire among eligible women of reproductive age. In 2006, overall non-response for South Sudan was 33 percent and in 2010, non-response was 21 percent (as a reference, in the 1989/90 DHS, non-response among eligible women respondents was 4.4%). Table B2 displays the response rates for the North and South as well as the range in response rates across individual states.

Table B2. Individual Women questionnaire non-response in the SHHS

Region	Number of Eligible Women	% Interviewed	Range (min-max)
2006*			
Sudan (North)	19,507	93.2%	85% [Khartoum] – 99% [Gezira]
South Sudan	13,092	66.7%	55% [Western BEG] – 84% [Eastern Equatoria]
2010			
Sudan (North)	18,614	95.2%	87 % [Northern] – 97.7% [Gezira]
South Sudan	11,568	78.5%	73 % [Unity, Central & Eastern Equatoria] – 90% [North BEG]

Notes: *Adapted from table HH1 on page 12 of the 2006 SHHS report.

While it is unclear how non-response affects mortality estimates, if the women who were not interviewed belong to a higher risk demographic (for example the poor, uneducated or rural), the omission of the birth histories of these women will likely underestimate the true mortality rate. Observations made in the official 2006 SHHS report (Central Bureau of Statistics and Southern Sudan Center for Census Statistics and Evaluation 2006) suggest that eligible women from sampled households in South Sudan, who were not interviewed, tended to live in areas with a legacy of violent conflict and neglected social services and were often too overburdened with household tasks to participate in the survey.

Unreported survival status, birth date and age at death is another source of measurement error if these omissions are associated with characteristics of the mother or household that are themselves associated with mortality risks. The degree of missing data from the SHHS for South Sudan is provided in Table B3. Overall, deceased children at the time of the survey and children from households in South Sudan were more likely to have missing values for birth dates and survival status relative to birth histories from Sudan (North). For example, out of 8,698 reported deaths in 2006, 1,816 (20.9 percent) had an unreported or unknown age at death; 75 percent of these cases were from the South Sudan. In some settings, underreporting of early childhood deaths has been observed for deaths occurring shortly after birth. Women may be reluctant to discuss deaths at early ages, especially if deaths occur before the child has been named (DHS 1991). Whether early neo-natal deaths (occurring between 0 and 6 days after birth) are selectively under-reported can be detected by observing abnormally low ratios of early-neonatal to neo-natal deaths (occurring between 0 – 30 days after birth). Overall, there isn't strong evidence for systematic under-reporting of early-neonatal deaths in the SHHS – the ratio of early-neonatal to neo-natal deaths in South Sudan ranges from 0.6 to 0.75 in the 2006 and 2010

SHHS which are comparable to those observed in Sudan (North) and neighboring countries (Annex 2B). Mothers also tend to misreport the birth dates of deceased children to avoid answering lengthy questions about these children (known as birth transference) which tends to under-estimate under-five mortality in the period closest to the survey.

Under-five mortality estimates produced in this report do not attempt to correct for non-response bias, survivorship bias or birth transference; however, missing values resulting from unreported or unknown birth dates or ages at death were imputed to minimize error in the measurement of under-five mortality resulting from non-random missing data. This imputation process is explained in Annex 2C.

Table B3. Completeness of reporting: percentage of cases with missing birth dates, survival status and age, South Sudan

	2006	**2010**		**2006**		**2010**	
Reference Group	N	N	Attribute	Percent missing	N	Percent missing	N
Live births to women aged 15-49	30,499	28,720	Birth Date				
			Month only missing	21%	6,399	21.24%	6,100
			Year only missing	0.98%	298	1.23%	354
			Month & year missing	27.2%	8,304	7.42%	2,131
			Survival Status	17.3%	5,289	0	0
Surviving children	22,290	25,160	Age	2.78%	2,155	0	0
Deceased children	2,920	3,560	Age at death	46.4%	1,355	19.8%	706
Live births to women aged 15-49	30,499	28,720	All birth history questions: birth date, survival status, current age, age at death	13.3%	4,043	0	0
Number of observations (live births) with complete data after imputation					26,456		28,720

Source: Author's calculations from the 2006 and 2010 SHHS.

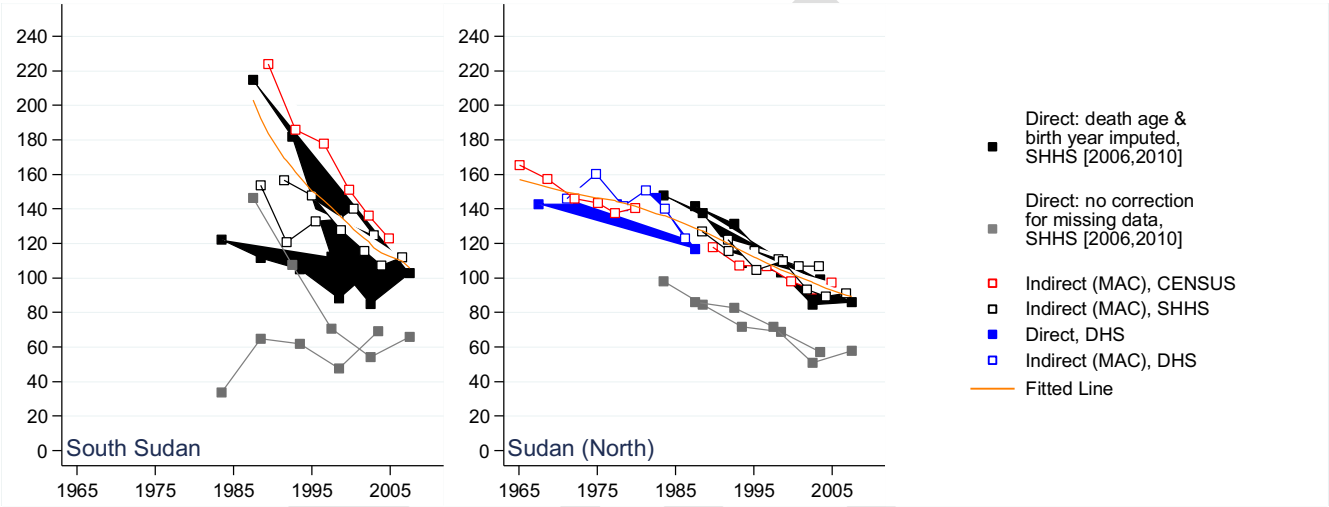
Results

Figure B1 displays estimates of under-five mortality obtained using: (1) the direct method (for five 5-year periods prior to the DHS, SHHS and Census) for South Sudan and Sudan (North), (2) the indirect method and (3) the lowess procedure. More specifically, two sets of direct estimates are provided. The first set uses the original data where cases with missing birth dates or ages at death were dropped from the analysis, while the second set uses imputed birth dates and ages at death where this information was missing from the birth history. As can be seen by the upward shifts in the trend lines, dropping cases with missing birth dates or ages at death from the SHHS datasets yields implausibly low under-five mortality rates. The tight clustering of mortality estimates from overlapping reference years and data sources for Sudan (North) provides a basis for having high confidence in the levels and trends in under-five mortality in Sudan (North). Estimates from available data sources using alternative methods for Southern Sudan, on the other hand, vary widely. Indirect estimates of under-5 mortality from the 2008 Census for Southern Sudan, for example, are systematically higher than estimates from the 2006 and 2010 SHHS even though there is considerable overlap in the calendar years of exposure to which those estimates refer. This could suggest differential population coverage in the Census relative to the SHHS (e.g. among vulnerable population groups).

Another salient observation is the spike in under-five mortality observed in the direct estimates in the period closest to the SHHS (2001-2006 and 2005-2010) relative to the second closest period (1996-2001 and 2000-2005)

for South Sudan. This could suggest the effects of recall bias in reporting ages at death; this pattern would be observed if, for example, mothers tend to incorrectly assign deaths that occurred 7 or 8 years ago to 5 or fewer years ago (although this would not accord with the commonly observed birth transference bias) or systematically under-reported deaths in more distant periods of time. While levels in the under-5 mortality estimates differ considerably for South Sudan, all series display a general downward trend over 1985 – 2008.

Figure B1. Direct and indirect estimates of under-five mortality by region, 1965-2005

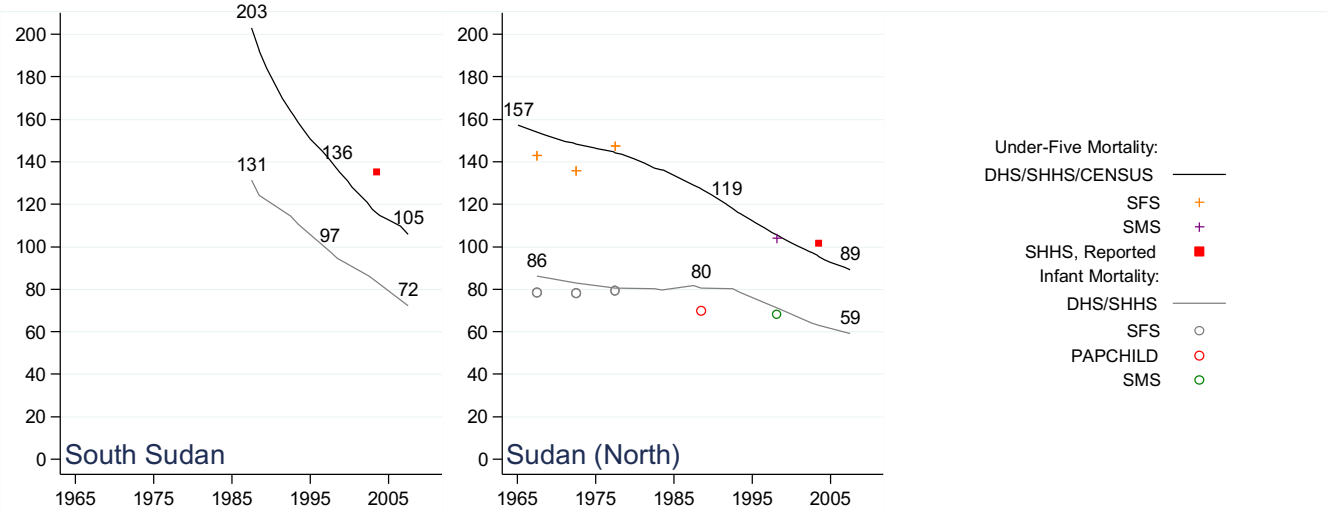


Source: Author's calculations using the 2006 and 2010 SHHS; 2008 Long Form Census and 1990 DHS.
Notes: SHHS estimates are derived from both the 2006 and 2010 surveys, corresponding to the two black and grey lines in each graph. Direct and indirect estimates are located at the mid-point of the period they correspond. For example mortality estimates that represent mortality risks from 2001-2006 are located at 2003.5. Fitted estimates are obtained from a locally weighted scatterplot smoothing procedure (lowess) that synthesizes the corrected direct and indirect estimates.

Figure B2 shows lowess estimates of the trends in under-five and infant mortality over time. Estimates available from the published reports of other population based surveys representative for Sudan (North) are also provided. The under-5 mortality estimates presented in the official 2006 SHHS report are shown– these estimates were obtained using unspecified indirect methods (Central Bureau of Statistics and Southern Sudan Center for Census Statistics and Evaluation 2006).

Given the difficulty of data collection in South Sudan - resulting in high non-response rates and missing data, and the divergence of estimates from different data sources - it is difficult to give a confident estimate of the levels of under-five mortality. The available evidence, however, suggests that between 1985 and 2010, under-five mortality fell substantially in the South, from 203 to 105 under-five deaths per 1000 live births, representing an annual rate of decline of 3.1 percent. The evidence from direct and indirect estimates based on the 2006 and 2010 SHHS, however, indicates that under-five mortality improvements slowed between 2000 and 2010. Between 1965 and 2010, under-five mortality in the North declined from 145 to 89 deaths per 1000 live births at an average annualized rate of 1.5 percent. While stagnant between 1965 and 1975, improvements in child survival conditions in Sudan (North) have been sustained since the early 1980s – with an annualized decline in mortality of 2 percent since 1980.

Figure B2. Under-five and infant mortality , South Sudan and Sudan (North), 1965-2008



Source: Author's calculations using the 2006 and 2010 SHHS; 2008 Long Form Census and 1990 DHS.
Notes: The Under-Five mortality estimates labeled as DHS/SHHS/CENSUS correspond to the fitted estimates computed using a locally weighted scatterplot smoothing (lowess) procedure synthesizing direct and indirect estimates (also displayed in Figure B1). SFS = Sudan Fertility Survey (1978-1979), SMS = Safe Motherhood Survey (1999), PAPCHILD = Pan Arab Project for Child and Mother Health (1992-1993)

Figure B3 compares estimated under-five mortality levels and trends for South Sudan and Sudan (North) with estimates available for neighboring countries. There is both wide variation in regional under-five mortality levels (ranging from a high of 170 in Chad to less than 25 in Egypt and Libya) and trends (Egypt, for example, reduced under five mortality by 6 percent per year on average between 1970 and 2010). During 2007, South Sudan ranks in the middle of the group of 10 countries with which it shares its borders, with under-five mortality conditions closest to those in Ethiopia. The geographic variation in under-five mortality both regionally and globally is displayed in Figure B4. In 2009, under-five mortality among low and low-middle income countries was 117 and 90 deaths per 1,000 live births and for the WHO African region, under-five mortality in 2009 was 127 deaths per 1,000 live births (WHO 2011).

Figures B5 and B6 display survey-specific and lowess state-level trends in under-five mortality between 1985 and 2008 for South Sudan. The states are ordered from lowest to highest according to average under-five mortality levels between 2005 and 2008 (Figure B6). All states show evidence of improved child survival conditions over the 20 year period (Figure B7) - except for East Equatoria – with annualized rates of decrease in under-five mortality between 0.8 percent (Lakes) to 7 percent (Upper Nile). With 151 and 142 under five deaths per 1000 live births between 2005 and 2010, North Bahr Al Gazal and West Equatoria stand out as having particularly poor child survival conditions. In contrast, Unity and Jonglei with 53 and 48 under-five deaths per 1000 live births, respectively, have the lowest estimated under-five mortality rate among the 15 states in the South Sudan. The plausibility of the estimates for Unity and Jonglei are questionable, as they are considerably low for South Sudan and Sudan (North) and Unity has among the highest poverty head counts of the country (68 percent). In

addition, the variation of under-five estimates for both of these states is very large (Figure B7). The degree to which selection bias is driving these estimates is difficult to gauge.

Figure B3. Under-five mortality, South Sudan, Sudan (North) and neighboring countries 1965-2010

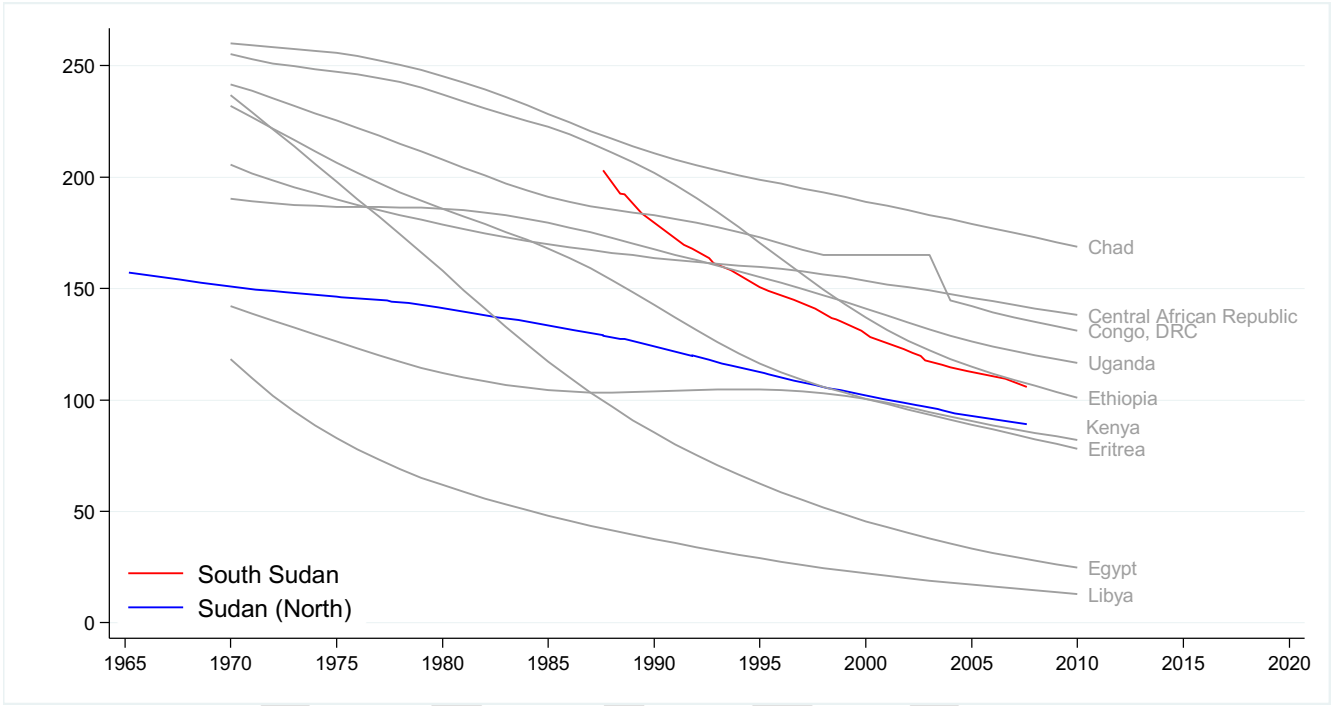
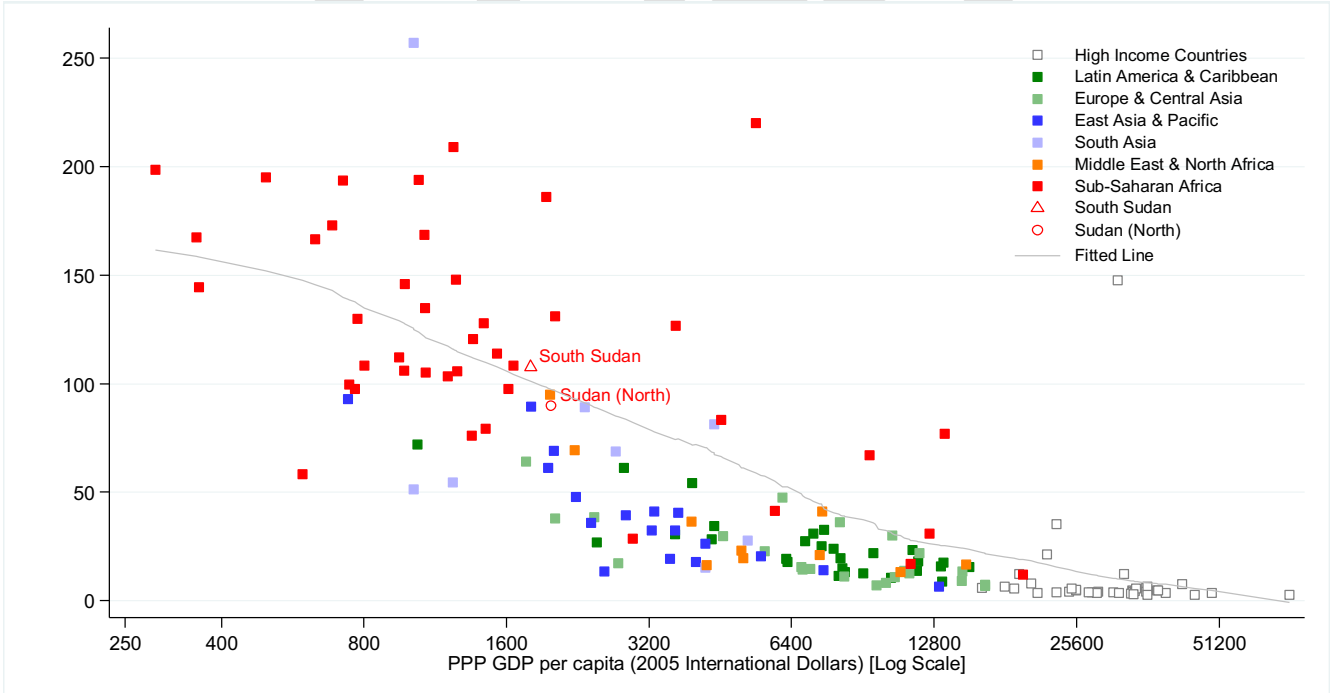


Figure B4. Under-five mortality vs. GDP per capita, by country & region, 2008



Source: Institute for Health Metrics & Evaluation (Figure B3); World Bank World Development Indicators 2010 (Figure B4)
Notes: South Sudan and North Sudan's under-five mortality estimates pertain to the 2005-2010 period and are based on estimates made by this author using the 1989/1990 DHS, 2006, 2010 SHHS and 2008 Long Form Census. South Sudan's GDP is predicted using a linear regression of the logarithm of PPP GDP per capita and under-five mortality among all available countries. Sudan (North)'s GDP presumed to equal officially reported GDP estimates for Sudan.

Figure B5. Direct and indirect estimates of under-five mortality by state, South Sudan, 1980-2008

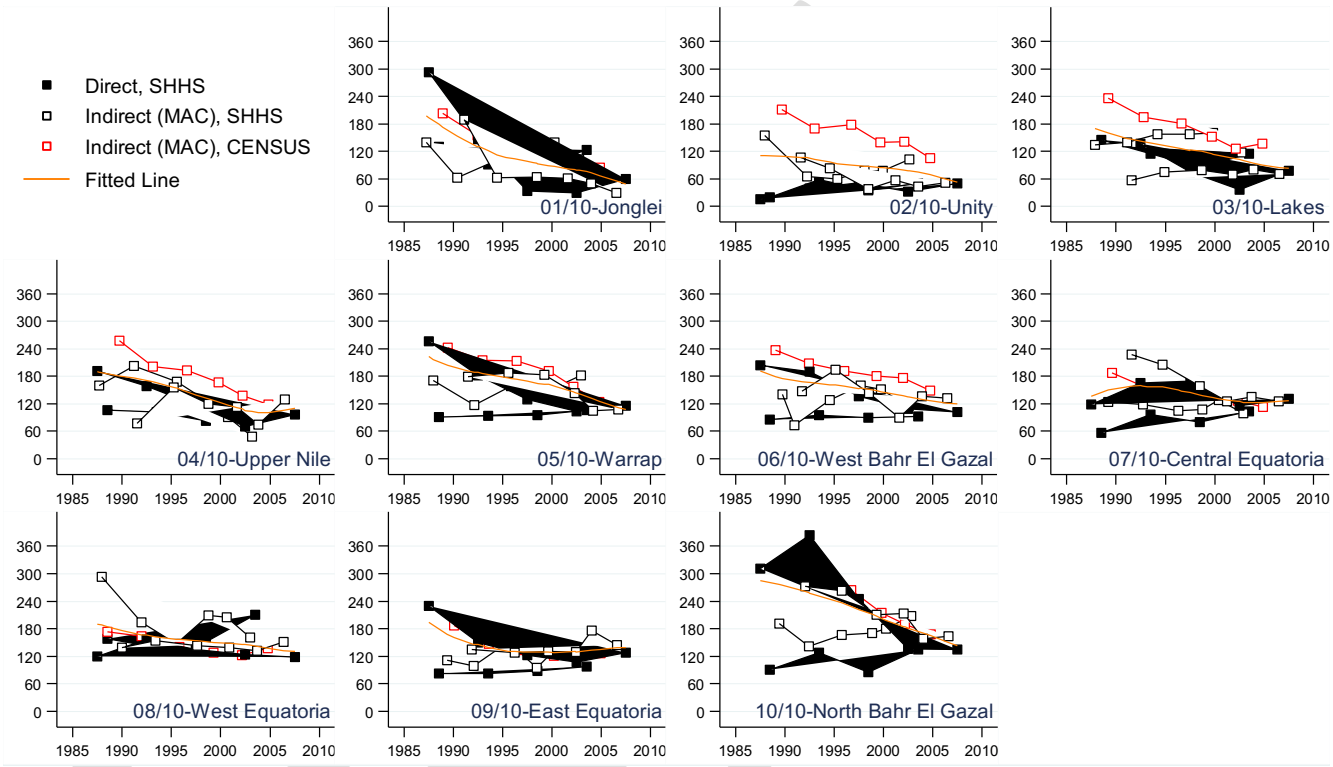
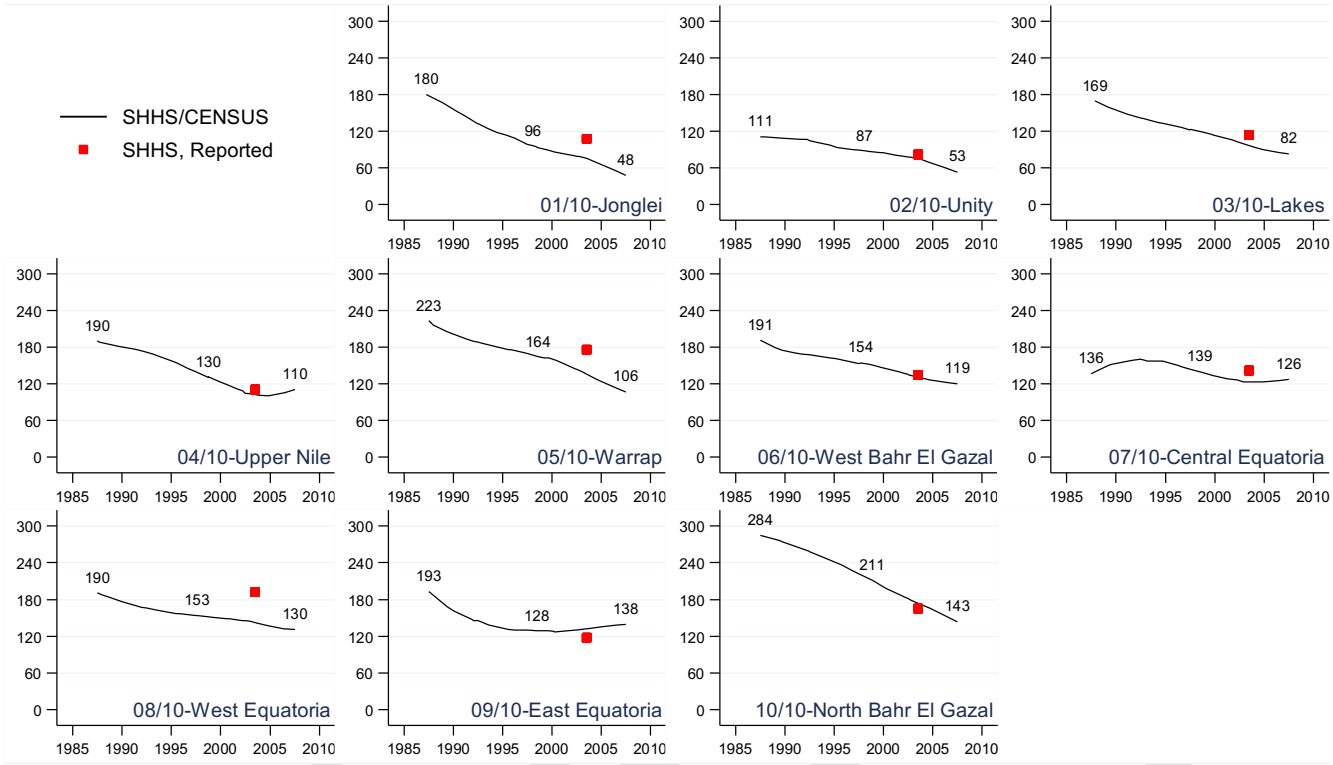


Figure B6. Under-five mortality by state, South Sudan, 1980-2008

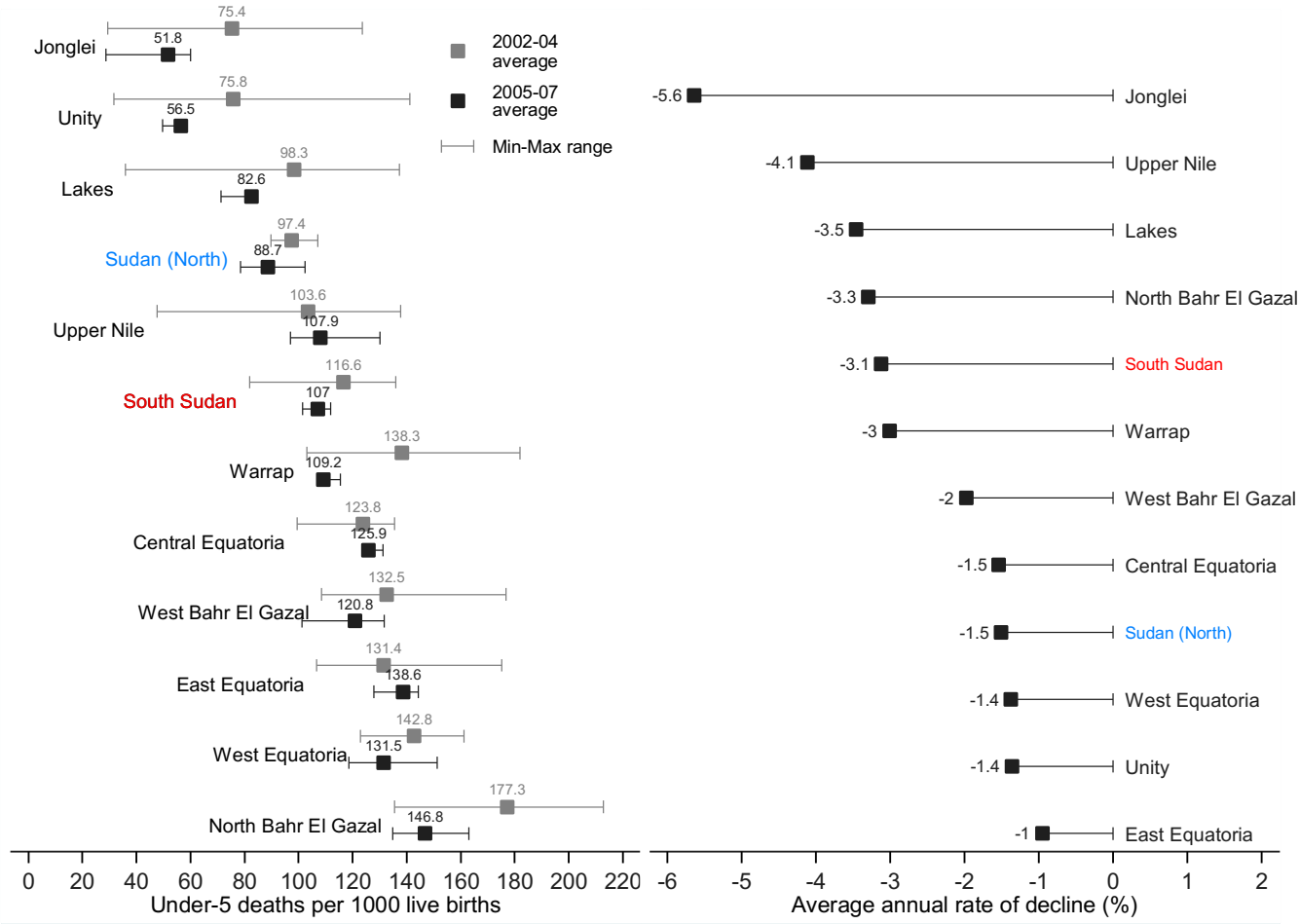


Source: Author's calculations using the 2006 and 2010 SHHS and 2008 Long Form Census.

Notes: States are ranked from lowest to highest mortality based on the fitted estimates in the 2005-2008 time range. Direct estimates are located at the mid-point of the period to which they correspond. For example, mortality estimates the represent mortality risks between 2001-2006 are located at 2003.5. Fitted estimates are obtained using a locally weighted regression (lowess) that combines the corrected direct and indirect estimates. Under-five mortality rates are labeled at the first point, mid-point and last point of the time series.

Figure B7. Average under-five mortality by state, South Sudan, 2002-2004 & 2005-2007

Figure B8. Annualized percent change in under-five mortality by state, South Sudan, 1984-2008



Source: Author's calculations using the 2006 and 2010 Sudan Household Health Survey and 2008 Long Form Census.
Notes: Under-5 mortality estimates are based on fitted estimates obtained using a locally weighted scatterplot smoothing procedure (lowess) that combines corrected direct and indirect mortality estimates. The average rate of decline for Sudan (North) in Figure B7 covers 1965-2008.

Determinants of under-five mortality

Key findings and discussion

- Heightened risk of under-five death associated with maternal age, birth order and birth interval suggest that educating adolescents on the importance of delaying first pregnancy and couples on spacing consecutive births by at least 2 years can have a large impact in reducing under-five mortality, especially as fertility remains high in South Sudan.

- No association is found between under-five mortality and the educational attainment of mothers in South Sudan. As the majority of women have no formal education, social learning (observed learning that takes place through interactions with peer-groups) might be an effective vehicle to transmit effective child-care and nutrition practices. Women with low education and no literacy are least exposed to and least able to access information and therefore stand to gain the most through social learning. Programs could be developed to target a small number of well-connected women in a village in order to disseminate information through existing social networks (Kandpal 2011).

- No association is found between under-five mortality and the location of households in urban versus rural settings once characteristics of the household, mother and birth are taken into account, a surprising finding since accessing health care is easier in urban settings.

- Wealth –a measure that largely reflects the living conditions of households (including access to improved drinking water and sanitation facilities) – is a significant determinant of under-five mortality. Children living in the most impoverished conditions are 44 percent more likely to die before the age of five compared to children living in the wealthiest households, pointing to the importance of removing income related barriers to health care access as well as supporting improvements to housing, hygiene and sanitation as complementary and necessary inputs to public health efforts.

- The elevated risk of under-five mortality in individual states (relative to Central Equatoria) - most notably West Equatoria - controlling for specific characteristics of mothers, births and the economic status of the household – may point to areas with critically weak health services or recurrence of conflict. Individual states with relatively lower under-five mortality, holding other factors constant - such as Unity and Jonglei – suggest an opportunity for inquiry to better understand whether certain behaviors or effective health care are responsible for lower mortality risks.

Data and methods

Determinants of under-five mortality between 2001 and 2010 are studied using complete birth history data from the 2006 and 2010 SHHS, where each observation represents the live birth of a successfully interviewed woman between the ages of 15 and 49. Under-five mortality events are modeled in a proportional hazards regression (the details of this method are provided in Annex 3A).

Table B6 lists the risk factors (independent variables) included in the model as well as the mean and standard deviation of each taking into account the sampling methodology of the survey. The risk factors are classified broadly between socioeconomic attributes: maternal educational attainment (given the small number of women with secondary education or higher in South Sudan, mothers with primary and secondary education were grouped together), household wealth (Annex 3B provides details on how wealth is measured), the urban or rural setting of the household, the state and region of residence; and demographic or biological attributes of the mother and child: maternal age at the first and current birth as well as the sex, birth spacing and birth order of the child. Two additional variables were created: maternal age at first birth squared, and maternal age at current birth squared to capture the additional risk of mortality to births from relatively young and old mothers. As the first birth to every mother is not preceded by a birth, to avoid having missing values in the birth interval variable, a variable combining birth order and birth interval was created with five categories: (1) first order, (2) second to fourth birth order with less than two years of preceding spacing, (3) second to fourth birth order with two years or more of preceding spacing, (4) fifth or higher birth order with less than 2 years of preceding spacing, (5) fifth or higher birth order with two years or more of preceding spacing. The sample of women is overwhelmingly uneducated - 86 percent of the mothers interviewed never attended school, the average age at birth is 19 years (the median is 18) and the median birth interval is 27 months or 2.3 years. By the age of 45-49, women in Southern Sudan have given birth to an average of 5 children (Table B8).

Results

Figures B9 and B10 display the cumulative survival probabilities (survivor curves) for children under-five for population sub-groups defined by the highest level of education attained by the mother, the wealth quintile of the household and the urban or rural setting of the household for South Sudan and Sudan (North), respectively. A statistical procedure was conducted to test the equality of the survivor curves between each sub-group. For South Sudan, no statistical difference was found in child survival between mothers with no education versus mothers with primary education or higher and households in urban versus rural settings. Child survival in the poorest quintile was found to be statistically different (at the 10% level) from households in other wealth quintiles.

In contrast for Sudan (North), statistically significant advantages in survival were found for: (1) children whose mothers completed primary education over children whose mothers did not; (2) children whose mothers completed secondary education over children whose mothers completed primary education; (3) children living in the wealthiest households over children living in households belonging to any other wealth quintile; and (4) children living in urban areas over children living in rural areas.

Table B4. Independent variables included in regression models

#	Attribute	Variable	Variable Categories	Variable	Mean	S.D.
Socioeconomic						
1	Mother's Educational Attainment	None	Never Attended	[Ref]	0.862	0.008
		PRI/SEC ED	Primary Education or Higher	B	0.138	0.008
2	Household Wealth (quintiles)	WQ1	Wealth quintile 1 (Poorest)	B	0.226	0.010
		WQ2	Wealth quintile 2	B	0.180	0.006
		WQ3	Wealth quintile 3	B	0.196	0.006
		WQ4	Wealth quintile 4	B	0.187	0.006
		WQ5	Wealth qunitile 5 (Richest)	[Ref]	0.212	0.011
3	Urban/ Rural Setting	Rural	Rural	B	0.775	0.016
		Urban	Urban	B	0.225	0.016
4	State of Residence		Upper Nile	B	0.120	0.014
			Jonglei	B	0.158	0.018
			Unity	B	0.080	0.009
			Warab	B	0.113	0.013
			North Bahr El Gazal	B	0.098	0.012
			West Bahr El Gazal	B	0.042	0.005
			Lakes	B	0.075	0.010
			West Equatoria	B	0.069	0.009
			Central Equatoria	[Ref]	0.131	0.014
			East Equatoria	B	0.114	0.013
Demographic/ Biological						
5a	Maternal Age (years)	MAB	Mother's Age at birth	C	26.80	0.09
5b		MAB^2	$(\text{Mother's Age at birth})^2$	C	765.01	5.39
5c		MAFB	Mother's Age at first birth	C	18.98	0.08
5d		$MAFB^2$	$(\text{Mother's Age at first birth})^2$	C	390.47	3.26
6	Sex of child	Female	Female Child	[Ref]	0.488	0.004
		Male	Male Child	B	0.512	0.004
7a	Multiple/ Single Births	Single	Single Birth	[Ref]	0.951	0.002
7b		Multiple	Multiple Birth	B	0.040	0.002
8a	Birth order/ interval (months)	BOI 1	First birth order	[Ref]	0.154	0.004
8b		BOI 2	$2^{nd} – 4^{th}$ birth order, less than 2 yrs spacing	B	0.141	0.003
8c		BOI 3	$2^{nd} – 4^{th}$ birth order, 2 yrs or more spacing	B	0.374	0.005
8d		BOI 4	5^{th} or higher birth order, less than 2 yrs	B	0.126	0.004
8e		BOI 5	5^{th} or higher birth order, 2 yrs or more	B	0.204	0.004
9a	Risk Exposure Period	2001-2006		[Ref]	0.503	0.021
9b		2005-2010		B	0.497	0.021

*B=binary, C=continuous, [Ref] = Reference Category in regression

Figure B9. Cumulative survival probability by age of child, 2001-2010, South Sudan

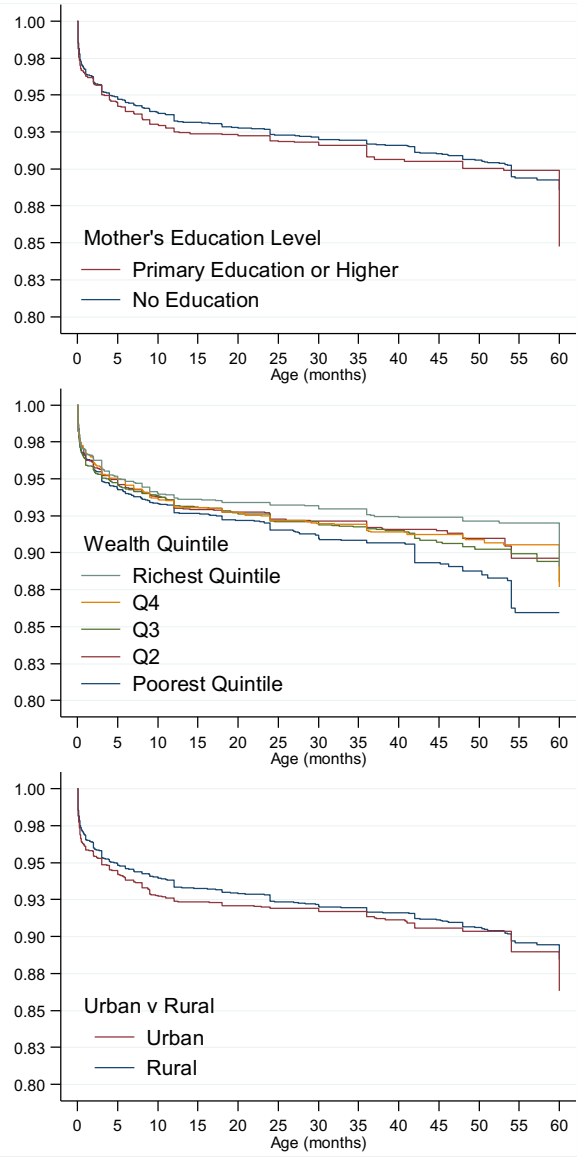
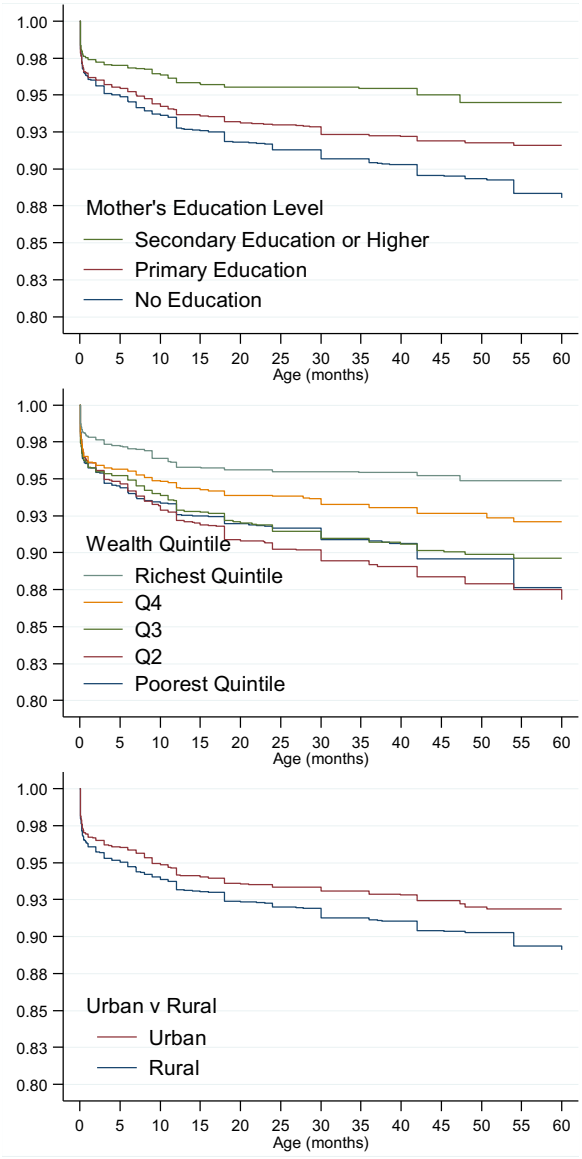


Figure B10. Cumulative survival probability by age of child, 2001-2006, Sudan (North)



Source: Author's calculations using the 2006 and 2010 Sudan Household Health Survey.

Table B5. Determinants of under-five mortality (2001-2010), South Sudan

	Model 1		Model 2		Model 3	
Covariate†	Hazard Ratio	Z -score	Hazard Ratio	Z - score	Hazard Ratio	Z - score
No education			[Reference]			
Prim/Sec Ed.	1.170	1.920	1.272**	2.850	1.069	0.75
MAB	0.935*	(-2.32)	0.934*	(-2.36)	0.930*	(-2.51)
MAB^2	1.002***	3.910	1.002***	3.970	1.002***	4.04
MAFB	0.971*	(-2.05)	0.970*	(-2.08)	0.968*	(-2.25)
MAFB^2	0.999	(-1.82)	0.999	(-1.82)	0.999	(-1.48)
Female			[Reference]			
Male	1.111	1.850	1.111	1.850	1.105	1.74
Single Birth			[Reference]			
Multiple Birth	2.259***	8.130	2.271***	8.200	2.253***	8.04
BOI 1			[Reference]			
BOI 2	1.262*	2.030	1.252	1.960	1.293*	2.24
BOI 3	0.656***	(-3.64)	0.650***	(-3.73)	0.681***	(-3.34)
BOI 4	1.596***	3.440	1.580***	3.390	1.657***	3.71
BOI 5	0.881	(-0.91)	0.872	(-0.98)	0.909	(-0.68)
Rural			[Reference]			
Urban	1.046	0.650	1.124	1.610	1.139	1.61
2001-2006			[Reference]			
2005-2010	0.963	(-0.65)	0.976	(-0.41)	0.984	(-0.27)
Poorest			1.464***	4.000	1.569***	4.64
WQ2			1.225*	2.010	1.287*	2.5
WQ3			1.229*	2.120	1.302**	2.7
WQ4			1.204	1.900	1.210*	1.97
Richest			[Reference]			
Upper Nile					0.797	(-1.80)
Jonglei					0.737*	(-2.33)
Unity					0.368***	(-6.85)
Warab					0.93	(-0.59)
North BEG					0.983	(-0.15)
West BEG					0.769*	(-2.15)
Lakes					0.763	(-1.93)
W.Equatoria					1.493***	3.3
C. Equatoria			[Reference]			
E. Equatoria					0.819	(-1.55)

Source: Author's calculation using 2000 Sudan Household Health Survey
†Abbreviation definitions are provided n Table B5.
Notes: Significance levels correspond to the following p-values:
* p<0.05, ** p<0.01, *** p<0.001

Three different proportional hazards regression models are fit to describe under-five mortality. Table B6 displays the hazard ratios and z-scores resulting from the statistical test assessing whether the hypothesis of no association between under-five mortality and each covariate holds. Proportional hazards coefficients are always positive – a coefficient above 1 indicates elevated risk of death, a coefficient equal to 1 represents no difference in risk and a coefficient below 1 represents reduced risk between groups. The first model is the most parsimonious and includes the mother's educational attainment, the household setting and characteristics of the birth (maternal age, sex of child, birth order and interval); the second model adds household wealth quintiles and the third adds dummy variables for the state of residence. In this multivariate regression framework, the question of interest becomes whether significant differences in mortality risk are observed among children who are otherwise similar (as measured by attributes of the birth, the mother and the household).

There is no strong evidence that mother's education is associated with reduced risk of under-five mortality. Wealth, however, is strongly associated with reduced child mortality holding other factors constant: relative to children in the wealthiest quintile, children in progressively poorer wealth quintiles are between 20 and 57 percent more likely to die before the age of five.

All birth characteristics - maternal age, birth order, birth interval, the sex of the child and twin birth – have consistent effects on mortality across each of the models. Maternal age during the current birth has a positive and non-linear association with under-five mortality so that, for example, births to mothers aged 40 years have more than twice the mortality risks compared to births to mothers half that age (20 years). Maternal age at first

birth is associated with reduced under-five mortality – on average, waiting one additional year to give birth is associated with a 3.2 percent reduction in mortality risk.

Having less than 2 years of spacing between consecutive births (independent of the number of births a mother already has) is a significant risk factor for child mortality. Births with less than 2 years of spacing with the previous birth, are between 25 percent (for births that are of a second, third or fourth birth order) and 60 percent (for births of a fifth or higher birth order) are more likely to die before the age of 5.

While the effects are not significant at the 95 percent level, there is some evidence that boys have elevated mortality risks relative to girls (on the order of 11 percent higher). Studies have documented higher mortality of boys during the neonatal period and attribute differential mortality between the sexes early in life to biological factors (Naeye, Burt et al. 1971).

No statistical difference in mortality risk is evident for births in urban setting relative to those in rural settings holding other factors constant. Relative to Central Equatoria, only West Equatoria was found to have significantly worse child survival conditions controlling for other factors, while two states were found to have significantly better child survival conditions: Jonglei, Unity and West Bahr El Ghazal.

Comparing births occurring in the 2005-2010 period to births occurring in the 2001-2006 period, holding other factors constant provides an indication of whether average child survival conditions improved due to unobserved factors changing over the course of the ten years covered by the SHHS data used in the analysis. There is no statistical evidence from the birth history data that under-five mortality declined over time in the 2000s due to unobserved factors.

An additional set of models was run using a dataset pooling observations from South Sudan and Sudan (North) (Annex 3C). Results from these regressions are consistent with the findings in Table B7. In addition, there is some evidence that children born to mothers with secondary education have a reduced risk of death relative to children of mothers with no education.

Maternal and child survival strategies

Two of the millennium development goals relate directly to maternal and child health conditions: reducing child mortality and improving maternal health, reflecting the large burden of disease they suffer. In 2008, the Sudan census places approximately 16 percent of South Sudan's population below the age of 5 – representing 1.3 million children. In South Sudan, approximately 10 children out of every 100 born will not survive to their fifth birthday. As suggested by evidence from burden of disease estimates for eastern and Sub-Saharan Africa, most of these deaths are from preventable causes: diarrhea, pneumonia, measles, malaria, the underlying causes of under nutrition and a small group of causes leading to neonatal deaths. Women of reproductive age (ages 15-49) represent another vulnerable group due to the risks of pregnancy and childbirth. In South Sudan, this group comprises approximately 24 percent of the population, or 1.98 million women. A key challenge in South Sudan is reaching these populations with key interventions as over 3 out of every 4 children and women of reproductive age live in rural areas.

Key findings and discussion

- Huge potential remains for effective and low cost health interventions to rapidly reduce mortality and morbidity among the population of South Sudan. An opportunity exists to learn from health improving behaviors, services and products that reached increasing numbers of women and children in need between 2006 and 2010, such as skilled birth assistance at delivery, exclusive breastfeeding, and ownership of insecticide treated nets.

Maternal Health

- Complications during pregnancy affect four out of every five pregnant women, complications during labor affect one in every two pregnant women and complications up to six weeks after delivery affect two in three pregnant women. Approximately one in four female deaths occurs during pregnancy, delivery or two months after delivery. In this high risk setting, access to a continuum of effective antenatal, intrapartum and post-partum care for pregnant women is critical. In 2010, evidence-based maternal survival interventions (including professional antenatal and delivery care) cover only one in five women in need.

- Family planning and effective ante-natal care are among the maternal survival interventions with the lowest population coverage: In 2010, only 5 percent of married or cohabiting women used some form of contraception (which seems to be driven by limited access to- rather than low demand for- contraception).

- Total fertility rates have come down over time from 7.8 to 5.5 births per woman between 2000 and 2010 but remain higher than the average for Sub-Saharan Africa (5 births per woman).

- While there is a tendency for women to marry early (close to 40 percent of women between the ages of 15 and 19 were married in 2010) adolescent fertility rates in South Sudan (at 40 births per 1000 women between the ages of 15 and 19 in the five years prior to the 2010 SHHS and 58 births per 1000 adolescent women in the five years prior to the 2006 SHHS) are more comparable to Middle East and North Africa (35 births per 1000 adolescent women) than Sub-Saharan Africa (110 births per 1000 adolescent women). Fertility is highest for women between the ages of 25 and 29 (225 live births per 1000 women).

- In the short run, family planning programs would do well by focusing on helping teenagers postpone pregnancies through contraceptive use, as well as helping older couples become familiar with modern contraceptive techniques. In the long run, broader efforts that foster social attitudes that value and provide economic opportunities for women will help create an environment that enables women to make the important decisions that affect their lives such as who to marry, when to marry and when to bear children.

- Between 2008 and 2010 only 3 percent of pregnant women reported receiving an effective package of antenatal services including four antenatal care visits, an assessment for blood pressure, urine screen for protein, a blood screen for anemia and two doses of tetanus toxoid vaccine.

- Among women of reproductive age with a pregnancy in the two years prior to the survey, skilled birth attendance (births attended by a doctor, nurse midwife or village midwife) increased from 41 percent of live births between 2004 and 2006 to 48 percent between 2008 and 2010 which was driven by an increase in the number of births delivered by nurse midwives, medical assistants and health visitors. The gains in professional support during childbirth, however, have been limited primarily to women in urban areas.

- As births primarily occur in the home (in 2010, 85 percent of births occurred in the home) and close to 50 percent of births are delivered by traditional birth attendants, strategies to expand coverage of professional assistance during child birth need to take this into account. There is likely significant scope for training traditional birth attendants and providing them with safe delivery kits in the short run as a means to improve the conditions at birth for women and their newborns. A significant challenge in this setting, however, is to ensure women have access to emergency obstetric care if needed, which requires the availability of unscheduled 24 hour services close enough to the home to be able to respond during emergencies. As mobile phone penetration has increased significantly (ownership of mobile phones increased from less than 1 percent in 2006 to close to 20 percent in 2010 – with over half of households in urban areas owning a mobile phone in 2010) – there may be a role for leveraging this technology in areas with reliable reception to develop emergency obstetric response programs.

Child Health

- In South Sudan, about one in ten children die before the age of five, one in three children are underweight and the probability a child suffers from diarrhea, acute respiratory infections and malaria is about 35, 20 and 32 percent. On average, evidence based interventions for children under the age of five reaches about 50 percent of children in need.

- Between 2006 and 2010, the nutritional status of South Sudan's children improved: underweight prevalence fell from 35 to 29 percent and stunting prevalence fell from 37 to 32 percent for both sexes combined. There is no evidence of declines in the percentage of wasted children, which remained at 24 percent for both sexes.

- The practice of exclusive breastfeeding increased substantially between 2006 and 2010 – from 28 to 48 percent of children between 0 and 6 months – but the introduction of appropriate complementary foods for children at 6 months remained low by comparison (at around 30 percent in 2006 and 2010).

- Household ownership of insecticide treated nets (ITNs) expanded rapidly between 2006 and 2010 from 27 to 42 percent. These gains were driven by progress in four states: East Equatoria (where ITN ownership

increased four-fold over the period), North Bahr el Ghazal, West and Central Equatoria (where the increases were greater than 100 percent). Reports form the 2010 SHHS indicate however that usage of ITNs is relatively low, with only 50 percent of households reporting that an individual slept under an ITN the night before the survey.

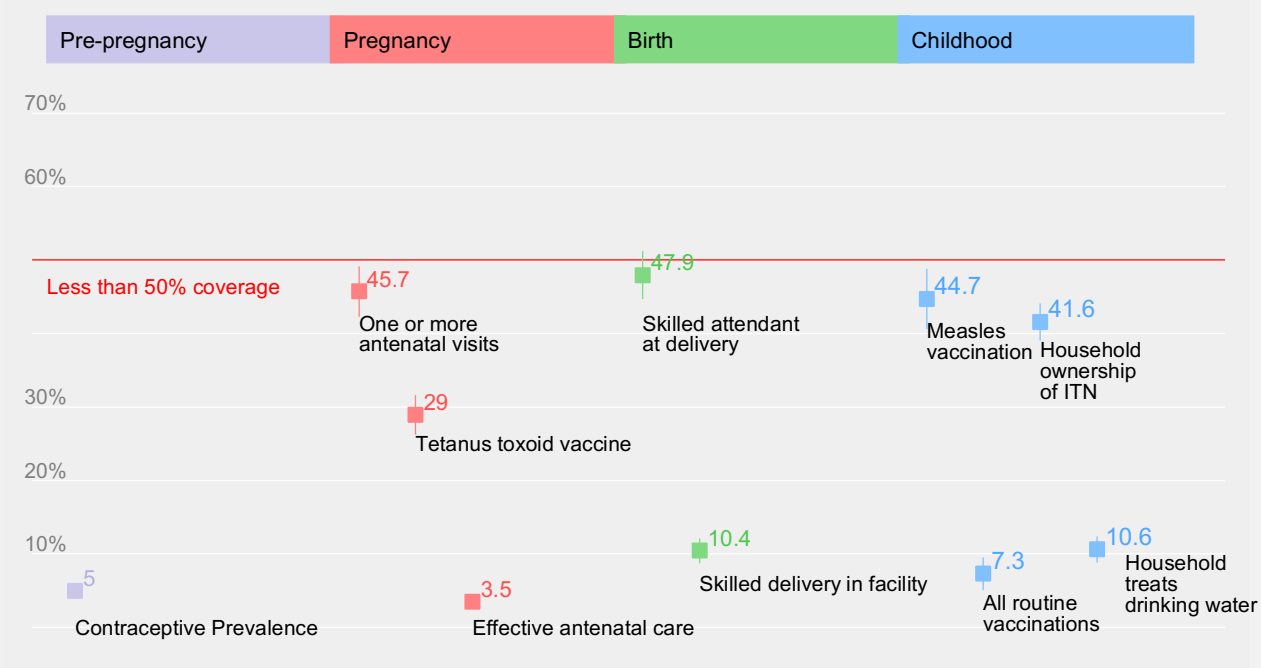
Service Delivery Challenges

- Disparities in intervention coverage associated with the education of mothers, the wealth of households and the urban or rural setting of households persist across a range of interventions.

- Uncovering and understanding the demand and supply side barriers that influence access to specific health services and products at a local level is critical in order to develop strategies and policies that expand coverage. In rural areas of South Sudan affected by conflict and isolation, for example, interrupted service-delivery or geographical distance to functional primary health care centers or hospitals may be the key bottleneck. In other areas, demand for health care may be low (even if primary or secondary care facilities are close by) among certain sub-groups as a result of social exclusion, illiteracy, inability to pay, uncertainty and skepticism about benefits of unfamiliar health care interventions and poor quality of services (such as long waits, drug stock outs or staff absenteeism). A finer grain understanding of the relative importance of these factors at a local level will help drive effective strategies to expand coverage.

- An important feature of many of the interventions assessed in this study (for example ante-natal visits, ITNs, vaccinations or treatment of water) is that they are preventive in nature and require incurring a small cost today for a potential benefit in the future. The tendency to postpone costs associated with future benefits, means that eliminating price barriers and providing information and knowledge about health care benefits may not be sufficient to encourage behaviors that lead to better health outcomes. In these cases, incentives – such as conditional cash or in-kind transfers – may be effective in encouraging uptake of interventions.

Coverage estimates across the continuum of care for women and children, South Sudan, 2010



Source: Author's calculations based on 2010 SHHS / Graph adapted from (Bryce, Daelmans et al. 2008)

- The figure above displays the coverage of a select number of evidence based interventions across the continuum of needs for mothers and their children and provides clues as to where key challenges lie. In general, interventions that rely more heavily on trained health workers, facilities, information systems and requirement for repeated contact with the patient – have lower coverage compared to those that can be delivered vertically through NGO's, community outreach and one-time campaigns. This is not surprising for the South Sudan setting which is set back by decades of under-investment, but points to the importance of focusing efforts and resources on building the systems – health worker training programs, health management information systems, health financing and drug and equipment supply chains – that can broadly support the delivery of a range of interventions.

- **Social norms and gender roles**: The fact that so few couples use contraception despite unmet demand for contraception, suggest that access to contraception is a major constraint. Low access to contraception may in turn point to social or cultural norms that make it difficult for women to exert fertility preferences.

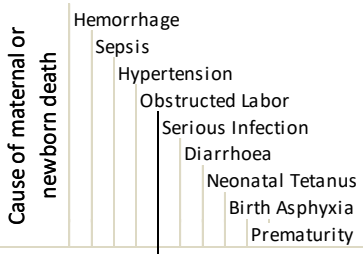
- **Integrated and scheduled care**: A much higher proportion of women receive ante-natal care only once compared to effective ante-natal care that includes at least four visits to a health facility, screenings to detect risk factors during pregnancy, and tetanus toxoid vaccines. A similar contrast is observed with measles vaccination and full immunization. Measles vaccination can be organized vertically, delivered by NGOs, and community outreach campaigns. Ensuring children receive a complete set of vaccinations requires functional health information systems and continuous engagement with the population.

- **Political and financial commitment**: The provision of insecticide treated bed nets is an example of a fairly simple preventive health technology that can be delivered vertically. In the past 10 years, the distribution of ITNs has been supported by the growing political and financial commitment of donors, NGOs and governments. This focus has driven progress in South Sudan where household ownership of ITNs increased by 56 percent in four years. For other simple preventive technologies such widespread support is not enjoyed – for example, chlorine treatment of water (drinking water is a major priority for households as reported by the South Sudan Experimental Phone Survey) is only practiced by 1 in 10 households.

Data and methods

This section draws from the 2006 and 2010 SHHS as well as the 2009 NBHS and looks at the degree to which Sudanese mothers and their children across different sub-groups of the population receive preventive or treatment interventions - biological agents or actions intended to reduce morbidity or mortality. The interventions assessed are those with sufficient evidence of effectiveness in reducing cause-specific mortality and morbidity among mothers, newborns and children younger than five years in developing countries. Tables B6 and B7 display the evidence-based interventions included in this assessment, the diseases against which each intervention acts and the indicator used to measure the level of coverage for each. The interventions considered are not exhaustive. The prevalence of risk factors for each disease is also assessed where possible.

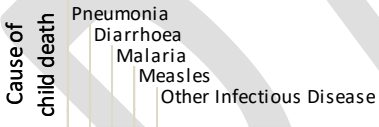
Table B6. Evidence based maternal and neonatal survival interventions and coverage indicators



Interventions	*Target:* Mother / Newborn	Indicator
Preconception		*Proportion of women (15-49 years)…*
Family Planning (Contraception)		… curently married or living with a man taking action to delay or avoid pregnancy
Antenatal		*Proportion of women (15-49 years) who had a pregnancy in the last two years…*
Tetanus Toxoid		…with at least 2 doses of tetanus toxoid vaccine
Intermittent malaria treatment		… given anti-malarials during ante-natal care
Effective ante-natal care		… with at least 4 professional outreach visits, with assessment of blood pressure, urine screen for proteing, blood screen for anaemia, two doses of tetanus toxoid
Intrapartum		
Corticosteroids		N/A
Skilled Attendant at Delivery		…whose last live birth was delivered by a doctor, nurse or midwife
Emergency Obstetric Services		N/A
Postnatal		
Resuscitation of newborn baby		N/A
Early and exclusive breasfeeding		Proportion of children aged 0-24 months fed breastmilk within one hour of birth
Kangaroo mother care		N/A

Source: Adapted from (Dormstadt, Bhutta et al. 2005) and (Lawn, Zupan et al. 2006)

Table B7. Evidence based child survival interventions and coverage indicators



	Indicator
Breastfeeding initiation	Proportion of children (0-24 months) who were fed breastmilk within one hour of birth
Exclusive Breastfeeding	Proportion of children (0 -5 months) fed exclusively by mother's breastmilk in past 24 hours
Continued Breastfeeding	Proportion of children (12-15 months) with continued breastfeeding
Complementary feeding	Proportion of children (6-8 months) who received solid, semi-solid or soft foods in past 24 hours
Vitamin A	Proportion of children (5-59 months) receiving Vitamin A supplementation in last 6 months
Insecticide Treated Bednets	Proportion of households with at least one insecticide treated bednet
Water, Sanitation & Hygiene	Proportion of households with a protected source of water
Routine Immunizations	*According to immunisation card or mother's report:*
Measles	Proportion of children (12-23 months) with Measles (MMR) vaccine
BCG	Proportion of children (12-23 months) with Tuberculosis (BCG) vaccine
DPT3	Proportion of children (12-23 months) with 3 doses of Diptheria, Pertussis, Tetanus (DPT3) vaccine
Polio	Proportion of children (12-23 months) with at least 3 doses Polio (OPV) vaccine
Treatment Interventions	
Oral Rehydration Therapy	Proportion of children under 5 yrs with diarrhoea given oral rehydration salts or homemade fluid
Antimalarials	Proportion of children under 5 yrs with fever or malaria prescribed anti-malarials at health facility

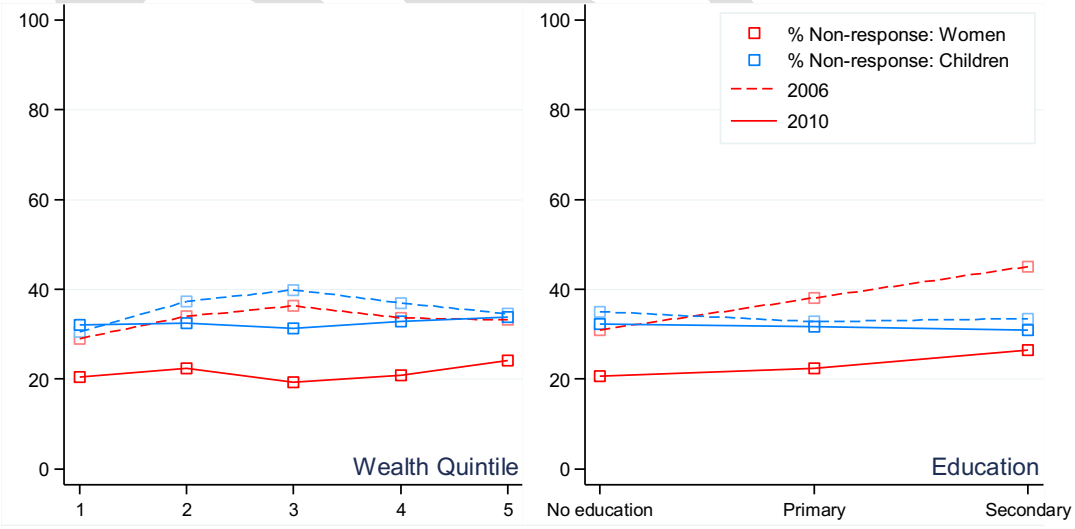
Notes: Adapted from (Jones, Steketee et al. 2003)

To assess factors that are associated with access to care, a logistic regression is used to measure the relationship between the probability of receiving an intervention with characteristics of the household, mother and child: primarily education level, age, wealth and whether the household is an urban or rural setting. This analysis pools observations from the 2006 and 2010 SHHS and associations are summarized using the marginal effect of each covariate (for example, the marginal increase or decrease in probability that a mother will receive an intervention if she were in the richest wealth quintile rather than the poorest, all else equal), assessed against a

"base" case: a women with no education, living in a rural household that classifies in the lowest quintile in the wealth distribution (Annex 4A explains in more detail the methods used).

Overall non-response among eligible women to the SHHS women questionnaire that provides the data for estimating coverage of key health interventions was 33 percent in 2006 and 22 percent in 2010 (Table B2) . If non-response is systematically associated with other attributes that influence intervention coverage (such as level of education or income, urban or rural household location, ethnicity) coverage estimates may suffer from a degree of selection bias depending on the strength of the association. Figure B11 shows the percentage of non-responding women and children by household wealth and education of the mother. Overall there is not a strong association between the degree of non-response and household wealth in either the 2006 or 2010 SHHS women's or children's questionnaires for South Sudan overall. There is, however, some indication that more educated women were less likely to respond to the women's questionnaire than less educated women. The analysis presented in this section did not impute missing data and therefore assumes that missing data on interventions occur at random – that is children with missing data are equally likely to have received an intervention as not received an intervention. By state - as mentioned previously - overall non-response rates varied from 44 percent among women in North and West Bahr El Ghazal to 16 percent in East Equatoria in 2006, and 27 percent in Central Equatoria to 10 percent in North Bahr El Ghazal in 2010. Assessing non-response rates by wealth status and education levels for each state reveals similar patterns as those observed for South Sudan overall, with some exceptions. In Central Equatoria, non –response rates for women and children among the poorest households in 2010 (approximately 60 and 80 percent) were close to twice as large as the non-response rates for the richest households. In some states, non-response rates to the women's questionnaire were markedly higher among women with secondary education or higher – such as Unity and Warrap in 2010 (Annex 4B).

Figure B11. Non-response to women and under-five surveys, by wealth and education, South Sudan

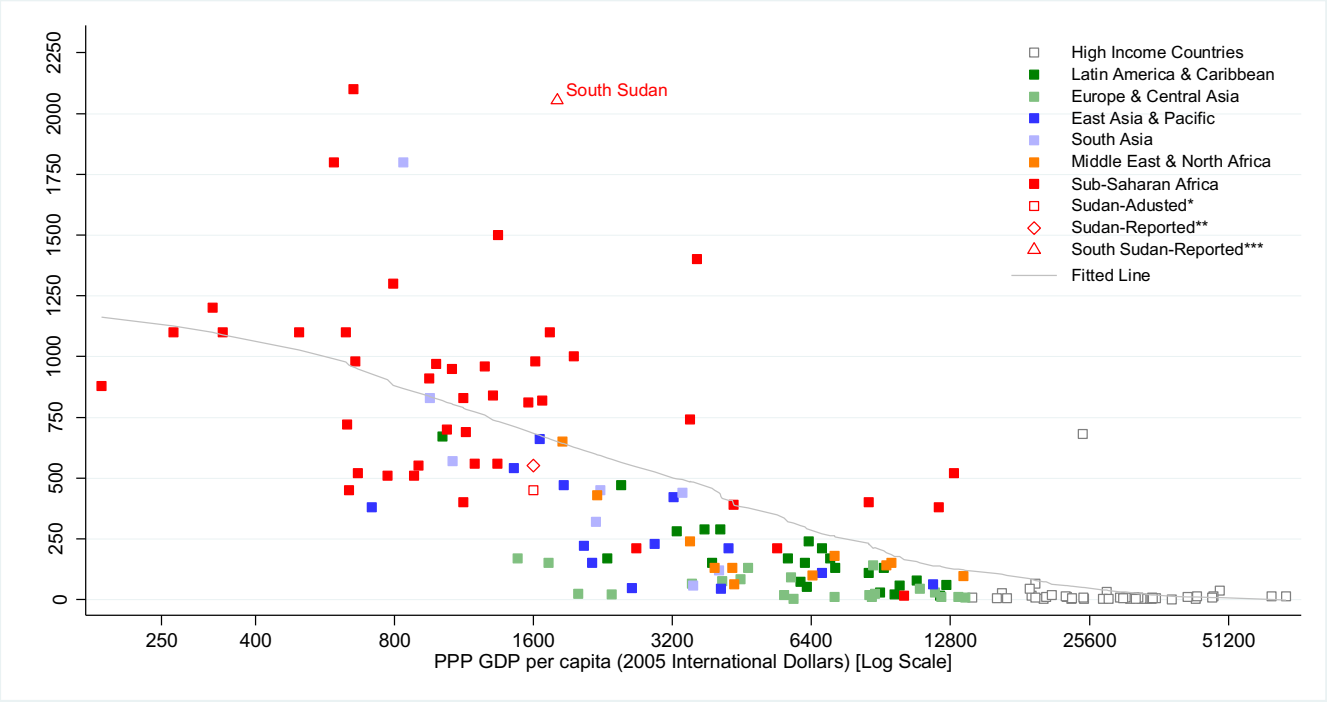


Source: Author's calculations based on 2006 and 2010 SHHS.
Notes: The education categories pertaining to children non-response rates reflect the educational levels of the head of the household in which the child resides.

Maternal and neonatal survival

The Maternal Mortality Ratio (MMR) (the number of maternal deaths per 100,000 live births) measures the level of obstetric risk - the probability women will die from direct or indirect causes once pregnant or 42 days after delivery. In 2005, the majority of global maternal deaths occurred in Sub-Saharan Africa (49 percent of all deaths) and South Asia (35 percent of all maternal deaths) (UN 2007). Sudan's MMR was estimated at 450[1] in 2005, compared to 900 for Sub-Saharan Africa and 200 for the Middle East and North Africa. As with under-five mortality, while large disparities in obstetric risk exist between countries at different stages of development (Figure B12), income levels alone do not fully explain the difference, especially among low and middle-income countries. In 2006, according to official estimates, the MMR for South Sudan stood at 2,054 maternal deaths per 100,000 live births – which would place it alongside Sierra Leone, Afghanistan and Niger as having the highest MMR in the world. In South Sudan, the MMR varies from 1,732 in Unity to a high of 2,327 in Western Equatoria (Central Bureau of Statistics and Southern Sudan Center for Census Statistics and Evaluation 2006).

Figure B12. Maternal mortality ratio (MMR) vs. GDP per capita, by country & region, 2005



Source: World Development Indicators 2010,

Notes: South Sudan's GDP is predicted using a linear regression of the logarithm of PPP GDP per capita and under-five mortality among all available countries. *Periodically, UNICEF, WHO, UNFPA and the World Bank evaluate nationally reported data and make adjustments to account for the well-documented problems of under-reporting and misclassification of maternal deaths and to develop estimates for countries with no data.** Reported by National Authority *** Reported in the 2006 SHHS report based on 2000 MICS2 survey data.

[1] The Maternal Mortality Ratio reported for Sudan is a model-based estimate derived from a regression model using information on fertility, birth attendants, and HIV prevalence. These estimates are developed by WHO, UNICEF, UNFPA and the World Bank.

The lifetime risk of complications from pregnancy increases with the number of pregnancies and births experienced by women. Table B8 presents the distribution of women of reproductive age by number of children ever born according to five-year age groups for South Sudan from all available data sources. Data on the number of children ever born reflect the accumulation of births to women over their entire reproductive lifetime. Therefore, this measure does not necessarily reflect current fertility levels. In South Sudan (according to the SHHS) childbearing starts early. Adolescent fertility rates in the five year period prior to the 2006 and 2010 SHHS are estimated at 58 and 40 births for every 1000 women between the ages of 15 and 19 (close to 40 percent of adolescent women in 2010 were married). By age 20-24, approximately two in three women has given birth (compared to one in two in the North) - and childbearing is nearly universal – by the end of the reproductive period only 8 to 11 percent of women have never given birth. On average, women have given birth to three children in their late twenties and to almost five children by their late thirties. In 2006 and 2010, the average number of children ever born among married women was 3.7 and 3.9, respectively. Observations from the census suggest lower fertility in South Sudan relative to the observations from the SHHS.

Table B8. Percent of women by number of children ever born, South Sudan

		Proportion of Women by Nº of Children Born										
	Mother's Age Group	0	1	2	3	4	5	6 or more	Mean Nº of children ever born	Mean Nº of children surviving	Mean Nº of children deceased	Conditional on at least one live birth: Proportion of children ever born, deceased at the time of survey
2006 SHHS												
South Sudan	15-19	0.68	0.18	0.06	0.03	0.02	0.01	0.03	0.75	0.64	0.11	0.15
	20-24	0.25	0.21	0.22	0.15	0.08	0.03	0.05	1.98	1.79	0.19	0.10
	25-29	0.14	0.08	0.16	0.20	0.16	0.10	0.16	3.30	2.89	0.42	0.13
	30-34	0.11	0.05	0.08	0.13	0.20	0.16	0.28	4.24	3.70	0.54	0.13
	35-39	0.10	0.03	0.07	0.10	0.14	0.14	0.41	4.92	4.27	0.65	0.13
	40-44	0.12	0.04	0.05	0.08	0.12	0.14	0.45	5.20	4.48	0.71	0.14
	45-49	0.11	0.03	0.05	0.09	0.11	0.08	0.52	5.71	4.69	1.01	0.18
2008 Long Form Census												
South Sudan	15-19	0.86	0.08	0.04	0.01	0.01	0.00	0.00	0.23	0.21	0.02	0.10
	20-24	0.52	0.13	0.15	0.10	0.05	0.03	0.02	1.22	1.09	0.13	0.11
	25-29	0.29	0.07	0.13	0.16	0.14	0.09	0.12	2.63	2.29	0.34	0.13
	30-34	0.24	0.04	0.08	0.11	0.14	0.13	0.26	3.60	3.08	0.54	0.15
	35-39	0.20	0.03	0.05	0.09	0.12	0.13	0.39	4.40	3.65	0.82	0.18
	40-44	0.21	0.03	0.05	0.07	0.09	0.11	0.45	4.66	3.75	1.03	0.21
	45-49	0.21	0.03	0.05	0.06	0.08	0.09	0.48	4.82	3.71	1.27	0.26
2010 SHHS												
South Sudan	15-19	0.38	0.46	0.12	0.02	0.01	0.00	0.01	0.87	0.80	0.07	0.08
	20-24	0.13	0.29	0.31	0.16	0.07	0.02	0.01	1.87	1.70	0.17	0.10
	25-29	0.05	0.09	0.18	0.25	0.22	0.12	0.09	3.26	2.94	0.33	0.11
	30-34	0.04	0.04	0.09	0.18	0.20	0.19	0.27	4.26	3.78	0.48	0.12
	35-39	0.04	0.03	0.04	0.11	0.16	0.20	0.42	5.11	4.45	0.67	0.14
	40-44	0.06	0.05	0.07	0.10	0.12	0.13	0.46	5.09	4.25	0.89	0.18
	45-49	0.08	0.05	0.07	0.11	0.12	0.12	0.45	5.01	4.11	0.96	0.21

Source: Author's calculations using the 2006 and 2010 SHHS and 2008 Long Form Census.

Figure B13. Total fertility rate by year

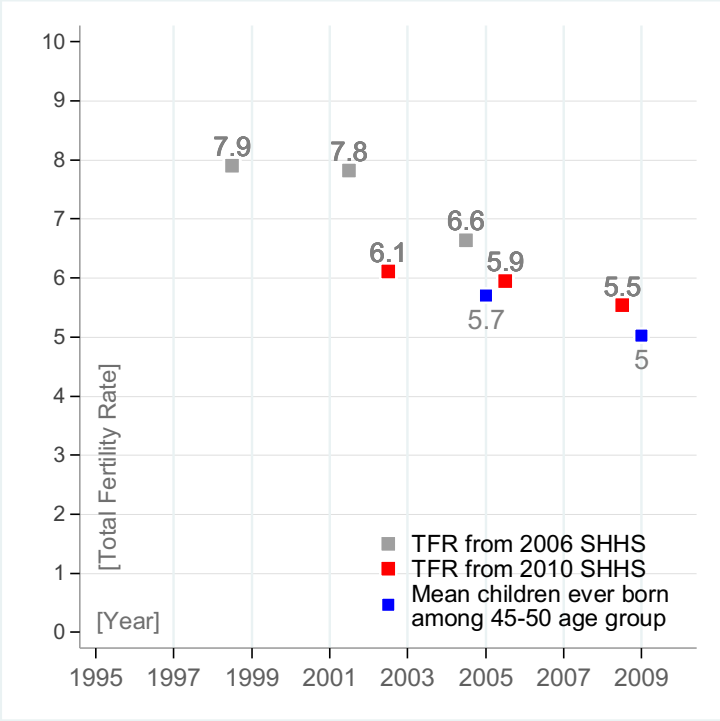
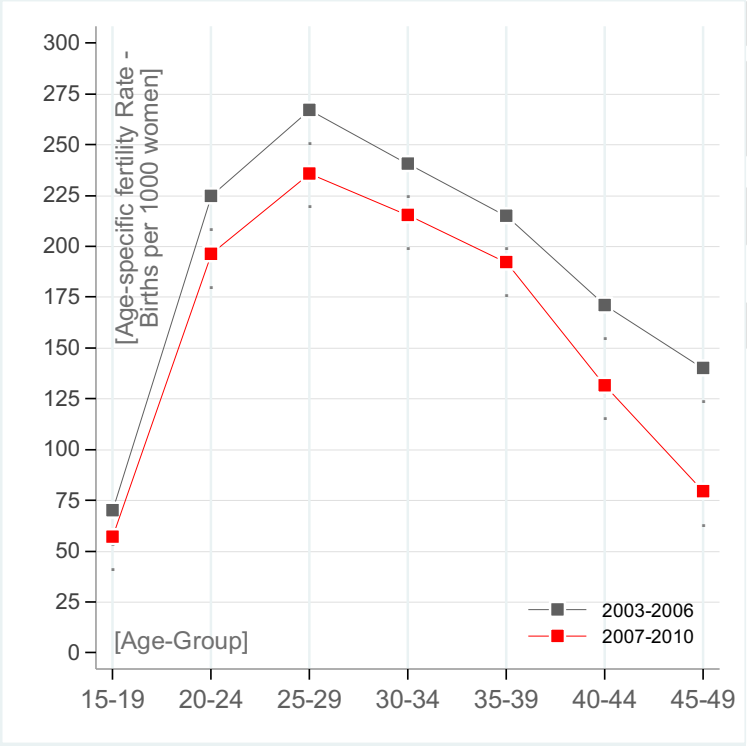


Figure B14. Age specific fertility rate by year and age-group of mother.



Source: Author's calaculations from the 2006 and 2010 SHHS. Fertility rates were computed for three 3 year periods prior to the survey and are plotted at the mid-point of each period so that 2007-2010 corresponds to 2008.5.

Evidence from the 2006 and 2010 household surveys indicate that the total fertility rate has fallen, with women having about 2 fewer children in the 2007-2010 period compared to the 1999 - 2002 period (Figure B13). Fertility rates declined for all age-groups (Figure B14).

A rough measure of the risks of death from pregnancy is the age-specific proportion of all deaths ocurring during pregnancy, delivery or two months after pregnancy among women aged 15-49 (table B9). The age-weighted proportion of female deaths ocurring during the exposure period for pregnancy and post-delivery in South Sudan in 2008 is 24 percent, with the highest percentage of pregnancy and delivery related deaths occuring between the ages of 20 and 24 years. Among states, the age weighted proportion of maternal deaths out of all female deaths is highest in Eastern Equatoria and Unity (40 percent) and lowest in North Bahr El Ghazal (12 percent) and Central Equatoria (15 percent).

The direct obstetric conditions that account for about 75 percent of maternal deaths are hemorrhage, sepsis, pregnancy-induced hypertension, obstructed labor and unsafe abortions; and for every death, around 16 or 17 pregnant women suffer long-lasting injuries or disabilities such as obstetric fistula, uterine prolapse, infertility and depression (Graham, Cairns et al. 2006). About 60 percent of perinatal deaths (including still births and neonatal deaths from any cause, during the perinatal period – 27 weeks of gestation to 28 days

of life) are low birth weight (less than 2,500 grams), birth asphyxia and infection (neonatal sepsis, tetanus, congenital syphilis, HIV infection) (Graham, Cairns et al. 2006). Death to the mother and baby is highly concentrated near delivery, from the onset of labor or abortion to 48 hours postpartum or post abortion, highlighting the need for mothers to have professional care at the time of delivery. Mortality among babies is directly linked to complications experience by mothers.

Table B9. Percent of female deaths ocurring during pregnancy (in year prior to survey) by age at death, South Sudan, 2008

Age at death	15-19	20-24	25-29	30-34	35-39	40-45	45-49
Percent of all reported female deaths (ages 15-49) ocurring during pregnancy, delivery or 2 months after delivery	24.2	31.0	26.1	21.0	15.9	19.9	21.9
Proportion of population of reproductive age, by age group	21.5	19.1	18.4	14.1	12.1	8.4	6.4

Source: Author's calculations based on 2008 long form census

In South Sudan, maternal conditions during pregnancy affect approximately four out of every five pregnant women (conditional on surviving pregnancy), complications during labor affect approximately one in every two pregnant women and conditions up to six weeks after delivery affect approximately two in three pregnant women (table B10). Among women experiencing complications, ante-partum hemorrhage and hypertension (two of the most severe conditions) were cited by 30 percent of pregnant women in 2006 and 20 percent in 2010. Postpartum hemorrhage was reported among 58 percent of pregnant women in 2006 and 41 percent in 2010. In 2006, among states, Lakes and Central Equatoria had the highest proportion of women reporting obstetric complications during pregnancy (upwards of 90 percent) while Jonglei had the lowest (63 percent). In 2010, Lakes and East Equatoria had the highest prevalence of obstetric complications (about 85 percent) while Jonglei and Unity had the lowest (about 65 percent).

Table B10. Proportion of women experiencing obstetric complications, South Sudan, 2006 and 2010

Conditional on women with pregnancy in 2 years prior to survey:	2006		2010	
	Mean	CI	Mean	CI
Complications during pregnancy (any)	0.799	(.767-.83)	0.743	(.72-.766)
Conditional on having reported at least one complication during pregnancy:*				
Hemorrhage (vaginal bleeding)	0.331	(.301-.361)	0.214	(.194-.234)
Raised Blood Pressure	0.321	(.291-.352)	0.186	(.165-.206)
Oedema (swelling of face or body)	0.426	(.397-.456)	0.190	(.133-.246)
Severe headache	0.793	(.773-.813)		[NA]
High fever	0.738	(.714-.761)	0.728	(.708-.749)
Abdominal Pain	0.615	(.588-.642)	0.715	(.696-.734)
Convulsions	0.279	(.251-.307)	0.178	(.158-.197)
Painful urination	0.403	(.375-.43)	0.430	(.407-.453)
Jaundice	0.186	(.164-.209)	0.116	(.102-.13)
Severe breathlessness	0.360	(.33-.39)		[NA]
Complications during labor (any)	0.742	(.711-.772)	0.527	(.499-.555)
Conditional on having reported at least one complication during labor:*				
Hemorrhage(vaginal bleeding)	0.584	(.553-.616)	0.412	(.38-.443)
Prolonged Labor	0.630	(.602-.658)	0.462	(.431-.494)
Convulsions	0.279	(.253-.306)	0.190	(.167-.214)
High fever	0.682	(.655-.708)	0.572	(.546-.598)

Source: Author's calculations using 2006 and 2010 SHHS.

Notes: *Complication categories will not add up to 1 (100%) as women may experience more than one symptom concurrently.

Given the diversity of causes leading to maternal and perinatal conditions threatening the health of women and newborns, there is no single intervention that warrants exclusive attention. Several opportunities and interventions exist to avert maternal and newborn mortality and morbidity that can be broadly grouped into three intervention pathways: preventing pregnancy, preventing complications and preventing death or disability from complications. The first pathway involves providing access to effective family planning; the second involves managing mild complications through quality antenatal, intra-partum and post-partum care while the third pathway involves providing effective, timely and appropriate emergency obstetric care (Graham, Cairns et al. 2006).

Population based interventions to reduce adverse outcomes for mothers and newborns include actions aimed at changing fertility behavior and those aimed at reducing the numbers of underweight and micronutrient deficient mothers. Malnourished women are more likely to deliver premature or small babies who are themselves more likely to die or suffer from suboptimal growth. Maternal nutritional status is usually measured using a reference body-mass index (BMI) of less than 18.5 kg/m^2 and a reference height of 145cm. Data on the height and weight of women of reproductive age is not available for South Sudan from nationally representative surveys but as a reference, the percentage of women aged 15-49 with low BMI among neighboring countries with data ranges from a low of 0.6 percent in Egypt to a high of 38 percent in Eritrea. Short stature ranges from 0.6 percent of women in Chad to 2.6 percent in Tanzania (Black, Allen et al. 2008). Maternal short stature is a risk factor for complications at delivery and low maternal BMI is associated with intrauterine growth restriction (which refers to the poor growth of a baby while in the mother's womb during pregnancy). Assessing the extent of population-level nutritional interventions for girls, adolescents and women of reproductive age to address adverse maternal outcomes is beyond the scope of this current study. The provision of iron and folic acid supplementation during routine antenatal care at the primary level, however, is a recommended strategy for which there is data from the SHHS. In South Sudan, the percentage of pregnant women (in the two years prior to the survey) taking iron supplementation was 32 percent in 2006 and 61 percent in 2010 - with all states, except for Jonglei (with 48 percent coverage) reaching over fifty percent of women in need in 2010. Effective nutritional strategies, however, need also address the long-term, chronic and intergenerational nature of undernutrition.

Evidence from this study and elsewhere links child mortality with the number, spacing and timing (in relation to mother's age) of pregnancies. In addition, unwanted or mistimed pregnancies brought about by lack of effective contraception carry risks for the mother – including unsafe abortion and sexually transmitted diseases. Effective family planning promotes delaying the age of first pregnancy to after 18 years of age, adequate spacing of births between 2 and 3 years and provides information, education and communication on contraceptive options. Here, contraceptive prevalence – the proportion of women of reproductive age currently married or living with a man using some form of contraception to delay or avoid pregnancy – is used as an indicator of the coverage of family planning services in South Sudan. In 2010, only 5 percent of married or cohabiting women used some form of contraception (Figure B13). There are signs of increased use – contraceptive prevalence increased from 3.6 percent in 2006 to 5 percent in 2010 – but this increase was driven mainly by gains in Central Equatoria and Jonglei which were the only two states to show statistically significant increases in coverage between 2006 and 2010.

Table B11. Marriage status and desire for children by women's age group, 2010, South Sudan

	Urban		Rural	
Age	Mean	95% CI	Mean	95% CI
Married or living with other man				
15-19	34.7	(27.8-41.6)	40.5	(36.4-44.6)
20-24	81.4	(74.9-88)	86.9	(84.6-89.1)
25-29	89.7	(85.9-93.4)	93.2	(91.8-94.6)
30-34	87.0	(81.1-93)	91.7	(89.6-93.8)
35-39	82.0	(76.6-87.4)	88.1	(86-90.2)
40-44	84.5	(76.1-92.9)	82.1	(77.7-86.4)
45-49	82.5	(73.6-91.3)	78.3	(73.6-82.9)
Did not want previous birth (if women gave birth in past 2 years)				
15-19	17.1	(7.4-26.8)	15.5	(9.2-21.8)
20-24	21.9	(13.9-30)	11.4	(7.8-15)
25-29	13.8	(7.3-20.2)	10.2	(7.8-12.6)
30-34	14.3	(5.9-22.6)	11.3	(8.2-14.5)
35-39	18.4	(9.3-27.5)	9.5	(6-12.9)
40-44	15.0	(1.9-28.1)	11.8	(5-18.5)
45-49	20.9	(1.3-40.4)	17.0	(5.9-28)
Did not want current pregnancy (if pregnant)				
15-19	43.3	(16.6-70.0)	14.5	(5.9-23.1)
20-24	27.9	(11.3-44.6)	10.2	(5.1-15.3)
25-29	24.6	(12.2-37)	11.8	(7.2-16.4)
30-34	15.9	(0-35.1)	12.0	(5.5-18.6)
35-39	23.0	(0-50.4)	11.9	(2.5-21.2)
40-44	57.3	(5.6-100)	28.2	(9-47.4)
45-49	--	--	24.2	(2-46.4)
Does not want future pregnancy				
15-19	13.4	(3.1-23.6)	8.9	(4.7-13.1)
20-24	14.4	(9.1-19.6)	8.2	(5.2-11.2)
25-29	14.2	(6.2-22.2)	8.1	(6-10.3)
30-34	16.4	(7.9-24.8)	12.7	(9.5-16)
35-39	37.2	(28.2-46.2)	21.6	(17-26.1)
40-44	50.4	(34.3-66.5)	40.5	(33.7-47.3)
45-49	50.3	(36.1-64.6)	58.0	(50.2-65.9)
Contraceptive Prevalence				
15-19	1.09	(0-2.7)	3.21	(1-5.5)
20-24	5.74	(2.2-9.3)	3.72	(2-5.5)
25-29	8.14	(3.4-12.8)	5.58	(3.9-7.3)
30-34	6.03	(1.3-10.8)	4.79	(3.1-6.5)
35-39	8.30	(3.2-13.3)	5.29	(3.2-7.3)
40-44	10.64	(3.1-18.2)	3.27	(1.1-5.5)
45-49	1.77	(0-4.4)	4.65	(2-7.3)

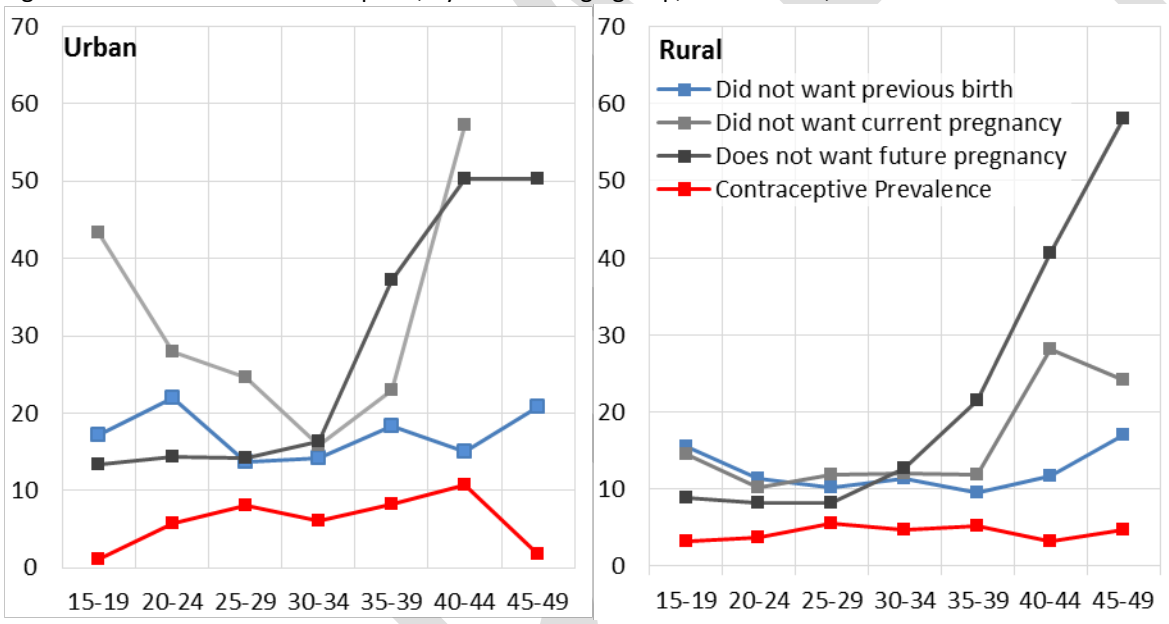
Source: Author's calculations based on 2010 SHHS

In 2010, contraceptive prevalence was 6.6 percent in urban areas versus 4.6 percent in rural areas and 3.4 percent among mothers with no education versus 16.3 percent among mothers with secondary education or higher. The extremely low use of contraception in South Sudan is worrying not only for creating the potential for unwanted births but also that low contraception tends to correlate with low use of protection during sex (in 2010, less than 3 percent of women reported using a condom during their last sexual encounter) which facilitates the transmission of sexually transmitted disease, including HIV/AIDS.

Exploring the reasons for low contraception use is important because low usage does not necessarily imply lack of access, and strategies for encouraging increased use of family planning methods need to be based on the reality of the decision-making process underlying fertility choices. The demand for contraception depends on whether women and their partner desire children and whether women have sufficient power (in cases where the fertility desires between men and women diverge) to influence decisions. Among women having had a live birth in the two years prior to the SHHS, in 2006, 34 percent in urban areas did not want their last birth compared to 53 percent in rural areas. In 2010, 17 percent of women in urban areas did not want their last birth compared to 11 percent in rural areas. A more prospective measure of the demand for contraception is the percentage of women not wanting to become pregnant in the future. In 2006, 57 percent of women in urban areas and 54 percent in rural areas did not want a future pregnancy; whereas in 2010, 23 percent of women in urban areas and 16 percent in rural areas did not want a future pregnancy. These results suggest that the desire for children increased between 2006 and 2010. Table B11 disaggregates the marriage status, desire for pregnancy and use of contraception among women by their age group in 2010. Figure B15 displays these results graphically. Some

salient observations are worth noting: (1) the percentage of married women is lower in urban (77 percent) compared to rural (82 percent) settings suggesting greater economic or schooling opportunities for women in urban areas. (Interestingly, marriage rates have gone down since 2006 when 83 percent of women among urban areas and 86 percent in rural areas were married. This decline was driven by reduction in the marriage rate of adolescent women which fell by 16 percent in urban areas (from 41 to 35 percent) and 18 percent in rural areas (from 49 to 41 percent)) (2) Younger women (ages 15-30) reported not wanting previous or current pregnancies at a higher rate than future pregnancies relative to older women (ages 30-49) (Figure B15). One explanation may be that younger women who have given birth or are currently pregnant became pregnant sooner than desired and that older women are more likely to have already had their desired number of children. In urban areas, adolescent women are more likely to not want current pregnancies compared to women in rural areas – this may be tied to higher employment or educational aspirations among urban relative to rural women and the recognition that pregnancies may hurt the chances of achieving those aspirations in the short run (3) the difference between the desire to avoid pregnancy (as a proxy for the demand for contraception) and the actual use of contraception suggests that access to, rather than demand for, contraception is the primary constraint leading to low use. The gap between demand and use (unmet need) is largest for adolescents (women of ages 15-19) and older women (over the age of 35).

Figure B15. Demand for contraception, by women's age group, South Sudan, 2010



Source: Author's calculations based on 2010 SHHS

The use of modern contraception (injectable and oral hormones, implants, intrauterine devices, spermicides, condoms, diaphragms, female and male sterilization) increased from 1.6 to 3.4 percent between 2006 and 2010 among women in urban areas. Given that contraceptive prevalence did not change significantly among women in urban areas between 2006 and 2010 means that increasing use of modern contraception is displacing traditional methods among women who do use contraception. For women in rural areas, while use of modern contraceptive remained stable at 1.1 percent between 2006 and 2010, the use of traditional methods expanded from 2.6 to 3.8 percent. The most commonly used methods for contraception in 2010 among couples using

contraception were lactational amenorrhea (21 percent), withdrawal (17 percent), male condoms (17 percent) , injectables (14 percent) and pills (13 percent).

Compared to family planning and nutrition, which are interventions that can take a wider population-based approach, interventions directed at individuals require a continuum of care for the mother and baby in terms of time (before and after delivery), place (linking home and health services through effective referral) and person (the provider of care) (Graham, Cairns et al. 2006).

The role of home-based and community care in South Sudan is a necessary strategy to prevent adverse maternal and child outcomes (given that over 85 percent of births are delivered in the home (table B12), and the vast majority of the population lives in relatively isolated rural areas). Home-based and community care is critical as a means to provide information, education and birth preparedness as well as promote male involvement to support care-seeking behavior. In addition involvement of the community in helping shape locally appropriate messages to promote health-seeking behavior and newborn care best practices can be effective. However, there is ample evidence that the chances of survival for mother and child are greatly improved if the mother can benefit from skilled care (Koblinsky, Mathews et al. 2006) as well. Child survival during the first 28 days of life requires a safe birth. A safe birth in turn, requires that women have access to a range of thoughtful and effective care: from routine antenatal care to delivery care to emergency obstetric services at the secondary level.

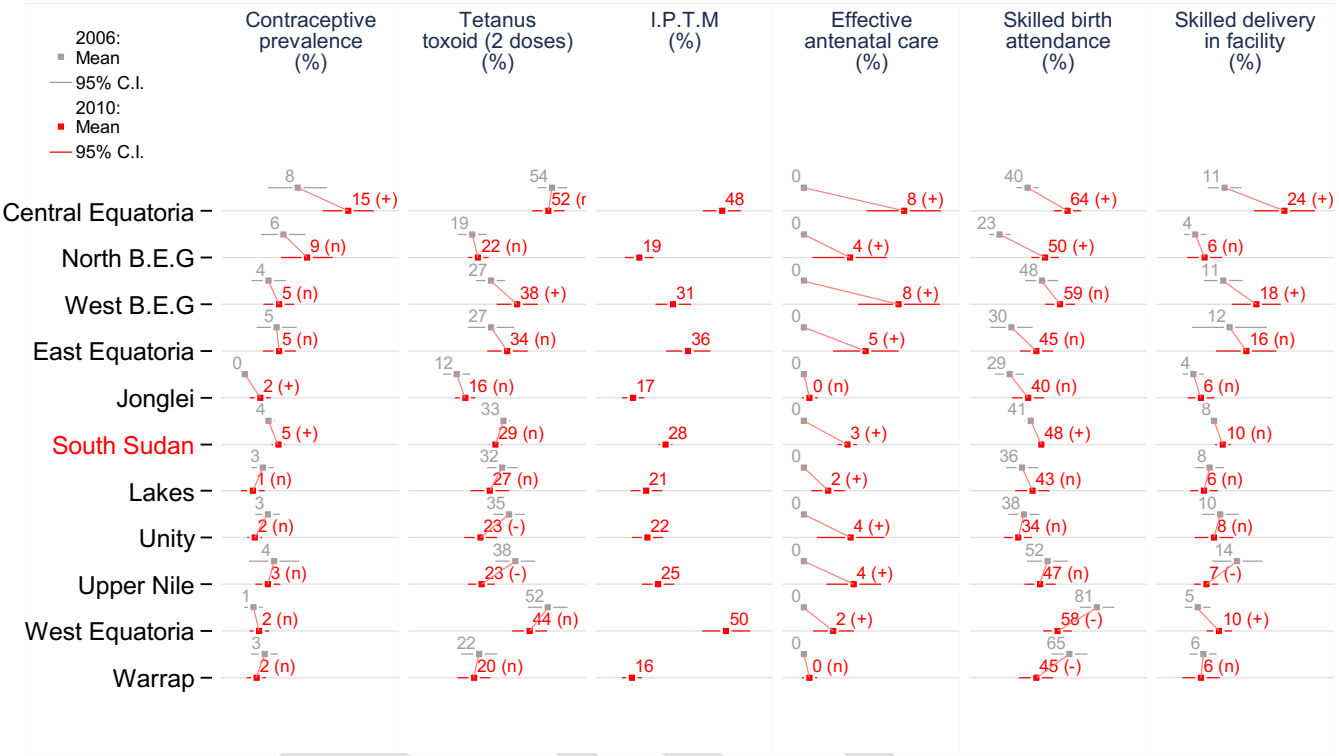
Table B12. Place of delivery among women giving birth in two years prior to survey, South Sudan, 2006 & 2010

Place of Delivery	Year	Wealth Quintile		Mother's Education			Household Setting		South Sudan
		Poorest	Richest	None	Primary	Secondary or Higher	Rural	Urban	
Home	2006	84.1	78.5	80.2	79.0	64.6	80.2	79.0	79.8
	2010	92.3	74.5	89.1	73.5	53.7	88.5	70.6	85.4
Hospital	2006	2.2	6.5	3.3	7.5	16.5	2.9	6.4	3.9
	2010	3.2	19.0	5.2	16.9	32.8	4.7	23.3	8.0
Primary Health Care Facility	2006	5.9	8.4	7.9	6.4	14.4	6.9	10.2	7.9
	2010	1.7	3.2	2.6	6.1	6.7	3.6	2.0	3.3
Other	2006	1.9	1.7	2.1	1.3	1.2	2.5	0.8	2.0
	2010	1.2	0.1	0.8	1.3	0.0	0.8	1.0	0.9

Source: Author's calculations based on 2006 and 2010 SHHS.

Five measures are used here to gauge the extent to which mothers have access to skilled care (table B6): (1) coverage of tetanus toxoid vaccine among pregnant women (which is provided as a component of antenatal care); (2) coverage of intermittent presumptive treatment for malaria among pregnant women (3) coverage of effective antenatal care among pregnant women, defined as at least four outreach visits with a doctor, nurse or midwife, during which the women was given an assessment for blood pressure, a urine screen for protein and a blood screen for anemia as well as two doses of tetanus toxoid vaccination; (4) assistance during birth by a doctor, nurse or midwife and (5) assistance during birth by a doctor, nurse or midwife in a hospital or primary health care facility (used as a proxy to gauge the extent to which pregnant women have access to some level of emergency care in a clinical setting should the need arise).

Figure B16. Maternal and neonatal survival interventions



Source: Author's calculations based on 2006 and 2010 SHHS
Notes: States or ordered based on largest average percentage point improvement in coverage between 2006 and 2010 across the five indicators. (+) Difference between means in 2010 and 2006 is positive and significant at the 95% level. (-) Difference between means in 2010 and 2006 is negative and significant at the 95% level. (n) no evidence of statistical difference in means between 2006 and 2010. I.P.T.M = Intermittent Presumptive Treatment for Malaria

Maternal and neonatal tetanus (MNT) is a vaccine preventable disease that is a major cause of newborn death worldwide commonly resulting from unhygienic cutting of the chord or care of the chord stump. One of the key recommended strategies to reduce child deaths from tetanus is the provision of at least 2 doses of tetanus toxoid vaccine to women during pregnancy. Between 2005 and 2009, the percentage of women aged 15-49 having had a pregnancy in the 2 years prior to the survey with at least 2 tetanus toxoid vaccines remained at around 30 percent. Only West Bahr El Ghazal showed statistically significant improvement in providing the vaccine, with coverage increasing from 27 to 38 percent between 2005 and 2009. Unity and Upper Nile showed declines in Tetanus Toxoid coverage from 35 and 38 percent, respectively, in 2009 - to 23 percent in 2005.

Intermittent presumptive treatment for malaria, a recommended antenatal intervention in malaria endemic areas, averaged 28 percent for South Sudan in 2009, ranging from a high of 48 and 50 percent in West and Central Equatoria to 16 and 17 percent in Warrap and Jonglei respectively. There were no data available from the 2006 SHHS to make comparisons over time.

Relative to the provision of individual interventions, the health system performs poorly in delivering an overall package of effective antenatal care. No pregnant women received an effective package of antenatal care between 2004 and 2006. Between 2008 and 2010, 3 percent of pregnant women reported receiving an effective

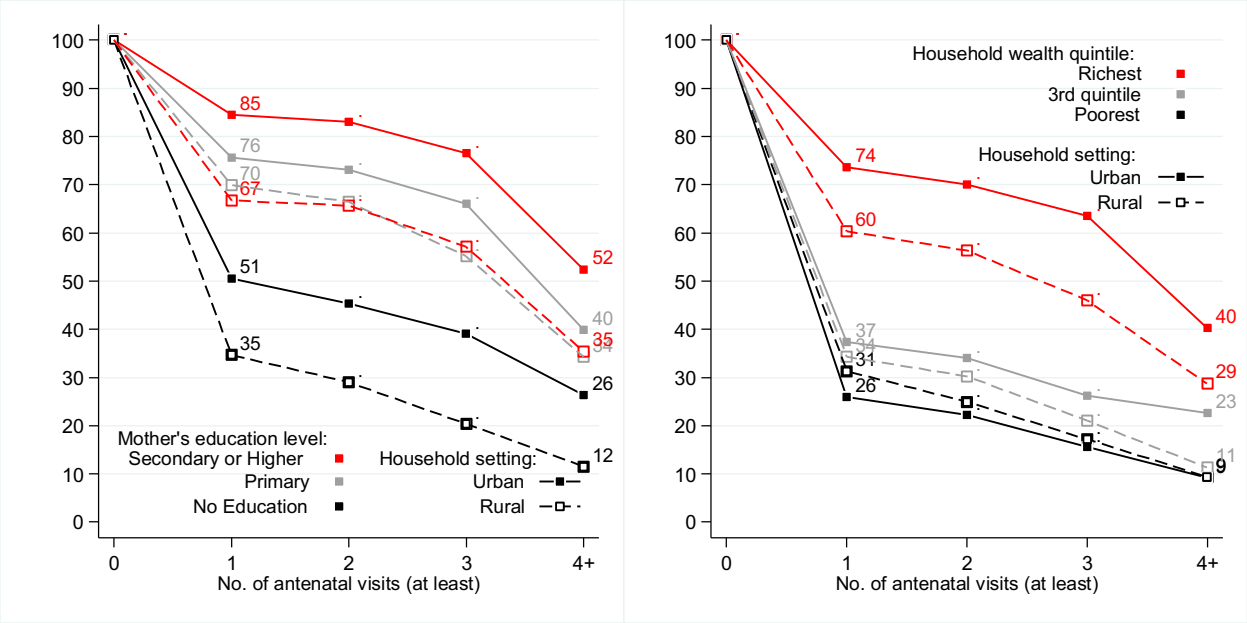
package of antenatal services – a statistically significant increase that provides evidence of improvement. The largest gains were made in Central Equatoria and West Bahr El Ghazal where a package of care was provided to approximately one in 10 pregnant women. Jonglei and Warrap were the only states to show no signs of improvement.

The fact that so few women benefit from an effective package of antenatal care yet a relatively higher percentage benefit from individual interventions (such as iron supplementation or tetanus toxoid vaccines) reflects the difficulty the health system has in delivering interventions that require repeated interactions and consistent engagement with the population. This difficultly likely reflects a mix of demand and supply side factors. For example, a pregnant woman in a rural household who is responsible for household tasks, tending to crops and caring for children might not prioritize visiting a clinic for a check-up until perceived benefits outweigh costs such as when something tangible is offered (like an injection or pill) or during an emergency. Pro-active management of risks may also be sub-optimal as a result of social norms or cultural beliefs, in India for example, among the poor, preparing for the worst is thought to increase the chances that the worst will happen (Das 2011). If the direct costs per facility visit are high, she may have to wait until she has saved sufficient cash to afford transportation to the clinic or to pay any associated fees at the point of care.

Figure B17 illustrates the effect of supply and demand factors in relation to antenatal care. The graph displays the percentage of women benefitting from at least zero (100 percent of pregnant women) to at least four antenatal visits during their last pregnancy (in the two years prior to the 2010 SHHS), in effect showing the points during the antenatal visit schedule at which pregnant women "drop out" of routine antenatal care. The left panel disaggregates this schedule by mother's education level and urban or rural household setting while the right panel disaggregates the schedule by the mother's wealth status and urban or rural household setting. Four observations are salient: (1) a significant number of the poorest (approximately 30 percent) and uneducated women (approximately 43 percent) never make it to a primary health care facility or hospital for a single antenatal visit (2) among women who do make it to a facility (regardless of education, wealth or household setting) for a first visit, only between a third to half of these women return to complete at least four visits (3) the demand for antenatal care increases with women's education and wealth (regardless of household setting) (4) households in rural settings have a more difficult time accessing care regardless of education or wealth.

Expanding preventive antenatal care for women hinges importantly on stimulating demand for care – through education, communication, improving the quality of care and reducing financial barriers at the point of care – as well as targeting investments in remote rural communities without ready access to primary health care facilities. This may include expanding health worker training, providing affordable transportation to health centers, improving roads and improving drug supply chains.

Figure B17. Number of antenatal visits, by education, wealth and household setting, South Sudan, 2010



Source: Author's calculations based on 2010 SHHS

Notes: For each education or wealth category, there are two lines: one for rural and another for urban households.

In 2000, approximately 50 percent of women in all low and middle-income countries were able to access professional care at childbirth. In Sub-Saharan Africa and the Middle East and North Africa, large discrepancies in coverage exist between women living in rural areas (30 percent coverage) and women living in urban areas (70 percent coverage). In South Sudan– among women of reproductive age with a pregnancy in the two years prior to the survey - skilled birth attendance (births attended by a doctor, nurse midwife or village midwife) covered 41 percent of live births between 2004 and 2006 and 48 percent between 2008 and 2010. Across states, skilled birth attendance ranges from a high of 64 percent in Central Equatoria to a low of 34 percent in Unity. Only two states (Central Equatoria and North Bahr El Ghazal) improved in coverage between 2006 and 2010. The higher percentage of women assisted by a professional during birth in West Equatoria and Warrap in 2006, relative to 2010, casts some doubt on the 2006 baseline values.

In urban settings, skilled birth attendance increased from 46 percent in 2006 to 67 percent in 2010, while in rural settings coverage was 39 percent in 2006 and 44 percent in 2010 (the difference is not statistically significant). By comparison, in-facility births attended by a professional did not change in the 4 year period (8.4 and 10.4 percent of pregnant women gave birth with the help of a professional in a facility in 2006 and 2010, respectively) but improved significantly for women in urban areas where skilled deliveries in facility increased almost twofold from 13 to 25 percent over the period (Among women in rural areas, skilled deliveries in facilities was 6.7 and 7.4 percent in 2006 and 2010). Gains in professional support during childbirth has been primarily limited to women in urban areas and was driven by an increase in the number of births delivered by nurse midwives, medical assistants and health visitors (table B13). The percentage of women receiving no assistance at delivery fell from 13 to 7 percent between 2006 and 2010 – a reduction that is consistent across groups defined by wealth, education and household setting.

While assessing the degree of coverage of professional staff is important, it is also critical for the Ministry of Health, NGOs and health worker training institutions to assess the degree to which these providers are adequately trained to provide effective care such as identifying high-risk pregnancies and to perform simple – potentially life-saving procedures – at the time of delivery. The role of traditional birth attendants in delivering births continues to be important, primarily in rural areas. To the extent this reflects women's preferences, efforts to improve the safety for the mother and child at birth should consider training traditional birth attendants and providing them with clean delivery kits.

Table B13. Assistance at delivery, South Sudan, 2006 & 2010

Person assisting at delivery		Year	Wealth Quintile		Mother's Education			Household Setting		South Sudan
			Poorest	Richest	No Education	Primary	Secondary or Higher	Rural	Urban	
Professional Cadres	Doctor	2006	2.3	5.5	4.9	6.6	3.3	4.2	6.9	5.0
		2010	1.1	7.4	3.3	5.5	10.5	3.0	8.3	4.0
	Nurse Midwife	2006	7.0	15.2	11.2	14.5	29.8	11.5	12.9	11.9
		2010	6.7	33.5	11.1	33.7	48.2	13.1	30.3	16.3
	Auxiliary/ Village Midwife	2006	22.7	31.3	25.5	43.1	49.1	26.8	30.7	28.0
		2010	28.4	27.9	27.8	25.8	18.9	27.0	27.8	27.1
	Medical Assistant	2006	Category not used in 2006							
		2010	1.0	2.7	2.4	2.8	1.1	2.3	2.8	2.4
	Health Visitor	2006	Category not used in 2006							
		2010	1.0	1.0	1.5	1.2	0.9	1.7	0.4	1.5
	Traditional Birth Attendant	2006	57.5	40.1	50.7	30.2	19.6	50.2	42.2	47.8
		2010	60.2	26.6	52.5	30.1	18.0	52.0	27.7	47.5
	Other	2006	5.4	2.3	3.6	1.3	0.0	3.6	2.6	3.3
		2010	3.5	3.5	4.6	3.3	1.4	4.6	2.6	4.3
	No Assistance	2006	13.5	14.4	13.6	8.3	10.9	12.2	14.4	12.9
		2010	6.4	6.1	6.8	6.0	7.0	7.0	5.6	6.7

Source: Author's calculations based on 2010 SHHS

With the exception of effective ante-natal care, the educational attainment of mothers is positively associated with professional maternal care. Holding other factors constant, the education effect is largest for skilled birth attendance (mothers with primary and secondary education are 15 and 24 percentage points more likely to be assisted at birth compared to mothers without education) and smallest for contraception (mothers with primary and secondary education are 1.3 and 5 percentage points more likely to use contraception relative to mothers without education). Household wealth is associated with all maternal care interventions with the exception of contraception and effective antenatal care. Holding other factors constant, the wealth effect is largest for skilled birth attendance (mothers in the richest households are 17 percentage points more likely than mothers in the poorest households to be assisted during delivery) and smallest for delivering in facility (where mothers in the richest households are 7 percentage points more likely than mothers in the poorest households to deliver in a facility). With the exception of contraception and intermittent preventive therapy for malaria, mothers in urban areas are more likely to receive care than mothers in rural areas, holding other factors constant. These results are summarized in table B14.

Table B14. Marginal effects for the association between maternal intervention coverage and select demographic variables

	Contraception		Tetanus Toxoid (2 doses)		Intermittent Preventive Therapy for Malaria		Effective Ante-natal care		Skilled Birth Attendance		Skilled Delivery in Facility	
	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t
Mother's Education												
None						[reference]						
Primary	0.0129	2.05	0.118	5.33	0.0981	4.66	0.0096	1.84	0.1500	6.85	0.0537	4.04
Secondary or Higher	0.0507	3.5	0.138	3.03	0.1414	3.13	0.0198	1.57	0.2370	5.23	0.1361	4.62
Mother's Age *	0.0003	0.37	-0.004	-0.88	-0.0072	-1.26	-0.0028	-2.35	-0.0060	-1.25	-0.0039	-1.49
Household Setting												
Rural						[reference]						
Urban	-0.0039	-0.68	0.055	2.61	0.0158	0.65	0.0269	3.15	0.1007	3.93	0.0480	3.34
Household Wealth												
Poorest						[reference]						
2nd quintile	-0.0030	-0.59	0.034	1.57	0.0008	0.03	-0.0111	-1.46	0.0400	1.88	0.0207	2.06
3rd quintile	-0.0049	-0.8	0.044	2.03	0.0430	1.55	-0.0032	-0.39	0.0444	1.94	0.0229	2.03
4th quintile	-0.0013	-0.19	0.109	4.95	0.0915	3.48	0.0019	0.23	0.1018	4.5	0.0594	5.29
Richest	-0.0021	-0.29	0.129	5.38	0.1350	4.83	0.0118	1.24	0.1749	7.38	0.0722	5.46
State of Residence												
Jonglei						[reference]						
Upper Nile	-0.0299	-2.48	-0.134	-4.2	-0.0537	-1.40	-0.0146	-2.49	-0.0153	-0.37	-0.0215	-1.29
Unity	-0.0117	-0.9	0.021	0.57	-0.0002	0.00	0.0103	1.12	-0.0207	-0.48	0.0227	1.11
Warab	-0.0140	-1.05	-0.054	-1.39	-0.0450	-1.17	-0.0152	-2.57	0.0942	1.85	-0.0073	-0.35
North Bahr Al Gazal	0.0336	1.91	-0.063	-1.92	-0.0166	-0.40	0.0215	1.55	0.0247	0.62	-0.0147	-0.81
West Bahr Al Gazal	0.0022	0.16	0.010	0.3	0.0353	0.91	0.0103	1.35	0.1394	3.1	0.0294	1.62
Lakes	-0.0164	-1.22	0.035	0.94	-0.0081	-0.19	0.0012	0.14	0.0075	0.18	0.0045	0.24
West Equatoria	-0.0248	-2.01	0.128	3.14	0.1773	4.08	-0.0066	-1.18	0.1343	2.86	-0.0293	-1.9
Central Equatoria	0.0595	2.96	0.142	4.01	0.1504	4.00	0.0114	1.46	-0.0587	-1.55	0.0078	0.45
East Equatoria	0.0070	0.44	0.038	0.9	0.1301	3.21	0.0216	1.82	-0.0230	-0.54	0.0612	2.35
Year												
2006						[reference]						
2010	0.0071	1.51	-0.032	-1.78	[omitted]		[omitted]		0.1131	5.76	0.0144	1.7
N	13,444		7,500		3,924		4,123		7,528		7,528	

Source: Author's calculations based on 2006 and 2010 SHHS from a multivariate logit regression.
Notes: *Mother's age represents five year age groups, so the marginal effects should be interpreted as the change in probability of coverage associated with a 5 year increase in the mother's age.

Nutritional status and infant and young child feeding

Undernutrition encompasses stunting, wasting and deficiencies of essential vitamins and minerals. Stunting and wasting is characterized by comparing the weights and heights (lengths) of children of a certain age and sex to the weight and heights of healthy children (of the same age and sex) from a reference population[2]. These comparisons yield z-scores – the difference between a child's weight or height and the median value at that age and sex in the reference population divided by the standard deviation in the reference population. Stunting (a

[2] Currently, two reference standards are in use: one from the World Health Organization (WHO) and the other from the National Center for Health Statistics (NCHS). The WHO standards are used in this report to measure stunting, wasting and underweight.

height for age z-score that is less than 2 standard deviations below the median of the reference population), wasting (a weight for height z-score that is less than 2 standard deviations below the reference median) and underweight (a weight for age z-score that is less than 2 standard deviations below the reference median) are three common indicators used to measure undernutrition in a population. Monitoring stunting and wasting is more useful as underweight encompasses the effects of both and the determinants of stunting and wasting may be different and respond to different interventions.

Growth faltering

Stunting generally results from chronic undernutrition whereas wasting results from poor nutrition in the short term. Qualitative observations from Twic County have noted the role of food insecurity (infrequent meals, lack of food variety and lack of meat) and an inadequate social and care environment (women's heavy workloads that prevent good feeding practices, limits on food intake during pregnancy and lactation) (Theuri 2007), and broader nutritional assessments focused on South Sudan underscore the high degree of infectious disease burden among children which worsens malnutrition, the role of traditional beliefs and customs which are at odds with feeding best practices and the inequitable distributions of food within the household (Harvey and Rogers-Witte 2007). In addition, the causes of undernutrition are varied, depending on geographic or livelihood area (which will moderate the availability and access to food through climactic and soil conditions) and ethnic group. Income poverty – the lack of employment, poor living conditions, savings and access to capital is also a major underlying cause of under nutrition.

Childhood malnutrition has significant long-term effects, including diminished adult intellectual ability, work capacity and productivity which ultimately lead to economic hardships for individuals and their families. For children of school-age, poor nutrition limits cognitive ability and school readiness. From a health standpoint, undernutrition increases vulnerability to disease and the likelihood of death from disease. Worldwide, 19 percent of under-5 deaths are directly attributable to being underweight. Even children who are mild to moderately underweight (weight-for-age less than 1 standard deviation below the reference median) are at increased risk of death. In Sub-Saharan Africa, an estimated 1.3 million deaths are attributable to undernourished children (weight-for-age less than 1 standard deviation below the reference median). In addition, there is growing evidence that early malnutrition is a risk factor for developing chronic diseases later in life such as diabetes, hypertension, renal disease and cardiovascular disease which are costly to manage. Infants and young children falter in their growth due to inadequate diets and recurrent illness which reduce appetite, increase metabolic requirements and increase nutrient loss (Caulfield, Richard et al. 2006).

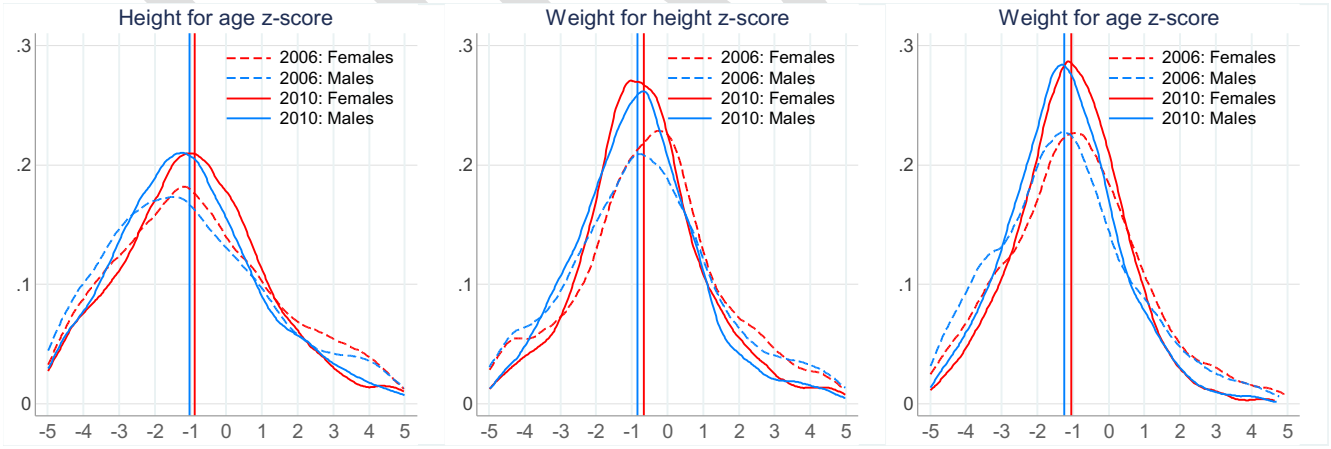
In 2010, the prevalence of underweight, stunted and wasted children under the age of five in South Sudan was 29, 32 and 24 percent, respectively (table B15 to B17). By comparison, regional estimates of underweight, stunting and wasting prevalence in 2010 place Eastern Africa at 22, 45 and 9 percent, respectively, and North Africa at 8, 22 and 10 percent, against a backdrop of stagnant rates in Africa as a whole, where – since 1990 - underweight prevalence has remained at 20 percent, stunting prevalence at close to 40 percent and wasting prevalence at close to 10 percent (Onis, Blossner et al. 2011) (Department of Nutrition 2011). Since 2006, the nutritional status of South Sudan's children has improved, with underweight prevalence falling by 14 percent (from 34.5 to 29.4 percent) and stunting prevalence by 13 percent (from 36.6 to 32.1) over the period for both sexes combined. There is no evidence of improvement in the percentage of wasted children, which remained at 24 percent in 2006 and 2010 for both sexes – much higher than the regional average (Figure B20). Even

compared to pre-CPA estimates (between 1995 and 2001) of wasting prevalence at 21.5 percent, the evidence suggests that little progress has been made in mitigating the short term factors that cause wasting (Harvey and Rogers-Witte 2007). There is, however, evidence that severe wasting (severe acute malnutrition) declined from 13.2 percent in 2006 to 10.8 percent in 2010.

On average, female children have better nutritional outcomes than males. Figure B18 shows the distribution of height for age, weight for height and weight for age z-scores for males and females. In each case, the mean z-score for females is greater than the mean z-score for males. This result is also apparent when comparing the prevalence of underweight, stunted and wasted females in males in tables B15 through B17.

Stunting prevalence shows a discernable age-pattern (Figure B19). Children between the ages of 6-11 months and 12-23 months are about 50 percent less likely to be stunted than children between 0-5 months and children between 24-60 months. Of note, is that the decline in stunting prevalence between 2006 and 2010 was driven predominantly by sharp declines in stunting prevalence among children of both sexes between the ages of 6 and 23 months. The observed age-pattern may suggest that children are born with a nutritional disadvantage (possibly resulting from maternal malnutrition and low birthweight) but gain nutritional advantage in the first year of life with good breastfeeding practices. Nutritional outcomes subsequently deteriorate, possibly as a result of inadequate transition to other foods that may be insufficient in quantity or lacking in key nutrients and as a result of more exposure to the environment, increasing their likelihood of illness. This hypothesis is supported by studies that have established the relationship between episodes of diarrhea and increased odds of stunting at 24 months of age (Black, Allen et al. 2008). The relatively high proportion of children being exclusively breastfed between the ages of 0 and 6 months compared to the proportion of children receiving adequate complementary foods at 6 months (Figure B21), as well as the spike in diarrhea prevalence among children between the ages of 12 and 23 months (Figure B22) also supports the observed pattern of nutritional status by the age of the child. The prevalence of wasting on the other hand is relatively uniform over age (figure B18).

Figure B18. Wasting prevalence by sex, age group and year, South Sudan



Source: Author's calculations based on 2006 & 2010 SHHS, WHO's Anthro software v3.2.2 and WHO growth standards.
Notes: The 2010 mean z-values are represented as vertical lines.

Table B15. Underweight and severe underweight prevalence by age, sex and year (all ages), South Sudan

	2006				2010			
	Severe underweight		underweight		Severe underweight		underweight	
	% < -3SD	(95% CI)	% < -2SD	(95% CI)	% < -3SD	(95% CI)	% < -2SD	(95% CI)
Both Sexes	20.2	(18.5- 21.9)	34.5	(32.7- 36.4)	13	(11.8- 14.4)	29.4	(27.6- 31.3)
Males	23	(21.1- 25.1)	37.9	(35.7- 40.2)	15.1	(13.4- 16.9)	32.5	(30.2- 34.9)
Females	17	(15.2- 19)	30.7	(28.5- 33)	10.9	(9.4- 12.5)	26.1	(24- 28.4)

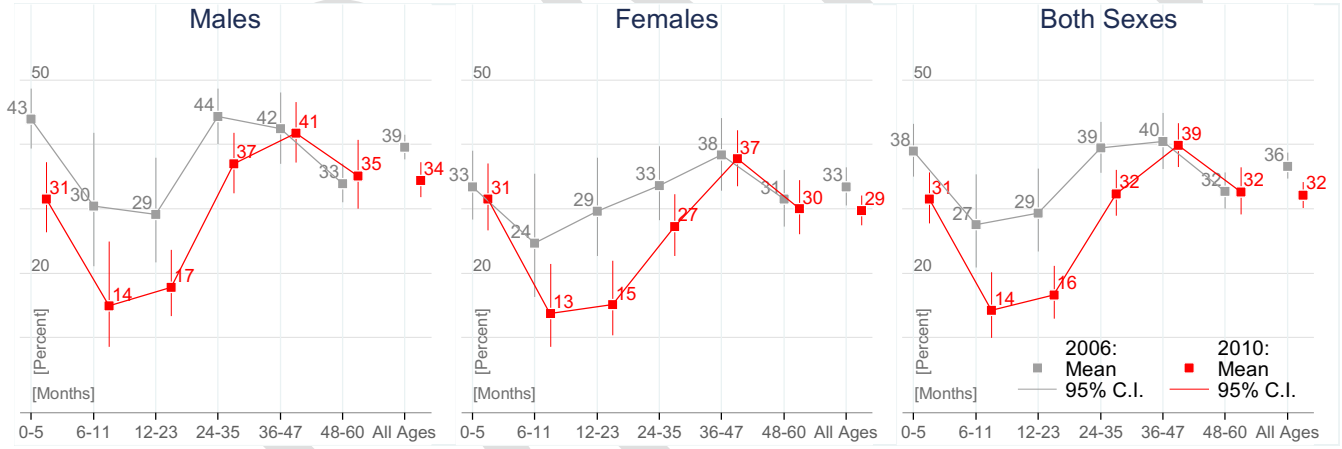
Source: Author's calculations based on 2006 & 2010 SHHS, WHO's Anthro software v3.2.2 and WHO growth standards.

Table B16. Stunting and severe stunting prevalence by sex and year (all ages), South Sudan

	2006				2010			
	Severe stunting		Stunting		Severe stunting		Stunting	
	% < -3SD	(95% CI)	% < -2SD	(95% CI)	% < -3SD	(95% CI)	% < -2SD	(95% CI)
Both Sexes	22.9	(21.4- 24.5)	36.6	(34.7- 38.6)	17.7	(16.1- 19.3)	32.1	(30.1- 34.1)
Males	24.8	(22.8- 26.9)	39.5	(37.6- 41.4)	18.6	(16.5- 20.8)	34.4	(31.8- 37.1)
Females	20.8	(18.8- 22.9)	33.4	(30.5- 36.4)	16.8	(15- 18.7)	29.7	(27.4- 32)

Source: Author's calculations based on 2006 & 2010 SHHS, WHO's Anthro software v3.2.2 and WHO growth standards.

Figure B19. Stunting prevalence (percentage of stunted children under-five) by sex, age group and year, South Sudan



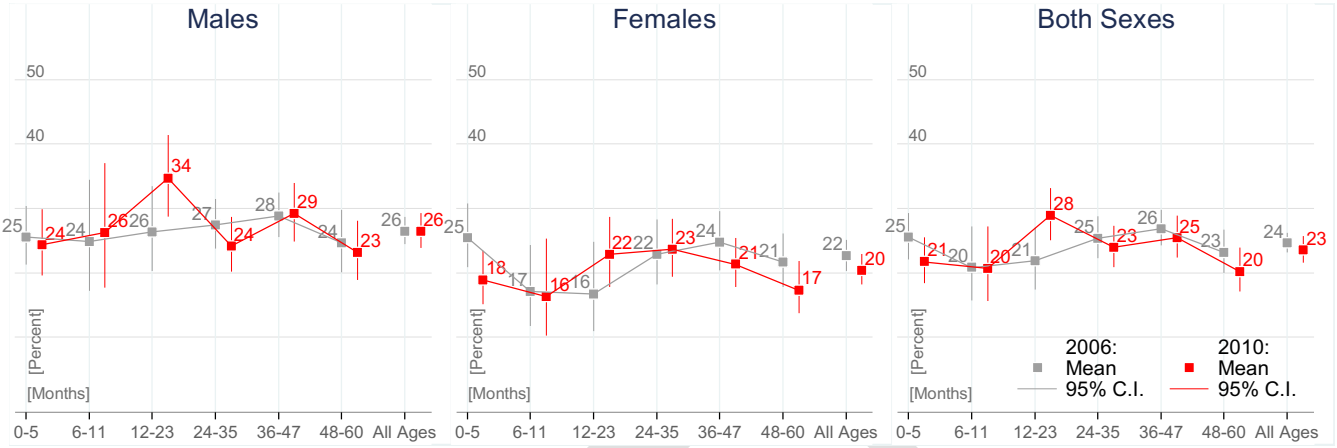
Source: Author's calculations based on 2006 & 2010 SHHS, WHO's Anthro software v3.2.2 and WHO growth standards.

Table B17. Wasting and severe wasting prevalence by sex and year (all ages), South Sudan

	2006				2010			
	Severe wasting		wasting		Severe wasting		wasting	
	% < -3SD	(95% CI)	% < -2SD	(95% CI)	% < -3SD	(95% CI)	% < -2SD	(95% CI)
Both sexes	13.2	(12- 14.5)	24.6	(23.1- 26.1)	10.8	(9.2- 12.6)	23.5	(21.5- 25.6)
Males	13.9	(12.2- 15.8)	26.4	(24.4- 28.6)	12.5	(10.3- 15)	26.4	(23.8- 29.2)
Females	12.5	(11- 14.2)	22.6	(20.3- 25)	9.1	(7.5- 10.9)	20.4	(18.2- 22.8)

Source: Author's calculations based on 2006 & 2010 SHHS, WHO's Anthro software v3.2.2 and WHO growth standards.

Figure B20. Wasting prevalence by sex, age group and year, South Sudan



Source: Author's calculations based on 2006 & 2010 SHHS, WHO's Anthro software v3.2.2 and WHO growth standards.

Central to interventions aimed at preventing under nutrition is the promotion of optimal feeding practices of infants and young children. Among these practices is exclusive breastfeeding beginning immediately after birth until six months of age – other liquids such as oral rehydration salts, drops or syrups for vitamins, minerals or medicines are allowed at this time (WHO). In South Sudan, 59 percent of children under the age of 2 were fed breast milk less than an hour after childbirth in 2010 (Figure B21). Interestingly mothers with primary or secondary education were about 12 and 13 percent less likely to initiate early breastfeeding compared to mothers without education; all other factors equal (table B18). There is also some evidence that early initiation of breastfeeding is negatively associated with wealth.

The coverage of exclusive breastfeeding through 6 months of age in South Sudan was 48 percent, representing a significant increase since 2006 when exclusive breastfeeding coverage stood at 28 percent. It is also recommended for mothers to continue frequent and on-demand breastfeeding until their child reaches two years of age or beyond. In South Sudan, continued breastfeeding – defined as the percentage of children aged 12-15 months who continue to be breastfed was 95 percent in 2010, up from 90 percent in 2006 (Figure B21). The women of West Bahr El Ghazal and Unity made substantial progress expanding the practice of exclusive and continued breastfeeding between 2006 and 2010. Breastfeeding promotion strategies include influencing hospital policies and practices to encourage breastfeeding and discourage bottle feeding, counseling and education provided by peers or health workers, mass media and community education and support groups. Given the increase in breastfeeding practice, there is an opportunity to identify and further scale specific approaches that have been effective in conveying public health messages related to breastfeeding. Interestingly women in wealthier households are around 10 percent less likely than women in the poorest households, all else equal, to exclusively breastfeed their child during the first 6 months; while there is no available evidence to assess why - this may be related to messages received by mothers or perceptions that formula feeding is better for the newborn (table B18). There is an important exception to breastfeeding which involves women who are HIV-positive due to the risk of transmitting HIV to the infant. For these women, the WHO currently recommends affordable and safe replacement feeding. When replacement feeding is not possible alternatives exist such as heat-treated breast-milk, HIV-negative wet nurses, uncontaminated donor milk or exclusive breastfeeding for six months and rapid discontinuation thereafter(WHO 2003).

When breast milk alone cannot satisfy all of a child's nutritional requirements, complementary foods and liquids (alongside breast milk) are needed to meet nutrient and energy demands starting at 6 months of age. Without adequate complementary foods – even with optimum breastfeeding – children will become stunted (Black, Allen et al. 2008). For South Sudan the introduction of complementary foods - measured as the percentage of infants aged 6-8 months who were fed solid, semi-solid or soft foods in the 24 hours prior to the survey – covered 35 percent of the infants in 2010 - no different statistically than the coverage in 2006. In fact, no state showed significant improvement in complementary feeding between 2006 and 2010. If thin porridge is excluded from the set of foods accepted under the definition of complementary foods in 2010 (which was included for consistency with the 2006 survey which made no distinction between solid or semi-solid foods with porridge), timely complementary feeding coverage falls to 19 percent for South Sudan. Naturally fermented cereal porridge made of sorghum, known locally as *medida or agiria* – is used frequently for the sick, nursing mothers and weaned infants. In 2010, close to 26 percent of infants aged 6 to 8 months were fed this thin porridge the day prior to the interview. Unfortunately, *medida* has very low nutritional content and energy and, as it contains 95 percent water, gives children a sensation of being full. Modifications to the preparation of *medida* by using additional ingredients such as milk and probiotic bacteria can significantly improve its nutritional value (Kabeir, Shuhaimi et al. 2004). Complementary feeding is significantly more likely among women with secondary education (compared to women without formal education), and among women in the wealthiest households (compared to women in the poorest households) (table B18). While monitoring whether a child is being given solid, semi-solid or soft foods is important, feeding practices related to hygiene, food handling, the quantity of food given and the frequency and diversity of meals are also critical as a strategy to prevent repeated infection and illness which can worsen a child's nutritional outcomes.

Micronutrient deficiencies

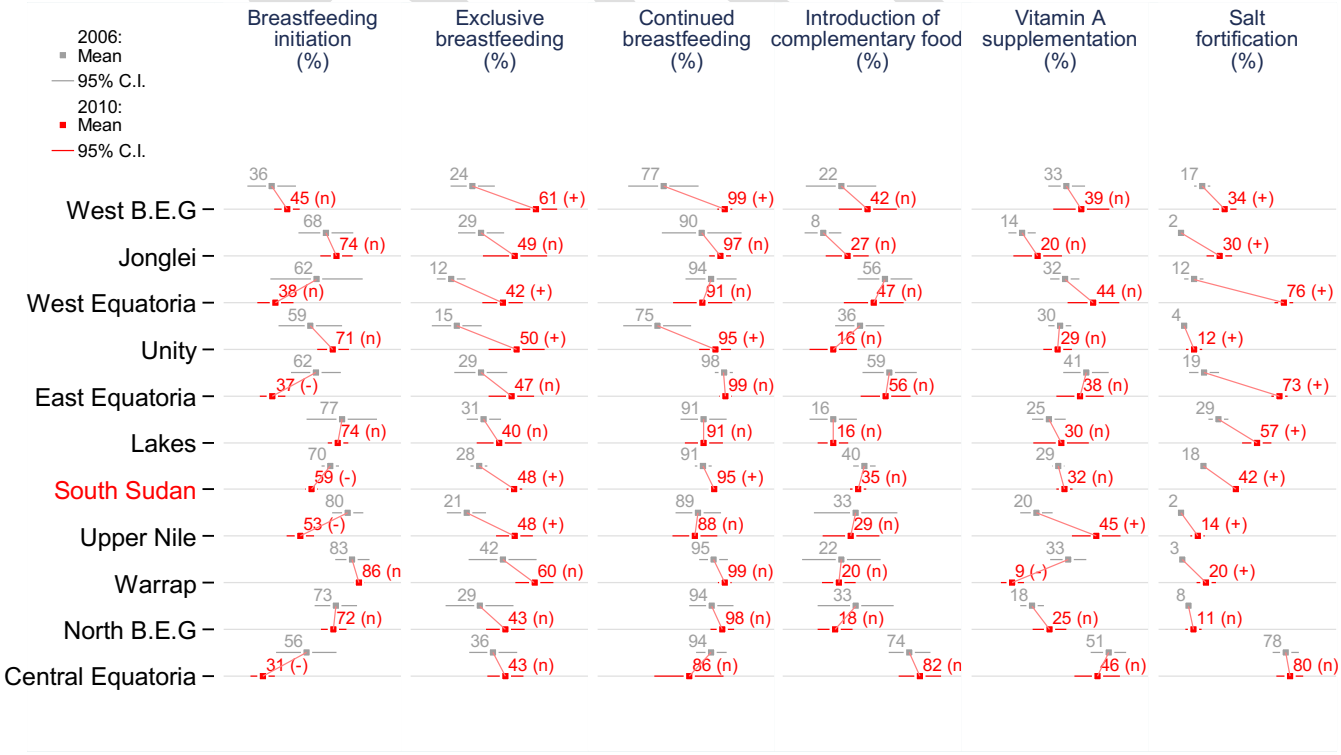
Vitamin A deficiency (causing an estimated 383 thousand deaths annually in Sub-Saharan Africa and affecting 32 percent of children ages birth through four in the region) is a preventable cause of blindness and a risk factor for infectious disease and mortality, most likely due to weakened immune system. The underlying causes of Vitamin A deficiency include low intakes of animal foods that provide vitamin A (such as milk and eggs), inadequate intakes of non-animal sources of carotenoids (dark green leafy vegetables, non-citrus fruits and other vegetables such as pumpkins and squash) and inadequate intakes of fat which facilitate the absorption of carotenoids. In South Sudan there is a lack of data describing the epidemiology of Vitamin A deficiency, but it is likely to be high given the overall levels of undernutrition. Vitamin A supplementation, given as an oral capsule, is an effective way to reduce blindness and mortality. Other approaches such as fortification and dietary diversification have been pursued to increase intake of Vitamin A. In South Sudan, the percentage of under-five children older than 6 months receiving oral Vitamin A capsules was 32 percent – no different than overall coverage in 2006 (Figure B21). Only Upper Nile showed significant improvements in Vitamin A coverage between 2006 and 2010.

Iodine is required for thyroid hormones which regulate growth, development and metabolism and prevent goiter and cretinism. Inadequate intake can result in impaired intellectual development and physical growth, the range of conditions resulting from iodine deficiency are known as iodine deficiency disorders and can include fetal loss, stillbirth, congenital anomalies and hearing impairment, however, the main burden of insufficient iodine is reduced mental capacity which carries long-term economic consequences. An indirect proxy for the prevalence of iodine deficiency in the population is the prevalence of goiter - in Sudan (including the North),

estimates from a 1997 national study place the prevalence of goiter at 22 percent (UNICEF 2007). A 2006 study, found that the prevalence of goiter in schoolchildren aged 6 to 12 years in Wau was 49 percent (Medani, Elnour et al. 2011).

Large scale salt fortification is the primary strategy for preventing iodine deficiency because of the nearly universal consumption of salt regardless of socioeconomic status and the fact that supplementation with iodine does not cause an effect on taste, consistency or color (Caulfield, Richard et al. 2006). In Sudan, a declaration in 2003 under the Public Health law of 1975 provided for blending salt with potassium iodate, calling on producers to begin this process within six months but with limited production capacity, lack of a ban on non-iodized salt, unclear role for inspectors and sanctions for non-compliant salt producers, little progress was made initially (UNICEF 2007). In South Sudan, it is unclear whether this program has been continued or adapted post-independence, but indicators of household salt consumption in South Sudan show signs of progress. Between 2006 and 2010, iodized salt consumption at the recommended level of 15 or more parts per million, rose from 18 to 42 percent (Figure B21). Except for North Bahr El Ghazal and Central Equatoria, households in all other states appear to be consuming significantly greater quantities of iodized salt. The association of household iodized salt consumption is strongly associated with wealth, with 32 percent of the poorest households compared to 58 percent of the richest households consuming iodized salt in 2010. The coverage ratio between the richest and poorest households in regards to salt consumption was also around 2 in 2006, suggesting that price or lack of knowledge about the benefits of iodized salt continues to be a significant barrier.

Figure B21. Infant and young child feeding interventions, by state, 2006 and 2010



Source: Author's calculations based on 2006 and 2010 SHHS

Notes: States or ordered based on largest average percentage point improvement in coverage between 2006 and 2010 across the five indicators. (+) Difference between means in 2010 and 2006 is positive and significant at the 95% level. (-)

Difference between means in 2010 and 2006 is negative and significant at the 95% level. (n) no evidence of statistical difference in means between 2006 and 2010.

Iron deficiency anemia affects about 60 percent of children between birth and age four in Sub-Saharan Africa and causes about 21 thousand deaths annually in the region (Caulfield, Richard et al. 2006) and is caused by insufficient absorption of iron or excess loss (occurring mainly from blood loss) and can result in neurological impairment and decreased immune function. Zinc deficiency results from inadequate intakes (which comes mainly from animal meat and shellfish) and excess losses (for example during diarrheal illness) and in severe cases, can result in growth retardation, impaired immune function, skin disorders and anorexia among others. Mild to moderate deficiency reduces immune function, increasing susceptibility to infection. In Sub-Saharan Africa, Zinc deficiency is estimated to affect 50 percent of children ages birth through four and cause 400 thousand deaths annually. Unfortunately, there is no data available to assess the degree of iron and zinc deficiency in South Sudan.

Table B18. Marginal effects for the association between intervention coverage and select demographic variables

	Early Initiation of Breastfeeding		Exclusive Breastfeeding		Continued Breastfeeding		Complementary Feeding		Vitamin A supplementation		Salt fortification with iodine	
	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t
Education[ŧ]												
None	[Reference]											
Primary	-0.118	-3.86	-0.071	-1.61	-0.028	-0.9	0.087	1.11	0.098	4.14	-0.022	-1.43
Secondary +	-0.134	-2.03	-0.027	-0.29	0.016	0.35	0.371	2.64	0.158	2.91	-0.034	-1.66
Setting												
Rural	[Reference]											
Urban	0.025	0.74	-0.032	-0.75	0.031	2.05	0.084	1.22	0.119	4.77	0.157	3.44
Wealth												
Poorest	[Reference]											
2nd quintile	-0.025	-0.81	-0.088	-1.76	-0.009	-0.39	-0.010	-0.13	-0.013	-0.56	0.017	0.88
3rd quintile	-0.054	-1.67	-0.113	-2.24	-0.018	-0.73	0.009	0.12	0.008	0.31	0.028	1.21
4th quintile	-0.128	-3.94	-0.133	-2.79	0.015	0.77	0.081	1.02	0.056	2.14	0.089	3.42
Richest	-0.067	-1.92	-0.098	-1.82	-0.030	-1.07	0.163	2.04	0.060	2.43	0.166	5.22
Year												
2006												
2010	-0.090	-2.83	0.210	6.16	0.043	2.3	-0.065	-1.2	0.026	1.23	0.223	7.51

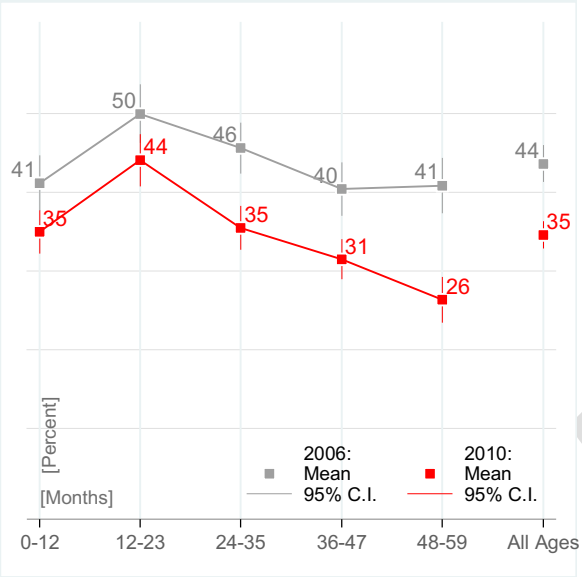
Source: Author's calculations based on 2006 and 2010 SHHS from a multivariate logit regression.

Notes: [ŧ] Education levels refer to the highest education level achieved by the mother, with the exception of education levels associated with salt fortification which correspond to the household head.

Diarrhea: Risk factors, prevention and care

Diarrheal diseases are a leading cause of preventable death and morbidity among children under-five years of age worldwide. In South Sudan, in the two weeks prior to the survey, diarrhea affected 35 percent of children under-five in 2010, down from 44 percent in 2006 (Figure B22). The frequency and severity of diarrhea is associated with housing conditions, access to clean water, sanitary disposal of fecal waste, cohabitation with

Figure B22. Diarrhea prevalence by age, South Sudan, 2006 and 2010



Source: Author's calculation based on 2006 & 2010 SHHS

domestic animals and lack of refrigerated storage. These factors, including inadequate personal hygiene are responsible for an estimated 90 percent of childhood diarrhea (Keusch, Fontaine et al. 2006).

About one in three households in South Sudan rely on an unprotected water source for drinking (including unprotected wells or springs and unfiltered open water from rivers, streams, ponds etc). Only one in ten households treats their drinking water; of those that do, close to 50 percent use chlorine (Figure B23). Between 2006 and 2010 among households who are treating their water, the use of chlorine increased substantially, from 10 percent in 2006 to 61 percent in 2010, suggesting that chlorine has partially displaced other means of treating water such as boiling and that efforts to expand the use of chlorine, while successful, have managed only to change the behaviors of households already treating their water. Relative to the poorest households, wealthier households are between 2 and 20 percentage points more likely to treat their water (table B19), controlling for other factors. In terms of sanitation, approximately 2 out of every 3 households in 2010 do not have any formal facility for disposing of solid waste. Given the association between poverty and housing conditions, children in the richest households are 6 percentage points less likely to suffer from diarrheal diseases compared to children in the poorest households while children living in urban households are about 4 percentage points less likely to suffer from diarrhea compared to rural households, all other factors equal (table B19). Children whose mothers have secondary education are 9 percentage points less likely to contract diarrhea relative to children whose mothers have no education, all else equal. The association between education and reduced diarrheal incidence is likely mediated through improved feeding and care practices as mother's education is also associated with increased likelihood of exclusive breastfeeding, complementary feeding and vitamin A supplementation (table B18).

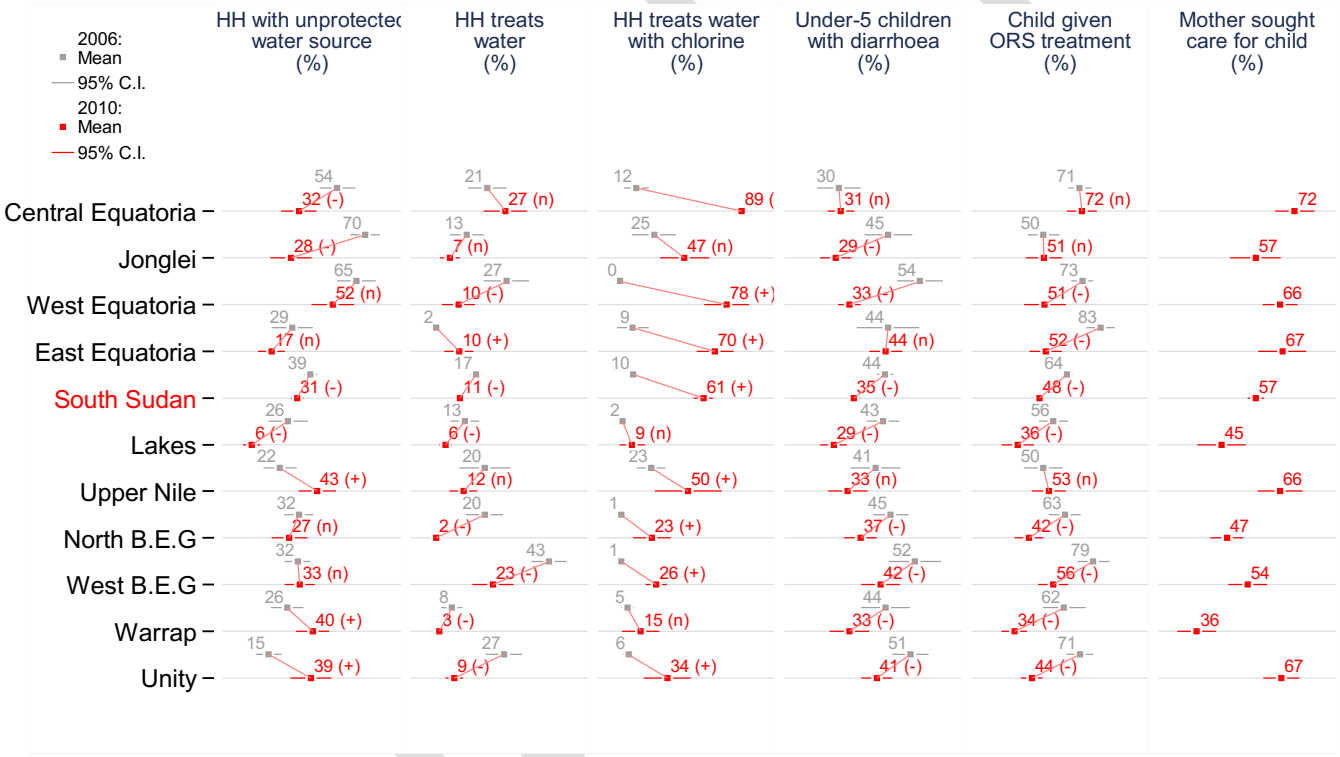
The prevalence of diarrhea is significantly higher among children between the ages of 12 and 23 months relative to other age groups (Figure B22). While it is difficult to draw conclusive inferences about the experience of children as they grow older from a cross sectional survey, the age pattern suggests that behaviors starting around 12 months increase children's vulnerability to diarrhea. As mentioned earlier, early childhood diarrhea during periods of critical postnatal development adversely affects the growth and nutritional status of children.

Promoting exclusive breastfeeding (which by eliminating the intake of food or drink other than breast milk significantly reduces a transmission pathway; breast milk also contains antimicrobial agents) is one key strategy for controlling diarrheal diseases. One observational study suggests that breastfed children are 6 times less likely to die of diarrhea compared to infants who are not breastfed (Keusch, Fontaine et al. 2006). Other key prevention strategies include improving complementary feeding practices to avoid microbial contamination of food, improving diets during and after episodes of diarrhea, and measles immunization (measles predisposes individuals to diarrheal disease). Improving hygiene practices such as hand washing, for example, has also been

shown to reduce diarrhea incidence substantially, however this requires availability of water and soap. Other observational studies have demonstrated an association between improved access to sanitation facilities and reductions in child mortality (Esrey, Potash et al. 1991). The impact of sanitation will likely have greater impact in areas with high population densities and when an entire community, rather than single households adopts the intervention (Keusch, Fontaine et al. 2006).

Two strategies are available to manage diarrheal disease: Oral rehydration solution (ORS) and zinc supplementation in combination with exclusive breastfeeding and proper nutrition. In South Sudan, among children who had diarrhea in the weeks before the 2010 SHHS, 57 percent were taken for care and 48 percent were treated for diarrhea with an ORS packet or a recommended homemade solution (Figure B23). Again, children whose mothers with formal education (relative to no education) and living in wealthier households (relative to the poorest households) were more likely to have received treatment and have been taken for care, all else equal (Table B18).

Figure B23. Diarrhea risk factors, prevention and care, by state, 2006 and 2010



Source: Author's calculations based on 2006 and 2010 SHHS

Notes: States or ordered based on largest average percentage point improvement in coverage between 2006 and 2010 across the five indicators. (+) Difference between means in 2010 and 2006 is positive and significant at the 95% level. (-) Difference between means in 2010 and 2006 is negative and significant at the 95% level. (n) no evidence of statistical difference in means between 2006 and 2010.

Table B19. Marginal effects for the association between select diarrhea risk factors and treatment indicators and select demographic variables

	Household with unprotected Water Source		Household treats water		Child has diarrhea		Child given ORS		Child taken for care	
	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t
Education ǂ										
None	[reference]									
Primary	0.003	0.19	-0.008	-1.11	0.017	1.04	0.037	1.32	0.104	2.66
Secondary +	-0.003	-0.14	-0.022	-2.31	-0.086	-2.86	0.192	3.48	0.166	1.96
Setting										
Rural	[reference]									
Urban	-0.075	-2.47	0.042	2.38	-0.035	-2.03	0.047	1.82	0.051	1.23
Wealth										
Poorest	[reference]									
2nd quintile	-0.164	-7.45	0.019	2.54	-0.002	-0.11	-0.003	-0.11	0.075	2.01
3rd quintile	-0.133	-5.35	0.050	5.39	-0.045	-2.58	0.019	0.65	0.069	1.89
4th quintile	-0.173	-6.55	0.084	7.34	-0.026	-1.48	0.095	3.51	0.149	4.01
Richest	-0.211	-7.13	0.201	10.46	-0.061	-3.54	0.155	5.54	0.176	4.54
Year										
2006	[reference]								[NA]	
2010	-0.079	-2.49	-0.062	-4.09	-0.095	-6.44	-0.164	-7.19		

Source: Author's calculations based on 2006 & 2010 SHHS from a multivariate logit regression.
Notes: ǂ Education levels refer to the highest education level achieved by the mother, with the exception of education levels associated with unprotected water source and treats water

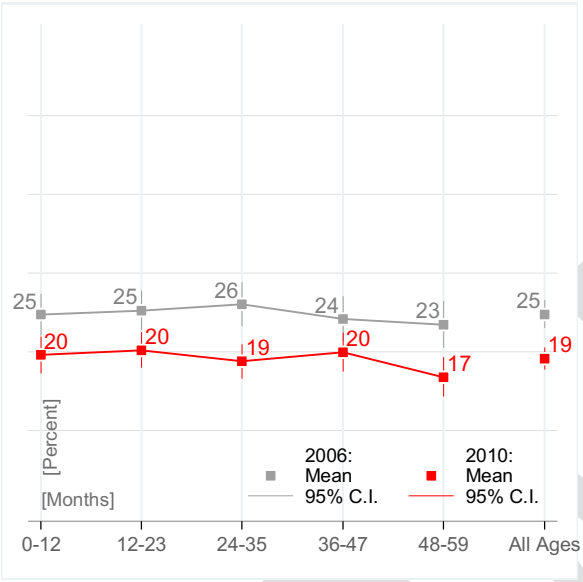
Acute respiratory infections: risk factors and care

Acute respiratory infections (ARIs) in children fall into two broad categories, those affecting the upper respiratory (URI) tract (more common) – such as rhinitis, sinusitis, ear infections, pharyngitis and laryngitis - and those affecting the lower respiratory (LRI) tract (more severe) – such as pneumonia, bronchiolitis and to a lesser extent influenza. ARIs are a major cause of under-five mortality past the neo-natal period and are responsible for nearly 20 percent of all child deaths (Simoes, Cherian et al. 2006). Clinical signs of acute lower respiratory infections include coughing and rapid breathing; and lower chest wall indrawing. In South Sudan, 19 percent of under-five children showed signs of ARIs in 2010 (25 percent in 2006) in the weeks prior to the survey (Figure B24, B25). The age pattern of ARIs is uniform over children's first five years of life (Figure B24) and episodes were no more or less frequent among children in relatively wealthier families (table B21). Children in urban areas, however, were about 2 percentage points less likely to have ARI symptoms relative to children in rural areas, all else equal (table B20).

Exposure to indoor air pollution from solid fuel use has been established as a risk factor for acute lower respiratory infection in children under five, including evidence linking higher concentrations of particulate matter with more severe ARI (Ezzati and Kammen 2002). The majority of exposure for women and children in the developing world occurs in the kitchen during cooking. In South Sudan, biomass (wood, charcoal, grass, crop residues and dung) is used by almost all households as the primary fuel for cooking (Figure B25). While wood is the predominant fuel, in Central Equatoria and West Bahr El Ghazal, charcoal use increased substantially between 2006 and 2010, partially displacing wood as a fuel source. Approximately 80 percent of households in

2006 and 60 percent in 2010 reported cooking was done indoors either in the house or in a separate building used specifically as a kitchen. Cleaner fuels for cooking such as liquid propane, biogas or kerosene are not yet in widespread use in South Sudan.

Figure B24. ARI prevalence by age, South Sudan, 2006 and 2010



Source: Author's calculation based on 2006 and 2010 SHHS

Interventions to control ARI's include immunization against specific pathogens, early diagnosis and treatment, improvements in nutrition and safer environments. Vaccines against measles, diphtheria, pertussis, Hib (*Haemophilus inluenzae* type b) and influenza can reduce the incidence of ARIs in children. The coverage of these vaccines is covered in the section on vaccine preventable disease. Effective case management of ARIs involves accurately detecting pneumonia and severe pneumonia based on respiration rate and lower chest wall indrawing based on WHO recommended guidelines. If pneumonia cases are detected, timely oral treatment options are recommended and for severe pneumonia, intramuscular antibiotics are recommended as well as the provision of oxygen.

Table B20. Place of care for ARI, South Sudan, 2006 & 2010

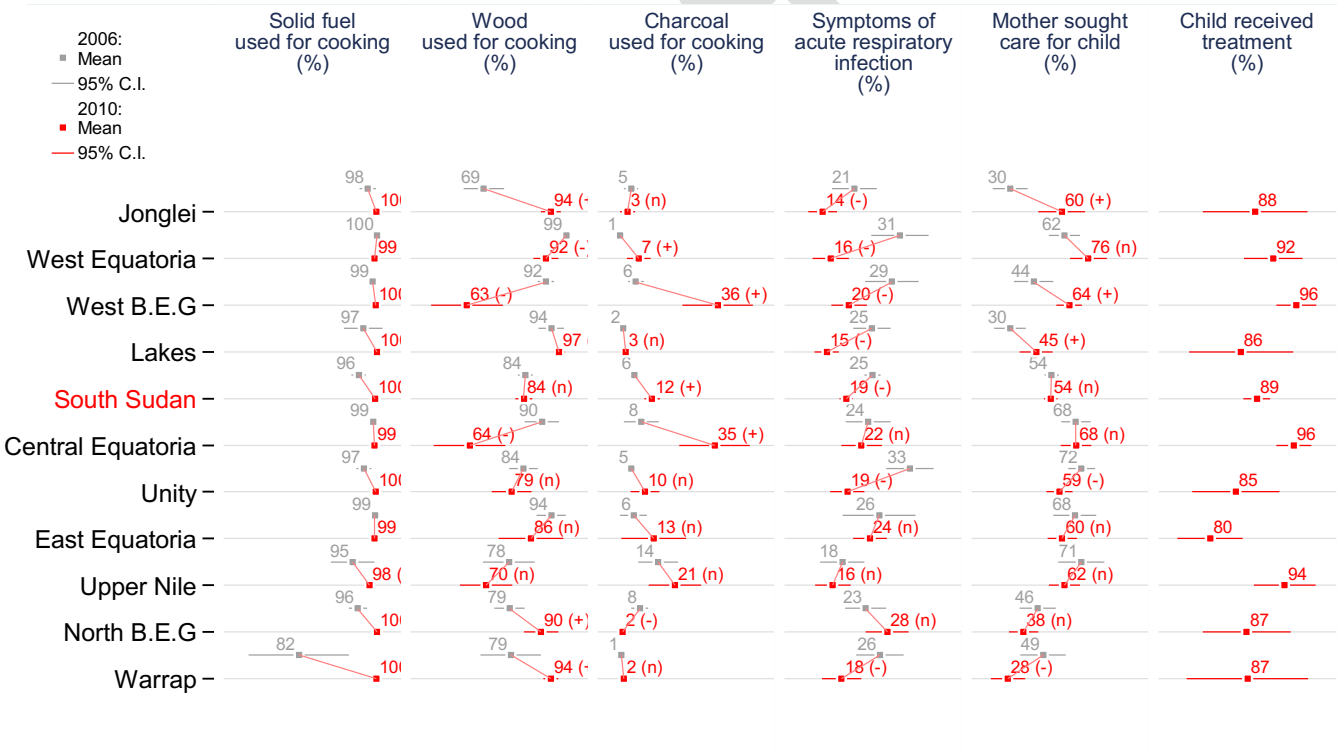
Place of Care	Year	South Sudan (mean %)	95% C.I.
Public Facility	2006	55%	(50-60.7)
	2010	67%	(62.9-71.5)
Private Facility	2006	23%	(18.3-26.7)
	2010	26%	(22.3-30.4)
Other (religious healer, traditional healer, relatives)	2006	19%	(15-23.3)
	2010	5%	(3.6-7)

Source: Author's calculations based on 2006 & 2010 SHHS

The effectiveness of early case detection and management depends on the mother's awareness of danger signs and ability to seek care if needed. In both 2006 and 2010, 54 percent of children displaying symptoms of acute ARI were taken for care. Between 2006 and 2010, care-seeking rates increased in Jonglei, West Bahr el Ghazal and Lakes with no evidence of change in most states; in two states (Unity and Warrap) there is evidence of declining rates of care-seeking among mothers in response to signs of ARI. Care-seeking behavior is strongly associated with mother's education and household wealth (table B21). Children with ARI symptoms whose mother has a primary or secondary education, were 11 and 27 percentage points more likely to be taken for care relative to children whose mothers have no formal education, all else equal. Children from households with progressively greater wealth are increasingly likely (from 8 to 13 percentage points more likely) to be taken for care. The independent and significant effects of education and household wealth suggests that some education is critical in order for mothers to recognize and respond to illness, but that barriers related to wealth also play a strong role (possibly income and access to social networks and support).

Mothers in urban areas are about 15 percentage points more likely to take their ill child for care relative to mothers in rural areas (table B21). This finding again highlights the problem of access in rural areas relative to urban areas – which is that even if mothers are educated (and thus presumably know the benefits of care) and can partially offset some direct or indirect costs (such as transportation or lost wage income) they still cannot access care routinely if they live in a rural area. Given that children average six to three to six episodes of ARI every year (Simoes, Cherian et al. 2006) (in addition to episodes of illness from other conditions), the cumulative transaction related costs of care for rural families may simply be too high to seek care for every episode - this likely results in care-seeking only for the most severe cases of illness.

Figure B25. Acute respiratory infections: risk factors, prevalence and care, by state, 2006 and 2010



Source: Author's calculations based on 2006 and 2010 SHHS

Notes: States or ordered based on largest average percentage point improvement in coverage between 2005 and 2009 across the five indicators. (+) Difference between means in 2009 and 2005 is positive and significant at the 95% level. (-) Difference between means in 2010 and 2006 is negative and significant at the 95% level. (n) no evidence of statistical difference in means between 2006 and 2010.

When children are taken for care, they are primarily taken to a public health facility (67 percent of children with ARI symptoms and taken for care in 2010) or a private facility (26 percent of children with ARI symptoms and taken for care in 2010) (table B20). Between 2006 and 2010, the percentage of children visiting traditional or religious healers declined from 19 to 5 percent with the majority of that decline subsequently feeding into public rather than private facilities. The shift away from informal care towards formal care in a clinical setting might suggest greater awareness of the benefits of formal health care, increasing severity of illness (for which traditional healers cannot offer adequate care), reduction of barriers for formal care (such as increases in

disposable income, or new facilities close to the home). For a finer disaggregation, in 2010, about 44 percent of children with ARI symptoms taken for care visited a public primary care facility (health center or unit), 25 percent of children went to a public hospital, 13 percent went to a private hospital and 13 percent went to a private pharmacy. Among children in urban areas, 40 percent were taken to public hospitals, 26 percent to public primary care facilities, 19 percent to private hospitals and 11 percent to private pharmacies. Among rural areas, 20 percent were taken to public hospitals, 48 percent to public primary care facilities, 13 percent to private pharmacies and 11 percent to private hospitals. Not surprisingly, rural mothers rely much more on primary health care facilities than hospitals for their child's health care, which also means they are less likely to get needed clinical care for more severe cases of ARI.

In 2010, among children who were taken for care, 89 percent received treatment. Of those receiving treatment, approximately 50 percent were given antibiotic pills, 30 percent were given acetaminophen, 14 percent an injectable antibiotic and 11 percent aspirin. The relatively large provision of acetaminophen is consistent with guidelines for the case management of non-severe pneumonia at the community level (Simoes, Cherian et al. 2006). Interestingly, 11 percent of the children with ARI symptoms taken for care were treated with anti-malarials in response to signs of acute ARI, which suggests that either (1) children with ARI symptoms also exhibited symptoms of malaria or (2) there was a mistreatment. The former hypothesis is supported by the data, as close to 10 percent of children had both ARI and malaria symptoms in the weeks before the survey.

Table B21. Marginal effects for the association between select ARI related indicators and select demographic variables

	Household uses solid fuel for cooking		Child has ARI symptoms		Child taken for care [if child has ARI symptoms]		Child received treatment for ARI [if taken for care]	
	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t
Education ǂ								
None	[reference]							
Primary	-0.001	-1.08	0.019	1.29	0.106	3.26	0.011	0.32
Secondary +	-0.001	-1.09	-0.010	-0.38	0.267	4.17	0.034	0.58
Setting								
Rural	[reference]							
Urban	0.003	2.48	-0.023	-1.79	0.148	4.65	0.025	0.65
Wealth								
Poorest	[reference]							
2nd quintile	-0.001	-1.11	-0.005	-0.35	-0.002	-0.04	0.030	0.77
3rd quintile	-0.009	-3.33	-0.014	-0.99	0.058	1.51	-0.048	-1.61
4th quintile	-0.026	-4.67	-0.010	-0.75	0.080	2.21	0.028	0.77
Richest	-0.023	-4.59	0.009	0.59	0.125	2.96	0.068	1.62
Year								
2006	[reference]							
2010	0.017	3.39	-0.059	-5.18	0.000	0	[NA]	

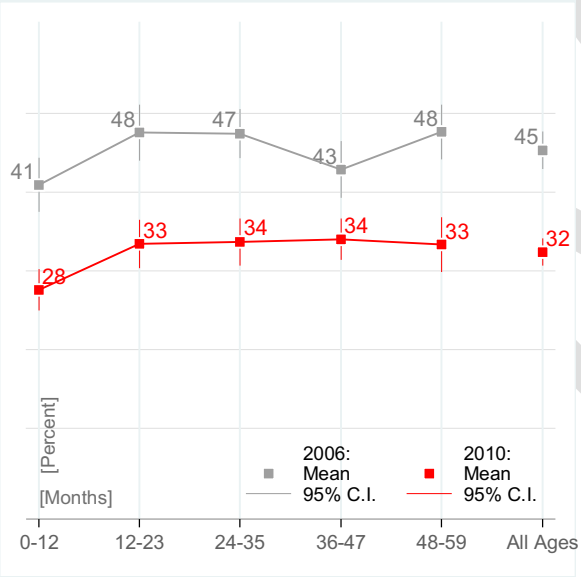
Source: Author's calculations based on 2006 & 2010 SHHS from a multivariate logit regression.

Notes: ǂ Education levels refer to the highest education level achieved by the mother, with the exception of education levels associated with unprotected solid fuel for cooking which refer to those of the household head.

Malaria: prevention and treatment

Malaria is estimated to cause about 8 percent of all child deaths, primarily as a result of *Plasmodium falciparum* that is transmitted through female anopheline mosquitoes (Breman, Mills et al. 2006). In a 2002 national burden of disease study focusing on malaria in Sudan, of approximately 9 million episodes of malaria, 44 thousand resulted in deaths, with the highest mortality among children under-five (Abdalla, Malik et al. 2007). Most of South Sudan has stable endemic *plasmodium falciparum* - as measured by the parasite rate (the proportion of people sampled showing detectable parasites) (Hay, Guerra et al. 2009) – meaning that transmission occurs regularly year-round. In this setting, morbidity and mortality due to malaria is high during early childhood, but for survivors, some immunity is acquired so that infections at older ages are usually asymptomatic. Anemia among children is common in stable transmission areas and among pregnant women falciparum malaria is associated with anemia and low birth weight. If uncomplicated malaria is treated promptly, mortality is very low but mortality rises sharply with more complicated cases. The most common causes of malaria-related death are from cerebral malaria, severe malaria anemia (hemoglobin levels of less than 5 gm/dl in association with malaria parasites), respiratory distress, hypoglycemia (low blood sugar) and low birthweight. Long term morbidity after severe malaria can include neurological conditions affecting hearing, eyesight, speech and behavior (Breman, Mills et al. 2006).

Figure B26. Malaria (or fever) prevalence by age, South Sudan, 2006 and 2010



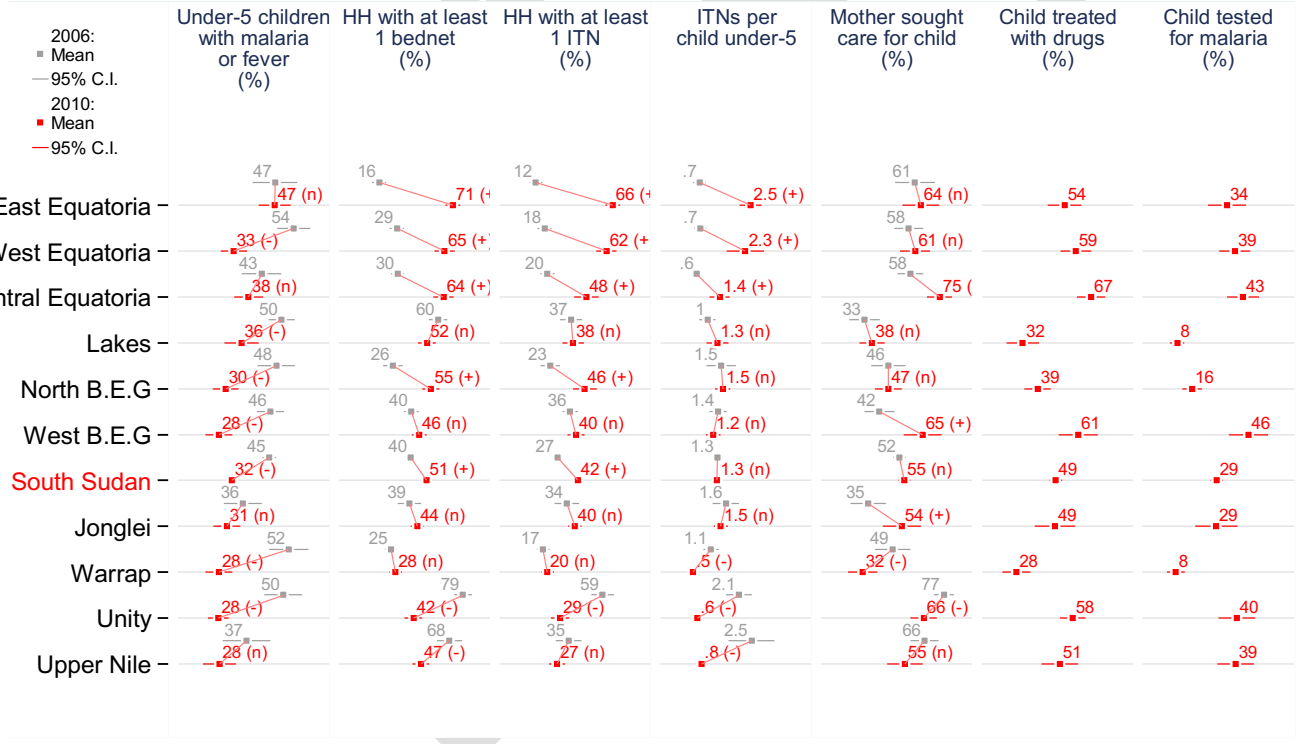
Source: Author's calculation based on 2006 and 2010 SHHS

Estimates indicate that in areas of stable malaria risk 4.9 episodes of malaria are experienced per person per year (Snow, Newton et al. 2003). In the two weeks prior to the 2010 SHHS, 32 percent of children under-five had a presumptive diagnosis of malaria (compared to 45 percent in 2006) – which includes reported episodes of fever. The sharp 30 percent reduction in reported malaria cases between 2006 and 2010 is notable and may suggest the effectiveness of malaria prevention efforts (Figure B27). It is important, however, to recognize that while fever is the primary clinical manifestation of malaria in the non-immune and has dominated the diagnosis and management of the disease, not all fevers result from malaria and thus diagnosis of malaria as a distinct clinical entity is difficult (Snow, Newton et al. 2003). The age-pattern of malaria illness is relatively uniform, with the exception of infants (ages 0-12 months) who were less likely to have malaria compared to other age groups (Figure B26).

Evidence-based interventions to reduce infection and the adverse outcomes of malaria infection include the use of insecticide treated nets (ITNs), indoor residual spraying with long lasting insecticides, effective disease management - including early diagnosis and treatment with proper drugs as well as intermittent presumptive treatment in pregnancy and infancy.

A recent study of the effectiveness of ITNs in Sub-Saharan Africa found that household ownership of at least one ITN was associated with a relative reduction in mortality among children of ages 1 month to 5 years of 23 percent (Lim, Fullman et al. 2011). Given the rapid expansion of ITN's in the past decade in the region, this finding – consistent with previous findings of ITN efficacy – is encouraging and supports further efforts to increase ITN coverage. ITNs reduce malaria transmission through a barrier effect that prevents blood feeding by mosquitos and an insecticide effect which kills and repels mosquitos. In South Sudan, ownership of at least 1 ITN increased from 27 percent in 2006 to 41 percent of households in 2010, with the largest gains occurring in West, Central and East Equatoria as well as North Bahr el Ghazal where household ownership of ITNs more than doubled (Figure B27). While progress has been made, approximately 56 percent of children under-five continue to live in households without ITNs. In 2006, about 41 percent of all bednets in circulation were treated with insecticide; by 2010, the share of ITNs out of all bednets increased to 77 percent suggesting an increasing rate of adoption of effective bednets. Whether households have ITNs is strongly associated with household wealth – the richest households are about 26 percentage points more likely than the poorest households (all other factors held constant) to own an ITN (table B23). The fact that urban households are equally as likely as rural households to own a bednet suggests that distribution efforts in rural areas have been effective.

Figure B27. Malaria prevalence, prevention and care, by state, 2006 and 2010



Source: Author's calculations based on 2006 and 2010 SHHS from a multivariate logit regression.

Notes: States or ordered based on largest average percentage point improvement in prevention or treatment coverage between 2006 and 2010. (+) Difference between means in 2010 and 2006 is positive and significant at the 95% level. (-) Difference between means in 2010 and 2006 is negative and significant at the 95% level. (n) no evidence of statistical difference in means between 2006 and 2010.

Of an estimated total 2.380 million bednets in circulation in 2010, 1.835 million were reported as being treated with insecticide. At the population level, the number of ITNs per under-five child remained at 1.3 between 2006 and 2010, so while there are sufficient ITNs in the population to cover all under-five children these ITNs are concentrated in less than half of the households in the country. The total number of ITNs per household averaged 0.72 in 2006 and 1.42 in 2010. Among households with at least one ITN and at least one under-five child, the average number of ITNs per child was 3.05 in 2006 and 2.55 in 2010 - households that do acquire at least one bednet acquire enough to cover all under-five children as well as older children and adults. Repeat purchases of bednets after the first bednet, suggests that demand increases as families interact with and experience the bednet, possibly after observing reduced episodes of malaria among members of the family.

Evidence from the 2009 NBHS (table B22) indicate that bednets are relatively affordable and primarily obtained commercially – on average, 77 percent of households purchased bednets from the market (the remainder obtained bednets for free from health facilities). An even higher percentage of the poorest households (80 percent) purchased bednets in the market. In 2008, households with a bednet reported paying between 2 and 6 SDG per bednet, on average they paid 2.9 SDG (roughly 1.4 USD), representing less than 1 percent of yearly consumption if households purchase 3 bednets per year. Of the most recently purchased ITN, 70 percent were purchased in the year prior to the 2010 survey (March 2009 to March 2010 approximately), around 8 percent between one and two years prior, 2 percent between two and three years prior and 19 percent more than three years prior.

Table B22. Bednet place of purchase, South Sudan, 2008

	Urban	Rural	Poorest	2nd wealth quintile	3rd wealth quintile	4th wealth quintile	Richest	South Sudan
Market (purchased)	74.8	77.0	79.0	77.0	76.1	72.3	78.6	76.6
Health Facility (free)	22.6	18.4	13.9	20.0	20.3	22.9	17.9	19.1
Other	2.6	4.6	7.1	3.0	3.7	4.8	3.5	4.3

Source: Author's calculations using 2008 National Baseline Household Survey

While scaling the coverage of ITNs is critical, fostering proper use and maintenance for durability is important as well. Whether households re-treat nets with insecticide in a timely way determines efficacy, low re-treatment rates have been attributed to additional cost and effort required by net owners and the perception that it is the physical barrier and not the insecticide that provides protection (Lindblade, Dotson et al. 2005). Given the difficulty of promoting net re-treatment, longer lasting insecticide treated nets (LLITNs) have been developed – these are being increasingly distributed in South Sudan with donor financing – in 2010, LLITNs comprised about 70 percent of all ITNs in circulation and 20 percent of households owned at least 1 LLITN. Even with these newer technologies, the degree to which LLITNs retain insecticide over time has been shown to vary widely by brand (Lindblade, Dotson et al. 2005), and factors such as the frequency and method of washing and drying, also moderate their effectiveness (Atieli, Munga et al. 2010). Use of nets also depends on their design and compatibility with local preferences, ITN distributors have noted that locally made *damuria* nets made of cotton are preferred among some groups of the population over mash nets (MoH GoSS 2008). In 2010, a household member slept under a bednet the night prior to the survey in only 50 percent of households – underscoring the need to understand determinants of use and not just ownership.

Table B23. Marginal effects for the association between malaria related indicators and select demographic variables

	Household owns at least 1 ITN		Under-five child has malaria or fever		Mother sought care for child [if ill with malaria]		Child given treatment for malaria or fever [if taken for care]		Child tested for malaria	
	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t
Education										
None	[reference]									
Primary	0.005	0.36	0.034	2.02	0.127	5.17	0.061	2.2	0.076	2.76
Secondary +	-0.021	-1.24	0.002	0.06	0.077	1.12	0.109	1.67	0.088	1.54
Setting										
Rural	[reference]									
Urban	-0.027	-1.25	-0.037	-2.1	0.108	4.05	0.129	5.35	0.206	5.58
Wealth										
Poorest	[reference]									
2nd quintile	0.029	1.84	0.015	0.95	0.075	2.65	0.006	0.19	-0.008	-0.2
3rd quintile	0.110	6.12	0.005	0.32	0.084	2.94	0.020	0.66	0.003	0.07
4th quintile	0.181	9.85	0.014	0.83	0.086	2.93	0.073	2.35	0.085	2.32
Richest	0.266	12.41	-0.005	-0.24	0.163	4.79	0.139	4.51	0.166	4.25
Year										
2006	[reference]								[NA]	
2010	0.121	5.85	-0.136	-9.29	0.032	1.31	-0.368	-18.56		

Source: Author's calculations based on 2006 & 2010 SHHS from a multivariate logit regression.
Notes: ¹ Education levels refer to the highest education level achieved by the mother, with the exception of education levels associated with ITN ownership which refer to those of the household head.

Indoor residual spraying (IRS) is a well-established method for controlling the transmission of malaria. The insecticide - which is applied to internal walls and ceilings - can kill a mosquito any time it enters a house for a blood meal. The challenges of implementing a widespread IRS strategy include the need to build public acceptance of spraying, the need for trained staff and well maintained equipment as well as adequate supervision to ensure adherence to application procedure and financial support (Malaria Consortium). No data was available to assess the degree to which IRS is used in South Sudan.

In addition to cost-effective population preventive measures – such as ITNs and IRS (and the communication and outreach strategies that accompany them) – early diagnosis and effective treatment can cure infection, prevent morbidity by halting progression to more severe disease and reduce transmission. Accurately diagnosing malaria depends on laboratory detection of the parasite (using a blood smear or a rapid diagnostic test) or a clinical diagnosis based on observed symptoms. In diagnosed cases, treatment using appropriate anti-malarial drugs should be prompt and in areas with resistance to single drugs, combination treatments are recommended, preferably using artemisinin combination therapy (ACT).

Effective diagnosis and treatment requires caregivers to recognize and respond to symptoms. In 2006 and 2010, the mothers of about half of the under-five population in need (children with malaria or fever) sought care for their child (Figure B27). Between 2006 and 2010, care seeking rates increased in Central Equatoria, West Bahr El Ghazal and Jonglei but stalled in all other states. Among children who were taken for care, in 2010, about 49 percent received drugs, so that only about one in four children with malaria or fever were treated with drugs. Treatment rates (among children taken for care) were highest in Central Equatoria (67 percent) and lowest in

Warrap (28 percent). Disparities in access to care are significant: children with signs of illness whose mothers have primary or secondary education were 20 and 27 percentage points more likely to have been taken for care compared to mothers without education, all else equal; children in urban areas were 10 percentage points more likely have been taken for care compared to children in rural areas and children from the wealthiest households were 17 percentage points more likely to have been taken for care compared to children in the poorest households (table B23).

Among children taken for care during the episode of malaria or fever, 56 percent were taken to a public facility (38 percent visited health centers or units and 18 percent public hospitals), 29 percent to a private facility (13 percent to a private hospital and 14 percent to a pharmacy) and 1.4 percent to a traditional or religious healer. In urban areas, children were equally as likely to visit a public facility as a private facility. In rural areas, children taken for care were about twice as likely to visit a public facility as a private facility.

Current treatment guidelines for uncomplicated malaria provide for artesunate plus amodiaquine as a first line of treatment, artemether plus lumefantrine as a second line treatment and quinine a third line with sulphadoxine-pyrimethamine (SP) reserved for treatment of malaria among pregnant women (MoH GoSS 2008). Of the children taken for care (in case of malaria or fever) and receiving treatment in 2010, the most commonly given anti-malarial was chloroquine (over half of children taken for care received the drug), followed by SP (received by 20 percent of children taken for care) and amodiaquine (received by 17.4 percent of children taken for care); quinine and artemisinin (in combination with other drugs) were received by 10 and 7 percent of children receiving care, respectively (table B24). Between 2006 and 2010, among children being treated, the use of chloroquine and SP has fallen alongside increases in the use of amodiaquine and artemisinin which suggests that adherence to treatment guidelines and availability of first and second line drugs is improving. However, monotherapy with chloroquine or SP is still the predominant form of treatment, possibly reflecting the low cost of these drugs and limited access by providers to artemisinin combination drugs.

Table B24. Percentage of children with fever or malaria, taken for care and receiving treatment, by drug given for treatment

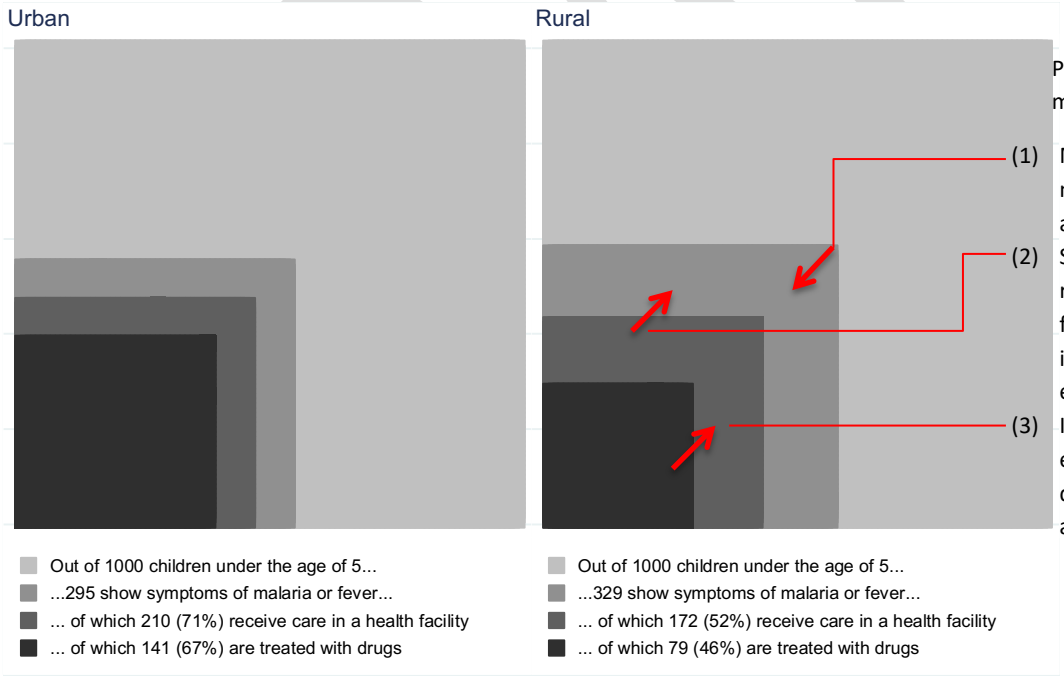
Drug Given	2006		2010	
	Mean	95% CI	Mean	95% CI
Chloroquine (Oral or Injection)	79.2	(75.9-82.5)	52.8	(49-56.5)
Paracetamol, Acetaminophen, Aspirin or Ibuprofen	43.4	(38.9-48)	28.7	(25.6-31.9)
Sulphadoxine-Pyrimethamine (SP) / Fansidar	24.0	(20.2-27.9)	19.7	(16.6-22.7)
Amodiaquine (Oral or Injection)	10.6	(7.5-13.6)	17.4	(14.1-20.8)
Quinine (Oral or injection)	9.7	(6.9-12.4)	10.2	(8.1-12.4)
Artemisinin combination	3.5	(1.6-5.5)	6.5	(4.6-8.4)
Metacalfin (Oral)	5.8	(3.7-7.9)	1.1	(0.4-1.7)
Other	4.2	(2.7-5.7)	6.2	(4.5-7.8)

Source: Author's calculations based on 2006 and 2010 SHHS
Notes: Categories do not add up to 100% as multiple drugs could be given to children

Figure B28 illustrates the relationship between reported malaria prevalence, household health seeking behavior (the demand for health care) and the provision of effective treatment among children living in urban and rural

areas, as well as children living in the wealthiest and least wealthy households. This figure serves to highlight where challenges and barriers to health service delivery might occur. Among the rural and poorest, for example, demand for- or ability to access health care for malaria is low compared to urban and wealthy households (urban and wealthy households are between 11 and 16 percentage points more likely to seek care for their children when needed relative to the rural and poorest, all else equal table B23) despite being equally burdened by malaria or fever. Financial and non-financial barriers – such as low awareness, user-fees, transportation costs and high opportunity costs of care (such as lost wage income or need to take care of children) – potentially limit demand and access. On the provision of care side, drugs are not given to nearly a third of the children in urban areas and about half of children in rural areas that do make it to a facility. There is a larger degree of inequality in the rate of drug treatment between children in the wealthiest compared to the poorest households. As service delivery relies on a series of sub-systems (Figure B29) – including health financing, pharmaceutical supply chains, the health workforce and governance - and each subsystem is in turn governed by a specific set of actors with a specific set of interests and resources, the underlying factors determining rates of service delivery are multi-faceted in nature and potentially difficult to diagnose. In addition, health seeking behavior and poor quality of care interact – low demand may be strongly influenced by poor responsiveness and quality of available health care. Nevertheless, there are important bottlenecks facing rural and poor households that if not addressed will likely exacerbate social inequalities.

Figure B28. Malaria prevalence, care-seeking and treatment coverage in urban versus rural settings and the poorest versus richest households.

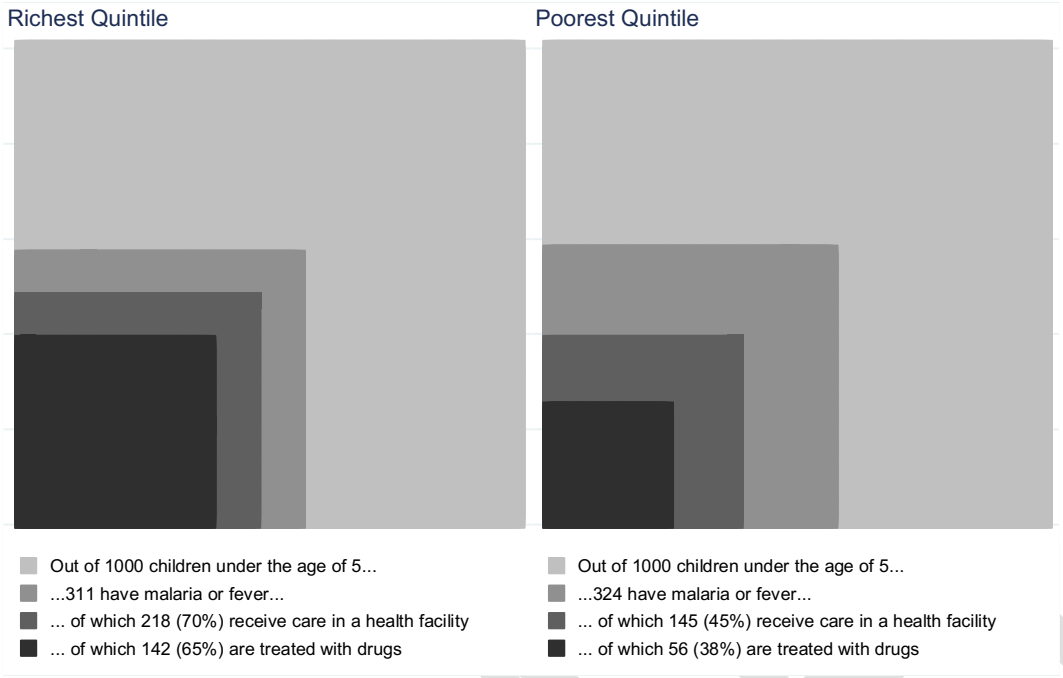


Pathways to the reduction of mortality and morbidity from malaria:

(1) Malaria prevention to reduce the number of children needing care and treatment

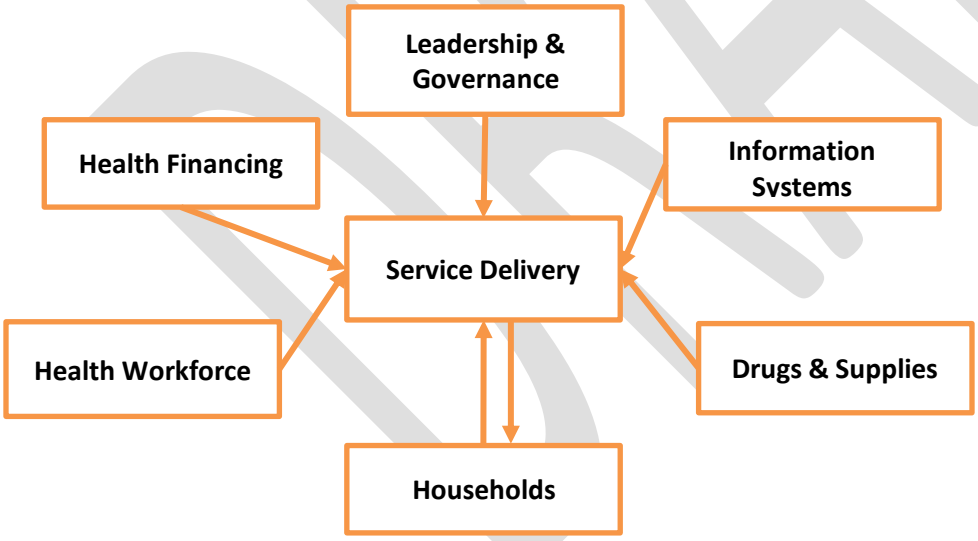
(2) Stimulate demand for care by reducing financial and non-financial barriers to access and increasing awareness through education and media.

(3) Improve quality of care by expanding availability of diagnostic testing and effective antimalarial drugs.



Source: Author's calculations based on 2010 SHHS

Figure B29. The centrality of service delivery in the health system

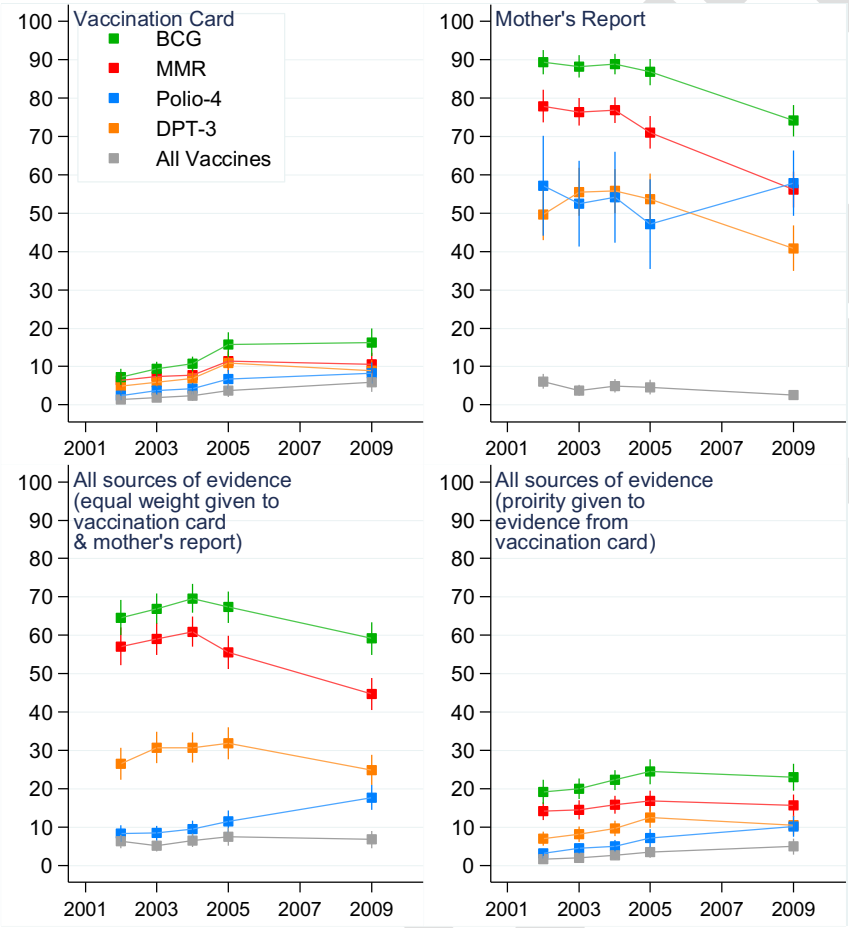


Source: Adapted from Johns Hopkins Health Systems Course Notes (Bishai)

Vaccine Preventable Disease: Coverage of routine immunizations

Vaccination against childhood communicable diseases through WHO's expanded program on immunization (EPI) is recognized as one of the most cost-effective public health interventions (Brenzel, Wolfson et al. 2006). The vaccines originally included under EPI were BCG (targeting tuberculosis), diphtheria-tetanus-pertussis (DTP), oral polio and measles, often given as a measles-mumps-rubella (MMR). Since 1999, GAVI – a public private partnership – has raised significant resources to help countries improve access to new and under-used vaccines including hepatitis B (HepB) and haemophilus influenza type b (Hib).

Figure B30. Percentage of children between the ages of 12-23 months vaccinated against MMR, DPT, Polio and BCG, South Sudan, 2002-2009



Source: Author's calculations based on 2006 and 2010 SHHS.
Notes: In 2009, Hib and HebB are provided with DPT as a pentavalent vaccine.

Figure B30, displays the coverage of DTP-3 (3 doses of DTP vaccine), polio (at least 4 doses), MMR and BCG in South Sudan among children between the ages of 12 and 23 months from two sources of evidence: a vaccination card if available and the mother's recollection. It should be noted that by 2010, two additional vaccines were rolled in with the DTP vaccine – HepB and Hib (which follow the same immunization schedule as DTP). In the 2006 SHHS, as the vaccination status for all children under five years of age was recorded, coverage estimates were placed in time as follows: children ages 12-23 years are placed at 1 year before the survey (2005), those with ages 24-35 months at 2 years before the survey (2004), those with ages 36-47 months at 3 years before the survey (2003) and those with ages 48-59 months at 4 years before the survey (2002). In the 2010 SHHS, vaccination status was recorded only for children between the ages of 12-23 months (corresponding to the 2009 calendar year).

Between 2006 and 2010, the percentage of children under-five with a vaccination card did not change, remaining at 57 percent (Figure B31). Compared to evidence from vaccine cards, mother's reports yield

substantially higher coverage estimates. In 2005 the ratio of vaccine coverage based on mother's reports to coverage based on vaccination cards averaged 7.9 for all four of the vaccines monitored; in 2009 that ratio fell to 4.4. While the evidence from vaccine cards indicate gradual improvements in vaccine coverage, between 2005 and 2009, evidence from mother's reports indicate a decline in vaccine coverage (with the exception of polio). These observations put into doubt the accuracy of mother's reports of their children's vaccination status from the 2006 SHHS. Nonetheless, the available evidence suggests that rates of BCG, MMR and DPT-3 vaccination declined between 2005 and 2009 while increasing for polio (table B25).

To consolidate these two sources of evidence into a single coverage indicator, two approaches were used. The first gives equal weight to the vaccination card and the mother's report so that a child is considered vaccinated if either a vaccination card was seen and displayed a date associated with the vaccination or the mother reported that the child had been vaccinated. The second approach, gives priority to the vaccine card so that the mother's report is only considered in cases where no information was available from the vaccine card. Overall levels of coverage are sensitive to the method used to consolidate vaccination reports from cards and mothers. National coverage estimates from these two approaches are presented in Figure B31.

Using the first approach (giving equal weight to vaccination reports from a card and mother), overall coverage of BCG, MMR, Polio-4 and DPT-3 in 2009 was 59.2, 44.7, 17.7 and 24.9 percent with 6.7 percent of children between the ages of 12 and 23 months having the complete set of immunizations. The fact that levels of BCG and MMR coverage are considerably higher than Polio and DPT-3 coverage highlights the additional challenges of delivering vaccines that require multiple doses and consistent engagement with the population compared to the delivery of single dose vaccines that can be organized through mass campaigns.

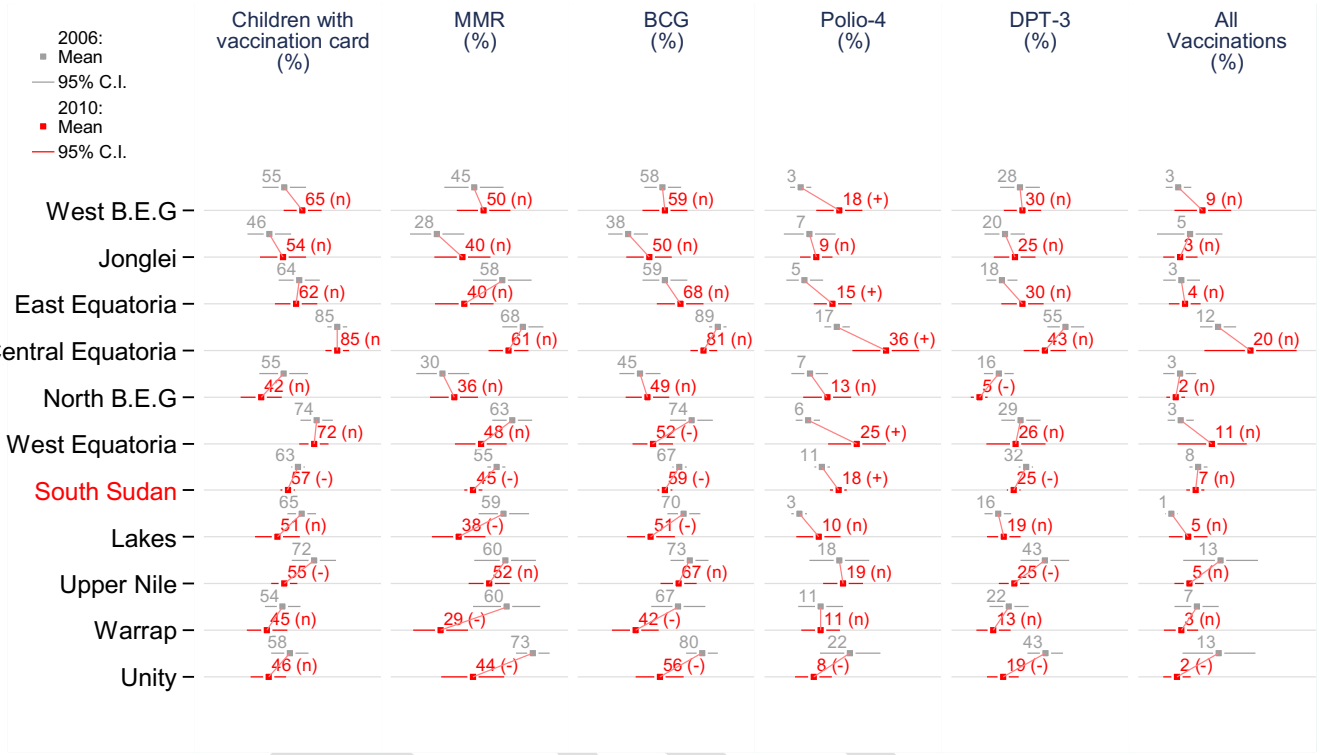
Table B25. Percent change in vaccination coverage between 2005 and 2009

Vaccine	Vaccination Card	Mother's Report	Combined (Equal weight given to both vaccination card and mother's report)	Combined (Priority given to evidence from vaccination card)
MMR	-7.94	-20.92	-19.45	-6.87
DPT-3	-19.14	-24.00	-21.98	-16.58
Polio-4	24.29	22.59	54.68	42.34
BCG	3.79	-14.64	-12.20	-5.98
All vaccines	54.69	-44.88	-9.59	42.30

Source: Author's calculations based on 2006 and 2010 SHHS

Vaccination coverage varies widely between states (Figure B31). MMR coverage, for example, ranges from a low of 29 percent in Warrap, to a high of 61 percent in Central Equatoria. The percentage of children completely vaccinated ranges from a low of 2 percent in Unity and Jonglei, to a high of 20 percent in Central Equatoria. Given the small sample size at the state level, the majority of differences in coverage between 2005 and 2010 are not statistically significant, however progress in vaccinating children fully against Polio was evident in Central Equatoria, West Equatoria, West Bahr El Gazal and East Equatoria.

Figure B31. Vaccination coverage by state, 2006 and 2010



Source: Author's calculations based on 2006 and 2010 SHHS

Notes: Estimates of coverage give equal weight to evidence of vaccination from cards and mother's reports. States ordered based on largest average percentage point improvement in coverage between 2005 & 2009 across the five indicators. (+) Difference in means between 2005 & 2009 is positive and significant at the 95% level. (-) Difference in means between 2005 & 2009 is negative and significant at the 95% level. (n) no evidence of a difference in means between 2005 & 2009.

Disparities in vaccine coverage across socio-economic indicators follow patterns similar to those observed with other child survival interventions. Children whose mothers completed primary education are between 5 and 11 percentage points more likely to be inoculated compared to children whose mothers have no formal education, all other factors equal (table B26). Children living in urban areas are between 3 and 16 percentage points more likely to have received vaccines compared to children living in rural areas; and children from the wealthiest households are 12 and 9 percentage points more likely to have received BCG and DPT-3 vaccines compared to children from the poorest households. The fact that polio and measles vaccination coverage is not associated with household wealth suggests that these vaccination efforts have performed well in reaching children living in poor or marginalized areas.

Table B26. Marginal effects for the association between vaccination outcomes and select demographic variables

	Child has vaccination card		MMR vaccine		BCG vaccine		Polio vaccine		DPT-3 vaccine		All vaccines	
	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t	dy/dx	t
Education												
None	[reference]											
Primary	0.15	7.22	0.07	2.99	0.11	5.04	0.01	0.84	0.08	3.03	0.02	1.94
Secondary +	0.17	2.95	0.20	4.08	0.16	3.45	0.03	1.02	0.11	1.95	0.01	0.38
Setting												
Rural	[reference]											
Urban	0.18	8.29	0.13	5.03	0.14	5.61	0.03	2.43	0.17	6.39	0.03	3.43
Wealth												
Poorest	[reference]											
2nd quintile	0.00	-0.11	0.00	0.01	0.01	0.43	0.00	-0.20	0.05	2.25	0.00	-0.32
3rd quintile	0.01	0.41	0.03	1.02	0.07	2.31	0.02	1.22	0.08	3.60	0.02	1.52
4th quintile	0.02	0.76	0.03	1.08	0.08	2.88	0.00	-0.11	0.07	2.78	0.00	-0.30
Richest	0.09	3.17	0.05	1.51	0.12	4.31	0.02	1.23	0.09	3.97	0.02	1.51
Year												
2006	[reference]											
2010	0.00	0.14	-0.11	-4.16	-0.08	-3.16	0.09	4.70	-0.04	-1.66	0.01	0.64

Source: Author's calculations based on 2006 & 2010 SHHS from a multivariate logit regression.
Notes: ᵗ Education levels refer to the highest education level achieved by the mother, with the exception of education levels associated with ITN ownership which refer to those of the household head.

Composite coverage of maternal and child interventions

To obtain an overall assessment of the degree to which health service delivery performance has progressed between 2006 and 2010, disease specific maternal and child interventions that were available from both the 2006 and 2010 SHHS were averaged to generate a year and state specific composite index for maternal and child interventions. The composite index can roughly be interpreted as the proportion of the target population (pregnant women or children under-five years of age, for example) receiving evidence-based care. Coverage estimates for the following maternal interventions were averaged: contraceptive prevalence, tetanus toxoid vaccines, effective antenatal care and skilled birth attendance. Coverage estimates for the following child survival interventions were averaged: early initiation of breastfeeding, exclusive breastfeeding, continued breastfeeding, introduction of complementary foods, vitamin A supplementation, insecticide treated net presence in home, treatment of diarrhea with ORS or appropriate homemade solution, measles vaccine, BCG vaccine, polio vaccine (at least 4 doses) and DPT vaccine (3 doses). This simple averaging procedure implicitly weights each intervention equally. The levels of composite coverage for 2006 and 2010, along with the percent change occurring over these two time points is shown in Table B27 for each state.

Table B27. Composite index of intervention coverage by state, South Sudan, 2006 and 2010.

	Maternal Interventions				Child Interventions			
State	2006	2010	Percent Change	Population of women (15-49)	2006	2010	Percent Change	Population of under-5 children
Warrap	0.22	0.17	-26%	244,758	0.51	0.47	-7%	169,599
West Equatoria	0.34	0.26	-21%	165,124	0.49	0.54	8%	81,154
Unity	0.19	0.15	-18%	129,087	0.49	0.48	-3%	108,357
Upper Nile	0.23	0.19	-17%	215,399	0.47	0.49	5%	150,872
Lakes	0.18	0.18	2%	163,511	0.48	0.46	-2%	106,232
South Sudan	0.19	0.21	10%	1,975,340	0.50	0.51	3%	1,304,131
Central Equatoria	0.25	0.35	38%	268,563	0.58	0.58	1%	163,539
West Bahr El Gazal	0.20	0.28	40%	78,092	0.44	0.55	24%	53,967
Jonglei	0.10	0.15	42%	316,793	0.42	0.51	22%	207,424
East Equatoria	0.15	0.22	45%	223,880	0.55	0.56	2%	126,467
North Bahr El Gazal	0.12	0.21	77%	170,133	0.47	0.49	4%	136,520

Source: Author's calculations based on 2006 and 2010 SHHS.

Notes: States are ordered in terms of the percent change in composite coverage of maternal survival interventions between 2006 and 2010.

Overall, expanding access to evidence based maternal or child survival interventions in South Sudan has been limited, with gains in service delivery in some states being counterweighed by reversals in others. In 2010, about one in five women and one in two children received evidence-based care when needed. Overall coverage of maternal survival interventions declined in five states: Warrap, Unity, Upper Nile, Lakes and West Equatoria. By contrast, overall coverage of child survival interventions declined in only three states; Warrap, Unity and Lakes. Large gains in providing essential maternal health services were made in West Bahr El Ghazal, North Bahr El Ghazal, East Equatoria and Central Equatoria. The greatest gains in scaling access to child survival interventions were in Jonglei and West Bahr El Ghazal.

Figures B32 and B33, summarize disparities in access to care for mothers and children resulting from economic differences (the wealthiest compared to the poorest households) and geographic differences (urban compared to rural households). Without adjusting for differences in other factors such as education, differences in access to care are on the order of 30 to over 200 percent. Gaps in access have reduced over time for only a couple of interventions: ownership of ITNs and contraception. The only interventions that benefit poor and rural households with relatively equal likelihood as the wealthiest and urban households involve breastfeeding which to some degree is not surprising as these interventions do not require out of pocket payments, are controlled by mothers and can be performed from the home.

Figure B32. Wealth disparities in coverage: the ratio of intervention coverage among the wealthiest and poorest households, South Sudan, 2006 and 2010

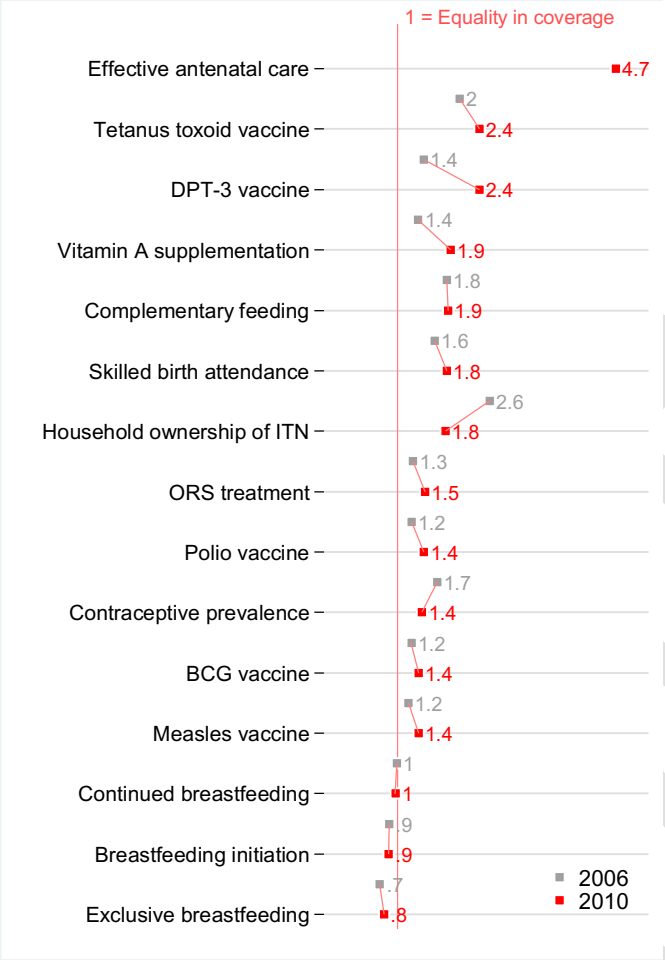
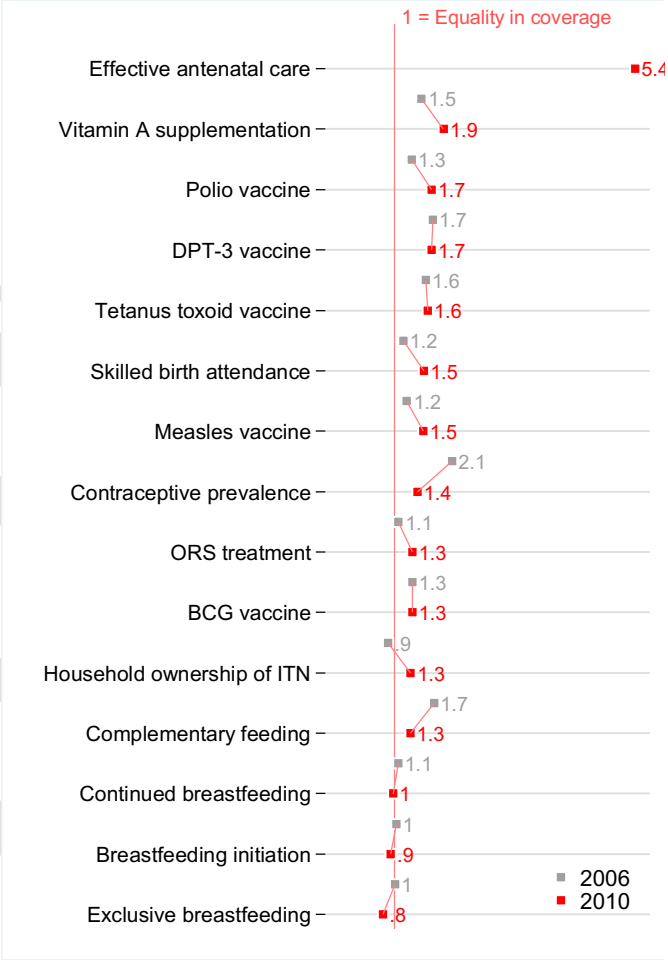


Figure B33. Urban-Rural disparities in coverage: the ratio of intervention coverage among urban and rural households, South Sudan, 2006 and 2010



Source: Author's calculations based on 2006 and 2010 SHHS.
Notes: Households are ordered from high to low based on the ratio of coverage in 2010.

C. HEALTH FINANCING

Key findings and discussion

- In absolute terms, government health spending per capita (factoring in development assistance) in South is high relative to its neighbors- but the prioritization of the health sector spending over time in the budget has fallen (in 2006 the health budget as a fraction of the total GoSS budget was 8 percent and in 2011, it was 4 percent). This may be in part a reaction to significant increases in the levels of donor spending in South Sudan. Between 2006 and 2010, the health budget execution was consistently low – in 2011 for example, among funding set aside for Health (including HIV/AIDS) only 65 percent was spent. In 2011, federal transfers to states for salaries and operating expenditures comprised 30 percent of the health budget; no federal transfers to states for capital investment were earmarked for the health sector. As South Sudan is committed to decentralization as guiding framework for its health system, building government capacity at the state and county level is critical.

- Out-of-pocket health spending in South Sudan averaged SDG 4 per person per month, ranging from a low of SDG 1 in Jonglei to a high of SDG 8.5 in Upper Nile. Using these estimates and census population data, a rough estimate of total out-of-pocket spending in 2009 is SDG 396.6 million (USD 172.4 million). By comparison, the total approved budget for health from the Government of South Sudan (GoSS) and donors was SDG 437.7 million (USD 190.2 million). Out-of-pocket spending by individuals at the point of care makes up approximately 48 percent of the funding envelope for health in South Sudan.

- In South Sudan, the lower level of out-of-pocket payments among rural and poor households compared to urban and rich households is associated with more restricted access to facilities (66 and 59 percent of the rural and poorest households, respectively, reported an ability to access a health facility when needed compared to 92 and 80 percent of the urban and richest households) and the different composition of health care facilities visited (rural households are more likely to visit a primary health care unit or center, which in turn are more likely to provide free services than a public hospital or private clinic). Further research is needed to pin-point factors that hinder access – in some areas – supply-side constraints likely predominate, in other areas demand-side factors (such as inability to pay, inadequate knowledge of services and their benefits or poor quality of health services) may predominate.

- Severe health shocks affect Southern Sudanese citizens with relatively equal likelihood across groups defined by wealth and urban or rural dwelling. Given that families devote considerable private resources to cope with these shocks (on average 85 percent of the value of yearly consumption, and up to four times the value of yearly consumption among the poorest households) demonstrates that people care significantly about their health.

- When affected by health shocks, families in South Sudan have relatively limited access to credit and therefore sell assets as a primary means to finance care for the consequences of those shocks. Since borrowing and selling assets threatens the future economic status of households (through interest payments or reduced ability to generate earnings through livelihood activities), severe health shocks may be a mechanism that makes it more difficult for families to escape poverty.

Introduction

Health financing is the process by which revenues are collected, accumulated in fund pools and allocated through purchasing to specific health actions. A well-functioning health financing system contributes to health system goals - primarily improved population health - by generating enough resources to adequately finance the health system (collecting), motivating actors in the system through financial incentives to work towards common goals (purchasing), and protecting individuals from the economic costs of health care by spreading risks over larger population groups (pre-payment and pooling). A key challenge in structuring health financing systems is expanding access to high quality health services while simultaneously protecting users from financial hardship resulting from healthcare. In South Sudan's context in which the health sector is transitioning from humanitarian to development assistance (Fox and Manu 2012), a major challenge is creating a financing framework that is structured towards supporting a system in addition to or in place of financing modalities that are organized to meet short term goals. Given the large share of funding for health provided by donors and the decentralized organization of the health system, a successful transition will involve coordination between donor agencies and government, alignment of efforts with national priorities (Fox and Manu 2012) and given the decentralized structure, strengthening capacity at the county and state level to plan and manage resources.

Government and Donor Health Spending

To gauge the magnitude of the resource envelope available for health in South Sudan, data was obtained from the official Government of Southern Sudan (GoSS) budget documents. Since spending figures are not consistently available for both GoSS and Donors in the budget documents, approved budget allocations that reflect estimated future spending by GoSS (including transfers to states, but not including spending by states enabled by their own revenue raising efforts) are presented to get a sense of the order of magnitude of available funds for health. The budget allocation for health from GoSS (fueled primarily by oil revenues) fell from SDG 237mn in 2006 to SDG 145mn in 2008 climbing up to 224mn in 2011 (Table C1). On a per capita basis, the GoSS health budget averaged 23 SDG over the time period and given an average budget execution rate for the health sector of 59 percent, GoSS health spending averaged 13 SDG per capita over between 2006 and 2010. Given that the consumer price index increased at an average annualized rate of 11 percent per year between 2007 and 2011, both total government budget allocations for health (increasing at an average annualized rate of 1.1 percent per year) and per-capita budget allocations (increasing at an average annualized rate of 0.95 percent per year) did not outpace inflation, and thus decreased in real terms over the 2007 to 2011 time period. The share of planned health sector spending in the total GoSS budget fell from 7.9 percent in 2006 to 3.9 percent in 2011, averaging 5 percent over this period. As noted in a recent study on health financing in South Sudan, this prioritization of health in the budget is low for the region (Fox and Manu 2012). Another indication of low prioritization of health in the budget is the low budget execution rates for health compared to the overall budget (only 65 percent of health funds were spent in 2010 compared to close to 100 percent of the overall budget).

Table C1. GOSS Approved Budget (SDG millions)

Year	All Sectors	All Sectors (per capita)	Overall Budget Execution (Percent of Budget that was spent during fiscal year) (%)	Health	Health (per capita)	Health Budget Execution (Percent of Health Budget spent during fiscal year) (%)	Health budget as a percent of total budget (%)	Per-capita health budget year on year percent change (%)
2006	2,990	377	119.8	237	30	57.3	7.9	
2007	3,094	382	94.9	168	21	39.9	5.4	-30.6
2008	3,428	415	166.6	145	18	78.7	4.2	-15.6
2009	3,606	428	117.4	175	21	55.5	4.8	18.1
2010	5,630	654	99.1	215	25	64.7	3.8	20.7
2011	5,767	656	N/A	224	25	N/A	3.9	1.8

Source: GoSS Annual Budgets (Health includes HIV/AIDS commission).
Notes: Growth rates for Sudan from the United Nations population division are applied to the 2008 Census population figures for South Sudan to get per-capita estimates for 2006,2007,2009,2010 and 2011.

In contrast to the first declining and then increasing allocation of resources for health from the GoSS budget has been a steady increase in funds available from donors, with the exception of 2011 in which planned funding for health from donors declined to SDG 298.7mn from SDG 406.3mn in 2010 (Table C2). In per-capita terms, donor funding averaged SDG 29 - approximately 25 percent larger than the per-capita funding levels from GoSS (averaging SDG 23 per capita between 2006 and 2011). Between 2006 and 2011, donors allocated approximately 20 percent of all development assistance funds to the health sector, reflecting greater prioritization of health by donors than GoSS.

Table C2. Donor Financing (SDG millions)

Year	All Sectors	All Sectors (per capita)	Health	Health (per capita)	Health funding as a percent of total (all sector) funding (%)	Per-capita donor funding year on year percent change (%)
2006	845	107	152	19	18.0	
2007	803	99	176	22	21.9	13.2
2008	807	98	180	22	22.3	0.2
2009	1,200	142	263	31	21.9	43.3
2010	1,772	206	406	47	22.9	51.4
2011	1,913	218	299	34	15.6	-28.0

Source: GoSS Annual Budgets (Health includes HIV/AIDS commission).
Notes: Growth rates for Sudan from the United Nations population division are applied to the 2008 Census population figures for South Sudan to get per-capita estimates for 2006,2007,2009,2010 and 2011.

Taken together, GoSS and donor funding create a resource envelope for health in 2011 of SDG 59.2 per capita (USD 23 per capita) in 2011, of which 57 percent (USD 13.1) is donor financed and the remainder (USD 9.9) is financed by GoSS (Table C3).

Table C3. All Funds (GOSS Approved Budget + Donor Funding (SDG millions))

Year	All Sectors	All sectors (per capita)	Health	Health (per capita)	Health funding as a percent of total funding	Per-capita health budget year on year percent change (%)
2006	3,836	484	389	49	10.1	
2007	3,897	482	344	43	8.8	-13.5
2008	4,235	513	325	39	7.7	-7.5
2009	4,806	570	438	52	9.1	32.0
2010	7,402	860	622	72	8.4	39.1
2011	7,680	874	523	59	6.8	-17.7

Source: GoSS Annual Budgets (Health includes HIV/AIDS commission).
Notes: Growth rates for Sudan from the United Nations population division are applied to the 2008 Census population figures for South Sudan to get per-capita estimates for 2006,2007,2009,2010 and 2011.

Table C4 compares the level of general government spending on health per capita and the share of government health spending in all government spending for South Sudan and Sudan (North), as well as neighboring countries and other conflict affected states in the region. This level of funding for health represents a huge opportunity for Southern Sudan to both address excess mortality and morbidity due to the lingering effects of conflict as well as invest in building the capacity of the health system.

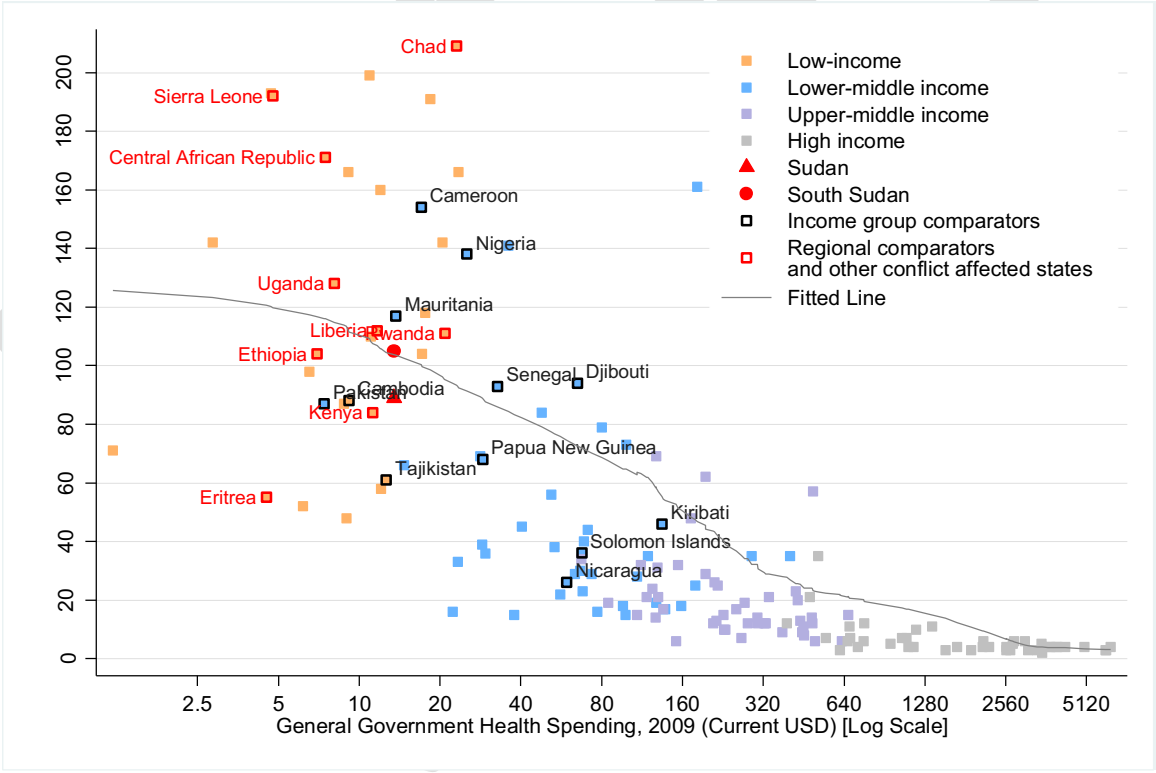
Table C4. General Government Health Expenditures (2009) among neighboring countries and other conflict affected states

Country	General government expenditure on health per capita 2009 (Current USD)	General government expenditure on health per capita 2009 (International USD)	General government expenditure on health as a fraction of total government expenditure (%)	Under Five Mortality (probability of death between age 0 and age 5 per 1000 live births)
Chad	23.1	52.1	13.8	209
Rwanda	20.8	44.1	16.8	111
Mozambique	20.4	41.4	14.2	142
Sudan*	13.5	23.0	[NA]	111
Republic of South Sudan*	13.5	23.0	4.9	104
Côte d'Ivoire	11.7	18.2	5.1	119
Liberia	11.6	20.8	17.2	112
Kenya	11.2	23.0	5.4	84
Uganda	8.1	21.8	11.6	128
Democratic Republic of the Congo	7.9	15.5	17.0	199
Central African Republic	7.5	12.5	11.0	171
Ethiopia	7.0	19.0	11.4	104
Sierra Leone	4.8	11.6	6.4	192
Eritrea	4.5	6.0	3.1	55

Source: WHO National Health Accounts Database, World Bank PETS, GoSS Annual Budgets
Notes: *Numbers for South Sudan and Northern Sudan are based on author's estimates all other data are from the WHO NHA database. *The estimates of general government health expenditure estimates for South Sudan, assumes that 30% of donor funding goes through the government budget. This assumption was needed for comparison purposes as General Government Health Expenditures in the NHA framework include Donor financing.

Figure C3 provides a broader view of the relationship between government expenditures on health and population health (as summarized by the under-five mortality rate). There is a strong negative relationship – countries that spend more on health care per citizen, have on average better health outcomes. At the lower end of the spending distribution (primarily low income countries), there is a very wide range of health outcomes suggesting other factors are at play (the prevalence of violent conflict or the degree of private spending, for example, but also how money is spent may be more important than how much is spent when resources are scarce). Among all low income countries, the average general government health spending per capita in 2009 was USD 11 placing South Sudan just above the average. Among the low income group, only four countries have spending levels above USD 20 per capita: Chad, Rwanda and Mozambique. Although all of these countries have relatively high levels of government health spending, only Rwanda has better child health outcomes than the average for low income countries (120 deaths per 1000 live births). Other countries in the same region or income group as Sudan that have significantly better outcomes than would be expected by their spending levels are Eritrea, Bangladesh, Madagascar, Tajikistan, the Democratic Republic of Korea, Myanmar and Kyrgyz Republic. Among lower-middle income countries average spending on health per capita in 2009 was USD 79.8 and average under-five mortality was 53.4 deaths per 1000 live births.

Figure C4. Under Five Mortality and General Government Health Spending by Income Groups, 2009



Source: WHO National Health Accounts Database, World Bank PETS, GoSS Annual Budgets

Assessing the effectiveness of government health spending – the degree to which public financing mechanisms promote better population health - requires understanding not only the level of donor and public spending but also understanding how funds flow through the health system and are translated into services. Decentralization – as a means to provide greater fiscal and decision-making authority to subnational governments – is a guiding

principle for the structure of South Sudan's health services and government more broadly. In this setting, states assume the primary role of basic health service management and provision.

Recent studies looking at the health financing in Sudan (North) (World Bank 2011) have identified several challenges with the decentralized structure of the health system. Among these, states have a weak ability to raise tax revenues (a result of both having a narrow tax base and limited tax instruments at their disposal); federal development transfers for health have a low budget execution (and therefore credibility) and low predictability, complicating state-level planning; given the dependence on federal transfers for capital improvements, there is a very low level of investment (84 percent of all health spending is made up by current spending); and the allocation of health spending across states is not rationalized with need (for example, poverty rates or burden of disease). The institutionalization of national policies (such as the free health care initiative for children under-five and pregnant women) when there are multiple actors and weak central monitoring and evaluation mechanisms is also difficult. As South Sudan develops its health financing system it should pay close attention to the challenges faced by Sudan (North) and other decentralized systems. These risks have also been voiced in a recent review of health financing in South Sudan (Fox and Manu 2012).

Economic hardship and health care spending

Data and methods

This section draws on household consumption data from the 2009 National Baseline Household Survey (Table C5) to measure out-of-pocket spending on health and the extent to which those payments contribute to economic hardship. The analysis that follows is restricted to households who sought care and reported paying for care in the 4 weeks prior to the survey, thus focusing on the financial consequences of paying for care rather than on the financial consequences on households who could not afford or access health care.

Table C5. NBHS sample characteristics

	South Sudan
No of households	4,969
Male (Respondent) (%)	67.8
Average Age	42.2
Education	
No schooling (%)	71.13
Primary (%)	17.80
Secondary or Higher (%)	11.18

Table C6. Health spending items in NBHS

Medicines and Drugs
- Cough Syrup medicine (cold)
- Drug tabs and roots for reducing fever and malaria
- Antibiotics
- Other pharmaceutical products

Equipment for Curative Services
- Medical eye glasses
- Hearing aid

Medical Doctoral Services
- Specialist and general doctors
- Medical consultation at hospital
- Planning blood vessels

Medical Dental Services
- Filling and treatment of teeth

Medical Tests and Others
- Malaria blood testing
- Other tests (blood, urine, feces)
- x-ray test
- Physiotherapy

Other hospital and healer services
- Birth in general hospital
- Operations in hospital
- Government hospital
- Private hospital
- Traditional healers fee/medicine

Source: NBHS Questionnaire

Private out-of-pocket spending on health is measured using consumption spending captured in the NBHS using an aggregation of the items shown in Table C6. For each item, households were asked how much was spent in the month and year prior to the time of the survey. The preferred recall period used for the construction of non-food consumption measures was the last month. The annual consumption amount was used if the household did not report the last month but reported in the last year. Adjustments for price differences in urban and rural settings were made so the consumption expenditure is in real terms. In addition, consumption measures are presented on a per-capita basis to adjust for household size. Total household spending is constructed by aggregating monthly expenses on education, health, clothing, utilities, transportation and communication, personal care, maintenance, utensils and accessories for the house and entertainment and leisure.

In addition to measuring the levels of out-of-pocket health spending and the share of health spending in the overall household consumption budget, three measures were constructed to gauge the extent to which households face economic hardship as a result of out-of-pocket payments for health care:

(1) **Catastrophic Expenditure:** The percentage of households incurring catastrophic health expenditures where catastrophic expenditure is defined as out-of-pocket health payments exceeding 40% of a household's capacity to pay for health services (defined as total household spending minus subsistence spending defined by the poverty line) (Xu, Evans et al. 2003). For households whose total consumption spending is below the poverty line, capacity to pay is defined as the observed level of non-food spending.

(2) Impoverishment: The percentage of households pushed below the poverty line due to out-of-pocket health payments.

(3) Hardship Financing: The percentage of households having to borrow or sell assets to financially cope with the severe illness or accident of a household member (Kruk, Goldmann et al. 2009). Unpredictable illness or accidents that diminish the health status of individuals have two important economic consequences, firstly they are often associated with the need for hospitalization that require payments of large sums of money in a short period of time and secondly they bring about loss of income to the household due to the temporary or prolonged disability of a wage earner. Assessing the coping mechanisms used by households to respond to health shocks is important as it can shed light on how health payments affect future welfare (Leive and Xu 2008). Table C7 displays the coping strategies captured by the NBHS among households reported to have been severely affected by the illness or accident of a household member in the five years prior to the survey. For purposes of analysis, the coping strategies were aggregated to seven categories: savings, sale of assets, borrowing, income or labor allocation, social assistance or charity, consumption reduction and other. In addition, the NBHS captures the estimated value of the health shocks to households; however, it does not capture the proportion recovered by the coping strategy.

Several advantages are associated with using the extent of borrowing and selling assets to measure the economic hardship associated with health payments including its ability to distinguish between affordable and less-affordable payments that might have negative long-term consequences for households by increasing their exposure to debt or ability to generate revenue in the long term. In addition, this measure can also take into account non-financial costs such as those associated with travel to a facility or income loss (Kruk, Goldmann et al. 2009).

Table C7. Coping categories/ strategies

Savings
- Spent Cash Saving

Sale of assets
- Sold assets (tools, furniture etc.)
- Sold farm land
- Sold animals

Borrowing
- Borrowed money from relatives
- Borrowed money from money lender
- Borrowed money from institutions (banks)

Income/ Labor allocation
- Rented out farm
- Sold more crops
- Worked more/ longer hours
- Other household members who weren't working went to work
- Removed children from school to work
- Went elsewhere to find work for more than a month
- Started a new business

Social Assistance/ Charity
- Received help from religious institutions
- Received help from local NGO
- Received help from international NGO
- Received help from Government
- Received help from family/friends

Consumption reduction
- Reduced food consumption
- Consumed lower cost, but less preferred foods
- Reduced non-food expenditures

Other
- Sent Children to live with relatives
- Spiritual help – prayers, sacrifices, consulted diviner, etc.

Limitations

Measuring out-of-pocket spending directly from surveys has limitations resulting from sampling error and non-sampling error. Sampling error results both from the inherent variation between individuals and households in the population (random error) as well as factors related to the sampling design (fixed error). Fixed sampling error related to health care spending can arise if sub-groups of the population are not surveyed – such as groups living in institutions (hospitals and prisons for example). However, in the case of North and South Sudan – this group is not likely to represent a large portion of the population. Fixed sampling error can also result from

seasonal variations in health care use and expenditure. Non-sampling errors on the other hand – rather than resulting from the sampling design – result from issues in the design and implementation of the survey and from characteristics of human behavior under survey conditions. One notable issue is recall bias – individuals are rarely able to accurately recall the full details and timing of events in the past. In addition, as household surveys (including the NBHS) rely on proxy respondents to obtain information, there is a larger chance that that the respondent will not recall important events if they did not experience it directly. For example, relative to mothers, adult male respondents are likely to be less familiar with expenditures involving their children. In addition, deliberate errors might be introduced by respondents in order to conceal sensitive information and in the case of very long surveys, some respondents may simply omit responses in order to complete the interview more quickly (Rannan-Eliya 2008).

Relative to surveys that are specialized to collect health care spending, surveys conducted to collect data on all items of household consumption – like the NBHS – tend to underestimate health spending. Excluding non-financial costs from survey questionnaires – such as transportation to access health facilities and health services provided at home, will also tend to underestimate health-care related consumption – especially for households in isolated settings.

Results

In South Sudan, 45.8 percent of households reported purchasing health care services or products in the month prior to the survey, spending an average of SDG 4 per person per month (SDG 48 per year) on these services (Table C8). Out of total reported health spending, 25 percent went towards the purchase of medicines, 22 percent was associated with hospitalization, 17 percent for general consultations or consultations with specialists, 16 percent for medical tests and the remainder was split between purchases of curative equipment, fees for dental services and fees for traditional healers. In urban areas, 74.4 percent of households reported purchasing health care, spending an average of SDG 10 per capita per month (5.3 percent of total consumption) whereas in rural areas, only 40.5 percent reported health care purchases, spending an average of SDG 3 per capita per month on health care (representing 2.9 percent of total consumption). The wealthiest households spend approximately SDG 12 per person per month (4.3 percent of total consumption) on health care compared to an average of SDG 0.5 per person (2.4 percent of total consumption) among the poorest households. Only one quarter of the poorest households reported spending on health in the prior month compared to two thirds of the richest households.

Table C8. Health spending, exposure to health shocks and measures of economic hardship, South Sudan

	Urban	Rural	Poorest	2nd wealth quintile	3rd wealth quintile	4th wealth quintile	Richest	South Sudan
Consumption per capita per month (SDG)								
Food	109.5	73.1	15.3	36.4	60	93.8	188.5	78.7
Education	3.2	0.6	0.2	0.4	0.7	1	2.8	1
Health	10	2.9	0.5	1.3	2.3	4.3	11.8	4
Total Consumption	167.8	87.8	19.9	44.2	72.5	115.2	249.7	100.3
Households reporting health spending in past month (%)	74.4	40.5	25.5	37.6	44.6	56.6	64.9	45.8
Consumption categories as a share of total consumption:								
Food (%)	69	81.3	73	82.2	82.8	81.5	77.3	79.4
Education (%)	1.8	0.9	1.4	0.9	0.9	0.9	1	1
Health (%)	5.3	2.9	2.4	3	3.1	3.7	4.3	3.3

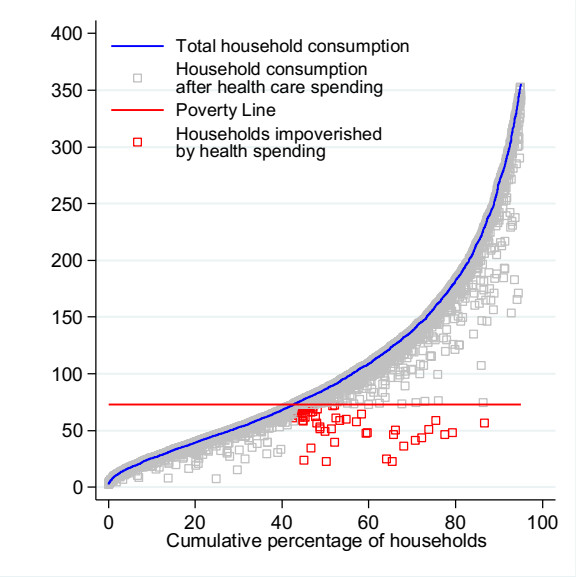
Share of Health Spending in Non-Subsistence Spending (%)	15	14.2	6.2	10.9	37.1	11	6.4	14.3
Poverty								
Poverty headcount (%)	24.4	55.4	100	100	52.8	0	0	50.6
Exposure to health shocks and coping strategies								
Households faced with severe health shock in past five years (%)	45.1	33.2	28.7	33.8	35.2	35.5	39.9	35
Value of Health Shock (SDG)	1,455	913	1,053	850	838	1,006	1,245	1,022
Households affected with health shock by coping strategy:								
Savings	23.6	10.9	6.2	9.2	12.8	14.9	19	13.4
Sale of assets	13	27.8	28.9	31.2	23.4	27.3	18.3	24.9
Borrowing	6.8	4.6	4.5	3.5	4.1	5.5	6.5	5
Income/Labor Allocation	15.6	16.4	13.4	12	20.2	15.3	18.3	16.3
Social Assistance/ Charity	21.2	16.8	13.1	17.4	14.8	17	22.8	17.7
Consumption reduction	6.9	2.7	2.9	1.9	3.8	4.3	4	3.5
Other	12.9	20.8	30.9	24.8	20.8	15.7	11.2	19.3
Measures of economic hardship from health spending								
Catastrophic Health Expenditures (%)	9.5	8.5	6.5	10.1	15.5	7.3	3.7	8.6
Impoverishment (%)	1.9	2.8	--	--	10.4	1.7	0.3	2.6
Hardship financing (%)	19.8	32.4	33.4	34.7	27.5	32.9	24.7	29.9

Source: Author's calculations using 2008 National Baseline Household Survey

Overall, 8.6 percent of households incurred catastrophic health payments and 2.9 percent were impoverished as a result (Figure C5 visually displays the households that are impoverished). The prevalence of catastrophic health payments is highest among households in the third wealth quintile (16 percent) but not substantially different between urban and rural households. Approximately ten percent of households in the third wealth quintile had consumption spending lower than the poverty line after health expenditures. This mainly reflects the vulnerability to shocks of any kind among households whose consumption budget is above, but close to, the poverty line.

Thirty-five percent of households were affected by the severe illness or accident of a family member – the reported rate of health shocks was higher among the urban and rich (45 and 40 percent, respectively) compared to the rural and poorest (35 and 33 percent). Whether this difference reflects actual underlying differences in exposure to health risks or differences in the propensity to report cases of illness or accident is difficult to ascertain. The average reported value of these health shocks was SDG 1,022 or 85 percent of the value of yearly per capita consumption. Among the poorest, the value of reported health shocks represents over four times the average value of per capita consumption among poor households. Of the households affected by health shocks, close to one in three, borrowed or sold assets to cope with the illness or accident of a family member. Only a small percentage of households borrowed money (5 percent). Among those who borrowed, the vast majority borrowed from relatives or a money lender, the remainder from formal institutions. When households sold assets (25 percent of those affected by health shocks), they primarily sold animals (79 percent) or sold durable items such as tools or furniture (20 percent). Using savings to cope with health shocks was a strategy used among 1 in 5 rich households but less than 1 in 10 poor households did so. Urban households were more than twice as likely as rural households to draw on savings as a coping strategy.

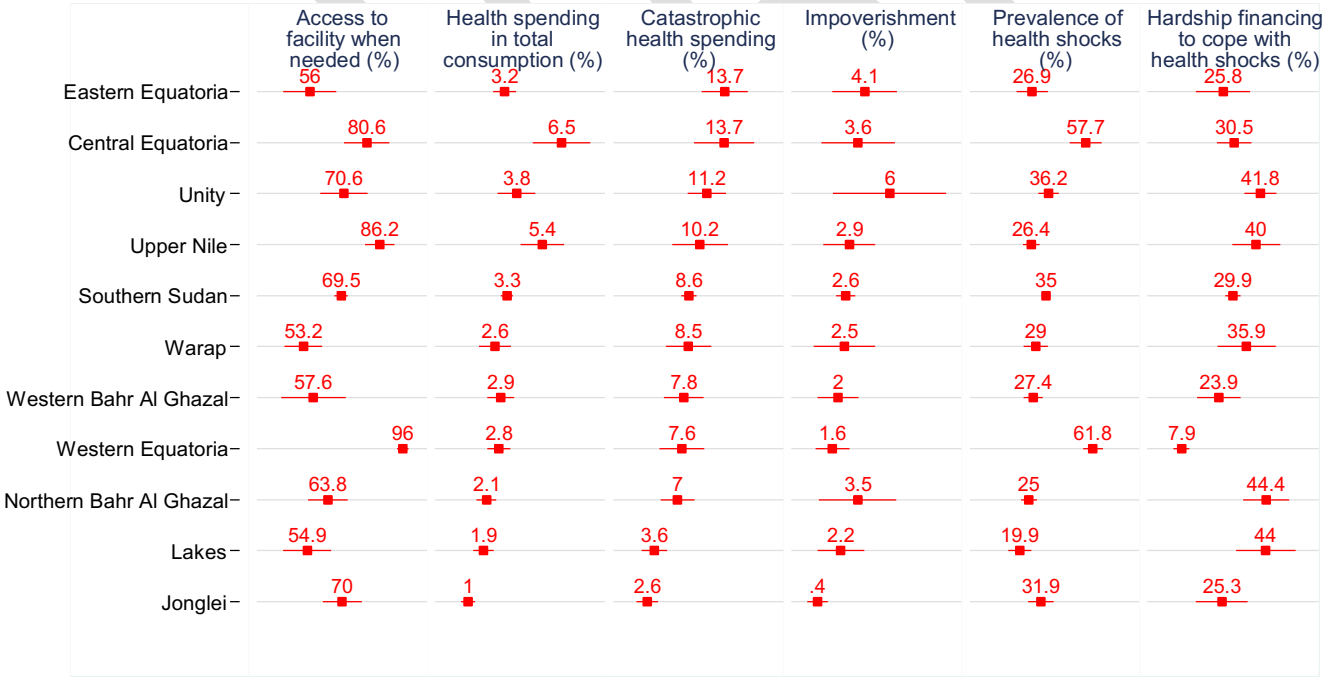
Figure C5. Impoverishment from health spending, Southern Sudan



Source: Author's calculations using 2009 National Baseline Household Survey

Across states, health care access was highest in Western Equatoria – where 96 percent of households reported having routine access to a facility when needed – and lowest in Warap where only 53 percent of households have access (Figure C6). Upper Nile and Central Equatoria have the highest levels of per capita health spending (SDG 8.5 and SDG 8.2 per month, respectively) – approximately twice the amount spent by individuals in Eastern Equatoria and Unity – the states with the third and fourth highest health spending per capita at around SDG 4 per capita per month. Relative to total consumption, health spending is highest in Central Equatoria (6.5 percent of total consumption) and lowest in Lakes and Jonglei (less than 2 percent of total consumption is spent on health). Eastern and Central Equatoria have the highest prevalence of catastrophic spending (13.7 percent). Reported exposure to health shocks is highest in Western and Central Equatoria (62 and 58 percent, respectively) but hardship financing to cope with health shocks was highest in Northern Bahr al Ghazal and Lakes where 44 percent of households borrowed or sold assets.

Figure C6. Health spending, exposure to health shocks and measures of economic hardship, North Sudan, by State



Source: Author's calculations using 2009 National Baseline Household Survey
Notes: States sorted in order of catastrophic health spending prevalence

Table C9 provides an overview of the degree of access households in South Sudan have to health care. Overall, 70 percent of households are able to access a health care facility when needed. Over 60 percent of these households visit primary health care centers or units most often when needed, 25 percent visit public hospitals and about 10 percent rely primarily on private hospitals, clinics and pharmacies for care. Over 2 percent of all households reported not having access to any medical help – the majority being poor. The rural and poorest households are less able to access health care when needed: 66 and 59 percent of the rural and poorest households, respectively, are able to access a health facility compared to 92 and 80 percent of the urban and richest households. In urban areas public hospitals are the primary point of care - 55 percent of households with access to a facility choose to visit public hospitals, whereas in rural areas 70 percent visited primary health care units or centers. Of the households able to access care, 39 percent reported that the facility most often visited provided free care – with rural households about twice as likely as urban households to have access to free care. Among households able to access a facility, 32 percent are within 30 minutes of the facility, 35 percent are between 30 minutes to an hour of a facility and 33 percent are between 1 to 2 hours of a facility.

Table C9. Reported ability to access health care, South Sudan

	Urban	Rural	Poorest	2nd wealth quintile	3rd wealth quintile	4th wealth quintile	Richest	South Sudan
Access to any health care facility when needed								
Overall	92.4	65.6	58.7	68.0	67.0	69.8	80.4	69.5
By Facility Type								
Primary Health Care Unit	8.7	42.9	43.5	45.5	38.0	35.5	25.8	36.3
Primary Health Care Centre	18.2	27.5	24.8	23.5	27.9	28.4	24.3	25.7
Public Hospital	54.9	17.9	16.3	17.5	23.9	26.1	34.6	25.0
Private Hospital/ Clinic	15.5	6.0	7.9	5.3	5.0	6.5	12.4	7.8
Pharmacy/ Drug Store	2.1	2.3	1.9	3.2	2.6	1.7	2.0	2.3
No medical Help Available	0.0	2.7	5.1	4.2	2.0	1.1	0.3	2.2
Other	0.7	0.7	0.4	0.8	0.6	0.7	0.7	0.7
Access to facility with free care								
Overall	21.1	43.4	33.5	39.5	41.4	44.7	36.0	39.0
By facility Type								
Public facility (any)	22.7	46.1	37.1	41.5	43.7	47.2	39.3	41.9
Primary Health Care Unit	19.8	44.8	39.8	42.3	42.1	52.6	41.7	43.7
Primary Health Care Centre	30.2	49.8	35.8	43.9	53.3	50.1	47.9	47.1
Public Hospital	20.6	43.7	31.8	36.5	35.0	36.8	31.6	33.9
Private Hospital/ Clinic	13.0	11.8	3.0	5.8	10.5	17.0	16.0	12.3
Time to facility (m = minutes, hr = hour)								
< 15m	16.4	15.9	13.0	17.5	15.5	15.9	17.2	16.0
15-30m	22.7	14.3	10.8	13.6	16.1	16.2	19.9	16.0
30m - 1hr	40.7	33.7	32.5	34.3	32.7	38.8	36.0	35.1
1-2hrs	20.2	36.0	43.4	34.4	35.7	29.2	27.0	32.8
> 2hrs	0.0	0.1	0.3	0.3	0.0	0.0	0.0	0.1
Alternative health care (if not able or willing to seek care at a facility)								
Religious Healer/ Witch Doctor	31.4	18.2	24.1	16.2	18.2	17.8	15.4	18.7
Traditional Healer	51.1	49.9	47.4	50.7	48.6	50.0	54.5	49.9
Other (e.g. Family Friends)	17.4	31.9	28.5	33.1	33.2	32.2	30.1	31.4

Source: Author's calculations using 2008 National Baseline Household Survey

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ANNEXES

Annex 1. Sample Weight Adjustments

One recognized challenge of conducting the SHHS was the compilation of a sampling frame with high coverage of the Sudanese population. The only reference available at the time from which to draw a population sample was the 1993 population census which was far in the past and conducted in a period of conflict which allowed only for very limited enumeration in South Sudan (Central Bureau of Statistics and Southern Sudan Center for Census Statistics and Evaluation 2006). Alternative sample frames were identified (such as the World Health Organization's list of villages developed for the EPI Program) but only provided a rough benchmark of the population in areas not covered by the 1993 census. The extent of error in the implied state-level population from the SHHS using the SHHS sample weights can be gauged by comparison with the 2008 census short form numbers (Table A1.1 – A1.3). In order to more accurately compute national level estimates, household, child and women weights in the SHHS were re-calibrated using the state-specific adjustment factors displayed in Tables A1.1-A1.3. A new weight was used by multiplying the old weight by the adjustment factor. Implied population counts computed using the new weights yield state-level population counts equal to the census counts.

Table A1.1Population (All Individuals)

State	2006 SHHS (Implied Population)	Census	Percent Error	Household Weight Adjustment Factor
Jonglei	1,511,544	1,358,602	11%	0.899
Upper Nile	1,041,410	964,353	8%	0.926
Unity	589,718	585,801	1%	0.993
Warrap	1,505,818	972,928	55%	0.646
Northern Bahr-El-Ghazal	1,415,054	720,898	96%	0.509
Western Bahr-El-Ghazal	417,967	333,431	25%	0.798
Lakes	956,444	695,730	37%	0.727
Western Equatoria	680,750	619,029	10%	0.909
Central Equatoria	1,072,047	1,103,592	-3%	1.029
Eastern Equatoria	913,244	906,126	1%	0.992

Source: Author's calculations based on 2006 SHHS and census county-state population counts by age and sex provided by the South Sudan Center for Census, Statistics and Evaluation, September 2011.

Table A1.2 Population (Children Under-five)

State	2006 SHHS (Implied Population)	Census	Percent Error	Child Weight Adjustment Factor
Jonglei	243,190	207,424	17%	0.853
Upper Nile	171,127	150,872	13%	0.882
Unity	120,333	108,357	11%	0.900
Warrap	238,751	169,599	41%	0.710
Northern Bahr-El-Ghazal	215,026	136,520	58%	0.635
Western Bahr-El-Ghazal	75,022	53,967	39%	0.719
Lakes	155,869	106,232	47%	0.682
Western Equatoria	84,986	81,154	5%	0.955
Central Equatoria	189,908	163,539	16%	0.861
Eastern Equatoria	162,590	126,467	29%	0.778

Source: Author's calculations based on 2006 SHHS and census county-state population counts by age and sex provided by the South Sudan Center for Census, Statistics and Evaluation, September 2011.

Table A1. 3 Population (Women Ages 15-49)

State	2006 SHHS (Implied Population)	Census	Percent Error	Women weight Adjustment Factor
Jonglei	330,303	316,793	4%	0.959
Upper Nile	232,889	215,399	8%	0.925
Unity	125,494	129,087	-3%	1.029
Warrap	331,612	244,758	35%	0.738
Northern Bahr-El-Ghazal	354,118	170,133	108%	0.480
Western Bahr-El-Ghazal	102,590	78,092	31%	0.761
Lakes	199,539	163,511	22%	0.819
Western Equatoria	146,550	165,124	-11%	1.127
Central Equatoria	232,219	268,563	-14%	1.157
Eastern Equatoria	194,865	223,880	-13%	1.149

Source: Author's calculations based on 2006 SHHS and census county-state population counts by age and sex provided by the South Sudan Center for Census, Statistics and Evaluation, September 2011.

Annex 2. Under-Five Mortality Estimates

A. Direct Methods

Producing estimates of under-five mortality using complete birth histories relies on the use of survival models that are characterized by two features of survival data:

(1) The outcome of interest is the time until the occurrence of a well-defined event – in this case the death of a child before his or her first or fifth birthday.
(2) Observations are censored: for some children, the event of interest has not occurred at the time the survey was collected.

In addition, survival models can be used to assess the relationship between variables of interest and time until death.

In the setting of under-five mortality, the outcome of interest (survival time) can be modeled as follows: **T** represents a non-negative continuous random variable representing the time until death which has a probability density function, $f(t)$ and a cumulative distribution function, $F(t) = \Pr\{T \leq t\}$ which gives the probability that the event has occurred by duration t.

The survival function gives the probability that a child is alive by duration (age) t, which is the complement of the probability that the child has died by duration t:

$$S(t) = \Pr\{T > t\} = 1 - F(t) = \int_t^{\infty} f(x)dx$$

The additional feature in survival models that must be taken into account is that at the time of the survey, some children have died and their survival time is known, while others are still alive and their survival times are not known. A key underlying assumption is that the children who are censored (resulting from the cross-sectional nature of the survey) are no more or less likely to survive beyond the censoring time than those who are not censored – that is, the censoring mechanism is non-informative.

B. Assessment of under-reporting of early neonatal and neonatal deaths, South Sudan

Table A2.1 displays the ratio of early neonatal deaths (0-6 days) to all neonatal deaths (0-30 days) as well as the ratio of neonatal deaths to all infant deaths (0-12 months) by region, the sex of the child and the calendar year of death.

Table A2.1 Assessment of under-reporting of child deaths, South Sudan

Calendar Year of Death	Ratio of Early Neonatal Deaths to All Neonatal Deaths		Ratio of Neonatal Deaths to all Infant Deaths	
	SHHS (2006)	SHHS (2010)	SHHS (2006)	SHHS (2010)
(2005-2010]	--	0.734	--	0.523
(2001-2006]	0.742	0.753	0.651	0.515
(1996-2001]	0.656	0.702	0.752	0.423
(1991-1996]	0.640	0.682	0.774	0.498
(1986-1991]	0.590	0.700	0.703	0.455
(1981-1986]	0.738	--	0.764	--

Source: Author's calculations from 2006 and 2010 SHHS.

The proportion of neonatal deaths reported during the first week of life ranges from 0.59 to 0.742 in the 2006 SHHS and 0.68 to 0.75 in the 2010 SHHS. With the exception of the 2001-2006 calendar period, the ratio is between 5 and 11 percentage points lower in the 2006 SHHS relative to the 2010 SHHS. Comparing these observations to other data sources, the ratio of early neonatal to all neonatal deaths ranges from 0.65 to 0.77 in the 1990 DHS (Northern States) and 0.685 to 0.701 in the 2005 Ethiopia DHS. So overall, there does not seem to be strong evidence for systematic under-reporting of early neonatal deaths.

The proportion of neonatal deaths occurring in the first year of life ranges from 0.65 to 0.77 in the 2006 SHHS and 0.42 to 0.52 in the 2010 SHHS – the ratio is between 15-25 percentage points higher in the 2006 SHHS relative to the 2010 SHHS. Compared to other data sources the ratio of neonatal to infant deaths ranges from 0.45 to 0.66 in the 1990 DHS and 0.498 to 0.528 in the 2005 Ethiopia DHS - supporting the hypothesis that neonatal deaths were over-reported in the 2006 SHHS.

C. Imputing of missing birth dates and ages at death for estimating under-five mortality using the direct method

For children missing the month of birth only, a month is randomly selected from a uniform distribution of numbers between 1 and 12 (representing January through December) for years of birth during or before 2005 and 2009 (corresponding to the year before the 2006 and 2010 SHHS survey interview). For children born in 2006 or 2009 (the years of the 2006 and 2010 SHHS survey interview), a month is randomly selected between January and the month of the interview date. Months are randomly selected within several logical constraints. Firstly, for mothers with multiple children, the randomly selected month preserves a minimum distance of 9 months between births. Secondly, for children belonging to a multiple birth, the birth with the missing month is assigned the same month of birth as the twin. For children still alive at the time of the survey with a missing birth month and year but non-missing age, the date of birth is imputed by subtracting the age from the date of the survey interview.

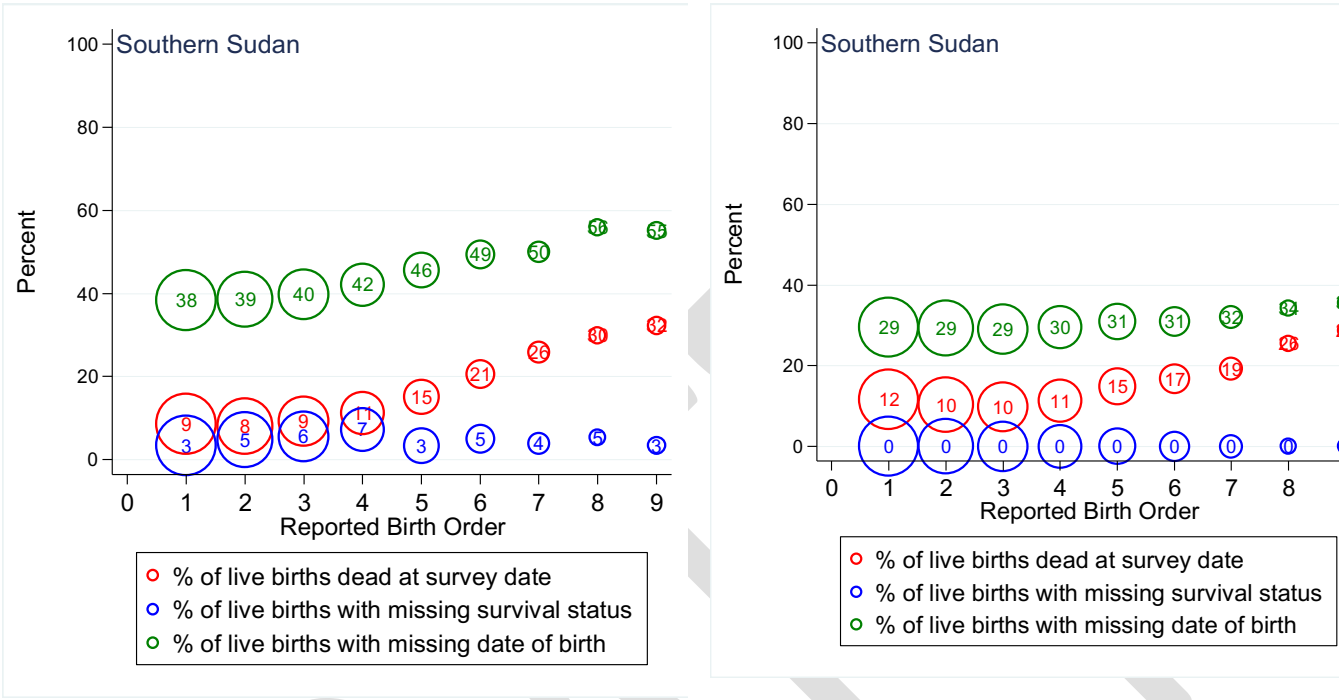
Three imputation strategies to estimate the birth dates for children with missing year of birth were attempted:

(1) Logical imputation assuming that the reported birth order (as listed in the birth history) is correct: If children with missing dates of birth have a younger and older sibling with known dates of birth, the value is imputed by randomly selected a date of birth 9 months after the younger sibling's birth and 9 months before the older sibling's birth. For children with missing birth dates and only a single sibling, or the children who are the first or last in the reported birth order, a set of intervals using logical constraints is created for child's birth date using the earliest possible childbearing date as a lower limit and the date of the interview as the upper limit. These intervals are further narrowed by dividing the possible range of months over which the birth could have occurred, by the number of children with missing birth dates per mother, so that imputed birth dates are evenly spaced over the range of all possible birth dates and at least 9 months apart from each other. Imputed birth dates are randomly selected from a uniform distribution of birth dates between the lower and upper limit of the intervals. This procedure assumes that all missing cases belong to single births.
(2) Logical imputation ignoring reported birth order. In this case, the dates of birth for children with missing information were imputed using the strategy for terminal births explained above. A correction procedure was applied to ensure that neighboring births are at least 9 months apart.
(3) Imputation using multivariate regression: missing dates of birth are predicted using information on the age of the mother at the time of the survey, the age of the mother at first birth, total number of children and the birth space between the current and last birth. Two different regressions were tried, one that used reported birth order as a predictor and another that did not.

The sensitivity of under-five mortality estimates resulting from these imputation strategies is shown in Figures A2.2 through A2.6.

Missing ages at death are imputed by randomly selecting from a log-uniform distribution of death ages bounded by the minimum death age observed for all deaths (with known death ages) of the same birth order and the maximum death age observed for all births (with known death ages) of the same birth order. If the upper bound death age exceeded the age the child would have been at the time of the survey, the upper bound is replaced by the child's hypothetical age at the time of the survey. After imputation of birth dates and ages at death, 26,456 live births from the 2006 SHHS and 28,720 live births from the 2010 SHHS were used to measure under-five mortality for South Sudan using the direct method.

Figure A2.1 Percentage of live births reported dead, with missing survival status and with missing data of birth by reported birth order, 2006 (left) and 2010 (right)



Source: Author's calculations using 2006 and 2010 SHHS.

Figure A2.1 Imputation ignoring reported birth order

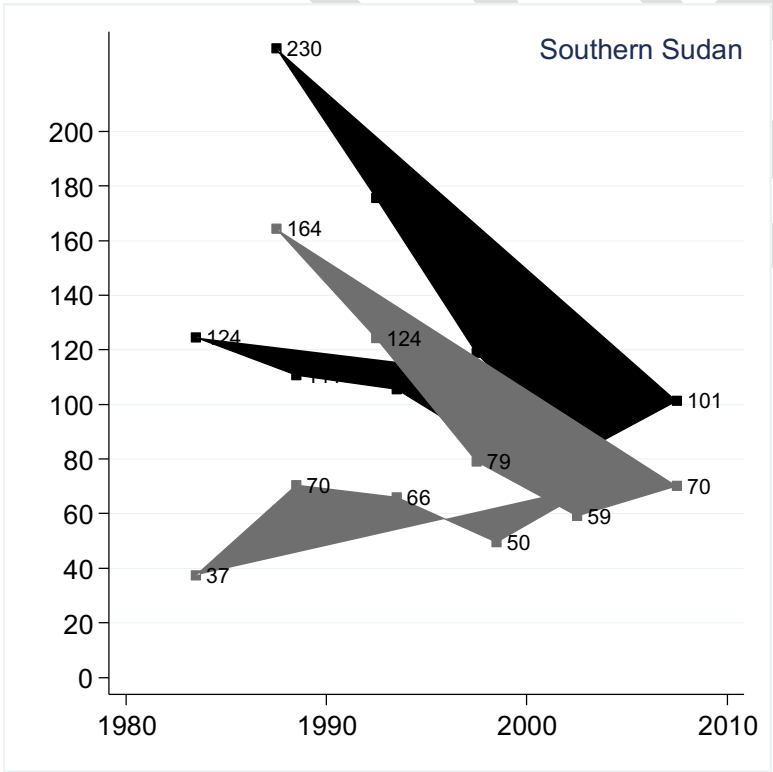


Figure A2.2 Logical imputation ignoring reported birth order for cases with missing birth dates at terminal ends of birth history

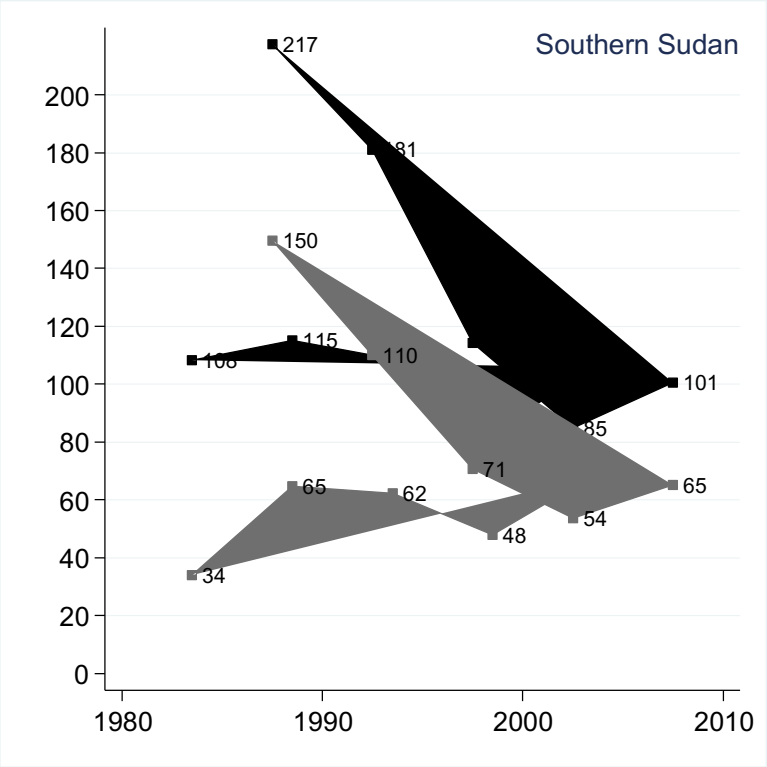


Figure A2.3 Logical imputation assuming reported birth order is accurate

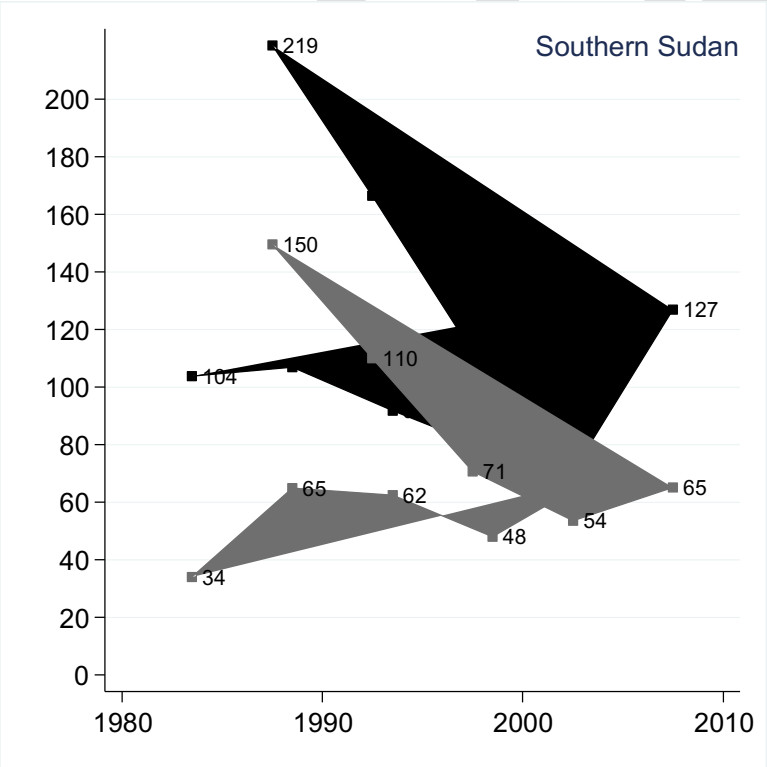


Figure A2.4 Imputation using a multivariate regression that omits reported birth order as a predictor

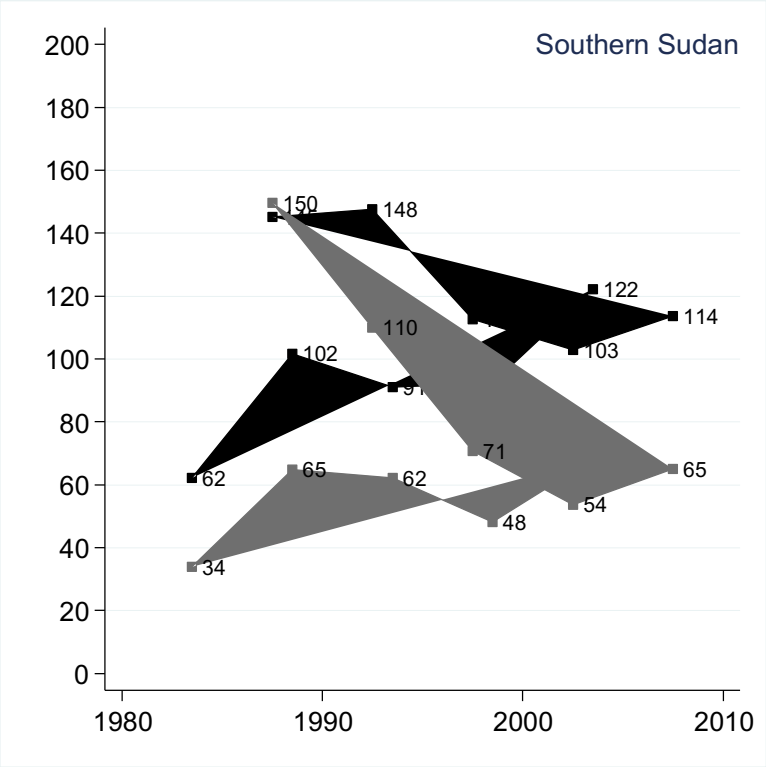
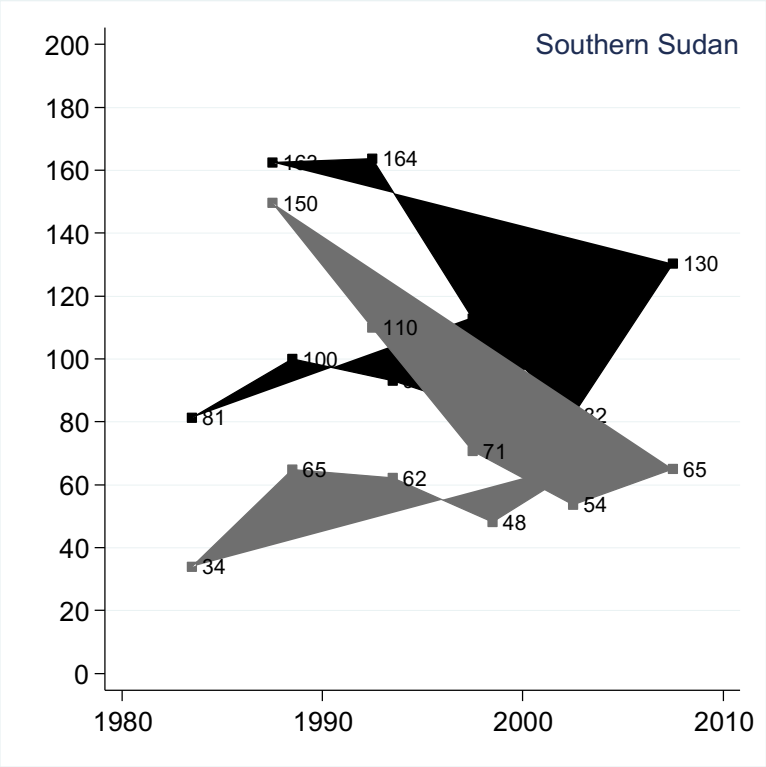


Figure A2.5 Imputation using a multivariate regression that includes reported birth order as a predictor



Annex 3. Determinants of Under-5 mortality

A. Methods

Proportional hazards regression is a framework that takes into account the feature of the data that children who have not yet reached their fifth birthday by the time of the survey have not been fully exposed to the risk of under-five death. In other words, some measurements of death are known exactly, and others are only known to exceed the date of the survey interview. Data in this setting are represented by two variables: An observation time, which identifies the time to death or censoring (whichever comes first) and an event indicator, which identifies actual death. The proportional hazards model (Equation 1) describes the hazard (the instantaneous risk of death) for individuals with a certain set of characteristics (x_i). This approach estimates a baseline hazard function $\lambda_0(t)$ that describes the risk of death at each time among individuals with $x_i = 0$ and the relative risk - $e^{x_i'\beta}$ - associated with the specific set of characteristics x_i. Proportional hazards models assume that relative risk is constant in time between two groups and treats the survival distribution within a group semi-parametrically. The model estimates the relative risk of death (measured by the hazard ratio) between groups of individuals defined by an attribute (such as the education or age of the mother), controlling for other attributes.

$$\lambda_i(t|x_i) = \lambda_0(t)e^{x_i'\beta} \quad \text{(Equation 1)}$$

B. Measuring Wealth

In order to assess inequalities in health outcomes or health services associated with economic status, a measure of household wealth is needed. In the absence of monetary measures of household wealth such as income or expenditure, a wealth or asset index can be constructed using observations on household asset ownership (such as consumer durables) and housing characteristics (such as availability of piped water or a flush toilet). Table A3.1 provides an overview of the types of assets captured in the SHHS as well as the mean ownership of each asset across households in 1006 and 2010. To aggregate the assets into an index, a linear combination of the available asset variables is constructed as follows (Equation 2):

$$A_i = b_1 a_{1i} + b_2 a_{2i} + \cdots + b_k a_{ki} \quad \text{(Equation 2)}$$

Where A_i the asset is index for household i, a_{ki} are indicators of asset ownership and household characteristics and $b_k$are the weights used to aggregate the indicators into an index. While there are several approaches to estimate the weights the statistical method of principal components is used. The asset index can be best interpreted as a measure of a household's long-run economic status. Five different asset groupings were used to generate candidate asset indices (these are described below). For variables describing household characteristics, two approaches were tried. The first approach incorporated the variables dichotomously in the principal components model. The second approach allowed for more parsimonious modeling, by grouping together similar household features into a single continuous variable.

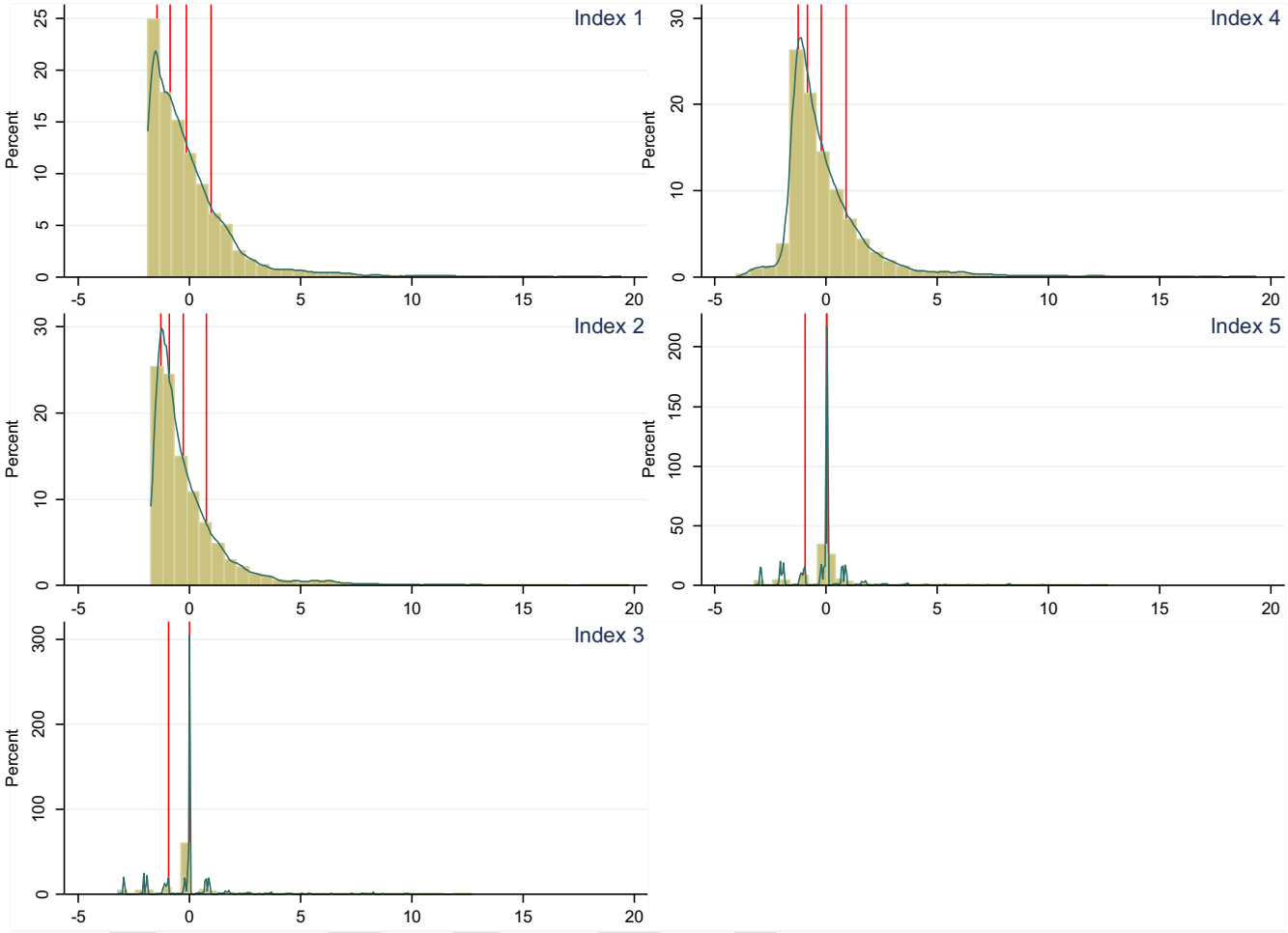
Asset group 1: consumer durables, dichotomous water and sanitation variables, dichotomous household structure variables, [No livestock**] Asset group 2**: consumer durables, continuous water and sanitation variables, continuous household structure variables, [No livestock] **Asset group 3**: only livestock ownership variable. **Asset**

group 4: consumer durables, continuous water and sanitation variables, continuous household structure variables and livestock variables. **Asset group 5**: land ownership and livestock ownership variables. The resulting distributions of the asset indices are displayed in Figure A3.1. Given the non-smooth distributions of the wealth indices produced by asset group 3 and 5, these were not considered. To choose among the remaining three asset indices, the correlation of the index with other proxies of economic status, such as the education of the household head and the employment status of the household head was used (Table A3.2). Using these criteria, asset group 2 was chosen.

Table A3.1. Household ownership of assets (proportion of households), South Sudan, 2006 & 2010

	2006			2010		
Asset	**South Sudan**	**Rural**	**Urban**	**South Sudan**	**Rural**	**Urban**
Consumer Durables						
Electricity	0.006	0.003	0.011	0.015	0.003	0.142
Radio	0.219	0.168	0.326	0.300	0.273	0.602
Television	0.011	0.004	0.024	0.022	0.008	0.173
Mobile Phone	0.020	0.006	0.050	0.183	0.147	0.585
Non-Mobile Phone	0.016	0.005	0.037	0.029	0.026	0.069
Refrigerator	0.009	0.006	0.017	0.006	0.002	0.050
Computer	0.005	0.002	0.013	0.005	0.003	0.034
Internet	0.020	0.012	0.034	0.002	0.001	0.015
Watch	0.296	0.264	0.364	0.339	0.324	0.514
Bicycle	0.262	0.199	0.392	0.263	0.245	0.469
Motorcycle or Scooter	0.019	0.011	0.036	0.043	0.035	0.136
Animal Drawn Cart	0.010	0.008	0.016	0.024	0.024	0.032
Car or Truck	0.006	0.003	0.013	0.009	0.005	0.055
Boat with motor	0.009	0.006	0.015	0.004	0.004	0.007
Water & Sanitation						
Source of Drinking Water						
Piped (Into dwelling, yard or plot) or bottled	0.034	0.040	0.022	0.007	0.003	0.062
Public tap/ standpipe or borehole	0.488	0.503	0.456	0.554	0.564	0.439
Protected well or spring	0.040	0.038	0.044	0.034	0.034	0.040
Unprotected well or spring	0.214	0.174	0.297	0.181	0.183	0.159
Delivered by tanker or truck	0.019	0.015	0.029		NA	
Surface Water	0.163	0.183	0.120	0.203	0.206	0.173
Other	0.042	0.047	0.031	0.001	0.001	0.000
Type of Toilet Facility						
Flush System	0.408	0.459	0.303	0.096	0.093	0.123
Latrine	0.153	0.114	0.233	0.139	0.123	0.313
No Facilities	0.404	0.391	0.432	0.733	0.750	0.545
Other	0.035	0.036	0.033	0.032	0.034	0.019
Household Structure						
Number of Rooms/ Tukuls	2.76	2.63	3.03	1.86	1.81	2.37
Type of Floor						
Earth, Grass, Mud	0.918	0.913	0.927	0.867	0.869	0.851
Rudimentary - Wood planks, Palm, Bamboo	0.076	0.079	0.067	0.108	0.108	0.109
Finished - Parquet, polished wood, vinyl, ceramic,	0.006	0.007	0.005	0.025	0.024	0.040
Type of Roof						
Natural, no roof, thatch, grass	0.891	0.883	0.907	0.763	0.768	0.707
Rudimentary - Palm, bamboo, wood planks, animal skin	0.071	0.069	0.074	0.103	0.101	0.125
Finished - Metal, wood, ceramic, cement, shingles	0.038	0.048	0.019	0.134	0.131	0.168
Land Ownership						
Member of Household owns land for farming, grazing or	0.802	0.810	0.784	0.794	0.812	0.593
Member of household uses land for farming	0.885	0.897	0.859		NA	

Figure A3.1. Wealth index distributions by asset index model. Vertical lines represent quintiles of households.



Source: Author's calculations based on 2010 Sudan Household Health Survey

Table A3.2 Correlation between wealth indices and select proxies of household economic status

	Index 1	Index 2	Index 4
Total Assets	0.7729	0.7391	0.6541
Total Livestock	-0.0962	-0.0836	-0.2536
Any Education?	0.024	0.0235	0.0208
Employed?	0.0062	0.003	0.005

Source: Author's calculations based on 2010 Sudan Household Health Survey

C. Results

Table A3.3. Determinants of Under-Five Mortality (2001-2006), South Sudan and Sudan(North) pooled

	Model 1		Model 2		Model 3	
Covariate†	Hazard Ratio	Z - score	Hazard Ratio	Z - score	Hazard Ratio	Z - score
Prim. Ed.	0.906	(-1.37)	1.032	0.43	1.023	0.3
Sec. Ed.	0.655**	(-3.16)	0.863	(-1.04)	0.901	(-0.72)
MAB	0.941*	(-2.09)	0.943*	(-2.02)	0.946	(-1.92)
MAB^2	1.002***	3.49	1.002***	3.54	1.002***	3.39
MAFB	0.947***	(-4.04)	0.946***	(-4.12)	0.945***	(-4.17)
MAFB^2	1	(-0.04)	1	-0.01	1	0.41
Male	1.173**	2.92	1.175**	2.95	1.175**	2.95
Multiple	2.273***	8.6	2.292***	8.72	2.260***	8.51
BOI 2	1.154	1.39	1.13	1.19	1.145	1.31
BOI 3	0.628***	(-4.37)	0.617***	(-4.53)	0.631***	(-4.34)
BOI 4	1.178	1.23	1.142	1	1.168	1.16
BOI 5	0.594***	(-3.77)	0.585***	(-3.91)	0.597***	(-3.73)
Urban	0.945	(-0.88)	1.094	1.35	1.113	1.5
South	0.94	(-1.05)	0.866*	(-2.43)	0.983	(-0.08)
WQ1			1.867***	5.26	1.619***	3.72
WQ2			1.775***	4.84	1.536***	3.35
WQ3			1.664***	4.55	1.452**	3.14
WQ4			1.380**	2.76	1.252	1.82
Northern					0.889	(-0.47)
River Nile					1.427	1.59
Red Sea					1.317	1.28
Kassala					0.951	(-0.22)
Gadarif					1.597*	2.36
Khartoum					*Reference*	
Gezira					0.835	(-0.75)
Sinnar					1.165	0.72
Blue Nile					1.837**	3.12
White Nile					1.138	0.61
N. Kordofan					0.979	(-0.10)
S. Kordofan					1.692**	2.64
N. Darfur					1.091	0.42
W. Darfur					1.607*	2.33
S. Darfur					1.31	1.33
Jongolei					1.187	1.05
Upper Nile					1.174	0.81
Unity					0.469***	(-3.82)
Warab					1.217	1.09
North BAG					1.278	1.53
West BAG					0.904	(-0.55)
Lakes					1.141	0.73
W.Equatoria					2.230***	4.96
C. Equatoria					1.085	0.45
E. Equatoria					Dropped	

Source: Author's calculation using 2000 Sudan Household Health Survey
Abbreviation definitions are provided n Table B5.
Notes: Significance levels correspond to the following p-values:
* p<0.05, ** p<0.01, *** p<0.001; N = 22,178

In addition to a regression pooling live birth observations from South Sudan only, a separate regression pooling data from South Sudan and Sudan (North) was used to assess the consistency of results observed in the South Sudan specific analysis (Observations from 2010 were not used as the microdata for Sudan (North) was not available at the time of writing). In the North-South pooled regression, a wealth index variable was generated on a dataset combining households in the North and South was used. The results are consistent with those presented in the body of the report and suggest that the difference in under-five mortality between South Sudan and Sudan (North) is explained by the observed differences in characteristics of births, mothers and households (economic status). All else equal, several states have child survival conditions that are significantly worse than those in Khartoum: Gadarif, Blue Nile, South Kordofan and West Equatoria.

Annex 4. Maternal and child survival strategies

A. Logistic regression to assess factors associated with disease and uptake of interventions

The following is the functional form of the logistic regression used to explore factors associated with coverage of key maternal and child interventions (y_i), where x_i represents characteristics of the mother, child or household:

$$Pr(y_i = 1|x_i) = \frac{e^{x_i'\beta}}{1 + e^{x_i'\beta}}$$

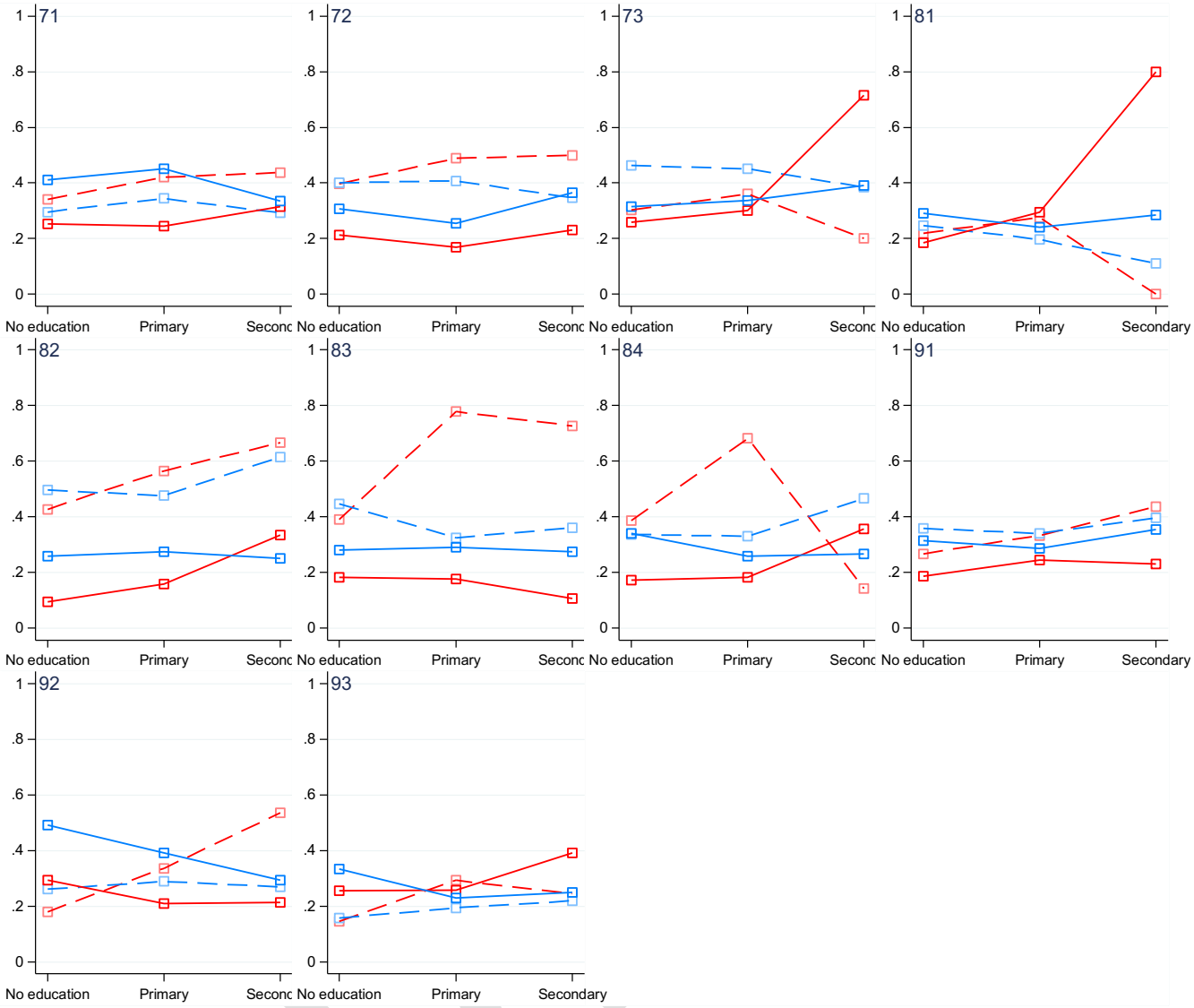
In order to compute the increase in probability of receiving an intervention associated with a marginal increase in a characteristic of the mother, child or household (for example, the increase in probability of receiving tetanus toxoid vaccine associated with an increase in mother's education from none to primary), the partial derivative is needed:

$$\frac{dy}{dx} = \beta e^{x_i'\beta}\left(1 + e^{x_i'\beta}\right)^{-2}$$

Since the marginal effect ($\frac{dy}{dx}$) varies with the value of the explanatory variables x_i, they are assessed at the average values of the explanatory variables.

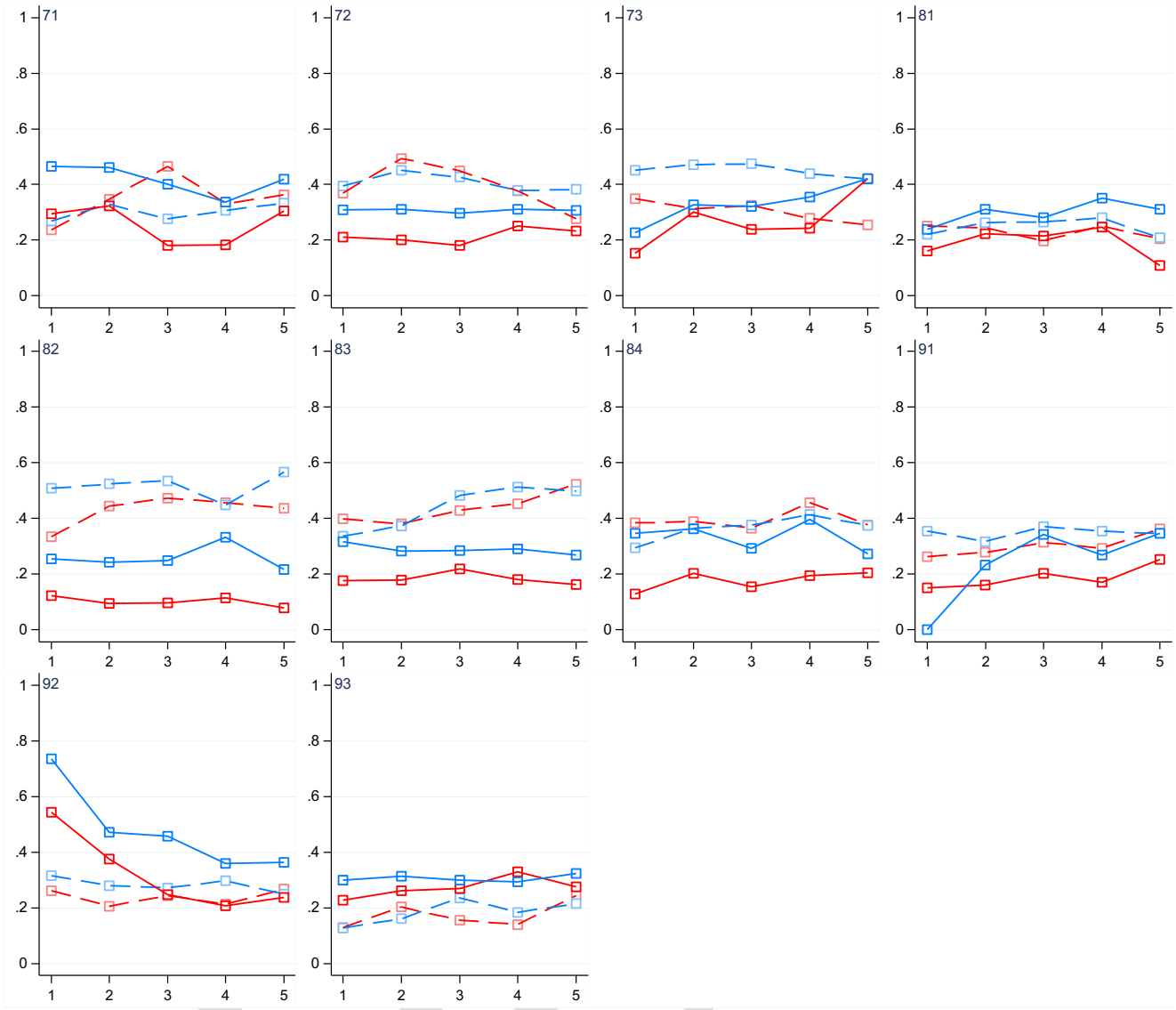
B. Non-response by wealth, education and state

Figure A4B.1. Non –response by mother's education and state



Source: Author's calculations based on 2006 and 2010 SHHS
Notes: Y-axis (percent)
State Codes: 71 = Upper Nile, 72 = Jonglei, 73 = Unity, 81 = Warrap, 82 = North Bahr El Ghazal, 83 = West Bahr El Ghazal, 84 = Lakes, 91 = West Equatoria, 92 = Central Equatoria, 93 = Eastern Equatoria

Figure A4B.2. Non –response by household wealth & state



Source: Author's calculations based on 2006 and 2010 SHHS
Notes: Y-axis (percent), X-axis (household wealth quintiles where 1 = Poorest and 5 = Richest)
State Codes: 71 = Upper Nile, 72 = Jonglei, 73 = Unity, 81 = Warrap, 82 = North Bahr El Ghazal, 83 = West Bahr El Ghazal, 84 = Lakes, 91 = West Equatoria, 92 = Central Equatoria, 93 = Eastern Equatoria