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HIV AND NUTRITION AMONG WOMEN IN SUB-SAHARAN AFRICA

DHS ANALYTICAL STUDIES 16

SEPTEMBER 2008

This publication was produced for review by the United States Agency for International Development. It was prepared by Sarah E.K. Bradley and Vinod Mishra of Macro International Inc.

MEASURE DHS assists countries worldwide in the collection and use of data to monitor and evaluate population, health, and nutrition programs. Additional information about the MEASURE DHS project can be obtained by contacting Macro International Inc., Demographic and Health Research Division, 11785 Beltsville Drive, Suite 300, Calverton, MD 20705 (telephone: 301-572-0200; fax: 301-572-0999; e-mail: reports@macrointernational.com; internet: www.measuredhs.com).

The main objectives of the MEASURE DHS project are:

- to provide decisionmakers in survey countries with information useful for informed policy choices;
- to expand the international population and health database;
- to advance survey methodology; and
- to develop in participating countries the skills and resources necessary to conduct high-quality demographic and health surveys.

DHS Analytical Studies No.16

HIV and Nutrition among Women in Sub-Saharan Africa

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September 2008

Editor: Bryant Robey
Document Production: Betty Olmeda

This study was carried out with support provided by the United States Agency for International Development (USAID) through the MEASURE DHS project (#GPO-C-00-03-00002-00). The views expressed are those of the authors and do not necessarily reflect the views of USAID or the United States Government.

Recommended citation:

Bradley, Sarah E.K., and Vinod Mishra. 2008. *HIV and Nutrition among Women in Sub-Saharan Africa.* DHS Analytical Studies No. 16. Calverton, Maryland, USA: Macro International Inc.

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Preface

One of the most significant contributions of the MEASURE DHS program is the creation of an internationally comparable body of data on the demographic and health characteristics of populations in developing countries.

The *DHS Comparative Reports* series examines these data across countries in a comparative framework. The *DHS Analytical Studies* series focuses on analysis of specific topics. The principal objectives of both series are to provide information for policy formulation at the international level and to examine individual country results in an international context.

While *Comparative Reports* are primarily descriptive, *Analytical Studies* comprise in-depth, focused studies on a variety of substantive topics. The studies are based on a variable number of data sets, depending on the topic being examined. A range of methodologies is used in these studies including multivariate statistical techniques.

The topics covered in *Analytical Studies* are selected by MEASURE DHS staff in conjunction with the U.S. Agency for International Development.

It is anticipated that the *DHS Analytical Studies* will enhance the understanding of analysts and policymakers regarding significant issues in the fields of international population and health.

Ann Way
Project Director

Acknowledgements

The authors would like to thank Rathavuth Hong for his assistance in the initial coding for the tables, Ruilin Ren for his direction and advice on pooled weights, Fred Arnold for his thoughtful edits, and Ted Greiner and Monica Kothari of PATH for their expertise and suggestions on interpreting the breastfeeding data and literature. Special thanks to Kiersten Johnson for her careful review and invaluable comments on this manuscript.

Executive Summary

Background

In the absence of antiretroviral therapy (ART), HIV-positive people will lose weight and eventually become wasted or severely underweight. However, levels of obesity and overweight seem to be increasing in several sub-Saharan African countries severely impacted by HIV and with little or no ART available. In many of these countries, HIV prevalence is higher among overweight people than those of normal or below-normal body weight.

Objectives

To better understand this apparent anomaly, this study investigates the relationship between HIV, body mass index (BMI), and hemoglobin levels (biomarker for anemia) among adult women in sub-Saharan Africa. The study also investigates the relationship between HIV, women's nutritional status, and their breastfeeding mode (exclusive, mixed, or none).

Methods

The data come from 12 nationally representative Demographic and Health Surveys (DHS) conducted between 2003 and 2006 in Burkina Faso, Cameroon, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Malawi, Niger, Rwanda, Senegal, and Zimbabwe. Because height and weight were not measured for men in the majority of surveys, this study focuses only on women. Blood samples were collected for HIV and anemia testing, following internationally accepted ethical standards and procedures. HIV and anemia test results were linked anonymously to socio-demographic and height and weight data. The study used descriptive and multivariate statistical methods to examine the relationships between HIV status and BMI, hemoglobin concentration, and breastfeeding mode. In multivariate analysis, data from all 12 countries were pooled together and sampling weights were adjusted according to the relative population sizes of the countries.

Results

HIV and BMI. HIV prevalence is highest among overweight women in 5 of the 12 countries studied, and it is highest among underweight women only in Malawi. In seven countries, the percentage of HIV-negative women who are underweight is greater than the percentage of HIV-positive women who are underweight. Similarly, in half of the countries studied the percentage of HIV-positive women who are overweight is greater than the percentage of HIV-negative women who are overweight. In pooled analysis, HIV-positive vs. HIV-negative status is significantly positively associated with being overweight, and is significantly negatively associated with being underweight. After controlling for wealth and other socio-demographic characteristics, however, the relationship reverses direction, and HIV-positive status becomes significantly positively associated with being underweight.

HIV and Anemia. HIV prevalence increases monotonically with severity of anemia for all countries except Ethiopia. In every country studied, the percentage of HIV-positive women who are anemic is much larger than the percentage of HIV-negative women who are anemic. In pooled analysis, HIV-positive status is significantly negatively associated with hemoglobin concentration, and the relationship grows stronger when background characteristics and BMI are controlled for.

HIV, Nutrition, and Breastfeeding. Only limited data are available on women's breastfeeding mode by HIV status, due to the small number of women who are HIV-positive and who have children less than six months old at the time of interview. In pooled multivariate models, however, there does not appear to be

any negative impact of breastfeeding on the nutritional status of HIV-positive mothers compared with non-breastfeeding HIV-negative mothers. In fact, HIV-positive women who exclusively breastfeed their infants have slightly higher hemoglobin concentrations than HIV-negative women who do not breastfeed, after controlling for BMI and background characteristics.

Conclusions

HIV is independently associated with poorer nutritional status—particularly low hemoglobin concentration—after controlling for household wealth and other socio-demographic characteristics of the women studied. This study therefore provides evidence to support increasing food security and providing nutritional supplementation to HIV-positive people. At the same time, this study shows that in bivariate analysis HIV is concentrated among overweight women in several sub-Saharan African countries, emphasizing the fact that HIV does not affect only those who "look sick" or appear malnourished. Implications for the general public include both an emphasis for everyone to get tested regardless of how healthy they may look, and for individuals to remember to use protection with every partner even if they appear healthy. Counselors should encourage people to be tested for HIV regardless of their current BMI, and they should consider that clients could be HIV-positive even if they appear overweight.

If past trends continue, the proportion of people in sub-Saharan Africa who are either overweight or underweight will grow. This dual burden has particular implications for ART, which is becoming more widely available as many countries work towards scale-up. To address potential problems with ART use in overweight and underweight patients, clinicians should consider their patient's nutritional status, including titrating drug combinations to patient's body weights when possible to limit adverse effects due to nutritional differences.

1

Introduction

In 1985 the first case of HIV was reported as "slim disease" (Serwadda et al. 1985). In the absence of ART, the natural history of AIDS indicates that people will lose weight and eventually become wasted or severely underweight (WHO 2007a; Mindel and Tenant-Flowers 2001). However, overweight and obesity levels have been increasing in several sub-Saharan African countries (Amuna and Zotor 2008; Villamor et al. 2006; Prentice 2006; Mendez et al. 2005). These countries have been severely impacted by HIV infection and have had little or no ART until recently. In many of these countries, HIV prevalence is higher among overweight people than people of normal or below-normal body weight.

For example, in Cameroon, at the same time that the AIDS epidemic appears to have been growing, the percentage of obese women has more than doubled, from 3.7 percent in 1998 to 8 percent in 2004. The proportion of women in Cameroon who are overweight also increased from 21.9 percent in 1998 to 29.5 percent in 2004 (CDHS data, 1998 and 2004). Cameroon is a high-prevalence country with over 6 percent of women estimated to be HIV-positive (CDHS 2004), while only 8 percent of adults who need access to ART received treatment in 2003 (UNAIDS/WHO 2006).

To better understand the apparent anomaly of increasing rates of obesity and overweight in high HIV prevalence countries, this study investigates the relationship between HIV, body mass index (BMI), and hemoglobin levels of adult women in sub-Saharan Africa. The study also investigates the relationship between HIV, women's nutritional status, and their breastfeeding mode (exclusive, mixed, or none).

1.1 Background

Though there is a great deal of literature on undernutrition and HIV, few studies have addressed HIV and overweight in the sub-Saharan African context. HIV appears to be at least as common among adults from wealthier households as poorer in several sub-Saharan African countries (Mishra et al. 2007). As increased BMI and wealth are directly and positively associated, an increase in the proportion of adults who are both overweight and HIV-positive follows logically.

At the same time that the prevalence of overweight is increasing in many sub-Saharan countries, the proportion of people who are underweight or wasted does not appear to be dramatically decreasing (Villamor et al. 2006). This experience is common in many developing or transitional countries, in which obesity and related non-communicable diseases are on the rise, coexisting with undernutrition, malnutrition, and related infectious diseases (Prentice 2006; Singh et al. 2007). This experience is often referred to as the dual burden of undernutrition and overnutrition. Even though the "dual burden" is affecting an increasing number of sub-Saharan African countries, we were not able to find any studies directly describing the relationship between HIV and overweight in a sub-Saharan context.

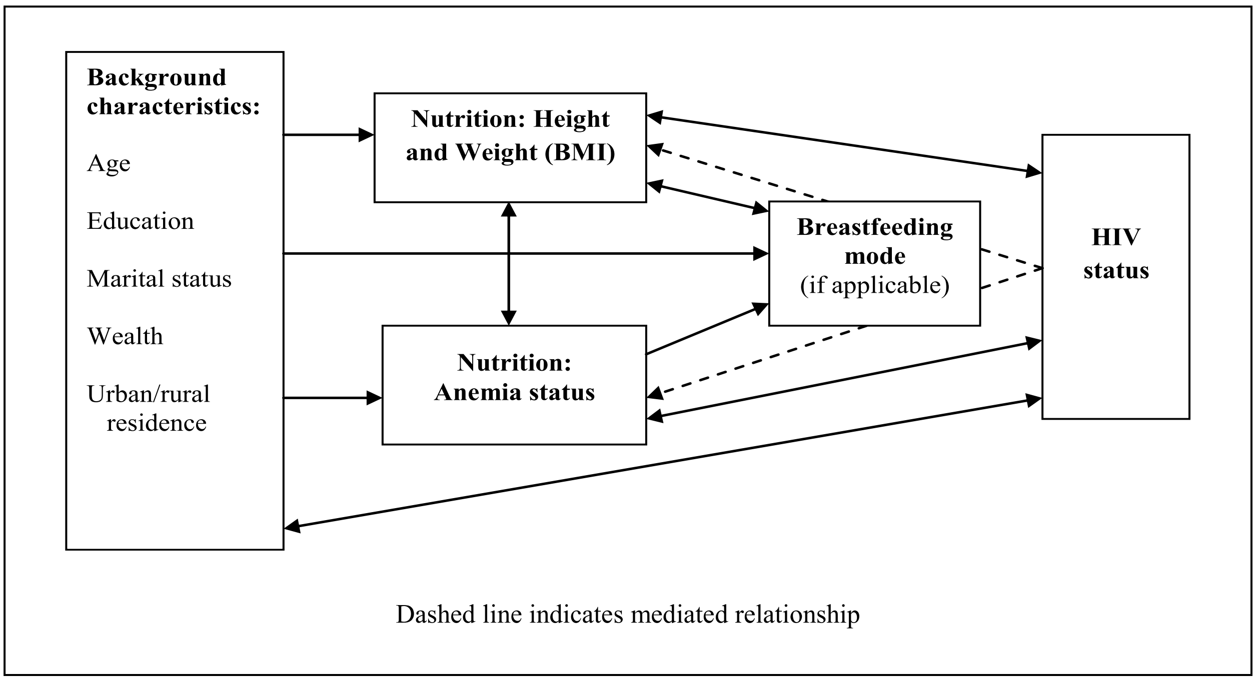
1.2 Conceptual Framework

The relationship between HIV and nutrition is likely bi-directional. HIV can lead to or exacerbate food insecurity, as more resources are spent on healthcare, and can also negatively impact income as people become too ill to work, or are stigmatized in the community or workplace. Conversely, HIV can spread faster when poor people "are forced to adopt ever more risky food provisioning strategies" (Gillespie and Kadiyala, 2005:vii).

There are notable gender differences in the relationship between food security and HIV susceptibility. Recent evidence from Swaziland and Botswana demonstrates strong relationships between a lack of food over the last 12 months and an increase in sexual risk-taking among women, though not among men. These risks include having sex without using condoms, intergenerational sex, and exchanging sex for goods or money (Weiser et al. 2007). A Tanzanian study found women with lower levels of education or who are unable to contribute to the household income appear most at risk for wasting associated with HIV (Villamor et al. 2002).

In addition to food insecurity increasing risk behaviors associated with HIV transmission, malnutrition likely also directly increases physical susceptibility to many types of infection including HIV, though limited data are available to study this relationship. In a study of sexually active women in Rwanda, weight loss among HIV-negative women was a strong predictor of seroconversion during the 24-month study period. This finding suggests that malnutrition can increase women's risk of contracting HIV (Moore et al. 1993).

Figure 1 Conceptual framework for examining the relationship between HIV and nutritional status in adult women



1.3 Approaches to Studying Nutrition and HIV

Nutrition can be studied in several ways. In this study we examine undernutrition in terms of body mass index (BMI), which is calculated as a person's weight in kilograms divided by the square of their height in meters. The World Health Organization (WHO) has established international cutoffs for BMI: under 18.50 is classified as underweight; 18.50-24.99 is the normal BMI range, and 25 or over is classified as overweight (WHO 2007b). People who are underweight are considered to suffer from chronic energy deficiency (CED) (WHO 1995), and are often referred to as malnourished or undernourished.[1] WHO also

[1] BMI of less than 18.5 in HIV-positive people is also used in the WHO criteria for determining HIV Wasting Syndrome, at clinical stage 4. The preferred measure of this indicator is unexplained weight loss of >10 percent of the person's initial body weight, but the BMI cutoff can be used in combination with other measures to determine wasting syndrome when initial body weight is not available (WHO 2007a).

categorizes people with BMIs between 25 and 29.99 as "pre-obese," and those with BMIs of 30 and above as obese.

Weight loss among patients who report they are not trying to lose weight is common among HIV-positive people. Such weight losses are of great concern, as even a 5 percent weight loss over 4-6 months markedly increases the risk of opportunistic infections and death (Tang et al. 2005; Wheeler et al. 1998). In addition to weight loss, initial lower BMI of HIV-positive people appears to be associated with an increased risk of contracting other infections and hastening disease progression. In Malawi, for example, low BMI was predictive of early death due to tuberculosis (TB), and the mortality risk increased with the patient's degree of undernutrition (Zachariah et al. 2002). Undernutrition was associated with an elevated risk of the person developing TB in Tanzania (Venkatesh et al. 2005), and lower BMI was associated with increasing severity of pulmonary TB and higher plasma HIV load in another Malawi study (van Lettow et al. 2004a and 2004b).

In contrast, higher BMI and weight gain appear to be protective against AIDS-related disease progression and mortality. Higher BMI among HIV-positive people at study enrollment was associated with a significantly longer lifespan compared with HIV-positive people with lower BMIs, after controlling for baseline CD4 count in the Gambia (van der Sande et al. 2004) and rural Malawi (Zachariah et al. 2006). Higher BMI, either at study enrollment or through weight gain during the observation period, was consistently associated with slower disease progression and lower mortality even at obese BMIs after controlling for prior CD4 count, viral load, and treatment in a large developed country prospective study (Jones et al. 2003). The protective effect of higher BMI remained even when baseline CD4 counts and time to ART initiation were similar in a US study (Shuter et al. 2001).

Higher BMI may not necessarily be good for all HIV-positive women, however. A recent study in Zambia found the likelihood of mother-to-child HIV transmission to increase with higher maternal BMI (Banda et al. 2007), but these findings have yet to be replicated.

While low BMI denotes chronic energy deficiency, representing a nutritional status likely accumulated over a period of years, anemia—measured in hemoglobin concentration—can be used to directly assess a woman's current nutritional status. Anemia is characterized by a reduction in the absolute volume of red blood cells, most commonly caused by iron deficiency. Anemia in the general population is associated with impairment of cognitive development, compromised immune function (directly associated with increased morbidity and mortality), and decreased capacity for physical labor. Pregnant women are especially susceptible to anemia, with multiple adverse outcomes for both mother and infant, including increased risk of hemorrhage, sepsis, maternal mortality, perinatal mortality, and low birth weight. Levels of anemia are classified as severe, moderate, or mild based on the hemoglobin concentration in the blood and according to criteria developed by WHO. Severe anemia is defined as a hemoglobin concentration less than 7.0 grams per deciliter of blood; moderate anemia when the hemoglobin concentration is 7.0 to 9.9 g/dl; and mild anemia when the hemoglobin concentration is 10.0 to 11.9 g/dl (10.0 to 10.9 for pregnant women) (Macro International 2007a).

Similar to undernutrition, anemia presents further complications for people with HIV. In Tanzania anemia was found to be a strong independent predictor of disease progression and mortality among a cohort of HIV-positive women (O'Brien et al. 2005). A Thai study found the median survival time of HIV-positive men decreased dramatically with lower initial BMI or with anemia, and decreased further when both factors were present (Costello et al. 2005). Anemia has also been found to be negatively associated with BMI. In Tanzania, higher levels of anemia were found among adults with lower BMIs, particularly among people who are HIV-positive (Antelman et al. 2000; Massawe et al. 2002). Lower BMI at treatment initiation was a predictor of development of severe anemia among a treatment-naïve symptomatic HIV-positive cohort of adults in Uganda after controlling for clinical HIV stage and baseline laboratory measurements (Ssali et al. 2006).

Together with studying BMI and anemia, a third way to examine the association between HIV and women's nutritional status is through an analysis of breastfeeding modes—whether a mother exclusively breastfeeds, combines breast milk with other foods/liquids, or does not breastfeed her child.[2] The issue of whether or not breastfeeding is harmful for HIV-positive mothers, either nutritionally and/or by speeding disease progression, is hotly contested. A 2001 study randomized HIV-positive mothers in Nairobi to either breastfeed or formula feed their infants. Disease progression and mortality was found to be significantly higher among breastfeeding mothers (Nduati et al. 2001), although these results have been questioned (see Aleem et al. 2001 and Newell 2001). Subsequent studies have found no association between breastfeeding and higher mortality or morbidity among HIV-positive mothers (Sedgh et al. 2004; Taha et al. 2006).

Two South African studies, however, have found links between breastfeeding and decreased maternal nutritional status among HIV-positive mothers, including faster decreases in weight compared with formula-feeding HIV-positive mothers (Papathakis et al. 2006), and higher levels of anemia and other vitamin deficiencies compared with HIV-negative breastfeeding mothers (Papathakis et al. 2007). Most recently, the Nduati team in Kenya (Otieno et al. 2007) released another study which found that breastfeeding was not associated with a significant compromise in maternal health, provided that maternal HIV care was available. The study found statistically significant decreases in both CD4 counts and BMI among HIV-positive breastfeeding mothers compared with formula-feeding mothers. The decreases in CD4 counts did not have clinical implications for the mothers, however, and the authors concluded that any adverse impact of breastfeeding was limited by mothers' access to ART.

As shown in the conceptual framework (Figure 1), this paper explores the complex relationship between HIV and nutritional status, as measured by BMI and anemia. We then explore the impact that background characteristics have on the nutrition-HIV relationship. The potentially mediated relationships between breastfeeding practice, HIV, and BMI, and breastfeeding practice, HIV, and anemia are also described. Finally, we use multivariate models to assess the independent effect of HIV on BMI and anemia, and explore whether breastfeeding has a different impact on the nutritional status of HIV-negative vs. HIV-positive women.

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[2] WHO recommends that HIV-positive mothers do not breastfeed, but rather use infant formula, animal milk, or other breastmilk replacement when circumstances allow. These circumstances include access to a consistent supply of animal milk or formula, clean water, and sterile feeding utensils. When replacement feeding is not "acceptable, feasible, affordable, sustainable and safe," WHO recommends that mothers exclusively breastfeed their babies. Mothers should exclusively breastfeed for the "first months of life," and then transition to replacement feeding around six months of age (WHO 2001). Mixed feeding—feeding an infant breastmilk and other liquids and/or solids—is associated with a higher risk of mother-to-child transmission (MTCT) (Iliff et al. 2005) and is thus discouraged. For HIV-negative women, however, the risk of MTCT does not exist. For HIV-negative women who do not wish to exclusively breastfeed, WHO recommends any breastfeeding—including mixed feeding—as better than no breastfeeding (WHO 2007c).

Several studies suggest that the WHO recommendations for HIV-positive women are problematic to implement in sub-Saharan Africa. Non-exclusive breastfeeding is the norm in many sub-Saharan countries (Becquet et al. 2005; de Paoli 2001; Yeo et al. 2005). Women who choose not to breastfeed at all may be stigmatized, as others may assume they are HIV-positive (Abiona et al. 2006; Doherty et al. 2006; Eide et al. 2006; Muko et al. 2004). HIV-positive women who choose not to breastfeed often do not have the resources necessary for safe replacement feeding (Bland et al. 2007). Infants may be protected from MTCT only to become ill or die from gastrointestinal and other diseases (Simpore et al. 2006). Finally, even when women know about the risks of MTCT through breastfeeding, this knowledge may not translate into changes in breastfeeding practice (de Paoli et al. 2001), even when the mothers know they are HIV-positive (Omari et al. 2003).

2

Data and Methods

2.1 Data

In this study we analyzed data from 12 sub-Saharan African national surveys with linked HIV test results: Burkina Faso, Cameroon, Ethiopia, Ghana, Guinea, Kenya, Lesotho, Malawi, Niger, Rwanda, Senegal, and Zimbabwe. All surveys were conducted between 2003 and 2006. Because height and weight were not measured for men in the majority of surveys, this study focuses only on women. The target for HIV testing for women in all surveys was nationally-representative samples of women age 15-49. The sampling design and implementation procedures for each country are described in detail in each of the country reports (INSD et ORC Macro 2004; INS et ORC Macro 2004; Central Statistical Agency and ORC Macro 2006; GSS, NMIMR, and ORC Macro 2004; DNS et ORC Macro 2006; CBS, MOH, and ORC Macro 2004; MOHSW, BOS, and ORC Macro 2005; NSO and ORC Macro 2005; INS et Macro International Inc. 2007; INSR and ORC Macro 2006; Ndiaye and Ayad 2006; CSO and Macro International Inc. 2007).

Capillary blood from a finger prick was collected for HIV and anemia testing. Participation in both tests was voluntary and before collecting blood samples each selected participant was asked to provide informed consent to the testing. Informed consent was obtained separately for the questionnaire interview. For anemia testing, hemoglobin levels were determined on-site using a battery-operated photometer (Macro International 2007a). Though anemia can be brought on by malaria or other factors not directly associated with food intake, the data do not provide enough information to establish whether anemia was attributable to malaria, malnutrition, or a combination of factors. In this analysis we have therefore treated all anemia the same and used it as an indicator of malnutrition.

For HIV testing, blood was collected on filter paper, sent to a central laboratory in each country, and tested by following a standard testing algorithm. The algorithm was designed to maximize the sensitivity and specificity of HIV test results, and followed an approved quality assurance and quality control plan (Macro International 2007b). The testing algorithm used two HIV enzyme immunosorbent assays (EIA) based on different antigens. All discordant samples that were positive on the first test and negative on the second test were retested with the same EIAs, and if still discordant, were resolved by Western blot testing. These steps were also repeated for 5-10 percent of randomly selected samples that tested negative on the first test. For external quality assessment, a subset of dried blood spot samples, usually about 5 percent, was retested at an outside reference laboratory using the same algorithm.

In order to ensure confidentiality, the HIV test results were anonymously linked to individual and household questionnaire information through bar codes after scrambling the household and cluster identifiers (Macro International 2007b). All HIV testing procedures were reviewed by the ethical review boards of Macro International (a U.S.-based company that provides technical assistance to DHS surveys around the world), the host country, and (as applicable) other implementing partners. Cameroon, Guinea, Niger, and Senegal tested for HIV-1 and HIV-2 separately. In this analysis we have not differentiated between HIV subtypes and treat anyone who tested positive for either HIV-1 or -2 as simply HIV-positive.

Table 1 shows the total population of each country included in the analysis at the midpoint of the year when the survey was conducted and the HIV testing response rate. Table 1 also shows the unweighted base population of women used in the following analyses, including the number of women who were tested for HIV and had height and weight collected; were tested for anemia; and who have a child less than six months old who is living with them. All analyses only include de facto resident women (women who stayed in the household of interview the previous night).

2.2 Methods

DHS surveys collect data from nationally-representative probability samples, often over-sampling certain categories of respondents. Because the samples are not self-weighting and because response rates vary across sampling domains, weights are used to obtain nationally-representative estimates.

Beyond the standard weighting, to deal with variations in non-response rates for HIV testing the DHS generates a separate weight for the sample of respondents who participate in HIV testing. These weights are constructed separately for men and women and are adjusted for non-response by sampling strata to develop nationally-representative HIV prevalence estimates that attempt to account for non-response on HIV testing.[3] These HIV sampling weights are used in all of the bivariate tables below that show data disaggregated by country. Only data from women tested for HIV are included in this study, so results presented in the tables will not match the majority of tables in DHS final reports.

In tables where pooled data are shown, data from the following countries have been combined for regional estimates: Burkina Faso, Cameroon, Ghana, Guinea, Niger, and Senegal for West Africa; Ethiopia, Kenya, and Rwanda for East Africa; and Lesotho, Malawi, and Zimbabwe for Southern Africa. For pooled estimates, data are weighted both by the HIV sample weight and the population of the country proportional to the rest of the pooled sample (region or total). Care should be taken not to interpret pooled estimates as representative of all countries in a region. Only the countries with available data were included in the pooled analyses, and the pooled results represent weighted results for those countries only. Pooled weights were calculated using the midyear total population for the year of the survey (Table 1). For surveys that spanned the years 2005-2006, the midyear population for 2005 was used.

HIV sampling weights were applied to all analyses. Standard errors were adjusted for sample clustering.

[3] HIV sampling weights only partially address non-response bias. Estimates of predicted HIV prevalence among those who were not tested (based on demographic characteristics) are almost always higher than observed prevalence. However, because the number of respondents who do not participate in HIV testing is small relative to those who do participate, the overall effects of non-response on observed national prevalence estimates have been found to be insignificant (see Mishra et al. 2008 for further discussion of non-response to HIV testing in DHS surveys).

Table 1 Total midyear population of survey reference year, women's HIV testing response rate and HIV prevalence, number of interviewed de facto resident women tested for HIV, with anthropometric data, tested for anemia, and who live with their last-born child who is less than 6 months old. Unweighted and weighted with HIV survey weights.

Country/year	Midyear total population[1]	HIV response rate	HIV prevalence among women tested and inter-viewed	Number tested for HIV and interviewed		Number with anthropometric data, interviewed and tested for HIV		Number interviewed and tested for anemia and HIV		Number interviewed and tested for HIV, living with last-born child <6 months old	
				Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted
Burkina Faso 2003	12,705,775	92.3	1.8	4,086	4,189	4,045	4,150	4,055	4,164	345	337
Cameroon 2004	16,872,750	92.1	6.6	5,126	5,154	5,025	5,053	5,096	5,129	378	378
Ethiopia 2005	73,053,286	83.4	1.9	5,736	5,942	5,693	5,884	5,689	5,860	486	439
Ghana 2003	21,111,483	89.3	2.7	5,089	5,289	4,889	5,111	5,002	5,195	279	316
Guinea 2005	9,452,670	92.5	1.9	3,737	3,842	3,696	3,807	3,715	3,820	355	350
Kenya 2003	33,041,785	76.3	8.7	3,148	3,271	3,044	3,169	n/a	n/a	226	241
Lesotho 2004	2,113,646	80.7	26.4	3,018	3,020	2,985	2,991	2,975	2,972	167	180
Malawi 2004	12,677,210	70.4	13.3	2,686	2,864	2,643	2,834	2,437	2,610	254	276
Niger 2005/06	12,162,856	90.7	0.7	4,406	4,441	4,381	4,409	4,197	4,238	489	447
Rwanda 2005	9,378,226	97.3	3.6	5,641	5,663	5,586	5,607	5,614	5,635	437	439
Senegal 2005	11,860,429	84.5	0.9	4,229	4,465	4,192	4,430	4,123	4,332	342	370
Zimbabwe 2005/06	12,160,782	75.9	21.1	6,947	7,494	6,842	7,391	6,947	7,494	401	454

[1] US Census Bureau IDB
n/a = not available

The Relationship between BMI and HIV Serostatus, and BMI and Anemia

To examine the proportions of women who were underweight or overweight and the relationship between BMI and HIV status, crosstabulations are presented by country. In all tables that include BMI, women who were currently pregnant or who gave birth in the two months preceding the interview have been excluded unless otherwise noted. Pooled data are used to assess the distribution of BMI and HIV prevalence by background characteristics, including age, education, marital status,[4] relative wealth,[5] and whether the respondent is in a rural or urban area.

To model the association between HIV and BMI, several types of models were considered. Because the relationship between BMI and HIV is not linear (HIV prevalence is more concentrated among the underweight and overweight than women of normal weight: see Table 4), we investigated logistic regression models. A maximum-likelihood ordered logit estimation model was fitted, but the data violated the assumption of proportional odds. A maximum-likelihood multinomial logistic regression model is therefore used to measure the independent relationship between HIV and BMI after controlling for underlying socio-demographic factors. Univariate and multivariate models are presented, using pooled data.

The same series of crosstabulations with BMI are presented with anemia data, both by country and using pooled data. Because the Kenya DHS did not test for anemia, Kenya is excluded from all analyses that include anemia data. Pooled analyses that exclude Kenya are re-weighted based on the 11 remaining countries.

The relationship between HIV and hemoglobin concentration appears to be linear—that is, as HIV prevalence increases, hemoglobin concentration decreases. A linear model is therefore used to examine the impact of HIV on hemoglobin concentration as a continuous variable, controlling again for BMI and background characteristics.

The Relationship between Breastfeeding and HIV Serostatus

Women's breastfeeding mode (exclusive, mixed, or no breastfeeding) is determined by respondents' recall of everything their infant had to eat or drink in the day and night before the survey. Breastfeeding mode is tabulated only for women whose infants are currently living with them. Women whose youngest child living with them is 3+ years old but are still breastfeeding are assumed to be mixed feeding. Data are presented by region (pooled data), age of the child, and breastfeeding mode disaggregated by HIV status of the mother. To evaluate the relationships between HIV, breastfeeding, and nutritional status, tables are presented on the type of breastfeeding and anemia status, and the type of breastfeeding and BMI, both disaggregated by HIV status. Finally, breastfeeding mode is included in the BMI and hemoglobin concentration multivariate models. To determine whether breastfeeding mode has a

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[4] Women's marital status in this analysis is categorized as never married, currently married or in union, or widowed/divorced/separated. Currently married women are further divided into monogamous or polygynous unions, with the exception of Lesotho, where respondents were not asked if their relationship was polygamous. All women currently in union in Lesotho were therefore coded as in a monogamous union.

[5] DHS surveys do not collect direct information on income or wealth, but collect information on household ownership of durable goods and amenities that tend to be correlated with household wealth status. For each DHS survey, a "wealth index" made up of these survey items is constructed using principal component analysis, placing households on a continuous scale of wealth within a given country. The wealth index is divided into population quintiles, with the lowest quintile representing the poorest 20 percent of the population, and the highest quintile representing the wealthiest 20 percent within each country. For further details on the wealth index, see Rutstein and Johnson 2004.

differential effect on HIV-positive vs. HIV-negative women's nutritional status, breastfeeding mode is modeled as an interaction term with HIV status.

2.3 Limitations

There are several limitations that should be kept in mind when interpreting the results presented below.

The primary limitation is that the data the DHS collect are cross-sectional, not longitudinal. In this study we are not able to ascertain when women contracted HIV nor their nutritional status when they seroconverted. We therefore cannot determine whether any differences we see in nutritional status between HIV-positive and HIV-negative women are a result of HIV; whether these health differences were present before seroconversion; or if poor nutritional status made women more susceptible to infection.

DHS surveys do not include women who are no longer living. Though this limitation is unavoidable, it should be kept in mind as a possible reason we do not see more HIV-positive women who are underweight. As several studies have found a link between lower BMI and higher mortality risk for HIV-positive people, it is possible that HIV-positive women who were underweight died at a faster rate than HIV-positive women who have normal or higher BMIs.

We also do not have any direct measure of general health of the women interviewed. Half of the countries studied asked whether the respondent was "chronically ill" for more than three months in the past year.[6] Because this question was not standard, results are not directly comparable across countries. Because of these limitations, we did not use the measure and therefore are unable to assess whether, for example, women who did not breastfeed their infants were too ill to do so.

Use of ART could lead to lipodystrophy and increases in BMI among ART users. To examine the possible confounding relationship ART could have on nutritional status, we ran crosstabulations of HIV-positive women's BMI and anemia status by a proxy measure of awareness of status among HIV-positive women. For ethical reasons, the DHS does not ask directly about people's HIV status or if they are using ART. Under the assumption that women must be aware of their status in order to be using ART, we examine awareness of HIV status as a necessary precondition to ART use. The best measure the DHS collects on awareness of status is whether women have been tested for HIV and received their results in the last 12 months preceding the interview. Using a wider potential definition of awareness of status, we also present these crosstabulations by women's lifetime experience of testing and receiving their HIV test results. Though these measures are far from perfect, they do offer an approximation of the percentage of women whose BMI could be affected by ART or other changes (e.g. changes in eating habits to deflect speculation about their HIV status; see Bentley et al. 2005) upon learning their status.

As shown in Annex 7, only 7-10 percent of HIV-positive women know their status, as measured by testing and receiving results in the last year (before DHS testing). An additional 10-15 percent have ever been tested and received their results, but not within the year before the survey. As few women in this sample are aware of their status; as ART was not widely available when these surveys were conducted; and as only slight differences in nutritional status are seen by awareness of HIV status, we conclude that ART does not appear to be a factor in this study. It is possible, however, that we do not adequately assess HIV-positive women's exposure to ART, which could significantly alter the relationship between HIV and nutritional status.

[6] Cameroon, Malawi, Niger, Rwanda, Senegal, and Zimbabwe.

The methodology to compute the pooled sampling weights should be taken into account when interpreting pooled results. Because data pooling is based on the country's population size, results from some countries have greater impact on the pooled results than others. For example, because Ethiopia's population is more than twice the size of Kenya's, and almost eight times the size of Rwanda's (see Table 1), data from Ethiopia exert much more weight on the East African pooled data than the other two countries. Therefore, East African pooled data in bivariate analyses should be interpreted as more closely reflecting the situation in Ethiopia than in Kenya or Rwanda. This statement also applies to the total pooled data—because the populations of Ethiopia, Kenya, and Ghana are much larger than the others, data from these countries exert more weight on the total pooled estimates than the smaller countries do.

Small sample sizes are a problem in a few of our analyses, particularly within groups of HIV-positive breastfeeding mothers. The proportion of women who have been tested for HIV, who gave birth in the previous six months before the survey, and who live with their children (child is still living and does not live away from the mother) in each country is small. Particularly in lower-prevalence countries, the number of HIV-positive women sampled who meet all these criteria is even smaller. Data had to be pooled for these analyses to be interpretable, and pooling may hide national or regional-level variations. Additionally, results based on particularly small numbers of unweighted cases have been marked and should be interpreted with care.

3

Results

3.1 Descriptive Results

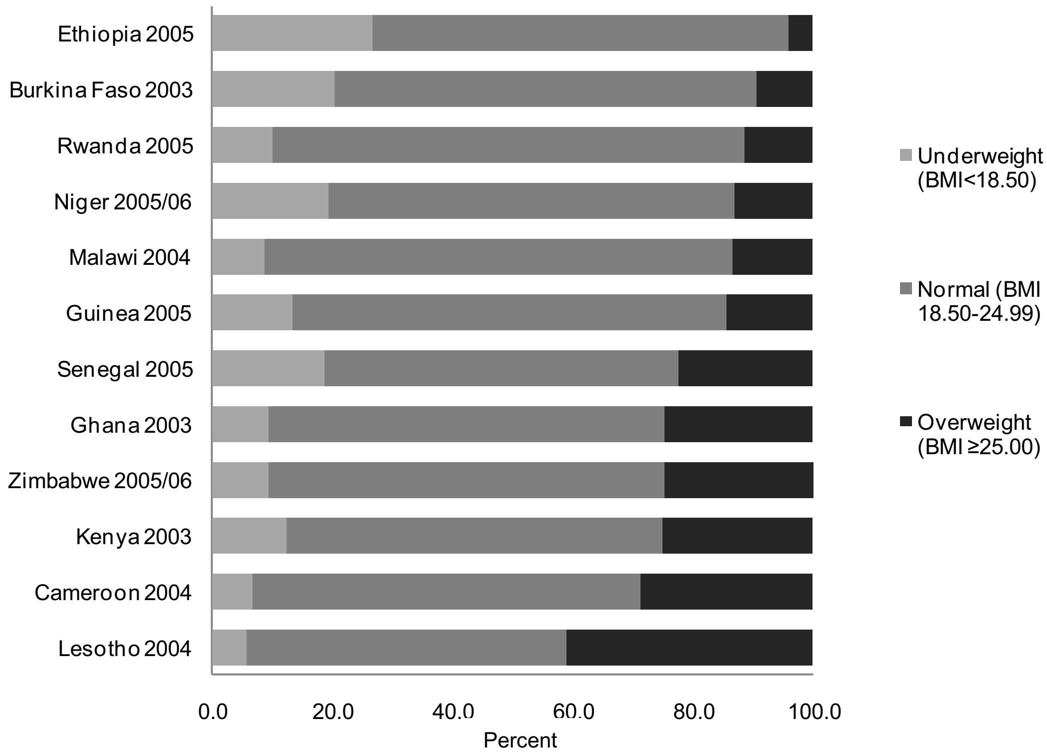
Relationship between HIV and BMI

Among the 12 countries studied here (Table 2 and Figure 2), the proportion of women who are overweight in this sample of women tested for HIV is greatest in Lesotho, at 41 percent, and Cameroon, at 29 percent. In Ghana, Kenya, and Zimbabwe one-quarter of women in this sample also are overweight. The prevalence of undernutrition, or BMI below 18.50, is highest in Ethiopia, at over 25 percent, and is also widespread in Burkina Faso, Niger, and Senegal, where approximately 20 percent of women are underweight. Along with Lesotho, Senegal is the only country where less than 60 percent of the women in this sample are of normal weight. Unlike Lesotho, however, where this anomaly is due solely to the large number of women who are overweight, in Senegal there appears to be a double burden of undernutrition and overnutrition at the same time. A version of Table 2 using expanded BMI categories can be found in Annex 1.

Table 2 Percent distribution of women age 15-49 tested for HIV (excluding women who were currently pregnant or had a birth in last 2 months) by BMI status, DHS surveys with linked HIV testing

	BMI (kg/m^2)				
Country/year	<18.50	18.50-24.99	≥25.00	Total	n
West Africa					
Burkina Faso 2003	20.5	70.1	9.4	100.0	3,446
Cameroon 2004	6.8	64.3	28.9	100.0	4,325
Ghana 2003	9.5	65.7	24.8	100.0	4,389
Guinea 2005	13.5	71.9	14.6	100.0	3,147
Niger 2005/06	19.2	67.7	13.0	100.0	3,503
Senegal 2005	18.6	59.1	22.2	100.0	3,710
East Africa					
Ethiopia 2005	26.7	69.0	4.3	100.0	4,965
Kenya 2003	12.2	62.8	24.9	100.0	2,728
Rwanda 2005	9.9	78.5	11.6	100.0	4,942
Southern Africa					
Lesotho 2004	5.7	53.4	40.9	100.0	2,706
Malawi 2004	8.6	77.8	13.6	100.0	2,152
Zimbabwe 2005/06	9.4	65.8	24.9	100.0	6,190

Figure 2 Distribution of BMI by country*



*Excluding women currently pregnant or who had a birth in past 2 months

Table 3 and Figure 3 show that in 6 of the 12 countries studied and in all pooled analyses, the percentage of women who are overweight is higher among HIV-positive women than among HIV-negative women. Additionally, in 7 countries the percentage of women who are underweight is higher among HIV-negative than among HIV-positive women. In Guinea, Ethiopia, and Malawi, however, HIV-positive women are far more likely to be underweight than their HIV-negative counterparts. A version of Table 3 using expanded BMI categories can be found in Annex 2.

Table 3 Distribution of HIV-positive and HIV-negative women age 15-49 (excluding women who were pregnant or had a birth in last 2 months) by BMI status, DHS surveys with linked HIV testing

			BMI (kg/m^2)			
Country/year	HIV status		<18.50	18.50-24.99	≥25.00	Total
West Africa						
Burkina Faso 2003	Positive	%	21.2	67.3	11.5	100.0
		n	13	42	7	63
	Negative	%	20.5	70.2	9.3	100.0
		n	692	2,374	316	3,383
Cameroon 2004	Positive	%	4.7	67.5	27.8	100.0
		n	13	188	78	279
	Negative	%	7.0	64.1	29.0	100.0
		n	282	2,593	1,171	4,046
Ghana 2003	Positive	%	6.8	69.4	23.8	100.0
		n	8	84	29	120
	Negative	%	9.5	65.6	24.9	100.0
		n	408	2,799	1,062	4,269
Guinea 2005	Positive	%	19.0	54.8	26.2	100.0
		n	13	37	18	67
	Negative	%	13.4	72.2	14.4	100.0
		n	412	2,225	443	3,080
Niger 2005/06	Positive	%	6.3	69.6	24.1	100.0
		n	2	18	6	26
	Negative	%	19.3	67.7	12.9	100.0
		n	672	2,356	450	3,478
Senegal 2005	Positive	%	11.6	70.4	18.0	100.0
		n	3	21	5	29
	Negative	%	18.7	59.0	22.3	100.0
		n	688	2,173	820	3,681
Total (West Africa-pooled data)	Positive	%	8.5	67.0	24.5	100.0
		n	52	414	151	617
	Negative	%	13.8	66.1	20.1	100.0
		n	3,037	14,505	4,404	21,946
East Africa						
Ethiopia 2005	Positive	%	35.2	58.4	6.3	100.0
		n	34	57	6	97
	Negative	%	26.6	69.2	4.2	100.0
		n	1,294	3,369	205	4,868
Kenya 2003	Positive	%	7.2	68.7	24.1	100.0
		n	17	162	57	236
	Negative	%	12.7	62.3	25.0	100.0
		n	317	1,552	623	2,491
Rwanda 2005	Positive	%	8.7	75.6	15.7	100.0
		n	16	141	29	186
	Negative	%	10.0	78.6	11.4	100.0
		n	475	3,738	543	4,756
Total (East Africa-pooled data)	Positive	%	15.9	66.1	18.0	100.0
		n	80	331	90	501
	Negative	%	21.4	68.1	10.5	100.0
		n	2,563	8,154	1,251	11,967
Southern Africa						
Lesotho 2004	Positive	%	5.3	53.7	40.9	100.0
		n	38	388	295	722
	Negative	%	5.8	53.3	40.9	100.0
		n	115	1,057	812	1,985
Malawi 2004	Positive	%	11.7	73.8	14.5	100.0
		n	36	225	44	304
	Negative	%	8.1	78.4	13.5	100.0
		n	149	1,449	249	1,847

Continued…

Table 3—*Continued*

Country/year	HIV status		BMI (kg/m²) <18.50	18.50-24.99	≥25.00	Total
Zimbabwe 2005/06	Positive	%	9.4	68.8	21.8	100.0
		n	124	906	287	1,318
	Negative	%	9.4	64.9	25.7	100.0
		n	456	3,164	1,252	4,872
Total (Southern Africa-pooled data)	Positive	%	9.7	68.6	21.7	100.0
		n	192	1,359	431	1,981
	Negative	%	8.5	70.3	21.2	100.0
		n	734	6,100	1,838	8,673
Total (All countries-pooled data)	Positive	%	11.9	67.3	20.8	100.0
		n	287	1,615	499	2,401
	Negative	%	17.3	67.6	15.2	100.0
		n	7,540	29,504	6,618	43,662

Numbers in parentheses are based on 25-49 unweighted cases.

Figure 3 Percentage of women who are underweight or overweight by HIV status

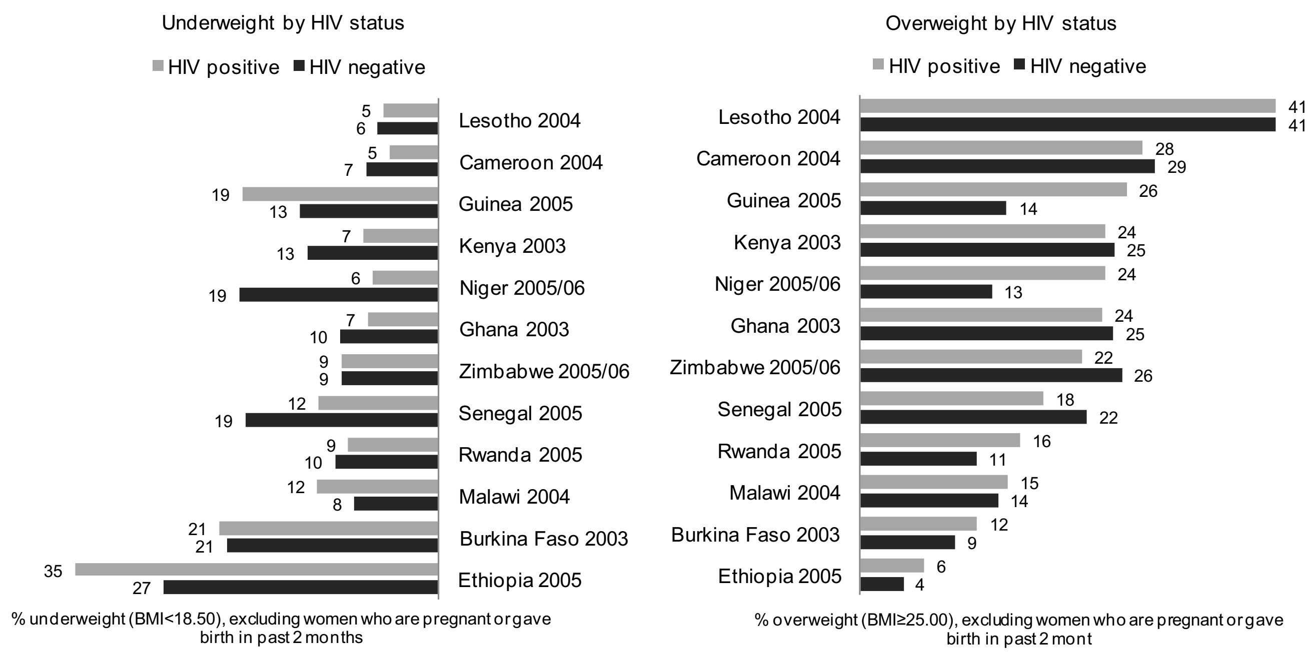
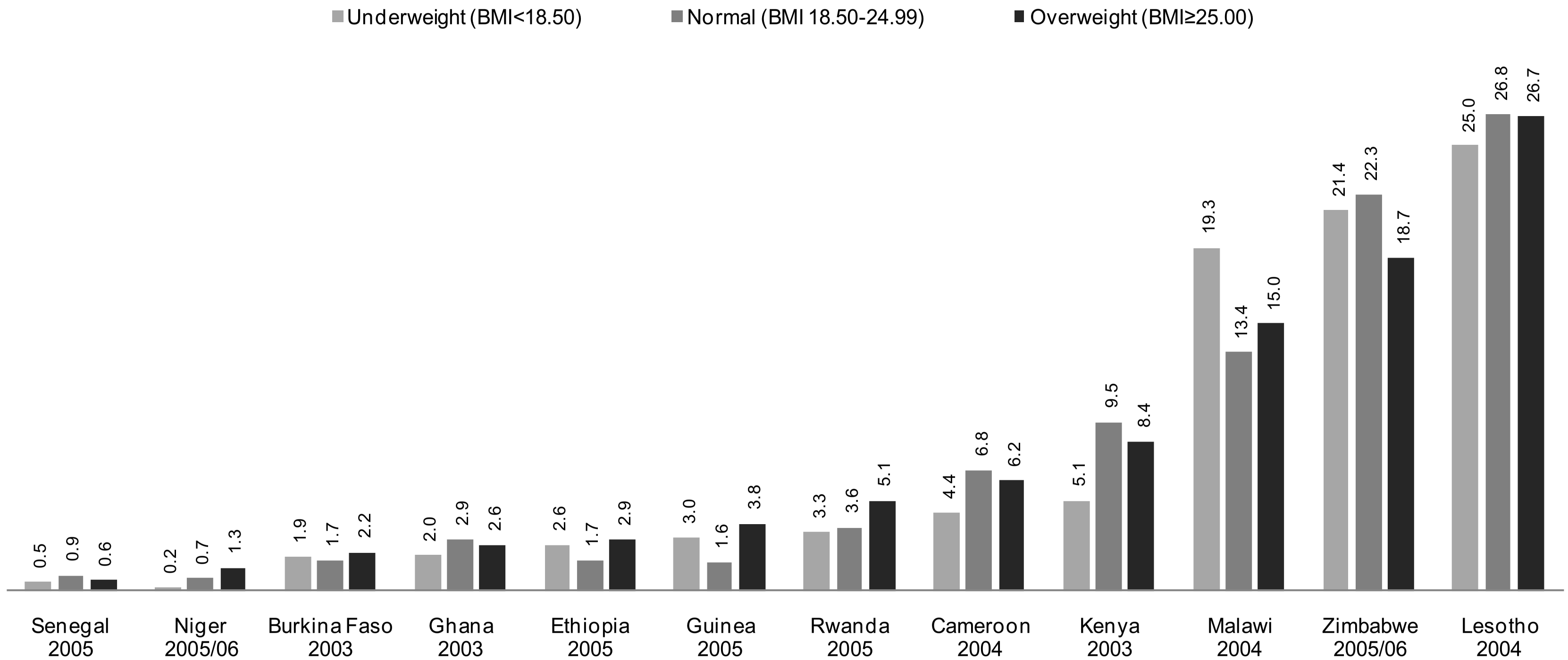


Table 4 and Figure 4 show HIV prevalence by BMI among women tested for HIV and whose height and weight were measured, excluding pregnant women and those who gave birth in the past 2 months. Total HIV prevalence among women in this sample is highest in the countries in Southern Africa, ranging from 14.1 percent in Malawi to 26.7 percent in Lesotho. Within East Africa, prevalence is highest in Kenya at 8.7 percent, and lowest in Ethiopia at 2 percent. Prevalence rates are relatively low—under 3 percent—in the West African countries with the notable exception of Cameroon, where prevalence is 6.4 percent. A version of Table 4 using expanded BMI categories can be found in Annex 3.

Table 4 HIV prevalence among women age 15-49 (excluding women who were pregnant or had a birth in the last 2 months) by BMI status, DHS surveys with linked HIV testing

	BMI (kg/m^2)				
Country/year	<18.50	18.50-24.99	≥25.00	Total	n
West Africa					
Burkina Faso 2003	1.9	1.7	2.2	1.8	3,446
Cameroon 2004	4.4	6.8	6.2	6.4	4,325
Ghana 2003	2.0	2.9	2.6	2.7	4,389
Guinea 2005	3.0	1.6	3.8	2.1	3,147
Niger 2005/06	0.2	0.7	1.3	0.7	3,503
Senegal 2005	0.5	0.9	0.6	0.8	3,710
East Africa					
Ethiopia 2005	2.6	1.7	2.9	2.0	4,965
Kenya 2003	5.1	9.5	8.4	8.7	2,728
Rwanda 2005	3.3	3.6	5.1	3.8	4,942
Southern Africa					
Lesotho 2004	25.0	26.8	26.7	26.7	2,706
Malawi 2004	19.3	13.4	15.0	14.1	2,152
Zimbabwe 2005/06	21.4	22.3	18.7	21.3	6,190

Figure 4 Women's HIV prevalence by BMI category*



*Excluding pregnant women and those who gave birth in past 2 months

While there is a different relationship between BMI and HIV prevalence in each country, it is clear from Figure 4 that there is not a monotonic relationship between HIV and BMI; HIV prevalence does not steadily increase or decrease along with increases or decreases in BMI. In all countries in this analysis except Malawi and Zimbabwe, HIV prevalence is higher among women who are overweight than women who are underweight. In Burkina Faso, Ethiopia, Guinea, and Malawi, the relationship is U-shaped—that is, HIV prevalence is higher among women who are overweight or underweight than among women with normal BMIs.

In general, BMI tends to increase with age; in each higher age category, increasing proportions of women are overweight in West and Southern Africa (Table 5). In East Africa, the proportion of women who are overweight also increases with age until age 40, where it levels off, and then decreases slightly among women age 45-49. Also in East Africa, the proportion of women who are underweight increases steadily with age after age 19. A similar pattern for underweight is seen in the total pooled data, but not in West or Southern Africa.

BMI also generally increases with women's education level. The most striking example of this relationship is in the East Africa pooled data, where only 4 percent of women with no education are overweight, but one-quarter of women with secondary or higher levels of education are overweight. A version of Table 5 using expanded BMI categories can be found in Annex 4.

In West and Southern African countries, women who have never been in union and women in polygynous unions are more likely to be underweight, and less likely to be overweight, than women in monogamous unions, or those who are widowed, divorced, or separated. In the total pooled data, however, only never-married women are more likely to have lower BMIs than women of other marital statuses.

In all regions the proportion of women who are underweight dramatically decreases linearly as wealth quintile increases, except for a slight anomaly among West African women in the second wealth quintile. There is also a corresponding increase in the proportion of women who are overweight with each higher wealth level. This relationship is most striking in the East Africa pooled data, where fewer women overall are overweight. In East Africa there is a five-fold increase in the percentage of women who are overweight between the poorest quintile of women and the wealthiest.

Similar to wealth, BMI varies consistently between urban and rural women; urban women are more likely to be overweight and rural women are more likely to be underweight. This difference is smallest in the Southern Africa pooled data, where the lowest overall proportion of women are underweight, and urban women are about twice as likely to be overweight as rural women. In West and East African pooled data, urban women are roughly three times more likely than rural women to be overweight.

Table 5 Percent distribution of women age 15-49 tested for HIV (excluding women who were pregnant or had a birth in last 2 months) by BMI status and selected characteristics, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

	West Africa				East Africa				Southern Africa				Total pooled			
	BMI (kg/m^2)				BMI (kg/m^2)				BMI (kg/m^2)				BMI (kg/m^2)			
Characteristic	<18.50	18.50-24.99	≥25.00	n	<18.50	18.50-24.99	≥25.00	n	<18.50	18.50-24.99	≥25.00	n	<18.50	18.50-24.99	≥25.00	n
Age																
15-19	21.4	70.4	8.3	5,207	29.1	65.6	5.3	3,129	15.0	74.4	10.6	2,315	24.9	68.2	6.9	11,039
20-24	11.8	73.5	14.7	3,962	14.3	76.6	9.1	2,239	5.8	80.0	14.2	2,260	12.2	75.9	11.8	8,375
25-29	10.8	68.4	20.8	3,512	17.5	73.1	9.4	1,988	7.3	72.4	20.3	1,741	13.9	71.3	14.8	7,300
30-34	10.8	63.7	25.6	2,869	17.6	67.3	15.1	1,561	7.6	66.5	25.9	1,475	13.8	65.9	20.3	5,869
35-39	11.2	60.0	28.8	2,756	19.9	64.2	15.8	1,381	7.2	61.0	31.8	1,083	15.2	62.2	22.6	5,248
40-44	12.2	57.9	29.9	2,279	21.4	62.8	15.7	1,150	7.9	57.7	34.3	962	16.4	60.3	23.3	4,387
45-49	11.9	57.7	30.5	1,978	26.3	59.2	14.4	1,021	6.6	57.3	36.1	819	18.6	58.4	22.9	3,844
Education																
No education	17.4	70.5	12.2	11,409	26.5	69.3	4.1	5,629	10.1	76.5	13.4	1,395	22.0	70.1	7.9	20,029
Primary incomplete	13.2	63.5	23.3	3,331	21.6	69.2	9.3	3,434	9.6	72.8	17.7	4,012	17.5	68.5	14.0	11,044
Primary complete	8.0	60.8	31.1	1,499	12.1	68.2	19.7	1,223	7.5	68.9	23.6	1,006	10.3	66.2	23.5	3,959
Secondary +	8.7	60.9	30.5	6,325	11.9	62.9	25.2	2,182	7.7	65.5	26.8	4,241	9.7	62.5	27.8	11,031
Marital status																
Never in union	19.6	68.6	11.8	5,634	23.7	68.3	8.0	3,854	13.6	71.9	14.6	2,589	21.3	68.7	9.9	12,877
In monogamous union	11.0	64.8	24.2	9,552	19.8	68.2	11.9	6,117	6.1	69.4	24.4	5,434	15.2	67.2	17.6	21,555
In polygynous union	13.3	67.8	18.9	5,749	21.8	64.6	13.6	1,021	11.5	72.4	16.1	1,058	15.6	67.2	17.2	6,809
Widowed/divorced/ separated	10.2	59.5	30.3	1,629	19.9	69.1	11.0	1,477	7.6	67.4	25.0	1,573	15.5	66.4	18.2	4,821
Wealth quintile																
Lowest	16.1	76.0	7.9	3,811	26.5	69.5	4.0	2,177	10.7	77.4	12.0	1,763	21.0	72.7	6.3	7,898
Second	17.0	73.4	9.6	3,867	24.2	69.2	6.6	2,297	11.4	75.3	13.3	1,931	20.2	71.4	8.4	8,251
Middle	15.1	69.6	15.3	4,464	23.4	69.3	7.3	2,302	9.6	75.0	15.4	2,065	18.6	70.1	11.3	8,779
Fourth	13.1	63.1	23.9	4,653	20.0	69.0	10.9	2,463	7.6	68.0	24.3	2,361	15.9	66.7	17.5	9,374
Highest	9.3	54.5	36.3	5,769	14.8	64.6	20.6	3,229	5.5	58.6	35.9	2,533	11.7	60.2	28.0	11,762
Residence																
Urban	9.6	57.3	33.1	9,407	13.9	62.9	23.2	2,578	6.0	61.0	33.0	2,976	10.8	59.7	29.5	13,484
Rural	16.6	72.4	11.0	13,157	23.1	69.4	7.5	9,891	9.7	73.5	16.8	7,678	19.6	70.8	9.6	32,578
n	3,090	14,919	4,555	22,563	2,643	8,485	1,341	12,468	926	7,459	2,269	10,654	7,826	31,120	7,116	46,063

In Lesotho, women were not asked if their husbands had other spouses. All women currently in union in Lesotho are coded as in monogamous unions.

As shown in Table 6, HIV prevalence among women in the study is generally highest among women ages 25-39; women with at least a primary education (and particularly women who have completed primary but not continued to secondary education); women who are widowed, divorced, or separated; women who are in the higher wealth quintiles; and women who live in urban areas. In West and East Africa HIV prevalence generally increases with BMI. In Southern Africa prevalence is slightly higher among women who are underweight or overweight than among women with a normal BMI. A version of Table 6 using expanded BMI categories can be found in Annex 5.

The relationship between HIV prevalence, age, and BMI differs across the three regions (Table 6). In East Africa HIV prevalence increases steadily as BMI increases, but only among women under age 35. In Southern Africa HIV prevalence is inversely associated with BMI among women ages 35 and older, decreasing steadily as BMI increases. In the total pooled data, HIV prevalence increases with increasing BMI among women under 35; has a U-shaped relationship with higher prevalence among underweight and overweight women ages 35-44, and has an inverted U-shaped relationship with the highest prevalence among women with normal BMIs in the 45-49 age group.

In all regions HIV prevalence increases with education among women with less than complete secondary schooling, then decreases among women with a secondary or higher-level education. In the East African data and the total pooled data, HIV prevalence increases steadily with BMI and education level among women with less than a complete secondary level education, and is then highest among women with normal BMIs. In West Africa a different pattern emerges: HIV prevalence is highest for overweight women only among those with no formal education. For women with any education, prevalence is highest among women with normal BMIs. In Southern Africa, prevalence is highest for underweight women among those who have not completed a primary education, and highest for overweight women among those with secondary or higher education.

For most never-married women and women who are monogamously married, HIV prevalence increases steadily with BMI. The most interesting differences are among widowed, divorced, and separated (formerly in-union) women, who make up less than 1 percent of the total sample. HIV prevalence is much higher among these women, ranging from 10 percent in West Africa to over 40 percent in Southern Africa. In East Africa prevalence is almost twice as high among formerly in-union women who are overweight than underweight (21 percent compared with 11 percent). In West Africa prevalence is lowest among underweight formerly in-union women, and in Southern Africa prevalence is highest among the underweight formerly in-union group, at over 51 percent.

In the total pooled data, the relationship between wealth, BMI, and HIV prevalence is remarkably consistent. Prevalence increases steadily with wealth among all women, and increases at each BMI category within wealth quintile, with a slight exception in the second quintile. The relationship is similar in regional data as well, with few anomalies.

Table 6 HIV prevalence among women age 15-49 (excluding women who were pregnant or had a birth in last 2 months) by BMI status and selected characteristics, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

	West Africa				East Africa				Southern Africa				Total pooled			
	BMI (kg/m^2)				BMI (kg/m^2)				BMI (kg/m^2)				BMI (kg/m^2)			
Characteristic	<18.50	18.50-24.99	≥25.00	Total	<18.50	18.50-24.99	≥25.00	Total	<18.50	18.50-24.99	≥25.00	Total	<18.50	18.50-24.99	≥25.00	Total
Age																
15-19	0.3	0.8	1.4	0.7	0.5	1.6	2.0	1.3	4.2	4.9	3.9	4.7	0.7	1.6	2.1	1.4
20-24	2.3	3.4	2.1	3.1	2.5	4.1	6.7	4.1	26.1	15.3	18.4	16.3	3.9	5.4	6.5	5.4
25-29	1.8	3.4	5.6	3.7	1.8	6.3	8.5	5.7	37.6	23.8	22.4	24.5	4.0	7.4	9.2	7.2
30-34	3.4	4.4	4.5	4.3	2.8	4.4	9.5	4.9	26.9	29.0	27.1	28.3	4.6	7.5	10.0	7.6
35-39	4.3	3.7	3.5	3.7	9.6	6.3	7.1	7.1	42.1	28.2	26.3	28.6	9.6	7.5	8.0	7.9
40-44	1.4	2.6	2.6	2.4	8.5	3.1	9.8	5.3	29.8	25.8	15.6	22.6	7.5	5.3	7.1	6.1
45-49	1.8	2.7	2.3	2.5	2.4	2.0	0.9	2.0	17.4	18.0	12.7	16.0	2.8	3.9	3.6	3.6
Education																
No education	1.4	1.4	2.2	1.5	2.7	1.0	3.1	1.6	28.9	14.6	12.3	15.7	2.7	1.7	3.0	2.0
Primary incomplete	1.3	3.9	2.4	3.2	3.3	4.9	9.2	4.9	18.9	16.7	17.0	17.0	4.5	6.9	8.4	6.7
Primary complete	3.8	7.3	5.5	6.4	2.1	8.4	10.9	8.1	22.6	22.3	22.1	22.3	4.4	9.9	10.2	9.4
Secondary +	2.7	4.0	4.0	3.9	4.7	7.7	4.9	6.6	18.8	20.2	20.6	20.2	6.0	8.6	7.4	8.0
Marital status																
Never in union	0.5	1.6	1.9	1.4	0.4	2.1	4.2	1.8	5.0	8.0	11.6	8.1	0.7	2.5	4.4	2.3
In monogamous union	1.6	2.8	2.9	2.7	2.8	3.1	4.9	3.2	26.5	16.2	15.9	16.7	3.7	4.7	5.9	4.7
In polygynous union	2.4	2.0	2.3	2.1	4.6	7.0	4.8	6.2	20.1	21.6	17.5	20.8	4.3	5.0	3.9	4.7
Widowed/divorced/ separated	7.1	10.0	9.5	9.5	10.9	10.1	21.0	11.5	51.0	41.1	37.2	40.8	13.5	15.1	19.7	15.7
Wealth quintile																
Lowest	2.0	1.5	1.2	1.6	0.8	1.6	2.9	1.4	18.9	15.7	15.4	16.0	2.1	3.2	4.7	3.1
Second	2.2	1.8	2.3	1.9	3.8	3.1	3.9	3.3	24.8	15.1	18.0	16.6	4.7	4.1	5.9	4.4
Middle	1.4	3.2	4.0	3.0	2.0	2.3	4.6	2.4	24.7	18.2	14.0	18.2	3.2	4.6	5.8	4.5
Fourth	1.4	3.8	3.7	3.4	1.2	3.7	5.7	3.4	18.5	22.5	22.1	22.1	2.3	6.1	7.5	5.8
Highest	1.5	3.5	3.4	3.3	7.9	7.6	8.8	7.9	13.7	18.9	19.8	19.0	6.3	7.4	7.7	7.3
Residence																
Urban	2.0	4.4	3.8	4.0	10.9	9.0	9.6	9.4	21.0	21.9	21.4	21.7	7.3	8.1	7.6	7.9
Rural	1.6	1.9	2.2	1.8	1.8	2.7	4.4	2.6	20.6	17.0	17.1	17.4	2.8	4.2	6.2	4.1
Total	1.7	2.8	3.3	2.7	3.0	3.9	6.7	4.0	20.7	18.2	19.0	18.6	3.7	5.2	7.0	5.2

Relationship between HIV and Anemia

Concerning the relationship between anemia and HIV, Table 7 and Figure 5 show the distribution of anemia prevalence among women who were tested for HIV. Overall anemia levels, or hemoglobin concentration of less than 12 grams per deciliter of blood,[7] are highest in Senegal (59 percent), followed by Burkina Faso (54 percent) and Guinea (53 percent). Overall anemia is lowest in Ethiopia, where just over one-quarter of women are anemic. This result is particularly interesting for Ethiopia, which also has the highest percentage of women who are underweight of any country in the sample. As we will see in later analyses, anemia is generally more common among underweight women, so Ethiopia stands out for having low anemia rates yet high proportions of women who are underweight.

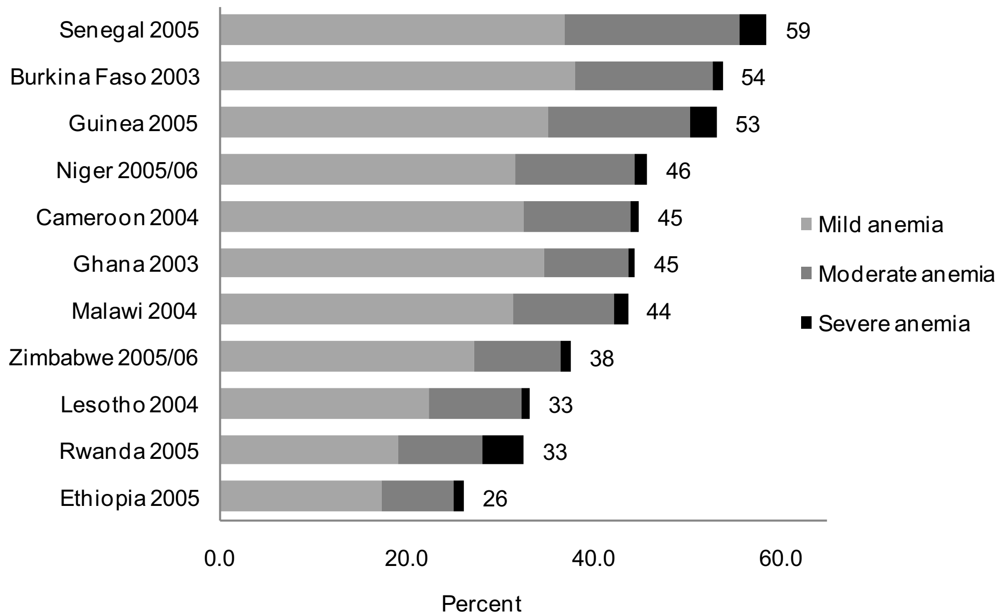
Table 7 Sample distribution of women age 15-49 who were tested for HIV and anemia, by anemia status, DHS surveys with linked HIV testing

		Anemic				
Country/year	Not anemic	Mildly	Moderately	Severely	Total	n
West Africa						
Burkina Faso 2003	46.2	38.1	14.7	1.1	100.0	4,055
Cameroon 2004	55.0	32.5	11.6	0.9	100.0	5,096
Ghana 2003	55.4	34.8	9.0	0.8	100.0	5,002
Guinea 2005	46.7	35.3	15.1	2.9	100.0	3,712
Niger 2005/06	54.1	31.8	12.6	1.5	100.0	4,197
Senegal 2005	41.2	37.1	18.7	2.9	100.0	4,123
East Africa						
Ethiopia 2005	73.6	17.3	7.8	1.2	100.0	5,689
Rwanda 2005	67.3	19.2	8.9	4.6	100.0	5,614
Southern Africa						
Lesotho 2004	66.6	22.4	10.0	0.9	100.0	2,975
Malawi 2004	56.3	31.5	10.7	1.6	100.0	2,437
Zimbabwe 2005/06	62.3	27.3	9.3	1.1	100.0	6,906

Anemia testing not conducted in Kenya; Kenya not included in any anemia analyses.

[7] Less than 11.0 g/dl for pregnant women.

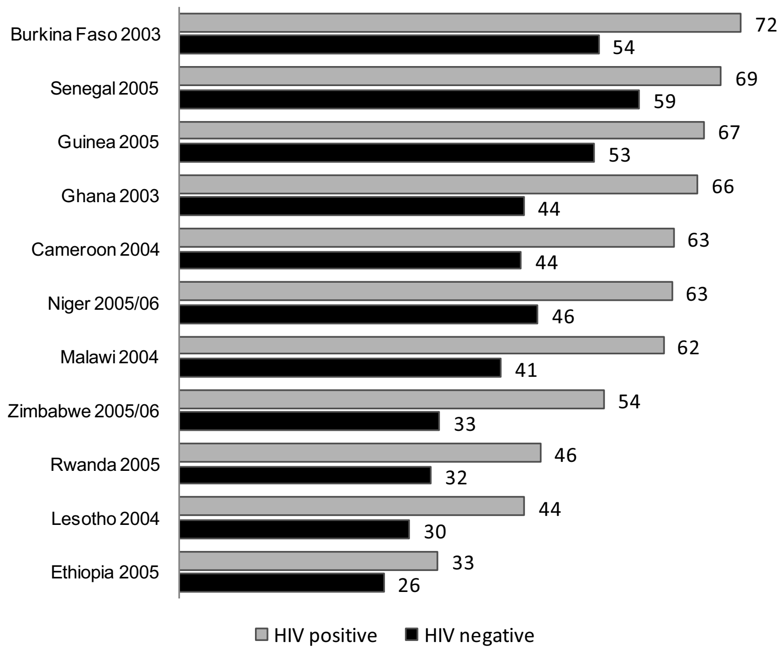
Figure 5 Distribution of anemia by country



Severe anemia is a rare event among women in this sample, with the highest prevalence in Rwanda, at 5 percent. Because so few women have severe anemia, the following tables are presented with moderate and severe anemia levels combined.

For every country in this analysis, prevalence of anemia at any level (mild or moderate to severe) is higher among HIV-positive women than HIV-negative women (Figure 6). The differences in anemia prevalence by HIV status are large—on average across countries, anemia prevalence is 16 percentage points higher among HIV-positive women than HIV-negative women.

Figure 6 Percentage of women who are anemic* by HIV status



* Anemic: <12.0 g/dl (<11.0 g/dl for pregnant women)

In the total pooled data the percentage of HIV-positive women who have anemia at any level is about 1.4 times higher than the percentage of HIV-negative women and almost 1.7 times higher for moderate to severe anemia (Table 8).

Table 8 Distribution of HIV-positive and HIV-negative women age 15-49 by anemia status, DHS surveys with linked HIV testing						
				Anemic		
Country	HIV status		Not anemic	Mildly	Moderately - Severely	Total
West Africa						
Burkina Faso 2003	Positive	%	28.4	34.0	37.5	100.0
		n	21	25	28	73
	Negative	%	46.5	38.1	15.3	100.0
		n	1,853	1,518	610	3,981
Cameroon 2004	Positive	%	37.0	36.7	26.2	100.0
		n	125	124	89	339
	Negative	%	56.3	32.2	11.5	100.0
		n	2,679	1,530	549	4,758
Ghana 2003	Positive	%	33.9	46.4	19.7	100.0
		n	45	62	26	133
	Negative	%	56.0	34.5	9.5	100.0
		n	2,727	1,678	465	4,869
Guinea 2005	Positive	%	33.1	38.5	28.4	100.0
		n	23	27	20	71
	Negative	%	47.0	35.2	17.7	100.0
		n	1,715	1,283	647	3,641
Niger 2005/06	Positive	%	(37.2)	(35.0)	(27.7)	100.0
		n	12	11	9	31
	Negative	%	54.2	31.8	14.0	100.0
		n	2,260	1,324	582	4,166
Senegal 2005	Positive	%	(30.9)	(40.5)	(28.6)	100.0
		n	11	15	10	36
	Negative	%	41.3	37.1	21.6	100.0
		n	1,687	1,517	883	4,087
Total (West Africa-pooled data)	Positive	%	34.9	39.0	26.1	100.0
		n	252	281	189	722
	Negative	%	51.3	34.6	14.1	100.0
		n	13,072	8,828	3,591	25,489
East Africa						
Ethiopia 2005	Positive	%	66.9	23.4	9.7	100.0
		n	71	25	10	107
	Negative	%	73.8	17.2	9.0	100.0
		n	4,118	962	502	5,582
Rwanda 2005	Positive	%	53.9	26.3	19.8	100.0
		n	108	53	40	201
	Negative	%	67.8	18.9	13.3	100.0
		n	3,668	1,023	722	5,413
Total (East Africa-Ethiopia and Rwanda pooled)	Positive	%	64.2	24.0	11.8	100.0
		n	149	55	27	231
	Negative	%	73.1	17.4	9.5	100.0
		n	7,983	1,904	1,038	10,924
Southern Africa						
Lesotho 2004	Positive	%	55.9	26.0	18.1	100.0
		n	439	204	142	785
	Negative	%	70.5	21.2	8.3	100.0
		n	1,544	463	183	2,190
Malawi 2004	Positive	%	38.3	39.8	21.9	100.0
		n	120	124	69	312
	Negative	%	58.9	30.2	10.9	100.0
		n	1,252	642	231	2,125
Zimbabwe 2005/06	Positive	%	46.0	35.8	18.2	100.0
		n	675	526	267	1,462
	Negative	%	66.9	24.8	8.3	100.0
		n	3,667	1,361	452	5,444
Total (Southern Africa-pooled data)	Positive	%	44.8	35.9	19.4	100.0
		n	959	768	415	2,136
	Negative	%	63.4	27.1	9.5	100.0
		n	6,240	2,668	934	9,814
Total (All countries-pooled data)	Positive	%	46.0	34.3	19.7	100.0
		n	1,017	759	435	2,209
	Negative	%	62.3	26.2	11.5	100.0
		n	29,613	12,454	5,490	47,539

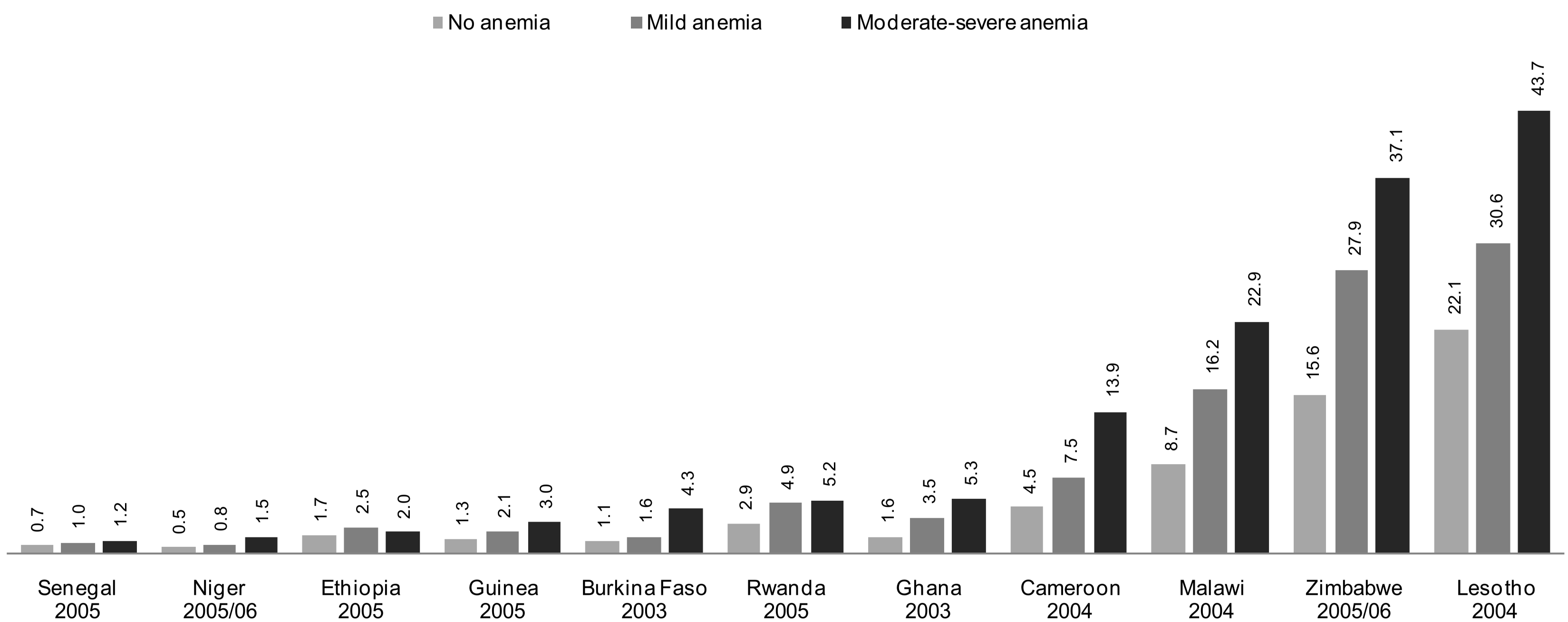
Numbers in parentheses are based on 25-49 unweighted cases.

HIV prevalence increases as anemia level rises for all countries in this analysis except Ethiopia, which has both a low prevalence of HIV and the lowest overall prevalence of anemia of any country in this analysis (Table 9, Figure 7).

Table 9 HIV prevalence among women age 15-49 by anemia status, DHS surveys with linked HIV testing

Country/year	Not anemic	Anemic: Mildly	Anemic: Moderately - Severely	Total	n
West Africa					
Burkina Faso 2003	1.1	1.6	4.3	1.8	4,055
Cameroon 2004	4.5	7.5	13.9	6.6	5,096
Ghana 2003	1.6	3.5	5.3	2.7	5,002
Guinea 2005	1.3	2.1	3.0	1.9	3,712
Niger 2005/06	0.5	0.8	1.5	0.7	4,197
Senegal 2005	0.7	1.0	1.2	0.9	4,123
Total (West Africa-pooled data)	1.9	3.1	5.0	2.8	26,211
East Africa					
Ethiopia 2005	1.7	2.5	2.0	1.9	5,689
Rwanda 2005	2.9	4.9	5.2	3.6	5,614
Total (East Africa-Ethiopia and Rwanda pooled)	1.8	2.8	2.6	2.1	11,155
Southern Africa					
Lesotho 2004	22.1	30.6	43.7	26.4	2,975
Malawi 2004	8.7	16.2	22.9	12.8	2,437
Zimbabwe 2005/06	15.6	27.9	37.1	21.2	6,906
Total (Southern Africa-pooled data)	13.3	22.3	30.7	17.9	11,950
Total (All countries-pooled data)	3.3	5.7	7.3	4.4	49,748

Figure 7 Women's HIV prevalence by anemia status



Prevalence of any anemia consistently decreases as BMI increases (Table 10), and moderate to severe anemia is highest among women with BMI<18.5 kg/m^2 in West and Southern Africa, but does not vary by BMI in East Africa. Kenya is not included in this analysis, so the East Africa pooled data only include Ethiopia and Rwanda. And because countries are weighted by population size in the pooled analyses, the East Africa pooled data mainly reflect the situation in Ethiopia.

Prevalence of anemia increases with age in the Southern pooled data until age 45. The relationship between age and anemia is not clear in the other regions. In the West and East African pooled data, anemia generally decreases as education level increases, except for a plateau between incomplete and complete primary schooling in East Africa. Eighty-two percent of women with a secondary or higher education in the East African pooled data have no anemia compared with 71 percent of women with no formal education. In the Southern Africa pooled data, rates of mild and moderate to severe anemia are both highest among women with no formal education, but there is not a linear decrease in anemia as education level increases.

Overall rates of anemia are higher for women who are formerly married or in polygynous unions in all regions than for women who are unmarried or in monogamous relationships.

Similar to the relationship between anemia and education, anemia clearly decreases as wealth increases among women in West and East Africa, but there is no clear relationship in the Southern African pooled data. In Southern Africa, the prevalence of mild anemia mostly decreases as wealth increases, but the prevalence of moderate to severe anemia is highest at higher wealth quintiles. Anemia is lower among urban women in West and East Africa, but there is no difference between urban and rural women in Southern Africa.

Table 10 Percent distribution of women age 15-49 tested for HIV (excluding women who were pregnant or had a birth in the last 2 months or did not have height and weight recorded) by anemia status and selected characteristics, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

Characteristic	West Africa				East Africa (Ethiopia and Rwanda pooled)				Southern Africa				Total pooled			
		Anemic				Anemic				Anemic				Anemic		
	Not anemic	Mildly	Moderately - Severely	n	Not anemic	Mildly	Moderately - Severely	n	Not anemic	Mildly	Moderately - Severely	n	Not anemic	Mildly	Moderately - Severely	n
BMI (kg/m^2)																
<18.50	48.5	36.5	15.0	3,039	70.9	20.3	8.7	2,392	56.9	30.6	12.5	891	62.6	26.4	11.0	7,611
18.50-24.99	52.0	35.9	12.1	14,668	74.6	16.8	8.6	6,794	59.3	30.1	10.6	7,064	63.1	26.6	10.3	29,104
$\geq$25.00	57.8	33.7	8.5	4,519	76.2	15.1	8.7	498	67.7	26.3	6.0	2,220	62.8	29.2	8.1	5,925
Age																
15-19	52.3	36.6	11.2	5,118	75.8	16.3	7.9	2,510	64.8	26.4	8.8	2,248	64.8	25.9	9.3	10,306
20-24	53.2	35.0	11.7	3,893	77.1	15.3	7.6	1,673	64.2	27.1	8.6	2,169	65.0	25.5	9.5	7,635
25-29	53.8	34.8	11.3	3,466	74.9	17.1	8.0	1,557	62.8	28.2	9.0	1,653	64.3	26.1	9.6	6,776
30-34	53.9	35.4	10.8	2,831	73.0	17.1	10.0	1,168	58.0	32.8	9.2	1,386	62.5	27.3	10.2	5,355
35-39	51.0	36.1	12.9	2,715	66.8	23.3	9.9	1,058	56.1	32.4	11.4	1,045	58.2	30.3	11.5	4,860
40-44	51.1	36.1	12.8	2,252	71.5	19.0	9.5	883	53.7	32.9	13.4	899	59.9	28.6	11.5	4,061
45-49	53.3	33.7	13.0	1,950	71.5	18.9	9.6	834	56.1	31.7	12.2	776	61.6	27.0	11.4	3,648
Education																
No education	50.5	36.2	13.2	11,198	71.4	18.7	9.9	5,650	54.2	35.3	10.6	1,297	61.5	27.1	11.4	20,878
Primary incomplete	53.4	34.7	11.9	3,285	75.0	17.1	7.8	2,467	60.9	29.5	9.7	3,762	65.8	24.8	9.4	9,524
Primary complete	55.0	34.3	10.7	1,479	74.9	17.5	7.6	380	58.2	32.9	8.8	967	61.5	29.1	9.4	2,487
Secondary +	55.7	35.0	9.4	6,263	82.2	13.3	4.5	1,187	63.7	26.5	9.9	4,149	63.7	27.9	8.3	9,751
Marital status																
Never in union	52.0	36.5	11.5	5,548	78.6	14.3	7.1	2,943	63.6	25.6	10.8	2,508	66.3	24.4	9.2	11,637
In monogamous union	54.4	34.5	11.1	9,391	72.6	18.3	9.1	4,889	63.2	28.4	8.5	5,176	64.2	26.0	9.8	20,026
In polygynous union	51.2	36.2	12.6	5,677	70.2	20.2	9.6	689	52.0	37.5	10.5	1,001	55.0	33.1	11.8	6,590
Widowed/divorced/ separated	50.6	35.3	14.1	1,609	68.5	21.6	10.0	1,163	54.5	33.4	12.1	1,490	60.4	27.9	11.6	4,386
Wealth quintile																
Lowest	49.3	37.7	12.9	3,721	67.8	19.3	12.9	1,779	60.6	31.1	8.3	1,664	59.2	28.4	12.3	7,421
Second	51.6	36.0	12.5	3,792	70.9	19.4	9.7	1,789	60.5	30.4	9.1	1,841	61.5	27.7	10.8	7,595
Middle	52.0	36.3	11.6	4,409	73.0	18.7	8.3	1,779	61.8	29.2	9.0	1,967	62.1	28.0	9.9	8,158
Fourth	53.4	34.8	11.8	4,594	72.6	18.1	9.3	1,855	59.4	29.9	10.7	2,255	62.2	27.2	10.6	8,614
Highest	55.6	33.7	10.7	5,709	81.6	13.9	4.5	2,482	62.1	26.8	11.1	2,449	67.8	24.2	8.0	10,853
Residence																
Urban	54.3	34.3	11.5	9,320	80.7	13.6	5.7	1,817	60.9	27.5	11.6	2,900	62.3	27.8	9.9	12,823
Rural	51.6	36.4	12.0	12,905	72.2	18.5	9.3	7,868	60.9	30.1	9.0	7,275	63.3	26.5	10.2	29,817
n	11,713	7,894	2,619	22,225	7,145	1,705	834	9,685	6,197	2,983	995	10,175	26,849	11,468	4,323	42,640

In Lesotho, women were not asked if their husbands had other spouses. All women currently in union in Lesotho are coded as in monogamous unions.
Kenya not included in analysis.

Table 11 shows the relationship between HIV, anemia, and background characteristics among pooled regional and total datasets. HIV prevalence increases with anemia within each BMI category, except in East Africa, where there is no clear relationship. Similarly, in West and Southern Africa HIV prevalence generally increases with anemia within each age category, but this relationship is not consistent in East Africa.

In West and Southern Africa HIV prevalence increases with anemia within each educational category and wealth quintile, but in East Africa there is no clear relationship. In Southern Africa HIV prevalence increases with anemia prevalence within each category of marital status, but among polygynous women in West Africa, HIV prevalence is slightly higher among women with mild anemia rather than moderate to severe anemia. The relationship between anemia, marital status, and HIV is particularly strong in Southern Africa. The percentage of women who are HIV-positive is almost 10 times higher among formerly married women with moderate to severe anemia than among women who are not anemic and who have never been married (62.4 percent and 6.4 percent HIV-positive, respectively).

Within urban and rural categories, HIV prevalence rises steadily with anemia levels among women in West and Southern Africa. Among urban women in East Africa, however, HIV prevalence is highest among women with mild anemia.

Table 11 HIV prevalence among women age 15-49 (excluding women who were pregnant or had a birth in the last 2 months or did not have height and weight recorded) by anemia status and selected characteristics, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

	West Africa				East Africa (Ethiopia and Rwanda pooled)				Southern Africa				Total pooled			
		Anemic				Anemic				Anemic				Anemic		
Characteristic	Not anemic	Mildly	Moderately - Severely	Total	Not anemic	Mildly	Moderately - Severely	Total	Not anemic	Mildly	Moderately - Severely	Total	Not anemic	Mildly	Moderately - Severely	Total
BMI (kg/m^2)																
<18.50	0.9	1.8	4.2	1.7	1.8	4.4	5.6	2.6	14.1	21.5	45.7	20.3	2.3	4.5	7.9	3.5
18.50-24.99	1.9	3.0	5.6	2.8	1.8	2.6	2.0	1.9	13.1	22.9	34.1	18.3	3.2	5.9	8.1	4.4
≥25.00	2.5	4.1	5.9	3.3	3.9	1.4	3.3	3.5	15.8	23.6	30.2	18.7	5.7	7.5	9.1	6.5
Age																
15-19	0.4	1.0	1.6	0.7	0.9	0.2	0.1	0.7	3.8	5.5	8.1	4.6	1.1	1.3	1.7	1.2
20-24	2.6	2.8	6.1	3.1	1.6	1.9	4.2	1.9	12.1	22.8	28.7	16.4	3.6	5.9	8.6	4.6
25-29	2.2	4.6	7.9	3.7	2.4	3.7	3.2	2.7	19.7	27.2	51.9	24.7	4.6	7.6	11.7	6.1
30-34	3.2	4.2	9.8	4.2	2.0	1.6	2.0	1.9	21.5	33.9	55.1	28.6	5.0	8.5	12.4	6.7
35-39	2.4	4.4	6.4	3.6	3.9	7.8	7.4	5.2	21.9	35.3	47.8	29.2	5.3	9.4	11.6	7.3
40-44	2.6	2.3	2.7	2.5	2.5	6.9	4.9	3.6	15.7	24.7	40.3	22.0	4.0	6.7	8.8	5.3
45-49	0.8	4.0	5.4	2.5	1.1	1.6	1.3	1.2	11.8	18.0	26.3	15.6	2.2	5.2	6.4	3.5
Education																
No education	1.0	1.7	2.8	1.5	1.0	2.2	1.8	1.3	8.8	19.1	29.8	14.6	1.2	2.6	3.2	1.8
Primary incomplete	2.3	3.1	6.8	3.1	1.8	4.7	5.5	2.6	12.8	20.7	32.6	17.1	4.1	8.2	12.0	5.9
Primary complete	5.9	6.3	9.6	6.4	2.9	2.0	1.7	2.6	18.9	22.3	45.9	22.4	7.4	9.4	15.0	8.7
Secondary +	2.3	4.9	10.0	3.9	5.5	5.1	6.6	5.5	14.9	26.9	36.3	20.2	6.2	9.7	16.8	8.0
Marital status																
Never in union	1.0	1.6	2.9	1.4	0.9	0.6	0.8	0.8	6.4	9.4	13.3	7.9	1.5	2.3	3.6	1.9
In monogamous union	1.9	3.0	5.6	2.7	1.6	2.3	2.0	1.8	12.3	20.7	36.2	16.7	3.2	5.5	7.8	4.2
In polygynous union	1.6	2.7	2.4	2.1	1.3	3.3	5.7	2.1	15.6	23.6	37.9	20.9	2.6	4.8	5.5	3.7
Widowed/divorced/ separated	6.5	9.6	21.0	9.7	6.4	9.5	9.0	7.3	33.3	46.6	62.4	41.3	10.9	17.8	23.7	14.3
Wealth quintile																
Lowest	0.9	1.6	3.4	1.5	0.8	0.4	0.8	0.7	12.5	17.8	34.5	16.0	2.3	3.4	4.7	2.9
Second	0.9	2.8	3.3	1.9	0.7	1.4	4.5	1.2	12.6	19.3	27.5	16.0	2.3	4.8	6.5	3.4
Middle	2.5	2.9	6.1	3.1	0.5	2.5	0.3	0.8	12.2	25.4	40.1	18.6	2.8	5.8	8.1	4.2
Fourth	2.8	3.5	6.5	3.5	0.6	1.0	0.8	0.7	16.4	26.2	41.5	22.0	3.6	6.4	9.5	4.9
Highest	2.0	4.1	7.0	3.3	5.1	9.9	11.8	6.0	14.6	24.5	30.4	19.0	5.0	8.4	12.2	6.4
Residence																
Urban	2.7	4.4	8.6	4.0	6.5	13.4	13.1	7.8	17.3	24.4	38.6	21.7	5.8	8.1	13.6	7.2
Rural	1.3	2.1	3.2	1.8	0.7	1.3	1.5	0.9	12.4	22.4	33.0	17.3	2.4	4.9	5.9	3.4
Total	1.9	3.1	5.4	2.7	1.9	3.1	3.0	2.2	13.8	22.9	34.9	18.5	3.4	5.9	8.2	4.6

In Lesotho, women were not asked if their husbands had other spouses. All women currently in union in Lesotho are coded as in monogamous unions.
Kenya not included in analysis.

Relationship between HIV and Breastfeeding

Concerning the relationship between HIV and breastfeeding status, Table 12 presents breastfeeding data for mothers whose last child was born less than 2 months, less than 6 months, 6-11 months, and 12-23 months preceding the interview, disaggregated by mothers' HIV status. Because the numbers of women who tested positive for HIV and have infants in these age groups are small, the data are pooled by region to allow meaningful analysis.

The number of surveyed HIV-positive women living with their infants less than two years old is very small. In West and East Africa fewer than 25 women (unweighted) were in this category, and so the data have been suppressed. In Southern Africa fewer than 50 women were in this category, and so the results should be interpreted with caution.

As mentioned above, WHO recommends that all women exclusively breastfeed infants under six months, unless using a breast milk substitute is acceptable, feasible, affordable, sustainable and safe (known as the AFASS criteria), in which case HIV-positive mothers should not breastfeed (WHO 2001, 2007c). Very few mothers of children under six months do not breastfeed, regardless of mothers' HIV status (0-3 percent). In West and Southern Africa the percentage of women who exclusively breastfeed does not seem to vary a great deal by HIV status. In East Africa a larger percentage of HIV-negative women than HIV-positive women are exclusively breastfeeding infants under six months, but this finding is not reliable due to the small number of HIV-positive women in this category. Overall, it appears that exclusive breastfeeding is more common in Southern than in Western or Eastern Africa.

Mixed feeding is by far the most common feeding mode for children age 2-11 months in all regions. Few women continue to exclusively breastfeed between 6-11 months. The percentage of women who are not breastfeeding at 6-11 months is larger for HIV-positive women than HIV-negative women in the total pooled data, which may indicate some adherence to WHO recommendations for HIV-positive women to wean at 6 months.[8]

The great majority of women in this sample are still breastfeeding at 6 months, and 84 percent of HIV-negative and 77 percent of HIV-positive mothers are still breastfeeding at 12-23 months. More HIV-positive women than HIV-negative women are not breastfeeding at all at 12-23 months in all regions except East Africa.

[8] This recommendation was updated in late 2007 to take into account inconsistent findings on the benefit of abrupt weaning. However, the 2001 recommendations for weaning at 6 months would have been in place when data were collected (WHO 2001, 2007c).

Table 12 Percent distribution of infant feeding practice among women 15-49 for last-born children living with their mother, by child's age and mother's HIV status, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

Country	No breastfeeding	Exclusive breastfeeding	Mixed feeding	Total	n
West Africa					
Children <2 months					
Mother HIV positive	*	*	*	*	9
Mother HIV negative	1.1	35.1	63.8	100.0	592
Children <6 months					
Mother HIV positive	(0.0)	(24.6)	(75.4)	(100.0)	42
Mother HIV negative	0.7	28.1	71.3	100.0	2,081
Children 6-11 months					
Mother HIV positive	(4.0)	(4.1)	(91.9)	(100.0)	34
Mother HIV negative	1.4	6.6	92.0	100.0	1,986
Children 12-23 months					
Mother HIV positive	43.9	3.4	52.7	100.0	55
Mother HIV negative	21.7	1.8	76.5	100.0	3,303
East Africa					
Children <2 months					
Mother HIV positive	*	*	*	*	8
Mother HIV negative	0.8	64.2	34.9	100.0	330
Children <6 months					
Mother HIV positive	(0.0)	(24.0)	(76.0)	(100.0)	36
Mother HIV negative	1.0	43.7	55.4	100.0	1,122
Children 6-11 months					
Mother HIV positive	(11.0)	(0.4)	(88.6)	(100.0)	33
Mother HIV negative	2.2	6.1	91.7	100.0	1,037
Children 12-23 months					
Mother HIV positive	13.2	0.4	86.4	100.0	62
Mother HIV negative	13.2	0.7	86.1	100.0	1,615
Southern Africa					
Children <2 months					
Mother HIV positive	(0.2)	(74.3)	(25.4)	(100.0)	29
Mother HIV negative	2.7	65.0	32.3	100.0	236
Children <6 months					
Mother HIV positive	2.1	43.6	54.3	100.0	119
Mother HIV negative	1.4	42.6	56.0	100.0	821
Children 6-11 months					
Mother HIV positive	3.0	1.4	95.5	100.0	135
Mother HIV negative	0.8	1.8	97.5	100.0	769
Children 12-23 months					
Mother HIV positive	27.2	0.1	72.7	100.0	223
Mother HIV negative	19.3	0.3	80.4	100.0	1,499
Total					
Children <2 months					
Mother HIV positive	0.1	54.7	45.2	100.0	36
Mother HIV negative	1.1	53.4	45.5	100.0	1,193
Children <6 months					
Mother HIV positive	0.8	31.3	67.9	100.0	159
Mother HIV negative	0.9	37.6	61.5	100.0	4,115
Children 6-11 months					
Mother HIV positive	6.4	1.4	92.1	100.0	156
Mother HIV negative	1.8	5.8	92.4	100.0	3,855
Children 12-23 months					
Mother HIV positive	23.4	0.7	75.9	100.0	300
Mother HIV negative	15.9	1.2	82.9	100.0	7,062

Numbers in parentheses are based on 25-49 unweighted cases. An asterisk indicates that a figure is based on fewer than 25 cases and has been suppressed.

To assess whether any differences in breastfeeding mode may be related to women's knowledge about mother-to-child-transmission (MTCT) and their HIV status, analyses of these issues were conducted and are included in Annex 6. Our primary focus, however, was on whether breastfeeding practice had a different impact on the nutritional status of HIV-positive than HIV-negative women. Tables 13 and 14 show the relationships between breastfeeding practice, BMI, and anemia level among women who gave birth less than two years ago.

Table 13 BMI and breastfeeding status among non-pregnant women 15-49 whose youngest child living with them is under 24 months old by HIV status, total pooled data

	BMI (kg/m^2)				
Characteristic	<18.50	18.50-24.99	≥25.00	Total	n
No breastfeeding					
HIV-positive women	6.9	70.4	22.7	100.0	69
HIV-negative women	10.4	66.7	22.9	100.0	771
Exclusive breastfeeding					
HIV-positive women	10.5	73.7	15.8	100.0	54
HIV-negative women	9.1	79.9	11.0	100.0	1,847
Mixed feeding					
HIV-positive women	14.9	70.5	14.6	100.0	465
HIV-negative women	15.3	74.2	10.6	100.0	11,660

All non-pregnant women living with their children <24 months old included in this table. Excluding women who gave birth in the last 2 months decreased the number of exclusively breastfeeding HIV-positive women below 50 unweighted cases.

Most analyses of BMI exclude women who are currently pregnant or who have given birth in the last two months. This limitation becomes problematic when analyzing breastfeeding modes, however, because exclusive breastfeeding is strongly associated with infant age. To preserve the sample size of exclusively breastfeeding women,[9] all non-pregnant women whose BMI was measured and who live with their infants less than 24 months old are included in Table 13. The proportions of women whose BMIs are of 25 or over should not be looked upon as overweight in this analysis, as many women gave birth recently and have likely not returned to their pre-pregnancy BMIs. Rather, we are examining BMIs of women by breastfeeding mode and HIV status to see if breastfeeding impacts HIV-positive women differently than HIV-negative women.

The proportions of women who are underweight do vary by breastfeeding mode; women who mixed feed their infants are more likely to be underweight than women who do not breastfeed at all or who exclusively breastfeed (Table 13). The percentage of women who are underweight is higher among HIV-negative women than HIV-positive women who are not breastfeeding, and does not differ by HIV status among breastfeeding women. The percentage of women who are overweight among exclusively breastfeeding or mixed feeding women is higher for HIV-positive than HIV-negative women. Non-breastfeeding women are more likely to be overweight than women who breastfeed, but the proportion of women who are overweight within this category does not vary by HIV status.

Table 14 includes all women tested for anemia who lived with their infants under 24 months old at the time of the survey. As expected based on Table 8, anemia is more prevalent among HIV-positive than HIV-negative women regardless of breastfeeding mode. There is a 9-10 percentage point gap in the prevalence of mild anemia between HIV-positive and HIV-negative women within each breastfeeding mode. HIV-positive breastfeeding women are also more likely to have moderate to severe anemia than HIV-negative breastfeeding women. However, HIV-positive women who do not breastfeed appear less likely to have moderate to severe anemia than HIV-negative non-breastfeeding women.

[9] Even in pooled analysis, the unweighted number of HIV-positive exclusively breastfeeding women living with infants 2-23 months old is less than 50. The crosstabulation of BMI, breastfeeding mode, and HIV excluding pregnant women and women who gave birth in the last 2 months looks virtually identical to the crosstabulation in the larger sample, except for a slightly larger proportion of exclusively breastfeeding women with BMIs of 25 or more (22 percent of HIV-positive and 12 percent of HIV-negative women) and of exclusively breastfeeding women with BMIs below 18.5 (13 percent of HIV-positive and 11 percent of HIV-negative women) (analysis not shown).

Table 14 Anemia and breastfeeding status among women 15-49 whose youngest child living with them is under 24 months old, by mother's HIV status, total pooled data

Characteristic	Not anemic	Anemic: Mildly	Anemic: Moderately - Severely	Total	n
No breastfeeding					
HIV-positive women	52.5	37.6	9.9	100.0	73
HIV-negative women	58.2	27.2	14.6	100.0	1,082
Exclusive breastfeeding					
HIV-positive women	46.2	36.8	17.0	100.0	48
HIV-negative women	57.8	27.6	14.6	100.0	1,932
Mixed feeding					
HIV-positive women	47.8	38.0	14.2	100.0	365
HIV-negative women	61.6	28.3	10.1	100.0	11,121

Kenya excluded from analysis

3.2 Multivariate Results

HIV as a Risk Factor for Underweight and Overweight

Table 15 presents the unadjusted and adjusted relative risk ratios (RRR) for BMI, comparing the likelihood of being overweight or underweight to the likelihood of having a normal BMI (the reference category) while controlling for other variables in the model. The RRR of 0.69 for the upper-left-hand-most result in Table 15 is therefore interpreted as the unadjusted RRR of being underweight vs. normal BMI if a woman is HIV-positive vs. HIV-negative.

In unadjusted analysis, women in the 12 sub-Saharan African countries studied are, on average, significantly less likely to be underweight and more likely to be overweight if they are HIV-positive than if they are HIV-negative. Women are more likely to be overweight if they have mild anemia, but less likely to be overweight if they have moderate to severe anemia in unadjusted analysis, but this is primarily due to the influence of Ethiopia, which as discussed has a different pattern for anemia and BMI than any other country and a large population size that heavily influences pooled results. When a dichotomous variable for Ethiopia (1=Ethiopia, 0=all other countries) is held constant, anemia at all levels becomes significantly positively associated with being underweight (RRR=1.21 $p<0.001$ for mild anemia, RRR=1.24 $p<0.01$ for moderate to severe anemia), and significantly negatively associated with being overweight (RRR=0.68 $p<0.001$ for mild anemia, 0.64 $p<0.001$ for moderate to severe anemia; analysis not shown). As expected based on the results of Table 13, women are less likely to be overweight or underweight if they are exclusively breastfeeding vs. not breastfeeding, and less likely to be overweight if they are mixed feeding vs. not breastfeeding. There is no significant unadjusted interaction between HIV, breastfeeding, and BMI.

Once background characteristics are controlled for (Model 1, Table 15), the relationship between BMI and HIV changes direction. Wealth and education levels are the primary factors that reverse the direction of the association when added to the model one at a time. The odds of being underweight are higher if a woman is HIV-positive than if she is HIV-negative, and the odds of being overweight are lower if a woman is HIV-positive vs. HIV-negative, controlling for background characteristics.

Table 15 Multinomial logistic models of BMI by HIV status and socio-demographic factors among women age 15-49, all countries (pooled data)

Characteristic	Unadjusted (crude) Underweight vs. Normal BMI RRR (95% CI)	Unadjusted (crude) Overweight vs. Normal BMI RRR (95% CI)	Model 1 Underweight vs. Normal BMI RRR (95% CI)	Model 1 Overweight vs. Normal BMI RRR (95% CI)	Model 2 Underweight vs. Normal BMI RRR (95% CI)	Model 2 Overweight vs. Normal BMI RRR (95% CI)	Model 3 Underweight vs. Normal BMI RRR (95% CI)	Model 3 Overweight vs. Normal BMI RRR (95% CI)
HIV status (ref: Negative)								
Positive	0.69*** (0.57, 0.85)	1.38*** (1.19, 1.60)	1.28* (1.03, 1.59)	0.66*** (0.56, 0.78)	1.48** (1.17, 1.88)	0.69*** (0.60, 0.81)	1.52* (1.09, 2.13)	0.62*** (0.48, 0.80)
Anemia status (ref: No anemia)								
Mild	1.00 (0.92, 1.09)	1.10* (1.01, 1.20)			1.04 (0.95, 1.14)	0.89** (0.82, 0.95)	0.98 (0.86, 1.12)	0.85** (0.76, 0.94)
Moderate - Severe	1.08 (0.93, 1.25)	0.78*** (0.69, 0.89)			1.17* (1.02, 1.33)	0.60*** (0.53, 0.67)	1.32** (1.11, 1.57)	0.64*** (0.53, 0.76)
Breastfeeding mode (ref: Not breastfeeding)								
Exclusive breastfeeding	0.58*** (0.43, 0.79)	0.45*** (0.37, 0.56)					0.53** (0.36, 0.78)	0.81 (0.60, 1.09)
Mixed feeding	1.09 (0.96, 1.24)	0.43*** (0.38 , 0.47)					0.98 (0.80, 1.20)	0.65*** (0.56, 0.77)
Interaction for HIV and breastfeeding mode (ref: Not breastfeeding, HIV negative)								
Exclusive breastfeeding*HIV	0.69 (0.22, 2.12)	1.14 (0.61, 2.12)					0.55 (0.14, 2.21)	1.50 (0.69, 3.25)
Mixed feeding*HIV	1.06 (0.68, 1.66)	1.08 (0.73, 1.60)					1.42 (0.80, 2.53)	1.27 (0.78, 2.04)
Interaction for anemia and Ethiopia (ref: Not anemic, not Ethiopia)								
Mild anemia*Ethiopia	1.97*** (1.68, 2.31)	0.23*** (0.15, 0.35)			1.23* (1.02,1.50)	0.95 (0.55,1.64)	1.31 (0.97, 1.76)	1.90 (0.93, 3.88)
Moderate - Severe anemia*Ethiopia	1.73*** (1.27, 2.36)	0.26*** (0.16, 0.43)			0.93 (0.65,1.35)	2.04* (1.08,3.86)	0.90 (0.57, 1.44)	1.83 (0.71, 4.72)
Number of women			46,063		42,640		22,970	

The reference category for the dependent variable is normal BMI.
All results exclude women who are pregnant or gave birth in the last 2 months, except results for breastfeeding (unadjusted and model 3). Breastfeeding results exclude only pregnant women to preserve sample size for exclusively breastfeeding women.
Model 1 controls for age, education, marital status, wealth quintile, urban/rural residence, and country; Model 2 controls for age, education, marital status, wealth quintile, urban/rural residence, country, anemia status, and interaction between anemia status*Ethiopia; Model 3 controls for age, education, marital status, wealth quintile, urban/rural residence, country, anemia status, interaction between anemia status*Ethiopia, breastfeeding mode, interaction between breastfeeding mode*HIV status, and time since last birth, among women who had a birth in the last 5 years. Models 2 and 3 exclude Kenya.
* significant at p<0.05 level; ** significant at p<0.01 level; *** significant at p<0.001 level

Model 2 introduces anemia into the model, which removes Kenya from the analysis. Also included is an interaction term for the relationship between anemia status and Ethiopia, which significantly improves model fit. The introduction of anemia into the model increases both the magnitude and significance of the relationship between HIV and BMI, particularly among underweight women. Controlling for HIV and background characteristics, the odds of being overweight are significantly lower if women are anemic vs. not. Women are significantly more likely to be underweight if they are severely anemic, but the association is not significant for mild anemia.

Model 3 attempts to estimate the independent effect of breastfeeding mode on BMI, and includes an interaction term for HIV and breastfeeding mode. The interaction term estimates the additive effect of being HIV-positive on the BMI of women who are breastfeeding (disaggregated by exclusive or mixed) vs. not breastfeeding. In addition, this model controls for time since last birth, and limits the analysis only to women who gave birth in the last 5 years. As in Table 13, this model includes women who gave birth in the last 2 months to preserve the sample size of exclusively breastfeeding women.[10]

The addition of breastfeeding into the model increases the magnitude of the effect of HIV on BMI, though the significance is lowered to $p<0.05$ for underweight women. Independently, the odds of being underweight are decreased when a woman is exclusively breastfeeding, and the odds of being overweight are decreased when a woman is mixed feeding. As an interaction effect, being both HIV-positive and breastfeeding does not significantly increase the odds of being overweight or underweight. This finding suggests that there is no additional impact of breastfeeding for HIV-positive women that would make them more likely to be overweight or underweight vs. normal BMI.

HIV as a Risk Factor for Anemia

Table 16 shows the linear relationship of hemoglobin concentration (g/dl, as used to measure anemia) to HIV and other factors. In unadjusted analysis, HIV-positive status is associated with significantly lower average hemoglobin levels. Again, the impact of Ethiopia's large size and different relationship between anemia and BMI is clear: when the dichotomous Ethiopia variable is added to the regression of BMI on hemoglobin concentration, results become highly significant in the expected directions (-0.17 $p<0.001$ for underweight vs. normal BMI; 0.27 $p<0.001$ for overweight vs. normal BMI; analysis not shown).

[10] This model was also run excluding women who were pregnant or gave birth in the past two months. Results between these two models vary only slightly. The effect of exclusive breastfeeding lessens slightly, from RRR= 0.53 $p<0.01$ when all non-pregnant women are included, to RRR=0.62 $p<0.05$ when women who gave birth in the past two months are excluded, likely due to the presence of fewer exclusively breastfeeding women in the model. All other results are virtually identical, and no differences are statistically significant.

Table 16 Linear regression models of hemoglobin concentration (g/dl) by HIV and socio-demographic factors, among women age 15-49, all countries except Kenya (pooled data)

Characteristic	Unadjusted (crude)		Model 1		Model 2		Model 3	
	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)	Coef.	(95% CI)
HIV status (ref: Negative)								
Positive	-0.73***	(-0.84, -0.62)	-0.78***	(-0.88, -0.68)	-0.78***	(-0.89, -0.67)	-0.92***	(-1.11, -0.72)
BMI (ref: Normal)								
Underweight	0.00	(-0.10, 0.10)			-0.11*	(-0.20, -0.02)	-0.14*	(-0.27, -0.01)
Overweight	0.02	(-0.06, 0.10)			0.22***	(0.14, 0.29)	0.13**	(0.03, 0.24)
Breastfeeding mode (ref: Not breastfeeding)								
Exclusive breastfeeding	0.12	(-0.08, 0.32)					-0.28*	(-0.51, -0.05)
Mixed feeding	0.40***	(0.32, 0.48)					0.03	(-0.10, 0.17)
Interaction for HIV and breastfeeding mode (ref: Not breastfeeding, HIV negative)								
Exclusive breastfeeding* HIV	-0.40	(-0.84, 0.05)					0.63*	(0.13, 1.13)
Mixed breastfeeding*HIV	-0.35***	(-0.53, -0.17)					0.22	(-0.05, 0.49)
Number of women			49,748		42,639		22,969	

Kenya excluded from analysis.
Model 1 controls for age, education, marital status, wealth quintile, urban/rural residence, and country; Model 2 controls for age, education, marital status, wealth quintile, urban/rural residence, country, and BMI, among women who are not pregnant and have not given birth in the last 2 months; Model 3 controls for age, education, marital status, wealth quintile, urban/rural residence, country, BMI, breastfeeding mode, and interaction of breastfeeding mode with HIV status, among women who gave birth in the last 5 years and are not pregnant.
* significant at p<0.05 level; ** significant at p<0.01 level; *** significant at p<0.001 level

After controlling for HIV and other factors, being underweight is strongly associated with decreased hemoglobin levels and being overweight with increased hemoglobin concentration (Model 2). The best model fit was found using the same breastfeeding mode and HIV interaction term as in the BMI model. Though mixed feeding is positively associated with hemoglobin concentration in unadjusted analysis, the relationship becomes non-significant after controlling for other factors. Exclusive breastfeeding independent of HIV status is significantly associated with a decrease in hemoglobin concentration when other factors are held constant. As the prevalence of any anemia is highest among exclusively breastfeeding women of both HIV statuses in Table 14, this result is not surprising.

As an interaction effect, breastfeeding—particularly mixed feeding—is negatively associated with HIV-positive mother's hemoglobin concentration, in unadjusted analysis. When other factors are controlled for, however, the association changes direction and the interaction term for exclusive breastfeeding*HIV is positively associated with women's hemoglobin concentration.

4

Conclusions and Policy Recommendations

Consistent with previous findings (Villamor et al. 2006; Prentice 2006; Singh et al. 2007), our study of women's HIV and nutritional status found both overweight and underweight to be common among women in many of the sub-Saharan African countries studied. Based on the natural progression of HIV, it would be expected that HIV prevalence would be highest among underweight women. But this state was found only in Malawi. In contrast, HIV prevalence is highest among overweight women in Burkina Faso, Guinea, Niger, Ethiopia, and Rwanda. Overall, HIV appears concentrated among overweight women in this total sample in bivariate analysis.

Based on this concentration of HIV among higher-BMI women, we would expect to see lower levels of anemia among HIV-positive women, as anemia is generally associated with lower BMI. In this population, however, the opposite is true: HIV prevalence is highest among women with the highest levels of anemia in all countries analyzed with the sole exception of Ethiopia.

Through multivariate analysis, the association of HIV with higher BMI levels can be explained by the confounding effects of the socio-demographic characteristics of the respondents. When these socio-demographic characteristics are controlled for, we also find that hemoglobin concentration is consistently positively associated with BMI, explaining the seemingly contradictory results of the crosstabulations. The negative relationship between HIV serostatus and hemoglobin concentration further supports the contention that HIV-positive people are disproportionately affected by undernutrition and malnutrition, and are in need of nutritional support.

The findings from multivariate analysis of the impact of breastfeeding on HIV-positive mothers are encouraging. After controlling for socio-demographic factors and HIV status, it appears that breastfeeding independently is not harmful to the nutritional status of HIV-positive mothers. The findings that the interaction between exclusive breastfeeding and HIV is associated with increased hemoglobin levels may indicate that HIV-positive mothers who are healthier are better able to breastfeed their infants than mothers with poor nutritional status. Additionally, because HIV limits fertility, we must consider that women who are HIV-positive and recently gave birth may not be a representative sample of HIV-positive women, especially with regard to their nutritional status.

Deriving recommendations from this set of analyses is complicated. Although HIV is negatively associated with BMI after controlling for other factors, the fact remains that HIV continues to affect both people who are both underweight and overweight. If past trends continue, the proportion of people in sub-Saharan Africa who are either overweight or underweight will grow. The dual burdens of rising overweight and underweight populations have particular implications for the treatment of HIV, which is becoming more widely available as many sub-Saharan countries work to scale up their ART programs.

For underweight and anemic HIV-positive people seeking treatment, the outlook is particularly bleak. ART and even highly active antiretroviral therapy (HAART) do not appear to mediate the effect of low pre-initiation BMI on faster disease progression to death (Paton et al. 2006; Jerene et al. 2006). ART among the underweight also carries particular risks, as most treatment regimens were designed for people of normal body mass. The effects of many ART and HAART medications on people who are underweight are unknown and could be harmful. In a recent South African study using nevirapine, two underweight patients died of hepatic failure and others suffered from hepatotoxicity (Sanne et al. 2005). In addition, some treatment regimens have been shown to contribute to or worsen anemia (Curkendall et al. 2007), which is of particular concern in this study population where HIV and anemia appear highly correlated.

As the proportion of people who are overweight and have related non-communicable diseases increase, so do potential problems with HIV treatment. Though higher BMI among HIV-positive people is associated with a longer lifespan (van der Sande et al. 2004; Zachariah et al. 2006), BMI levels that are too high can also contribute to treatment complications for HIV. Data from developed-country settings where ART is readily available indicate a host of obesity-related issues (high blood pressure, diabetes, high cholesterol) that are worsened by or increase risks associated with ART (Palacios et al. 2006; Moreno-Torres et al. 2007; Ledergerber et al. 2007).

In addition, food insecurity affects many people in sub-Saharan Africa, particularly the poor, and may have serious implications for adherence to HIV treatment regimens. For example, a recent study from Rwanda found that a major obstacle to accepting and adhering to ART was fear that the medication would increase the patients' appetite, without having enough to eat. This finding demonstrates that a lack of access to adequate nutrition may severely hamper the success of treatment regimens (Au et al. 2006).

In conclusion, this study provides further evidence that HIV is associated with poor nutrition, after controlling for wealth and other socio-demographic variables. We therefore support recommendations for efforts to increase food security and to provide nutritional supplementation to HIV-positive people. With or without ART, providing and/or counseling about nutrition has the potential to improve BMI and subsequently to prolong life for people living with HIV. Improving nutritional status of the malnourished could potentially even decrease susceptibility to HIV infection.

In addition, these data provide evidence that HIV is concentrated among overweight women in several sub-Saharan African countries, emphasizing the fact that HIV does not only affect those who "look sick" or have "slim disease." Implications for the general public include an emphasis for everyone to get tested regardless of how healthy they may look and for individuals to remember to use protection with every partner, even if they appear healthy. Counselors should encourage people to be tested for HIV, regardless of their current BMI, and should consider the fact that clients could be HIV-positive even if they appear overweight.

To address potential problems with ART use in overweight and underweight patients, we recommend that clinicians should consider their patient's nutritional status, up to and including Subbaraman et al.'s (2007) recommendation that clinicians titrate drug combinations to patient's body weights to limit adverse effects due to nutritional differences.

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Annex 1

Annex Table 1 Percent distribution of BMI among women age 15-49 who were tested for HIV (excluding women who were pregnant or had a birth in the last 2 months), DHS surveys with linked HIV testing

	BMI (kg/m^2)									
Country/year	<16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total	n
West Africa										
Burkina Faso 2003	2.2	3.9	14.4	52.6	17.5	7.0	2.1	0.3	100.0	3,446
Cameroon 2004	0.8	1.3	4.7	33.3	31.0	20.7	7.8	0.4	100.0	4,325
Ghana 2003	0.7	1.6	7.2	40.0	25.7	17.1	7.2	0.6	100.0	4,389
Guinea 2005	1.3	2.0	10.2	48.3	23.6	11.5	3.1	0.1	100.0	3,147
Niger 2005/06	1.9	3.9	13.4	48.0	19.8	9.8	3.0	0.2	100.0	3,503
Senegal 2005	2.5	4.1	12.0	38.5	20.6	14.7	6.9	0.6	100.0	3,710
East Africa										
Ethiopia 2005	3.5	5.5	17.8	54.0	15.0	3.6	0.5	0.1	100.0	4,965
Kenya 2003	1.5	2.3	8.4	39.1	23.8	17.8	6.8	0.3	100.0	2,728
Rwanda 2005	0.8	1.7	7.4	46.8	31.6	10.6	0.9	0.1	100.0	4,942
Southern Africa										
Lesotho 2004	0.7	1.1	3.8	26.3	27.1	25.1	14.0	1.8	100.0	2,706
Malawi 2004	0.7	1.5	6.4	47.5	30.3	10.7	2.7	0.2	100.0	2,152
Zimbabwe 2005/06	0.9	1.5	6.9	36.7	29.0	17.4	7.1	0.3	100.0	6,190

Annex 2

Annex Table 2 Distribution of HIV-positive and HIV-negative women age 15-49 (excluding women who were pregnant or had a birth in the last 2 months) by BMI status, DHS surveys with linked HIV testing

Country/year	HIV Status		BMI (kg/m^2) <16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total
West Africa											
Burkina Faso 2003	Positive	%	4.8	3.6	12.8	41.0	26.3	10.3	1.2	0.0	100.0
		n	3	2	8	26	17	7	1	0	63
	Negative	%	2.2	3.9	14.4	52.9	17.3	7.0	2.1	0.3	100.0
		n	74	130	488	1,788	586	236	71	9	3,383
Cameroon 2004	Positive	%	1.3	0.2	3.2	32.6	34.9	20.6	7.2	0.0	100.0
		n	4	1	9	91	97	58	20	0	279
	Negative	%	0.8	1.4	4.8	33.3	30.7	20.7	7.8	0.4	100.0
		n	33	56	193	1,349	1,244	837	317	17	4,046
Ghana 2003	Positive	%	1.3	0.9	4.6	43.6	25.8	17.4	6.4	0.0	100.0
		n	2	1	6	52	31	21	8	0	120
	Negative	%	0.6	1.6	7.3	39.9	25.7	17.1	7.2	0.6	100.0
		n	27	69	311	1,702	1,097	730	307	25	4,269
Guinea 2005	Positive	%	3.0	4.0	12.1	36.3	18.5	16.9	9.3	0.0	100.0
		n	2	3	8	24	12	11	6	0	67
	Negative	%	1.3	2.0	10.1	48.5	23.7	11.3	3.0	0.1	100.0
		n	40	60	312	1,495	730	349	91	3	3,080
Niger 2005/06	Positive	%	(0.0)	(0.0)	(6.3)	(24.1)	(45.5)	(19.9)	(4.2)	(0.0)	100.0
		n	0	0	2	6	12	5	1	0	26
	Negative	%	1.9	3.9	13.5	48.1	19.6	9.7	3	0.2	100.0
		n	67	137	468	1,674	682	339	105	6	3,478
Senegal 2005	Positive	%	(3.1)	(0.0)	(8.5)	(42.0)	(28.4)	(12.7)	(1.9)	(3.4)	100.0
		n	1	0	2	12	8	4	1	1	29
	Negative	%	2.5	4.1	12.1	38.5	20.6	14.7	6.9	0.6	100.0
		n	94	151	444	1,417	757	541	255	23	3,681
Total (West Africa-pooled data)	Positive	%	1.8	1.0	5.6	36.6	30.4	18.1	6.3	0.1	100.0
		n	11	6	35	226	188	112	39	1	617
	Negative	%	1.4	2.6	9.8	42.5	23.6	14.2	5.4	0.4	100.0
		n	316	579	2,142	9,329	5,176	3,122	1,194	87	21,946
East Africa											
Ethiopia 2005	Positive	%	0.6	3.0	31.7	43.1	15.3	6.0	0.4	0.0	100.0
		n	1	3	31	42	15	6	0	0	97
	Negative	%	3.5	5.5	17.5	54.2	15.0	3.6	0.6	0.1	100.0
		n	172	269	853	2,638	732	175	27	3	4,868
Kenya 2003	Positive	%	2.2	1.2	3.8	45.3	23.4	19.7	3.9	0.4	100.0
		n	5	3	9	107	55	47	9	1	236
	Negative	%	1.5	2.4	8.8	38.5	23.8	17.6	7.1	0.3	100.0
		n	37	60	220	959	593	440	176	7	2,491

Continued…

Annex Table 2—*Continued*

Country/year	HIV Status		BMI (kg/m^2)								
			<16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total
Rwanda 2005	Positive	%	0.7	1.4	6.6	47.5	28.0	13.2	2.5	0.0	100.0
		n	1	3	12	88	52	25	5	0	186
	Negative	%	0.8	1.7	7.4	46.8	31.8	10.5	0.8	0.1	100.0
		n	40	83	352	2,226	1,512	500	39	4	4,756
Total (East Africa-pooled data)	Positive	%	1.6	1.8	12.6	44.8	21.3	15.0	2.7	0.3	100.0
		n	8	9	63	224	107	75	14	1	501
	Negative	%	2.7	4.4	14.3	49.3	18.8	8.0	2.3	0.1	100.0
		n	329	521	1,712	5,901	2,253	956	280	15	11,967
Southern Africa											
Lesotho 2004	Positive	%	0.5	1.3	3.5	25.1	28.6	27.8	11.6	1.5	100.0
		n	3	9	25	181	206	201	84	11	722
	Negative	%	0.8	1.1	4.0	26.8	26.5	24.1	14.9	1.9	100.0
		n	16	21	78	531	526	479	296	37	1,985
Malawi 2004	Positive	%	0.7	2.5	8.5	45.1	28.8	12.1	2.0	0.3	100.0
		n	2	8	26	137	88	37	6	1	304
	Negative	%	0.7	1.3	6.0	47.9	30.5	10.5	2.8	0.2	100.0
		n	12	25	112	886	564	194	52	4	1,847
Zimbabwe 2005/06	Positive	%	1.0	1.9	6.5	38.3	30.4	15.8	5.8	0.2	100.0
		n	13	25	86	505	401	209	76	2	1,318
	Negative	%	0.9	1.4	7.0	36.3	28.6	17.9	7.5	0.3	100.0
		n	45	71	341	1,769	1,395	871	365	16	4,872
Total (Southern Africa-pooled data)	Positive	%	0.8	2.0	6.8	38.9	29.6	16.1	5.3	0.4	100.0
		n	17	40	135	771	587	319	104	8	1,981
	Negative	%	0.8	1.4	6.3	41.0	29.3	14.9	5.9	0.4	100.0
		n	69	118	547	3,555	2,545	1,294	511	33	8,673
Total (All countries-pooled data)	Positive	%	1.3	1.7	8.9	40.8	26.5	16.0	4.4	0.3	100.0
		n	32	41	213	980	635	385	107	7	2,401
	Negative	%	2.1	3.4	11.8	45.9	21.7	11.0	3.9	0.3	100.0
		n	900	1,489	5,151	20,045	9,459	4,819	1,688	110	43,662

Numbers in parentheses are based on 25-49 unweighted cases.

Annex 3

Annex Table 3 HIV prevalence among women age 15-49 (excluding women who were pregnant or had a birth in the last 2 months) by BMI status, DHS surveys with linked HIV testing

Country	BMI (kg/m^2)								Total HIV	
	<16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	prevalence	n
West Africa										
Burkina Faso 2003	3.9	1.7	1.6	1.4	2.7	2.7	1.0	*	1.8	3,446
Cameroon 2004	(9.7)	(0.9)	4.4	6.3	7.3	6.4	6.0	*	6.4	4,325
Ghana 2003	(5.4)	1.6	1.8	3.0	2.8	2.8	2.4	(0.0)	2.7	4,389
Guinea 2005	(4.9)	4.2	2.5	1.6	1.7	3.1	6.4	*	2.1	3,147
Niger 2005/06	0.0	0.0	0.3	0.4	1.7	1.5	1.0	*	0.7	3,503
Senegal 2005	1.0	0.0	0.6	0.9	1.1	0.7	0.2	*	0.8	3,710
East Africa										
Ethiopia 2005	0.3	1.1	3.5	1.6	2.0	3.2	1.3	*	2.0	4,965
Kenya 2003	(12.4)	4.5	3.9	10.0	8.5	9.6	5.0	*	8.7	2,728
Rwanda 2005	(3.4)	2.9	3.4	3.8	3.3	4.7	(10.5)	*	3.8	4,942
Southern Africa										
Lesotho 2004	*	(30.9)	24.5	25.5	28.2	29.6	22.0	(22.5)	26.7	2,706
Malawi 2004	*	(23.4)	18.8	13.4	13.4	16.0	10.7	*	14.1	2,152
Zimbabwe 2005/06	22.4	26.2	20.2	22.2	22.3	19.3	17.3	*	21.3	6,190

Numbers in parentheses are based on 25-49 unweighted cases. An asterisk indicates that a figure is based on fewer than 25 cases and has been suppressed.

Annex 4

Annex Table 4 Percent distribution of women age 15-49 (excluding women who were pregnant or had a birth in the last 2 months) by BMI status and selected characteristics, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

	BMI (kg/m^2)									
Characteristic	<16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total	n
West Africa										
Age										
15-19	3.2	4.5	13.7	49.0	21.4	7.4	0.8	0.0	100.0	5,207
20-24	1.0	2.2	8.6	45.7	27.8	12.6	2.0	0.1	100.0	3,962
25-29	0.6	1.8	8.3	43.5	24.9	15.8	4.6	0.3	100.0	3,512
30-34	1.1	1.7	7.9	38.2	25.5	17.6	7.5	0.5	100.0	2,869
35-39	0.7	1.8	8.6	38.4	21.6	18.8	9.8	0.2	100.0	2,756
40-44	1.0	2.4	8.8	35.8	22.1	18.2	10.6	1.1	100.0	2,279
45-49	1.1	2.4	8.3	34.9	22.7	17.9	11.3	1.3	100.0	1,978
Education										
No education	1.8	3.4	12.2	49.9	20.5	9.2	2.7	0.2	100.0	11,409
Primary incomplete	1.6	2.9	8.7	37.4	26.1	16.6	6.4	0.3	100.0	3,331
Primary complete	0.8	1.2	6.1	31.8	29.0	20.3	9.8	1.1	100.0	1,499
Secondary +	0.8	1.4	6.5	33.8	27.1	21.0	8.9	0.6	100.0	6,325
Marital status										
Never in union	3.0	4.1	12.5	43.9	24.6	10.1	1.6	0.1	100.0	5,634
In monogamous union	0.8	2.1	8.2	41.0	23.8	16.4	7.3	0.5	100.0	9,552
In polygynous union	1.1	2.3	10.0	45.7	22.1	13.2	5.3	0.5	100.0	5,749
Widowed/divorced/separated	1.2	1.7	7.3	32.9	26.6	20.7	8.8	0.8	100.0	1,629
Wealth quintile										
Lowest	1.8	3.3	11.0	52.9	23.1	6.7	1.1	0.1	100.0	3,811
Second	2.1	3.0	11.9	50.5	22.9	8.0	1.4	0.1	100.0	3,867
Middle	1.2	3.0	10.8	45.8	23.8	11.8	3.1	0.3	100.0	4,464
Fourth	1.1	2.5	9.5	38.4	24.6	16.7	6.8	0.3	100.0	4,653
Highest	1.3	1.6	6.4	30.3	24.1	23.6	11.8	0.9	100.0	5,769
Residence										
Urban	1.1	1.6	6.9	31.8	25.6	22.0	10.4	0.7	100.0	9,407
Rural	1.7	3.3	11.6	49.9	22.5	8.9	2.0	0.1	100.0	13,157
n	327	586	2,177	9,555	5,364	3,234	1,233	88		22,563
East Africa										
Age										
15-19	5.8	7.4	15.9	47.1	18.4	5.0	0.3	0.0	100.0	3,129
20-24	1.5	2.2	10.5	53.6	23.0	7.9	1.1	0.1	100.0	2,239
25-29	1.4	2.7	13.4	55.6	17.5	7.7	1.7	0.0	100.0	1,988
30-34	1.3	3.5	12.8	48.4	18.9	11.7	3.3	0.1	100.0	1,561
35-39	2.0	3.8	14.1	46.2	18.1	11.0	4.3	0.5	100.0	1,381
40-44	2.0	3.6	15.9	44.5	18.4	10.3	5.3	0.1	100.0	1,150
45-49	2.4	4.5	19.5	43.2	16.0	8.9	5.3	0.2	100.0	1,021
Education										
No education	3.0	4.8	18.7	55.3	14.0	3.3	0.7	0.1	100.0	5,629
Primary incomplete	3.4	4.8	13.5	49.0	20.1	7.8	1.4	0.1	100.0	3,434
Primary complete	1.7	3.6	6.8	42.7	25.5	14.6	4.9	0.3	100.0	1,223
Secondary +	1.3	2.5	8.1	36.9	26.0	18.1	6.8	0.2	100.0	2,182
Marital status										
Never in union	4.5	6.1	13.1	46.5	21.8	7.5	0.4	0.1	100.0	3,854
In monogamous union	2.0	3.2	14.6	50.9	17.3	8.6	3.2	0.1	100.0	6,117
In polygynous union	1.9	4.5	15.3	47.6	17.0	9.7	3.8	0.1	100.0	1,021
Widowed/divorced/separated	1.5	3.6	14.8	49.6	19.5	7.8	3.0	0.3	100.0	1,477
Wealth quintile										
Lowest	4.3	5.5	16.7	54.5	15.0	3.1	0.8	0.1	100.0	2,177
Second	2.5	4.7	17.1	51.6	17.6	5.4	1.1	0.0	100.0	2,297
Middle	3.2	4.7	15.5	50.5	18.8	5.7	1.5	0.1	100.0	2,302
Fourth	2.5	3.9	13.6	50.0	19.0	8.7	2.2	0.0	100.0	2,463
Highest	1.5	3.1	10.2	42.1	22.5	15.2	5.0	0.4	100.0	3,229
Residence										
Urban	1.4	3.6	8.9	39.0	23.9	17.3	5.5	0.4	100.0	2,578
Rural	3.0	4.4	15.6	51.8	17.6	5.9	1.6	0.1	100.0	9,891
n	337	530	1,775	6,125	2,359	1,031	294	16		12,468

Continued …

Annex Table 4—*Continued*

Characteristic	BMI (kg/m²) <16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total	n
Southern Africa										
Age										
15-19	2.2	3.1	9.8	47.0	27.4	9.1	1.3	0.2	100.0	2,315
20-24	0.4	0.9	4.5	47.2	32.9	11.8	2.3	0.1	100.0	2,260
25-29	0.3	0.9	6.0	39.0	33.5	15.2	4.7	0.4	100.0	1,741
30-34	0.4	1.0	6.2	38.1	28.4	18.3	7.1	0.4	100.0	1,475
35-39	0.2	1.0	6.0	34.3	26.7	20.9	10.2	0.6	100.0	1,083
40-44	0.8	1.7	5.4	30.9	26.8	19.6	13.9	0.9	100.0	962
45-49	0.7	0.9	5.0	32.1	25.2	22.7	12.6	0.8	100.0	819
Education										
No education	0.3	2.0	7.8	47.1	29.4	10.4	2.9	0.0	100.0	1,395
Primary incomplete	1.1	1.8	6.7	44.3	28.5	12.9	4.4	0.4	100.0	4,012
Primary complete	0.9	1.2	5.3	39.2	29.8	15.8	6.9	0.9	100.0	1,006
Secondary +	0.7	1.1	5.9	35.3	30.2	18.7	7.7	0.4	100.0	4,241
Marital status										
Never in union	2.0	2.6	9.0	43.2	28.7	12.2	2.1	0.3	100.0	2,589
In monogamous union	0.4	0.8	5.0	39.7	29.7	16.7	7.4	0.4	100.0	5,434
In polygynous union	0.2	2.1	9.2	43.1	29.3	11.2	4.6	0.2	100.0	1,058
Widowed/divorced/separated	0.8	1.7	5.2	37.6	29.7	17.4	7.1	0.5	100.0	1,573
Wealth quintile										
Lowest	0.6	2.6	7.5	49.7	27.7	9.9	1.9	0.2	100.0	1,763
Second	1.0	1.7	8.6	44.0	31.3	11.1	2.0	0.2	100.0	1,931
Middle	1.2	1.4	7.0	46.0	29.0	10.9	4.0	0.4	100.0	2,065
Fourth	0.7	1.3	5.6	38.8	29.2	17.3	6.7	0.4	100.0	2,361
Highest	0.6	0.7	4.2	28.9	29.7	23.3	11.9	0.7	100.0	2,533
Residence										
Urban	0.8	1.0	4.2	30.9	30.1	21.8	10.6	0.6	100.0	2,976
Rural	0.8	1.7	7.2	44.4	29.1	12.6	3.9	0.3	100.0	7,678
n	85	159	682	4,326	3,132	1,613	615	41		10,654
Pooled data (all countries)										
Age										
15-19	4.5	5.9	14.5	47.8	20.4	6.3	0.6	0.0	100.0	11,039
20-24	1.2	2.0	9.0	49.9	26.0	10.1	1.6	0.1	100.0	8,375
25-29	1.0	2.2	10.7	49.3	22.1	11.5	3.1	0.2	100.0	7,300
30-34	1.1	2.5	10.2	43.3	22.5	14.7	5.3	0.3	100.0	5,869
35-39	1.3	2.8	11.1	41.9	20.3	15.1	7.1	0.4	100.0	5,248
40-44	1.5	2.9	12.0	39.6	20.7	14.4	8.3	0.6	100.0	4,387
45-49	1.7	3.3	13.6	38.8	19.6	13.8	8.4	0.7	100.0	3,844
Education										
No education	2.4	4.1	15.5	52.7	17.4	6.1	1.7	0.1	100.0	20,029
Primary incomplete	2.6	3.8	11.2	45.5	23.0	10.7	3.1	0.2	100.0	11,044
Primary complete	1.3	2.6	6.4	39.2	27.0	16.4	6.5	0.6	100.0	3,959
Secondary +	1.0	1.8	7.0	35.3	27.3	19.5	7.9	0.4	100.0	11,031
Marital status										
Never in union	3.7	5.1	12.5	45.3	23.4	8.9	1.0	0.1	100.0	12,877
In monogamous union	1.4	2.5	11.3	46.2	21.0	12.2	5.1	0.3	100.0	21,555
In polygynous union	1.2	2.9	11.4	46.0	21.2	12.0	4.8	0.4	100.0	6,809
Widowed/divorced/separated	1.3	2.8	11.3	43.4	22.9	12.6	5.1	0.4	100.0	4,821
Wealth quintile										
Lowest	3.0	4.4	13.6	53.4	19.4	5.2	1.0	0.1	100.0	7,898
Second	2.2	3.8	14.3	50.3	21.1	7.0	1.3	0.1	100.0	8,251
Middle	2.2	3.7	12.7	48.2	21.9	8.7	2.4	0.2	100.0	8,779
Fourth	1.8	3.0	11.1	44.3	22.4	12.8	4.5	0.2	100.0	9,374
Highest	1.3	2.3	8.1	36.4	23.9	19.2	8.3	0.6	100.0	11,762
Residence										
Urban	1.2	2.3	7.4	34.3	25.5	20.3	8.6	0.6	100.0	13,484
Rural	2.4	3.8	13.4	50.3	20.5	7.6	2.0	0.1	100.0	32,578
n	931	1,531	5,364	21,025	10,095	5,204	1,795	117		46,063

In Lesotho, women were not asked if their husbands had other spouses. All women currently in union in Lesotho are coded as in monogamous unions.

Annex 5

Annex Table 5 HIV prevalence among women age 15-49 (excluding women who were pregnant or had a birth in the last 2 months) by BMI status and selected characteristics, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

	BMI (kg/m²)								
Characteristic	<16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total
West Africa									
Age									
15-19	0.6	0.0	0.3	0.8	0.8	1.6	(0.0)	*	0.7
20-24	(6.4)	0.6	2.2	2.7	4.6	2.1	1.5	*	3.1
25-29	(7.6)	0.0	1.7	3.0	4.2	5.8	5.0	*	3.7
30-34	(10.0)	3.3	2.5	4.3	4.4	4.8	4.1	*	4.3
35-39	(0.0)	2.9	5.0	3.3	4.3	3.6	3.3	*	3.7
40-44	(2.7)	2.4	0.9	2.1	3.3	2.7	2.3	*	2.4
45-49	(9.7)	3.0	0.4	1.9	3.9	2.2	2.7	*	2.5
Education									
No education	3.7	1.0	1.1	1.2	1.7	2.0	2.6	*	1.5
Primary incomplete	2.1	0.0	1.5	3.7	4.3	2.7	1.5	*	3.2
Primary complete	*	*	5.1	5.9	8.8	4.6	7.8	*	6.4
Secondary +	4.5	2.8	2.4	3.8	4.2	4.6	2.8	(0.0)	3.9
Marital status									
Never in union	0.5	0.0	0.7	1.2	2.5	1.5	4.8	*	1.4
In monogamous union	5.6	1.4	1.2	2.7	3.1	3.3	2.0	(0.9)	2.7
In polygynous union	8.1	1.8	1.9	1.6	2.9	2.1	2.7	(1.7)	2.1
Widowed/divorced/separated	*	(4.7)	7.9	9.5	10.5	10.3	8.7	*	9.5
Wealth quintile									
Lowest	6.6	0.4	1.8	1.5	1.7	1.3	(0.8)	*	1.6
Second	5.2	0.6	2.0	1.8	1.8	2.6	0.0	*	1.9
Middle	2.2	1.5	1.3	2.8	3.8	4.3	2.9	*	3.0
Fourth	2.6	1.5	1.2	3.5	4.2	3.9	3.4	*	3.4
Highest	0.0	1.4	1.8	2.4	4.9	3.5	3.4	(0.0)	3.3
Residence									
Urban	2.3	2.0	1.9	3.9	5.0	4.2	3.2	1.2	4.0
Rural	3.9	0.8	1.4	1.7	2.3	2.1	2.8	*	1.8
Total	3.4	1.1	1.6	2.4	3.5	3.5	3.1	1.0	2.7
East Africa									
Age									
15-19	0.0	0.1	0.8	1.4	2.0	2.1	*	*	1.3
20-24	(0.0)	1.3	3.2	4.5	3.3	7.7	(0.7)	*	4.1
25-29	(8.5)	0.0	1.5	5.4	9.0	8.4	8.6	*	5.7
30-34	*	(4.8)	2.4	4.0	5.5	10.6	6.1	*	4.9
35-39	(0.0)	(9.6)	10.9	6.2	6.6	6.6	9.3	*	7.1
40-44	*	(0.5)	8.3	3.2	3.0	13.1	1.4	*	5.3
45-49	(0.0)	(0.2)	3.1	1.0	4.8	0.6	(1.6)	*	2.0
Education									
No education	0.0	2.1	3.3	1.0	1.1	3.4	(2.2)	*	1.6
Primary incomplete	6.0	0.1	3.7	4.9	4.9	9.9	6.0	*	4.9
Primary complete	*	(1.4)	2.7	9.9	5.8	13.9	(2.3)	*	8.1
Secondary +	(2.3)	4.5	5.1	7.4	8.0	4.4	5.7	*	6.6
Marital status									
Never in union	0.0	0.1	0.7	1.5	3.3	4.3	(3.3)	*	1.8
In monogamous union	3.3	2.7	2.8	2.9	3.5	5.7	2.4	*	3.2
In polygynous union	*	(3.7)	4.6	7.4	6.0	5.5	(3.1)	*	6.2
Widowed/divorced/separated	(11.5)	(3.1)	12.7	9.8	10.8	23.4	(16.4)	*	11.5
Wealth quintile									
Lowest	3.3	0.0	0.3	1.6	1.2	3.7	*	*	1.4
Second	(2.3)	1.6	4.6	2.6	4.4	4.1	*	*	
Middle	0.4	0.4	2.9	2.2	2.9	4.8	(4.0)	*	2.4
Fourth	(3.7)	0.6	0.8	3.4	4.6	5.9	(4.8)	*	
Highest	(1.7)	6.1	9.3	7.9	7.0	9.8	5.4	*	7.9
Residence									
Urban	2.4	6.7	13.9	9.1	8.7	10.8	6.6	*	9.4
Rural	2.4	0.6	2.0	2.6	3.0	4.6	2.8	*	2.6
Total	2.4	1.7	3.6	3.7	4.5	7.3	4.6	*	4.0

Continued...

Annex Table 5—*Continued*

Characteristic	BMI (kg/m²) <16.00	16.00-16.99	17.00-18.49	18.50-21.99	22.00-24.99	25.00-29.99	30.00-39.99	≥40.00	Total
Southern Africa									
Age									
15-19	(1.6)	(6.6)	4.0	3.6	7.0	3.6	7.0	*	4.7
20-24	*	*	22.6	15.1	15.5	16.6	28.7	*	16.3
25-29	*	*	36.2	24.5	23.0	20.6	25.9	*	24.5
30-34	*	*	24.6	31.3	25.9	30.6	18.3	*	28.3
35-39	*	*	38.4	28.6	27.8	28.8	22.2	*	28.6
40-44	*	*	26.1	25.2	26.5	19.1	10.6	*	22.6
45-49	*	*	(10.3)	18.4	17.5	15.4	8.1	*	16.0
Education									
No education	*	*	24.2	15.4	13.1	14.7	(3.9)	*	15.7
Primary incomplete	(26.0)	20.9	17.2	16.0	17.7	19.1	11.2	*	17.0
Primary complete	*	*	24.2	20.6	24.5	21.7	23.6	*	22.3
Secondary +	(8.8)	20.4	19.7	20.3	20.1	20.7	20.3	(21.7)	20.2
Marital status									
Never in union	2.3	7.1	4.9	6.6	10.0	11.1	13.2	*	8.1
In monogamous union	*	37.2	24.1	16.9	15.1	16.7	13.8	(18.5)	16.7
In polygynous union	*	*	19.3	21.7	21.5	18.3	16.3	*	20.8
Widowed/divorced/separated	*	(53.8)	48.5	39.3	43.3	40.4	30.3	*	40.8
Wealth quintile									
Lowest	*	34.7	13.0	16.7	13.9	15.7	9.1	*	16.0
Second	*	(23.3)	24.9	14.7	15.7	18.6	13.6	*	16.6
Middle	(23.2)	(25.3)	24.9	16.9	20.2	13.9	14.2	*	18.2
Fourth	*	(12.7)	20.5	22.7	22.2	21.4	23.8	*	22.1
Highest	*	*	12.3	17.8	20.1	22.5	15.4	(6.0)	19.0
Residence									
Urban	*	(19.9)	22.5	22.4	21.4	23.7	17.4	(10.4)	21.7
Rural	21.6	26.5	19.2	16.6	17.7	17.2	16.5	(24.2)	17.4
Total	19.4	25.3	19.8	17.8	18.7	19.8	17.0	18.3	18.6
Pooled data (all countries)									
Age									
15-19	0.2	0.4	0.9	1.4	2.2	2.1	1.6	*	1.4
20-24	3.0	3.6	4.1	5.2	5.8	6.6	6.3	*	5.4
25-29	9.4	2.3	3.9	6.4	9.5	9.0	9.8	*	7.2
30-34	8.0	5.2	4.1	7.1	8.3	11.1	7.1	(4.5)	7.6
35-39	1.2	9.7	10.6	7.0	8.5	8.3	7.9	(0.8)	7.9
40-44	18.0	4.0	7.1	4.7	6.4	8.8	3.5	(15.2)	6.1
45-49	5.1	1.7	2.8	2.8	6.1	4.0	3.2	(1.1)	3.6
Education									
No education	1.4	2.4	2.9	1.5	2.1	3.2	2.6	(1.2)	2.0
Primary incomplete	6.9	1.9	4.8	6.6	7.6	9.3	5.3	(6.8)	6.7
Primary complete	(2.2)	2.5	5.6	10.3	9.3	11.5	7.5	(3.7)	9.4
Secondary +	4.0	5.8	6.4	8.4	8.9	7.5	7.0	9.7	8.0
Marital status*									
Never in union	0.3	0.4	1.0	1.9	3.8	4.2	6.1	*	2.3
In monogamous union	4.8	3.7	3.6	4.3	5.4	6.5	4.3	8.4	4.7
In polygynous union	7.7	3.8	4.0	4.7	5.6	4.1	3.8	(1.5)	4.7
Widowed/divorced/separated	14.8	8.3	14.6	13.9	17.5	21.7	16.1	(4.0)	15.7
Wealth quintile									
Lowest	4.5	2.4	1.5	3.1	3.4	5.1	2.3	*	3.1
Second	4.6	2.5	5.3	3.5	5.3	6.2	3.8	*	4.4
Middle	2.2	1.9	3.7	4.1	5.9	5.8	5.5	(5.5)	4.5
Fourth	3.9	1.6	2.2	5.5	7.3	7.6	7.5	(6.8)	5.8
Highest	1.5	5.5	7.3	7.0	7.9	8.6	5.9	4.6	7.3
Residence									
Urban	3.2	5.6	8.5	7.9	8.4	8.5	5.9	1.9	7.9
Rural	3.5	2.0	2.9	3.8	5.2	6.1	6.0	14.8	4.1
Total	3.4	1.1	1.6	2.4	3.5	3.5	3.1	1.0	2.7

Numbers in parentheses are based on 24-49 unweighted cases. An asterisk indicates that a figure is based on fewer than 25 unweighted cases and has been suppressed.

Annex 6

To assess the impact that women's knowledge and health program exposure may have had on breastfeeding practices, Annex Table 6 presents women's breastfeeding modes by knowledge of their status, modes of transmission, and prevention of MTCT. Although the risk of transmission of HIV via breastmilk is highest for infants under 2 months (De Cock et al. 2000), WHO recommendations at the time these surveys were conducted were for all HIV-negative women to exclusively breastfeed until six months, and for HIV-positive women to exclusively breastfeed until six months unless replacement feeding conforms with the AFASS criteria (WHO 2001). This table therefore includes all mothers of infants less than six months old.

Though the majority of women in this sample know that HIV can be transmitted by breastfeeding (80 percent of HIV-positive and 68 percent of HIV-negative women), less than half of women know about PMTCT medications (43 percent of HIV-positive and 23 percent of HIV-negative women). And although most women received ANC during their last pregnancy (62-91 percent), just over half of HIV-positive women and one-quarter of HIV-negative women were counseled about MTCT (58 percent and 26 percent, respectively). Further, only 12 percent of HIV-positive and 6 percent of HIV-negative women are aware of their status. An additional 11 percent of HIV-positive women and 4 percent of HIV-negative women may be aware of their status, measured through ever having been tested and received their results. As 77-88 percent of HIV-positive women are most likely unaware they are positive, it would be surprising if many women followed WHO guidelines on breastfeeding for HIV-positive mothers.

One promising indication from these data is that HIV-positive women who know about PMTCT medications appear slightly more likely to exclusively breastfeed than women who are not aware of the drugs. HIV-positive women also appear more likely to follow WHO infant feeding guidelines if they know their HIV status, measured by testing and receiving their results in the last year (preceding DHS testing), although there are few women in this category. These could be cases of reverse causality, however, as women may have learned about PMTCT breastfeeding recommendations and medications when they were tested, and they may have received counseling and/or breastfeeding support through PMTCT services.

Annex Table 6 Exposure to HIV testing, ANC, and knowledge about MTCT, by women's HIV status and infant feeding practice among women 15-49 living with their last-born children <6 months old, all countries (pooled data)

Characteristics	HIV-positive women					HIV-negative women				
	No breastfeeding	Exclusively breastfeeding	Mixed feeding	Total	n	No breastfeeding	Exclusively breastfeeding	Mixed feeding	Total	n
Knows HIV can be transmitted by breastfeeding										
No	(0.1)	(25.0)	(74.9)	(100.0)	32	1.1	34.2	64.6	100.0	1,442
Yes	1.0	32.9	66.1	100.0	127	0.8	39.5	59.7	100.0	2,669
Knows risk of MTCT can be reduced by mother taking special drugs during pregnancy[1]										
No	0.4	24.7	75.0	100.0	73	0.9	38.8	60.3	100.0	2,646
Yes	1.6	48.9	49.5	100.0	56	1.3	44.4	54.3	100.0	776
Knows HIV can be transmitted by breastfeeding and risk of MTCT can be reduced by mother taking special drugs during pregnancy[1]										
No	0.4	28.4	71.2	100.0	79	0.8	38.8	60.4	100.0	2,714
Yes	1.8	45.6	52.6	100.0	51	1.4	45.5	53.1	100.0	704
Received ANC during last pregnancy										
No	*	*	*	*	15	1.1	41.4	57.5	100.0	1,544
Yes	0.7	28.9	70.4	100.0	144	0.8	35.3	63.9	100.0	2,571
Received ANC and counselled about MTCT during last pregnancy[2]										
No	0.5	31.2	68.4	100.0	64	1.1	37.9	61.1	100.0	2,811
Yes	1.0	32.2	66.7	100.0	89	0.5	42.5	57.0	100.0	970
Ever tested and received results[1]										
No	0.2	32.5	67.4	100.0	118	0.9	39.2	59.9	100.0	3,346
Yes	2.9	29.5	67.6	100.0	36	0.8	38.2	61.0	100.0	435
Tested in last 12 months and received results[2]										
No	0.3	30.5	69.2	100.0	136	0.9	38.7	60.4	100.0	3,547
Yes	(4.4)	(41.9)	(53.7)	(100.0)	18	0.9	44.4	54.7	100.0	235

Numbers in parentheses are based on 25-49 unweighted cases. An asterisk indicates that a figure is based on fewer than 25 cases and has been suppressed.
[1] Question not asked in Burkina Faso or Cameroon
[2] Question not asked in Burkina Faso

Annex 7

Annex Table 7.1 Distribution of BMI among HIV-positive women (excluding women who were pregnant or had a birth in the last 2 months) by whether or not they were previously tested for HIV and received their results in the 12 months prior to interview, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

	BMI (kg/m²)				
Region	<18.50	18.50-24.99	≥25.00	Total	n
West Africa[1]					
Never tested and received results	8.1	66.7	25.2	100.0	455
Tested and received results in last 12 months	(0.0)	(62.6)	(37.4)	(100.0)	36
Tested and received results, not in last 12 months	3.4	72.0	24.6	100.0	64
East Africa					
Never tested and received results	17.9	65.7	16.5	100.0	412
Tested and received results in last 12 months	1.7	90.1	8.2	100.0	35
Tested and received results, not in last 12 months	10.6	54.1	35.3	100.0	55
Southern Africa					
Never tested and received results	9.3	70.5	20.2	100.0	1,555
Tested and received results in last 12 months	11.3	63.3	25.3	100.0	184
Tested and received results, not in last 12 months	10.7	60.2	29.2	100.0	241
Total (all countries pooled data)[1]					
Never tested and received results	12.6	67.8	19.5	100.0	1,897
Tested and received results in last 12 months	6.2	72.8	21.0	100.0	184
Tested and received results, not in last 12 months	9.3	59.9	30.7	100.0	272

[1] Prior testing and results received not asked in Burkina Faso; Burkina Faso data not included in analysis
Numbers in parentheses are based on 25-49 unweighted cases.

Annex Table 7.2 Distribution of anemia status among HIV-positive women 15-49 by whether or not they were previously tested for HIV and received their results in the 12 months prior to interview, separately for West Africa, East Africa, Southern Africa, and all countries (pooled data)

		Anemic			
Region	Not anemic	Mildly	Moderately - Severely	Total	n
West Africa[1]					
Never tested and received results	33.8	42.3	23.9	100.0	530
Tested and received results in last 12 months	(33.7)	(46.5)	(19.8)	(100.0)	40
Tested and received results, not in last 12 months	48.4	17.3	34.3	100.0	77
East Africa[2]					
Never tested and received results	63.3	25.0	11.7	100.0	193
Tested and received results in last 12 months	73.0	15.2	11.9	100.0	17
Tested and received results, not in last 12 months	65.8	21.8	12.3	100.0	21
Southern Africa					
Never tested and received results	44.5	35.5	20.0	100.0	1,677
Tested and received results in last 12 months	43.0	39.5	17.5	100.0	200
Tested and received results, not in last 12 months	47.2	36.0	16.8	100.0	259
Total (all countries pooled)[1, 2]					
Never tested and received results	45.8	35.0	19.2	100.0	1,726
Tested and received results in last 12 months	46.9	36.2	16.9	100.0	177
Tested and received results, not in last 12 months	50.6	28.8	20.7	100.0	246

[1] Prior testing and results received not asked in Burkina Faso; Burkina Faso data not included in analysis
[2] Anemia data not collected in Kenya; Kenya not included in analysis
Numbers in parentheses are based on 25-49 unweighted cases.

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