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Trends and Determinants of Anemia in Uganda: Further Analysis of the Demographic and Health Surveys

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DHS Working Paper No. 149

Trends and Determinants of Anemia in Uganda:

Further Analysis of the Demographic and Health Surveys

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Additional information about the 2016 UDHS or other UDHS surveys may be obtained from the Directorate of Population and Social Statistics, Uganda Bureau of Statistics, Colville Street, P.O. Box 7186, Kampala, Uganda; telephone +256-414-706000; email: ubos@ubos.org; Internet: www.ubos.org.

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ABSTRACT

Anemia is a public health problem in many developing countries. It affects a sizable proportion of children under age 5 and women of reproductive age. Anemia increases the risk of morbidity and mortality from infectious diseases, and can lead to poor fetal outcomes, inadequate bodily development, and low productivity. This study analyzed data from the Uganda Demographic and Health Surveys conducted in 2006, 2011, and 2016 to understand the trends and determinants of anemia in children age 6-59 months and women age 15-49. Bivariate analysis and multiple logistic regression analysis examined the association between the outcome variables and the determinants.

The results of the analysis show that anemia levels decreased in Uganda between 2006 and 2016, but with an increase between 2011 and 2016. The overall prevalence of anemia among children was 73% in 2006, 50% in 2011, and 53% in 2016. Among women, anemia prevalence was 49%, 23%, and 32% respectively in 2006, 2011, and 2006. Among the children studied, recent child sickness and maternal anemia were significantly associated with childhood anemia in all 3 years. Children who took drugs for intestinal worms had lower odds for anemia in 2006 and 2016. Household wealth, region, and maternal age were also associated with anemia in children. Women who were pregnant at the time of the survey had higher odds of being anemic across the surveys. Women in poorer households and women using nonimproved sources of drinking water also had higher odds for anemia. Interventions to reduce cases of anemia in children and women should address access to health care, treatment of sicknesses, improvement in household income, and women's empowerment.

Key words: Anemia prevalence, children under age 5, women of reproductive age, anemia trends and determinants, Uganda

1 INTRODUCTION

1.1 Background

Anemia is a major global public health concern, affecting approximately 2 billion people. In low- and middle-income countries, 47% of children age 6-59 months and 30% of women of reproductive age 15-49 suffer from anemia (World Health Organization 2014a). In Africa anemia affects 62% of children under age 5 and 33% of women of reproductive age (World Health Organization 2017). It also contributes to three-quarters of mortality in Africa and Southeast Asia (Osungbade and Oladunjoye 2012).

The World Health Organization (WHO) defines anemia as "a condition in which the number of red blood cells or their oxygen-carrying capacity is insufficient to meet the body's physiologic needs" (World Health Organization 2011b). It is diagnosed by establishing one's hemoglobin (Hb) levels through conducting blood tests. Anemia is caused by many factors, including iron deficiency, infections, genetics, and other nutritional deficiencies (Bharati, Som, Chakrabarty, Bharati, and Pal 2008; Kassebaum et al. 2014; Maaz, Tariq, Bhatti, and Ikram 2019; Stevens et al. 2013; World Health Organization 2014a, 2017).

The effects of anemia in a population are both short and long term. Among children, anemia leads to impaired cognitive development and increased expenditures on care for sick children, at both the household and national levels. In pregnant women, anemia is related to poor maternal health and fetal outcomes, which may include infections, illnesses, and possible death for both the mother and the baby (Ndibazza et al. 2010; World Health Organization 2017).

Reported risk factors for anemia in children include maternal anemia, sociodemographic status, number of children in the household, illness, poor sanitation, and the child's sex (Ayoya et al. 2013; Kikafunda, Lukwago, and Turyashemererwa 2009; Ngesa and Mwambi 2014; Simbauranga, Kamugisha, Hokororo, Kidenya, and Makani 2015; Stevens et al. 2013). The number of children in the household greatly affects the amount of household resources available per child, and consequently the feeding patterns of the household members. In addition, Uganda is a malaria-endemic region, and children under age 5 are among the population at risk. A study in Uganda found that children with malaria infection were more anemic than those without, implying that malaria increases the risk of anemia in children (Menon and Yoon 2015). In addition, children in rural areas and those in households with poor sanitation facilities are at risk of worm infections, which increase the risk of anemia (Stevens et al. 2013).

In women, common risk factors include residence, socioeconomic status, maternal education, and pregnancy status (Bharati et al. 2008; Gebremedhin and Enquselassie 2011; Kikafunda et al. 2009). Women of reproductive age have higher risk of anemia due to regular blood loss with menstruation, pregnancy, and childbirth (World Health Organization 2017). If the dietary requirements during pregnancy are not met or no iron supplements are taken, the risk of anemia among this group increases. In a number of households in developing countries, iron-rich foods needed to replenish such blood loss in women are either missing or insufficient (Torheim, Ferguson, Penrose, and Arimond 2010).

Many countries have sought support to combat this preventable public health concern. In 2014 a comprehensive plan on maternal, infant, and young child nutrition was approved by the World Health Assembly, with anemia being one of the global targets for reduction (by 50%) by 2025 and subsequent alleviation (World Health Organization 2014a, 2014b). Furthermore, countries including India, Pakistan, Ethiopia, Yemen, Nigeria, Malawi, and Uganda have systematically established investigations to understand the problems in their local contexts in order to design targeted approaches to combat the condition (Al-alimi, Bashanfer, and Morish 2018; Bekele, Tilahun, and Mekuria 2016; Habib et al. 2016; Kikafunda et al. 2009; Osungbade and Oladunjoye 2012; Sedlander, Rimal, Talegawkar, Yilma, and Munar 2018).

In Uganda the Ministry of Health has put in place deliberate interventions to improve maternal and child health outcomes through the Reproductive, Maternal, Neonatal and Child Health Sharpened Plan (MOH 2013). In addition, with support from development partners, the government embarked on a number of multisectoral nutrition interventions that include: the production of biofortified and iron-rich crops, provision of iron, anthelmintic and Vitamin A supplementation, promotion of breastfeeding, complementary feeding, family planning, delayed cord clamping, intensified malaria prevention and treatment, promotion of hygiene through increased access to water, improved latrines, hand washing, and infectious disease prevention (Government of Uganda 2015; MOH 2010; USAID 2016).

Despite multisectoral efforts to reduce the burden of anemia in Uganda, the 2016 Uganda Demographic and Health Survey (UDHS) reported that the prevalence of anemia was 53% in children age 6-59 months, up from 49% in 2011, and was 32% in women of reproductive age, up from 23% in 2011 (Uganda Bureau of Statistics–UBOS and ICF 2018; Uganda Bureau of Statistics–UBOS and ICF International 2012).

Past studies in Uganda have examined anemia using survey data for specific districts or regions (Kiggundu et al. 2013; Kikafunda et al. 2009; Kuziga, Adoke, and Wanyenze 2017; Legason, Atiku, Ssenyonga, Olupot-Olupot, and Barugahare 2017), but few have used multiple DHS datasets or considered a country-wide anemia assessment. In contrast, our study addresses the above gap by analyzing the anemia situation at a national scale and considering nationally representative DHS data for three survey years (2006, 2011, and 2016). The analyses were conducted for children age 6-59 months and women of reproductive age 15-49. The specific objective of this study was to identify factors associated with anemia in children and women in Uganda.

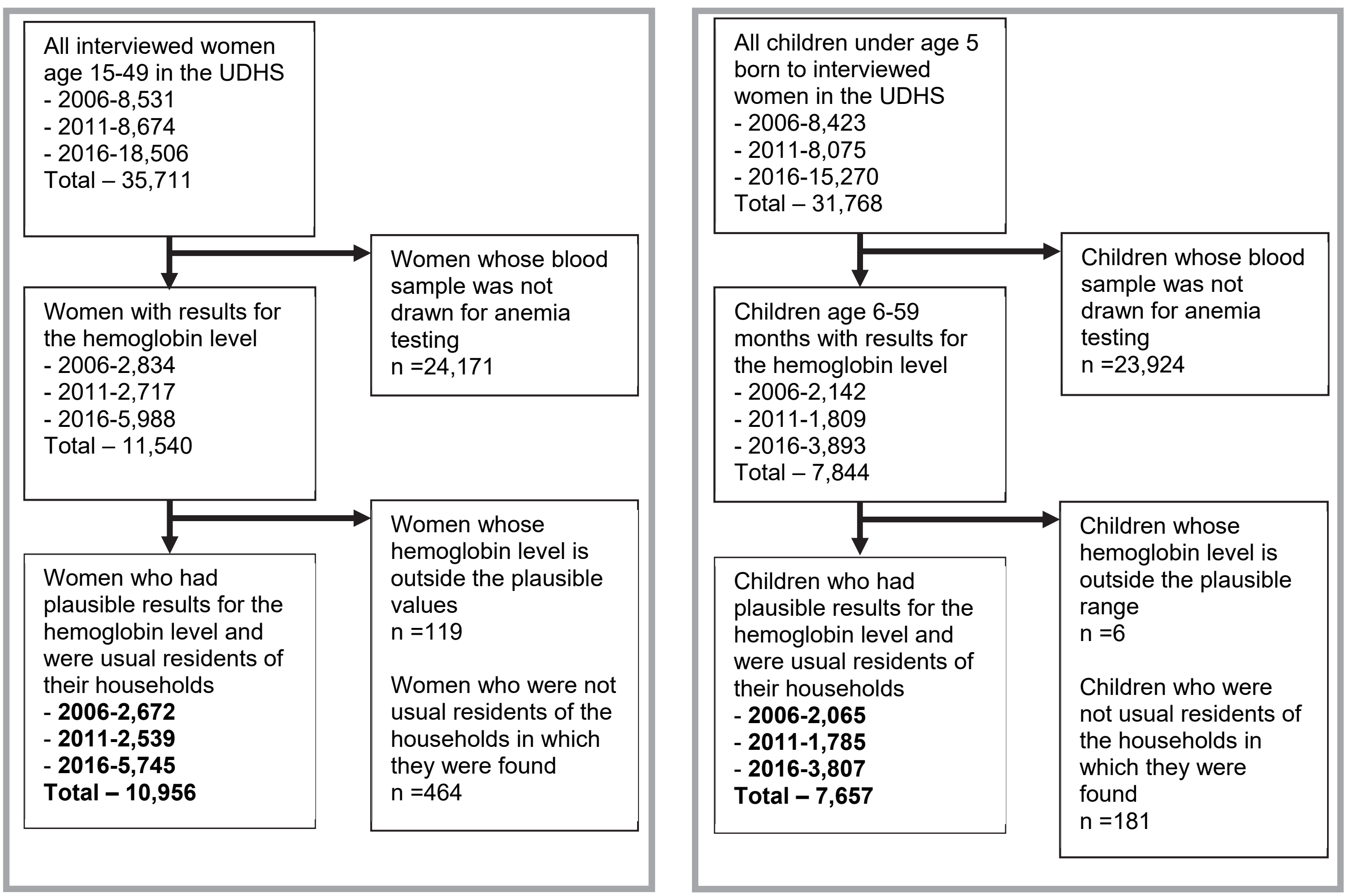
2 METHODS

2.1 Data Source

The study used datasets from the 2006, 2011, and 2016 Uganda Demographic and Health Survey (UDHS). The UDHS is a nationally representative survey conducted every 5 years. It captures information in such areas as nutrition of children, births to women age 15-49, women's characteristics, children's characteristics, and household characteristics. In this study we only considered women and children whose blood sample had been drawn for testing, who had a test result for the anemia level, and who were usual members of the household in which they were surveyed. These criteria resulted in 10,956 weighted cases for women and 7,657 cases for children.

Figure 1 Sample derivation flow diagram

Derivation of the women sample | Derivation of the children sample



2.2 Measurement of Outcome Variables

Anemia was marked by low levels of hemoglobin in the blood. For the analysis, all children who had less than 11.0 grams of hemoglobin per deciliter were coded as anemic, and children with 11.0 grams or higher were categorized as not anemic. Among nonpregnant women age 15-49, those with hemoglobin values less than 11.0 grams per deciliter (g/dl) were considered anemic. Pregnant women who had hemoglobin less than 12.0 grams were recoded as anemic. Cases of children and nonpregnant women with hemoglobin values below 4.0 grams per deciliter and those above 18.0 grams per deciliter (g/dl) were regarded as implausible. Also, hemoglobin values below 3.0 grams per deciliter and those above 17.0 grams per deciliter (g/dl) in pregnant women were regarded as implausible. All implausible cases were excluded from the analysis.

For the analysis of the data on children, the dependent variable—child's anemia status—was recoded into a binary outcome variable. All those who were anemic, whether severe, moderate, or mild, were recoded as yes, and nonanemic cases were recoded as no. Similarly, for the analysis of the data on women, the dependent variable—woman's anemia status—was recoded into a binary outcome variable. All women who were anemic were recoded as yes, and all the nonanemic were recoded as no.

2.3 Measurement of Other Explanatory Variables

For the analysis, covariates from the community, household, and individual levels were included, based on the bioecological conceptual framework (Bronfenbrenner and Morris 2006). Community-level variables included residence (urban/rural) and region. The region variable for the 2011 and 2016 UDHS was recoded as in the 2006 UDHS, for comparability. It was categorized as Kampala, Central 1, Central 2, East Central, Eastern, Northern, West Nile, Western, and South Western.

Household-level variables included wealth index, sex of the household head, type of toilet facility, source of drinking water, and number of children in the household. Wealth index was coded as 1 poorest, 2 poorer, 3 middle, 4 richer, and 5 richest. Sex of the household head was coded as 1 male and 2 female. Type of toilet facility was recoded as 1 improved toilet, 2 shared toilet, 3 nonimproved toilet, and 4 no facility. Source of drinking water was grouped into improved and nonimproved as in the DHS grouping. Number of children under age 5 in the household was recoded as 1, 2, 3, and 4, for households with one, two, three, and more than three children respectively.

Individual-level variables were included for both women and children. Variables for women included age, educational attainment, involvement in decision-making, ever giving birth, access to health services, pregnancy status, and anemia status. Age was coded into seven groups: 15-19, 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49. Educational attainment was coded as 0 no education, 1 primary, 2 secondary, and 3 higher. Involvement in decision-making was generated from three variables: Women who were involved in decision-making individually or jointly with their partner regarding spending of their income, their own health care, and household purchases were recoded as 1 involved, otherwise 0 not involved. All missing cases were recoded as 9.

Women who reported having given birth were recoded as 1 yes, otherwise 0 no. Access to health care was recoded as 1 yes, otherwise 0 no, depending on whether distance to facility was reported as a big problem in accessing health care or not. Pregnancy status was coded as 1 yes for women who reported they were pregnant at the time of the survey, and 0 no for women who were not pregnant or not sure of their status. Maternal anemia status was recoded as 1 yes for women who were anemic, and nonanemic women were recoded as 0 no.

Variables for children included sex (coded as 1, male, and 2, female), birth weight, sickness in last 2 weeks preceding the survey, and deworming in the 6 months preceding the survey. Birth weight was recoded as < 2.5 kgs for children whose weight at birth was less than 2.5 kilograms, 2.5+ kgs for children who were 2.5 or more kilograms at birth, and 3 for those who were not weighed at birth or whose weight was not known. All children who had suffered from any of the three sicknesses—fever, diarrhea, and cough—were recoded as 1, yes, and children who had none of the three were recoded as 0, no, to generate the variable for sickness in last 2 weeks. All don't know cases were omitted from the analysis. Deworming was recoded as 1, yes, for children who were reported to have taken drugs for intestinal parasites in the last 6 months before the survey, otherwise 0, no.

2.4 Statistical Analyses

Only women and children who had plausible results of the blood hemoglobin levels were included in the analyses. Data for both the women and children in the sample were weighted using the women's individual sample weight to adjust for nonresponse and disproportionate selection. The *svy* command was used to account for complex survey design. The independent variables were tested for multicollinearity using the pairwise correlation coefficient and only variables with a relationship below 0.5 cutoff were included in the analysis (Vatcheva, Lee, McCormick, and Rahbar 2016).

Bivariate analyses were conducted to examine association between the dependent variable (anemia) and the explanatory variables. Pearson's chi-squared ($\chi 2$) tests were used to examine the significant differences between anemia and the explanatory variables. Statistical significance using p-values was set at $p < 0.05$. Multivariate logistic regressions were used to examine the relationship between anemia status and the determinant variables. The results are presented for four models: Model 1 for 2006; Model 2 for 2011; Model 3 for 2016; and Model 4 for pooled data for the 3 survey years. Adjusted odds ratios and 95% confidence intervals are presented. All analyses were conducted using Stata version 15, and results are reported for the UDHS survey years 2006, 2011, and 2016.

2.5 Ethical Considerations

We sought permission to use the UDHS datasets from The DHS Program website https://www.dhsprogram.com/data/available-datasets.cfm. The ORC MACRO Institutional Review Board (IRB) reviewed and approved the 2006 UDHS. The ICF Macro IRB reviewed and approved the MEASURE Phase III Demographic and Health Surveys Program (also known as DHS-6), and the 2011 UDHS is categorized under that approval; UBOS carried out the 2011 UDHS within its mandate provided in the UBOS Act of 1998. The ICF IRB reviewed and approved the 2016 UDHS. The ORC MACRO, ICF Macro, and ICF IRBs complied with the United States Department of Health and Human Services regulations for the protection of human research subjects (45 CFR 46). Further details regarding the conduct of the study may be found in the 2016 UDHS report (Uganda Bureau of Statistics – UBOS and ICF 2018).

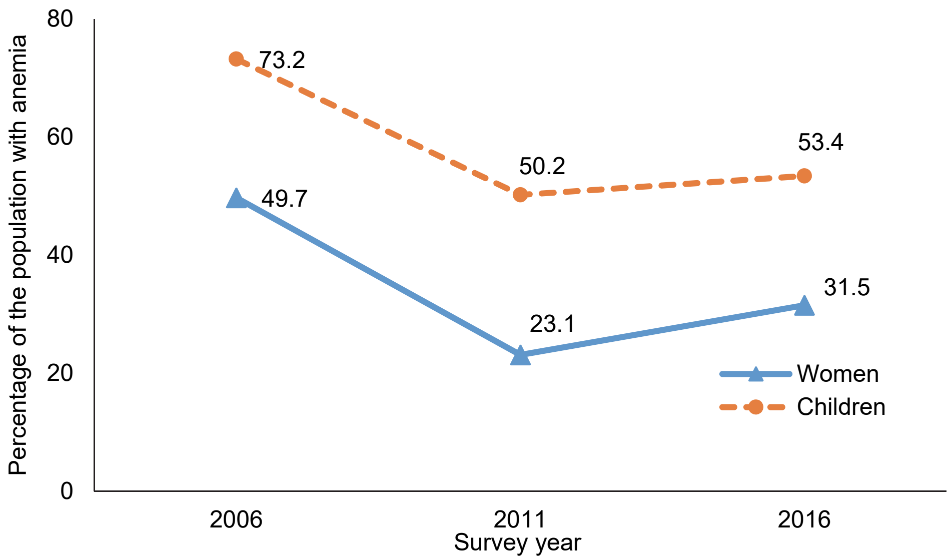
2.6 Study Limitations

This study is based on data from a cross-sectional survey, and therefore it is not possible to assess causal relationships, but only associations between the variables. The study did not include dietary data because this information was only collected for children under age 24 months, although the study considered children under age 60 months and women of the reproductive age 15-49. It was therefore not possible to assess associations between diet and the anemia status of women and children in our sample.

3 RESULTS

As Figure 2 shows, the proportion of anemia in children age 6-59 months declined from 73% to 53% between 2006 and 2016. However, between 2011 and 2016, anemia in children increased by 3.2 percentage points. In a similar trend, anemia among women age 15-49 declined from 49% to 32% between 2006 and 2016, but the proportion then increased by 8.4 percentage points between 2011 and 2016.

Figure 2 Trends of anemia among women age 15-49 and children age 6-59 months across the 3 survey years, UDHS 2006, 2011, 2016



3.1 Descriptive and Bivariate Analyses

Results of the analysis of data for children presented in Table 1 show that sickness in the last 2 weeks was associated with anemia among children in all the survey years. Among children in the sample reported to have been sick in the 2 weeks preceding the survey, 77%, 54%, and 57% were anemic in 2006, 2011, and 2016 respectively. Deworming for intestinal parasites was also associated with anemia in children. Results show that among children who took drugs for intestinal parasites, 68% in 2006, 49% in 2011, and 49% in 2016 were anemic. Maternal anemia was significantly associated with anemia in children; among children who had anemic mothers, 79%, 64%, and 65% in the respective survey years were anemic as well. The proportion of anemic children in rural areas was higher than in urban areas in all three years, at 75%, 52%, and 55% respectively. Prevalence of childhood anemia varied across regions; in 2016, for example, the range was from 32% in the South Western region to 66% in the Northern region. The proportion of children with anemia was highest among children in the poorest households and lowest among children in the richest households across all the survey years.

Results for women presented in Table 2 show that 64%, 31%, and 38% of pregnant women were anemic in 2006, 2011, and 2016 respectively, substantially higher than the prevalence of anemia among nonpregnant women, at 48%, 22%, and 31% in the respective survey years. By women's involvement in household decision-making, 52%, 24%, and 30% of women who reported being involved in decision-making in 2006, 2011, and 2016 respectively were anemic, somewhat lower than the 53%, 30%, and 36% of women who were not involved in decision-making. Anemia was also associated with household toilet facility; across the survey years 59%, 33% and 39% of women in households that reported no toilet facility were anemic. Region was significantly associated with anemia among women, though the prevalence varied across regions. Further, women in poorer households had higher prevalence of anemia than those in wealthier households across the survey years.

Table 1 Bivariate analysis showing the proportion of children age 6-59 months who were anemic by child and maternal background characteristics, UDHS 2006, 2011, 2016

	2006 UDHS		2011 UDHS		2016 UDHS		Pooled data	
Variables	p-value/ percent	n	p-value/ percent	n	p-value/ percent	n	p-value/ percent	n
Place of residence	**(0.000)**		**(0.000)**		**(0.036)**		**(0.000)**	
Urban	58.6	203	38.4	231	48.4	800	48.2	1,234
Rural	74.8	1,862	51.9	1,554	54.7	3,007	59.9	6,423
Region	**(0.000)**		**(0.000)**		**(0.000)**		**(0.000)**	
Kampala	52.3	98	39.5	108	52.7	118	48.2	324
Central1	80.6	204	56.5	142	52.9	480	60.3	825
Central2	74.0	175	57.1	147	55.5	398	60.3	720
East Central	80.2	228	68.8	223	62.4	414	68.7	866
Eastern	80.5	328	57.4	361	52.4	630	60.7	1,319
Northern	81.3	324	46.8	231	66.2	515	66.6	1,069
West Nile	71.6	119	68.3	114	56.5	266	62.8	499
Western	64.0	315	35.7	247	49.6	574	50.5	1,136
South Western	62.2	274	25.2	212	31.9	413	39.5	899
Wealth index	**(0.000)**		**(0.000)**		**(0.000)**		**(0.000)**	
Poorest	80.1	438	61.8	412	66.5	860	68.9	1,710
Poorer	75.2	454	52.7	379	56.0	786	60.6	1,619
Middle	73.1	462	52.0	373	47.9	742	56.2	1,578
Richer	73.4	383	41.9	327	47.9	674	53.6	1,383
Richest	61.4	328	37.4	294	45.8	744	47.7	1,366
Type of toilet facility	**(0.026)**		(0.052)		**(0.000)**		**(0.000)**	
Improved toilet	68.4	121	45.9	244	52.9	692	53.1	1,057
Shared toilet	69.6	251	47.2	272	47.3	661	52.0	1,184
Nonimproved toilet	72.9	1,425	49.5	1,050	53.3	2,172	58.4	4,648
No facility	80.9	264	61.6	218	69.1	282	71.0	764
Source of drinking water	(0.664)		(0.887)		**(0.036)**		(0.507)	
Improved	73.6	1,386	50.3	1,289	54.6	2,936	58.3	5,611
Nonimproved	72.5	679	49.8	495	49.4	871	57.2	2,046
Sex of the household head	(0.669)		(0.492)		(0.766)		(0.660)	
Male	73.0	1,631	50.7	1,383	53.2	2,849	58.1	5,863
Female	74.1	434	48.2	402	53.8	958	57.5	1,794
Number of children in household	(0.789)		(0.086)		**(0.000)**		**(0.000)**	
1 child	71.8	455	45.9	409	49.7	1,128	54.0	1,992
2 children	72.9	1,003	49.6	831	52.6	1,849	57.4	3,684
3 children	75.4	486	52.1	438	61.6	673	63.2	1,597
4+ children	72.7	121	62.5	106	53.6	157	62.1	384
Age of mother	**(0.005)**		(0.423)		**(0.000)**		**(0.000)**	
15-19	88.6	70	56.9	79	77.5	172	74.9	321
20-24	73.6	507	53.1	403	58.1	939	61.3	1,849
25-29	68.6	544	50.9	514	48.9	1,020	54.9	2,078
30-34	77.6	474	45.6	367	53.4	762	58.7	1,603
35-39	71.0	285	50.0	274	50.3	576	55.4	1,134
40-44	75.9	152	51.8	105	45.4	272	55.4	529
45-49	56.5	33	37.4	44	51.7	66	48.4	143
Mother's level of education	(0.149)		(0.270)		**(0.000)**		**(0.000)**	
No education	75.4	471	49.5	230	61.4	430	64.8	1,131
Primary	73.5	1,329	51.8	1,181	53.8	2,352	58.7	4,863
Secondary	70.0	218	46.5	308	51.5	787	53.4	1,313
Higher	59.5	47	40.0	66	40.6	237	43.0	350
Mother's anemia status	**(0.000)**		**(0.000)**		**(0.000)**		**(0.000)**	
No	66.6	981	45.7	1,330	48.0	2,615	51.1	4,926
Yes	79.4	1,069	64.3	432	65.1	1,170	70.7	2,670

Continued...

Table 1—*Continued*

Whether mother is involved in decision-making	(0.688)		**(0.016)**		**(0.012)**		**(0.000)**	
No	75.0	425	58.5	339	57.7	449	64.0	1,213
Yes	72.9	1,411	48.9	1,249	51.7	2,842	56.5	5,502
Missing	72.0	229	44.0	197	58.7	516	58.9	942
Distance to facility a big problem	(0.341)		(0.488)		**(0.001)**		**(0.000)**	
No	71.9	851	51.2	951	50.7	2,224	55.3	4,027
Yes	74.1	1,212	49.0	834	57.1	1,583	60.9	3,628
Sex of child	**(0.014)**		(0.628)		(0.099)		**(0.012)**	
Male	75.9	1,030	50.9	888	54.9	1,911	59.6	3,828
Female	70.6	1,036	49.4	897	51.8	1,896	56.3	3,828
Child's birth weight	(0.693)		(0.095)		(0.683)		**(0.002)**	
Less than 2.5 kgs	72.5	63	35.8	85	56.6	234	54.6	382
2.5 kgs or more	72.1	621	51.2	804	53.2	2,298	55.9	3,723
Don't know/Not weighed at birth	74.0	1,371	50.6	896	53.0	1,275	60.5	3,542
Sickness in last two weeks	**(0.000)**		**(0.000)**		**(0.000)**		**(0.000)**	
No	64.5	640	40.5	535	47.2	1,318	50.3	2,484
Yes	77.2	1,421	54.3	1,273	56.6	2,487	61.7	5,166
Child given drugs for intestinal parasites	**(0.000)**		**(0.045)**		**(0.000)**		**(0.000)**	
No	77.1	1,198	51.4	873	60.5	1,537	63.8	3,608
Yes	67.9	867	49.0	912	48.5	2,270	52.8	4,049
Total	**73.2 (N=2,065)**		**50.2 (N=1,785)**		**53.4 (N=3,807)**		**58.0 (N=7,657)**	

Table 2 Bivariate analysis showing the proportion of women age 15-49 who were anemic over the survey years by background characteristics, UDHS 2006, 2011, 2016

	2006 UDHS		**2011 UDHS**		**2016 UDHS**		**Pooled Data**	
Variables	**p-value/ percent**	**n**	**p-value/ percent**	**n**	**p-value/ percent**	**n**	**p-value/ percent**	**n**
Place of residence	**(0.000)**		(0.140)		**(0.003)**		**(0.000)**	
Urban	35.0	429	19.9	509	27.5	1,485	27.2	2,423
Rural	52.5	2,244	23.8	2,030	32.9	4,260	35.9	8,534
Region	**(0.000)**		**(0.000)**		**(0.000)**		**(0.000)**	
Kampala	33.2	204	19.6	243	25.3	294	25.6	741
Central1	59.7	284	23.6	261	27.8	757	33.9	1,303
Central2	42.1	240	30.3	243	31.6	614	33.6	1,097
East Central	48.9	257	29.8	269	39.2	608	39.1	1,134
Eastern	50.4	369	28.4	378	27.3	916	32.7	1,663
Northern	63.8	405	21.0	290	41.2	754	43.4	1,449
West Nile	37.4	149	32.1	161	39.8	374	37.4	685
Western	45.5	409	17.4	372	30.5	754	31.3	1,535
South Western	50.1	353	11.7	324	23.0	675	27.4	1,352
Wealth index	**(0.000)**		**(0.029)**		**(0.000)**		**(0.000)**	
Poorest	57.9	468	28.6	446	40.7	1,037	42.0	1,952
Poorer	55.9	520	26.4	448	32.9	1,029	37.4	1,998
Middle	50.4	500	19.4	469	30.8	1,079	32.9	2,048
Richer	48.1	527	22.2	540	31.0	1,168	32.9	2,235
Richest	39.6	657	20.2	636	25.0	1,432	27.4	2,725
Type of toilet facility	**(0.001)**		**(0.044)**		**(0.000)**		**(0.000)**	
Improved toilet	44.8	244	21.7	422	29.7	1,318	29.8	1,985
Shared toilet	42.2	431	22.9	501	26.8	1,090	29.2	2,022
Nonimproved toilet	50.7	1,701	22.0	1,403	33.2	3,018	35.5	6,122
No facility	58.8	291	33.0	212	39.3	319	44.6	822
Source of drinking water	(0.071)		(0.948)		**(0.023)**		**(0.001)**	
Improved	48.1	1,849	23.0	1,865	30.6	4,585	32.8	8,298
Nonimproved	53.2	823	23.2	675	35.3	1,160	37.8	2,659
Sex of the household head	(0.587)		(0.621)		(0.199)		(0.977)	
Male	50.1	1,842	23.4	1,715	30.8	3,677	34.0	7,233
Female	48.7	831	22.4	824	32.7	2,069	34.0	3,724

Continued...

Table 2—*Continued*

Age of mother	(0.295)		**(0.008)**		(0.113)		**(0.021)**	
15-19	44.8	578	19.2	603	32.4	1,290	29.9	2,471
20-24	50.7	518	24.5	443	33.7	1,160	36.0	2,122
25-29	50.6	458	22.1	474	27.2	944	31.6	1,875
30-34	50.2	396	18.1	323	30.8	802	33.1	1,564
35-39	54.4	308	30.8	319	30.6	645	36.4	1,272
40-44	51.1	240	25.9	195	33.5	538	36.3	973
45-49	48.9	174	27.1	181	32.9	366	35.3	722
Woman's level of education	**(0.018)**		(0.211)		(0.050)		**(0.000)**	
No education	56.0	532	27.5	308	37.2	567	42.2	1,406
Primary	49.2	1,585	22.9	1,537	31.6	3,308	33.8	6,431
Secondary	45.7	461	22.5	563	30.1	1,460	31.3	2,485
Higher	41.4	94	16.8	131	28.6	409	28.0	635
Woman is currently pregnant	**(0.000)**		**(0.006)**		**(0.006)**		**(0.000)**	
No	47.6	2,344	22.1	2,257	30.9	5,156	32.9	9,756
Yes	64.4	329	30.6	283	37.3	589	43.2	1,201
Woman has ever given birth	**(0.001)**		**(0.017)**		(0.750)		**(0.001)**	
No	43.2	608	19.3	658	31.1	1,446	30.9	2,712
Yes	51.6	2,064	24.4	1,881	31.7	4,299	35.0	8,245
Whether mother is involved in decision-making	**(0.008)**		**(0.019)**		(0.085)		**(0.000)**	
No	52.6	377	29.6	310	35.7	437	39.7	1,124
Yes	51.9	1,369	23.9	1,278	30.3	3,107	34.0	5,755
Missing	45.2	926	19.9	951	32.4	2,201	32.4	4,078
Distace to facility a big problem to mother	(0.182)		(0.127)		**(0.019)**		**(0.000)**	
No	48.0	1,252	21.7	1,466	30.3	3,581	31.8	6,299
Yes	51.1	1,418	25.0	1,073	33.6	2,164	36.9	4,656
Total	**49.7 (N=2,672)**		**23.1 (N=2,539)**		**31.5 (N=5,745)**		**34.0 (N=10957)**	

3.2 Multivariate Logistic Regression Analysis

3.2.1 Children

Table 3 and Figure 3 show that children of mothers who were anemic had higher odds of being anemic for all the survey years (OR 1.79, 95% CI 1.42-2.24; OR 1.94, 95% CI 1.44-2.64; OR 1.82, 95% CI 1.51-2.19) and for the pooled results (OR 1.88, 95% CI 1.65-2.13) compared with children of nonanemic mothers. Sickness in the last 2 weeks before the survey (Table 3 and Figure 4) was also significantly associated with childhood anemia for all survey years and the pooled results (OR 1.70, 95% CI 1.35-2.14; OR 1.32, 95% CI 1.02-1.71; OR 1.25, 95% CI 1.07-1.46; OR 1.39, 95% CI 1.24-1.56). Children in households with three children under age 5 had higher odds of anemia in 2016 and for the pooled results compared with children in households with just one child (OR 1.47, 95% CI 1.16-1.87; OR 1.34, 95% CI 1.12-1.60). Compared with children who weighed less than 2.5 kgs at birth, children who weighed 2.5 kgs or more at birth had twice the odds for anemia in 2011 (OR 2.11, 95% CI 1.21-3.68).

Table 3 and Figure 5 further show that children who took deworming medication had lower odds for anemia compared with children who did not in 2006 (OR 0.67, 95% CI 0.53-0.86), 2016 (OR 0.68, 95% CI 0.57-0.81), and for the pooled results (OR 0.74, 95% CI 0.65-0.83).

Children in wealthier households had lower odds for anemia compared with those in households in the poorest category for 2011 (OR 0.62, 95% CI 0.42-0.91; OR 0.34, 95% CI 0.21-0.54; OR 0.23, 95% CI 0.12 -0.43) and 2016 (OR 0.76, 95% CI 0.60-0.96; OR 0.60, 95% CI 0.47-0.77; OR 0.56, 95% CI 0.41-0.75; OR 0.48, 95% CI 0.32-0.73), and for the pooled results (OR 0.74, 95% CI 0.62-0.88; OR 0.67, 95% CI 0.55-

0.82; OR 0.55, 95% CI 0.45-0.68; OR 0.44, 95% CI 0.33-0.58). Compared with children in Kampala, those in the Northern and Western regions had lower odds for anemia in 2011 (OR 0.40, 95% CI 0.20-0.80; OR 0.39, 95% CI 0.21-0.72). Similarly, compared with children in Kampala, those in the South Western region had lower odds of being anemic in 2011 and 2016, and for the pooled results (OR 0.22, 95% CI 0.11-0.42; OR 0.36, 95% CI 0.21-0.63; OR O.44, 95% CI 0.29-0.65). Notably, there were higher odds for anemia in children in all regions except the Western and South Western in 2006. Though nonsignificant, the odds for anemia in all the regions were lower in 2011 and 2016 compared with Kampala.

Age of the mother had a mitigating impact on childhood anemia. Lower odds for anemia among children was noted among women age 20-29 (OR 0.35, 95% CI 0.14-0.86; OR 0.28, 95% CI 0.11-0.69), 35-39 (OR 0.30, 95% CI 0.11-0.78), and 45-49 (OR 0.17, 95% CI 0.05-0.53) compared with women age 15-19 in 2006. Analysis further showed lower odds of anemia in children for mothers age 20-49 compared with mothers age 15-19 in 2016 (OR 0.47, 95% CI 0.32-0.70; OR 0.34, 95% CI 0.23-0.51; OR 0.40, 95% CI 0.26-0.59; OR 0.33, 95% CI 0.22-0.49; OR 0.29, 95% CI 0.18-0.47; OR 0.35, 95% CI 0.19-0.66) and for the pooled results (OR 0.53, 95% CI 0.39-0.71; OR 0.41, 95% CI 0.31-0.56; OR 0.50, 95% CI 0.37-0.67; OR 0.42, 95% CI 0.31-0.58; OR 0.41, 95% CI 0.28-0.59; OR 0.32, 95% CI 0.20-0.51). The pooled results in Table 3 show lower odds for anemia in children in the 2011(OR 0.39, 95% CI 0.32-0.48) and 2016 surveys (OR 0.46, 95% CI 0.38-0.55) compared with the 2006 UDHS.

3.2.2 Women

Table 4 and Figure 6 show that women who were pregnant at the time of the survey had higher odds of being anemic compared with those who were not pregnant, for all the surveys years (OR 2.00, 95% CI 1.49-2.67; OR 1.47, 95% CI 1.02-2.10; OR 1.33, 95% CI 1.07-1.65) and for the pooled results (OR 1.49, 95% CI 1.28-1.73). Higher odds for anemia were observed among women with nonimproved sources of drinking water in 2016, and for the pooled results (OR 1.32, 95% CI 1.08-1.61; OR 1.18, 95% CI 1.03-1.36) compared with women with improved sources of water. Also, women age 35-39 had higher odds for anemia compared with women age 15-19 in 2011 (OR 1.99, 95% CI 1.27-3.14). Rural women had higher odds (OR 1.61, 95% CI 1.01-2.56) of anemia compared with urban women in 2006.

Compared with the poorest households, the odds of anemia in women in the wealthier household quintiles were lower in 2016 (OR 0.80, 95% CI 0.64-0.99; OR 0.74, 95% CI 0.58-0.95; OR 0.74, 95% CI 0.57-0.97; OR 0.55, 95% CI 0.40-0.76) and for the pooled results (OR 0.76, 95% CI 0.63-0.91; OR 0.75, 95% CI 0.62-0.90; OR 0.59, 95% CI 0.47-0.76). The same pattern was observed in 2006 and 2011, although it was not statistically significant. Women age 25-29 had lower odds for anemia compared with women age 15-19 in 2016 (OR 0.75, 95% CI 0.57-0.99). Women in the South Western region had lower odds for anemia compared with women in Kampala in 2011 (OR 0.40, 95% CI 0.19-0.84) and 2016 (OR 0.59, 95% CI 0.38-0.92), and for the pooled results (OR 0.71, 95% CI 0.51-1.00). The pooled results in Table 4 show lower odds for maternal anemia in the 2011 and 2016 surveys (OR 0.30, 95% CI 0.26-0.36; OR 0.47, 95% CI 0.41-0.54) compared with 2006.

Table 3 Adjusted odds ratios (AORs) for anemia among children age 6-59 months over the survey years, UDHS 2006, 2011, 2016

Variables	2006 UDHS		2011 UDHS		2016 UDHS		Pooled Data	
	Odds Ratio	[95% CI]	Odds Ratio	[95% CI]	Odds Ratio	[95% CI]	Odds Ratio	[95% CI]
Place of residence (rc: Urban)								
Rural	1.07	0.59 - 1.94	1.25	0.84 - 1.86	1.00	0.75 - 1.33	1.04	0.83 - 1.30
Region (rc: Kampala)								
Central1	1.73	0.63 - 4.72	0.92	0.45 - 1.88	0.91	0.53 - 1.59	1.17	0.77 - 1.79
Central2	1.44	0.54 - 3.82	0.95	0.50 - 1.80	0.87	0.51 - 1.51	1.11	0.74 - 1.66
East Central	1.88	0.66 - 5.39	1.39	0.73 - 2.66	0.95	0.53 - 1.69	1.35	0.89 - 2.05
Eastern	1.64	0.57 - 4.68	0.59	0.30 - 1.15	0.63	0.37 - 1.06	0.86	0.58 - 1.29
Northern	1.47	0.56 - 3.81	0.40*	0.20 - 0.80	0.93	0.54 - 1.61	0.95	0.63 - 1.42
West Nile	1.21	0.41 - 3.57	0.98	0.51 - 1.90	0.73	0.40 - 1.34	0.98	0.63 - 1.52
Western	0.77	0.29 - 2.05	0.39**	0.21 - 0.72	0.67	0.40 - 1.14	0.69	0.47 - 1.01
South Western	0.69	0.26 - 1.83	0.22***	0.11 - 0.42	0.36***	0.21 - 0.63	0.44***	0.29 - 0.65
Wealth index (rc: Poorest)								
Poorer	0.91	0.63 - 1.33	0.62*	0.42 - 0.91	0.76*	0.60 - 0.96	0.74***	0.62 - 0.88
Middle	0.94	0.61 - 1.46	0.69	0.45 - 1.06	0.60***	0.47 - 0.77	0.67***	0.55 - 0.82
Richer	0.89	0.57 - 1.37	0.34***	0.21 - 0.54	0.56***	0.41 - 0.75	0.55***	0.45 - 0.68
Richest	0.61	0.35 - 1.07	0.23***	0.12 - 0.43	0.48***	0.32 - 0.73	0.44***	0.33 - 0.58
Type of toilet facility (rc: Improved)								
Shared toilet	1.34	0.76 - 2.34	1.19	0.76 - 1.86	0.74*	0.56 - 0.97	0.89	0.71 - 1.10
Nonimproved toilet	1.20	0.70 - 2.06	1.02	0.65 - 1.58	0.81	0.64 - 1.04	0.92	0.75 - 1.12
No facility	1.17	0.61 - 2.24	1.10	0.59 - 2.06	0.98	0.65 - 1.47	1.02	0.76 - 1.3s6
Source of drinking water (rc: Improved)								
Nonimproved	1.01	0.74 - 1.36	1.17	0.85 - 1.60	0.81	0.65 - 1.00	0.93	0.80 - 1.09
Sex of the household head (rc: Male)								
Female	1.05	0.76 - 1.44	1.04	0.73 - 1.48	0.96	0.79 - 1.17	1.00	0.87 - 1.16
Children in household (rc: 1 child)								
2 children	1.09	0.80 - 1.47	1.06	0.76 - 1.48	1.10	0.91 - 1.32	1.08	0.93 - 1.24
3 children	1.22	0.82 - 1.83	1.22	0.83 - 1.78	1.47**	1.16 - 1.87	1.34**	1.12 - 1.60
4+ children	1.09	0.59 - 2.00	1.34	0.81 - 2.20	1.06	0.70 - 1.62	1.20	0.90 - 1.59
Age of mother (rc: 15-19)								
20-24	0.35*	0.14 - 0.86	0.87	0.47 - 1.62	0.47***	0.32 - 0.70	0.53***	0.39 - 0.71
25-29	0.28**	0.11 - 0.69	0.76	0.43 - 1.33	0.34***	0.23 - 0.51	0.41***	0.31 - 0.56
30-34	0.44	0.17 - 1.10	0.78	0.44 - 1.39	0.40***	0.26 - 0.59	0.50***	0.37 - 0.67
35-39	0.30*	0.11 - 0.78	0.84	0.46 - 1.56	0.33***	0.22 - 0.49	0.42***	0.31 - 0.58
40-44	0.40	0.15 - 1.11	0.78	0.36 - 1.69	0.29***	0.18 - 0.47	0.41***	0.28 - 0.59
45-49	0.17**	0.05 - 0.53	0.44	0.19 - 1.00	0.35**	0.19 - 0.66	0.32***	0.20 - 0.51
Mother’s level of education (rc: None)								
Primary	0.91	0.66 - 1.25	1.02	0.68 - 1.53	0.80	0.62 - 1.04	0.91	0.77 - 1.08
Secondary	1.00	0.62 - 1.62	1.09	0.61 - 1.96	0.81	0.57 - 1.15	0.96	0.75 - 1.22
Higher	0.79	0.33 - 1.86	1.72	0.77 - 3.84	0.60*	0.40 - 0.90	0.81	0.59 - 1.12
Mother’s anemia status (rc: No)								
Yes	1.79***	1.42 - 2.24	1.95***	1.44 - 2.64	1.82***	1.51 - 2.19	1.88***	1.65 - 2.13
Mother involved in decision-making (rc: No)								
Yes	1.08	0.79 - 1.48	0.78	0.55 - 1.10	0.88	0.69 - 1.13	0.91	0.77 - 1.08
Missing	1.09	0.67 - 1.79	0.57*	0.33 - 0.98	1.03	0.73 - 1.44	0.91	0.71 - 1.16
Distance to facility a problem to mother (rc: No)								
Yes	1.06	0.82 - 1.36	0.73*	0.56 - 0.96	1.11	0.94 - 1.31	1.01	0.89 - 1.14
Sex of child (rc: Male)								
Female	0.74*	0.58 - 0.94	0.92	0.72 - 1.18	0.88	0.75 - 1.04	0.86*	0.77 - 0.97
Child’s birth weight (rc: < 2.5 kgs)								
2.5 kgs or more	1.17	0.62 - 2.23	2.11**	1.21 - 3.68	0.93	0.66 - 1.32	1.13	0.87 - 1.47
Don’t know/not weighed at birth	1.10	0.59 - 2.06	1.96*	1.09 - 3.51	0.83	0.58 - 1.19	1.03	0.79 - 1.34
Sickness in last two weeks (rc: No)								
Yes	1.70***	1.35 - 2.14	1.32*	1.02 - 1.71	1.25**	1.07 - 1.46	1.39***	1.24 - 1.56
Deworming								
Yes	0.67**	0.53 - 0.86	0.99	0.77 - 1.26	0.68***	0.57 - 0.81	0.74***	0.65 - 0.83
Survey year (rc: 2006)								
2011							0.39***	0.32 - 0.48
2016							0.46***	0.38 - 0.55
Total observations	**2,001**		**1,757**		**3,831**		**7,589**	

Level of significance *** p<0.001, ** p<0.01, * p<0.05
CI: Confidence interval; rc: Reference category

Figure 3 Adjusted odds of anemia in children by mother's anemia status, UDHS 2006, 2011, 2016

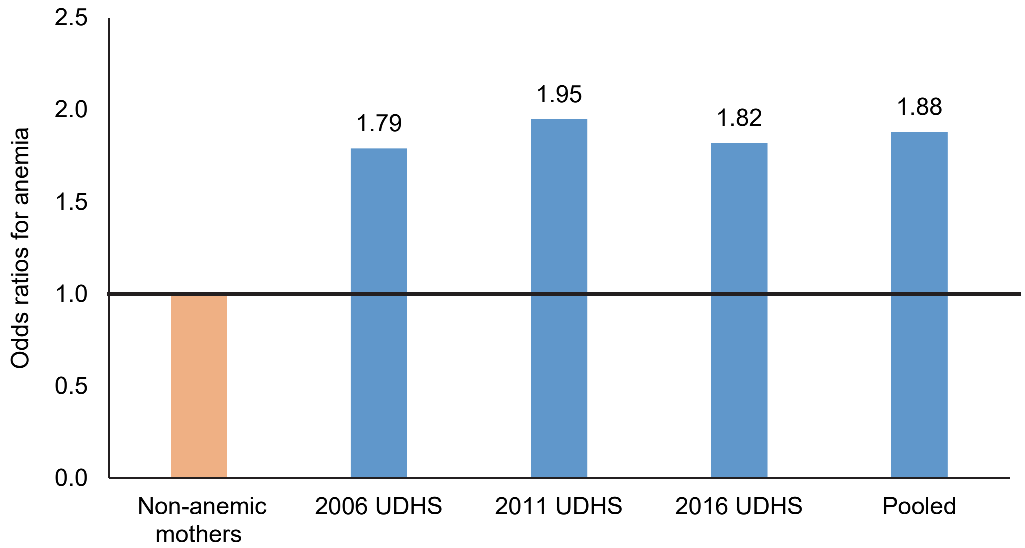


Figure 4 Adjusted odds of anemia in children by sickness in the last 2 weeks before the survey, UDHS 2006, 2011, 2016

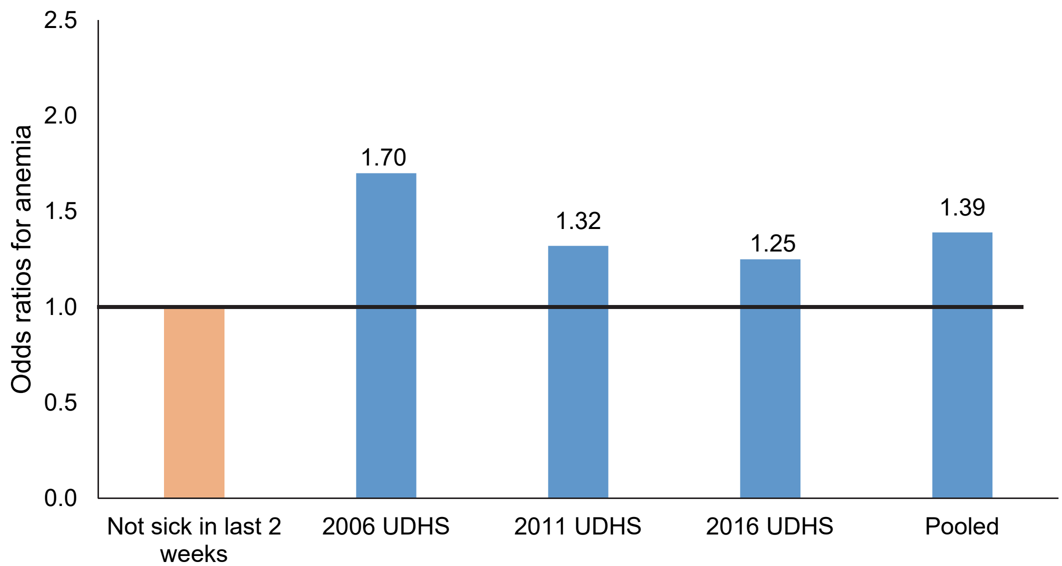


Figure 5 Adjusted odds of anemia in children by deworming, UDHS 2006, 2011, 2016

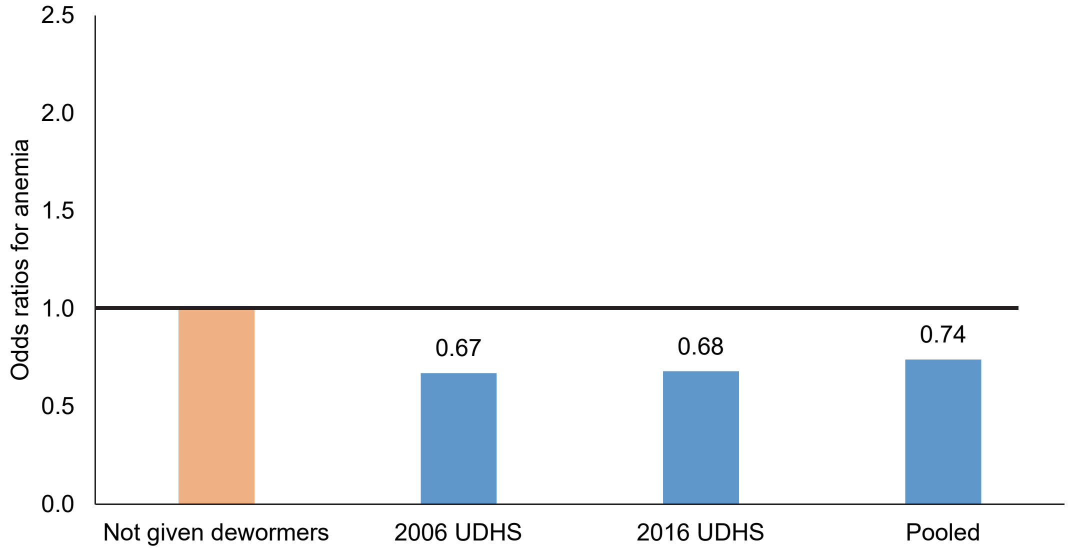


Table 4 Adjusted odds ratios (AORs) for anemia among women age 15-49 across the survey years, UDHS 2006, 2011, 2016

	2006 UDHS		2011 UDHS		2016 UDHS		Pooled Data	
VARIABLES	**Odds Ratio**	**[95% CI]**	**Odds Ratio**	**[95% CI]**	**Odds Ratio**	**[95% CI]**	**Odds Ratio**	**[95% CI]**
Place of residence (rc: Urban)								
Rural	1.61*	1.01 - 2.56	1.13	0.71 - 1.80	0.94	0.77 - 1.15	1.10	0.92 - 1.32
Region (rc: Kampala)								
Central1	1.60	0.78 - 3.29	0.95	0.49 - 1.85	0.92	0.63 - 1.32	1.14	0.85 - 1.54
Central2	0.76	0.38 - 1.52	1.40	0.76 - 2.55	1.00	0.67 - 1.48	1.07	0.79 - 1.45
East Central	0.98	0.49 - 1.95	1.35	0.74 - 2.46	1.40	0.97 - 2.03	1.33	0.98 - 1.80
Eastern	0.93	0.47 - 1.84	1.10	0.55 - 2.18	0.78	0.54 - 1.13	0.91	0.67 - 1.24
Northern	1.65	0.81 - 3.36	0.66	0.34 - 1.29	1.35	0.92 - 1.98	1.30	0.95 - 1.78
West Nile	0.58	0.30 - 1.13	1.32	0.69 - 2.54	1.31	0.83 - 2.05	1.15	0.81 - 1.61
Western	0.79	0.39 - 1.60	0.67	0.32 - 1.40	0.92	0.61 - 1.37	0.87	0.63 - 1.21
South Western	1.02	0.49 - 2.12	0.40*	0.19 - 0.84	0.59*	0.38 - 0.92	0.71*	0.51 - 1.00
Wealth index (rc: Poorest)								
Poorer	1.06	0.78 - 1.45	0.93	0.64 - 1.35	0.80*	0.64 - 0.99	0.86	0.74 - 1.01
Middle	0.92	0.64 - 1.31	0.74	0.48 - 1.15	0.74*	0.58 - 0.95	0.76**	0.63 - 0.91
Richer	0.84	0.60 - 1.19	0.85	0.56 - 1.29	0.74*	0.57 - 0.97	0.75**	0.62 - 0.90
Richest	0.71	0.47 - 1.08	0.77	0.39 - 1.53	0.55***	0.40 - 0.76	0.59***	0.47 - 0.76
Type of toilet facility (rc: Improved)								
Shared toilet	0.89	0.62 - 1.28	1.11	0.69 - 1.78	0.89	0.69 - 1.14	0.93	0.77 - 1.12
Nonimproved toilet	1.01	0.70 - 1.46	1.00	0.68 - 1.49	1.00	0.81 - 1.24	0.98	0.83 - 1.16
No facility	1.03	0.64 - 1.68	1.45	0.82 - 2.57	0.90	0.65 - 1.25	1.01	0.80 - 1.29
Source of drinking water (rc: Improved)								
Nonimproved	1.09	0.85 - 1.40	1.16	0.86 - 1.56	1.32**	1.08 - 1.61	1.18*	1.03 - 1.36
Sex of the household head (rc: Male)								
Female	1.01	0.80 - 1.28	0.96	0.74 - 1.25	1.05	0.90 - 1.22	1.03	0.92 - 1.15

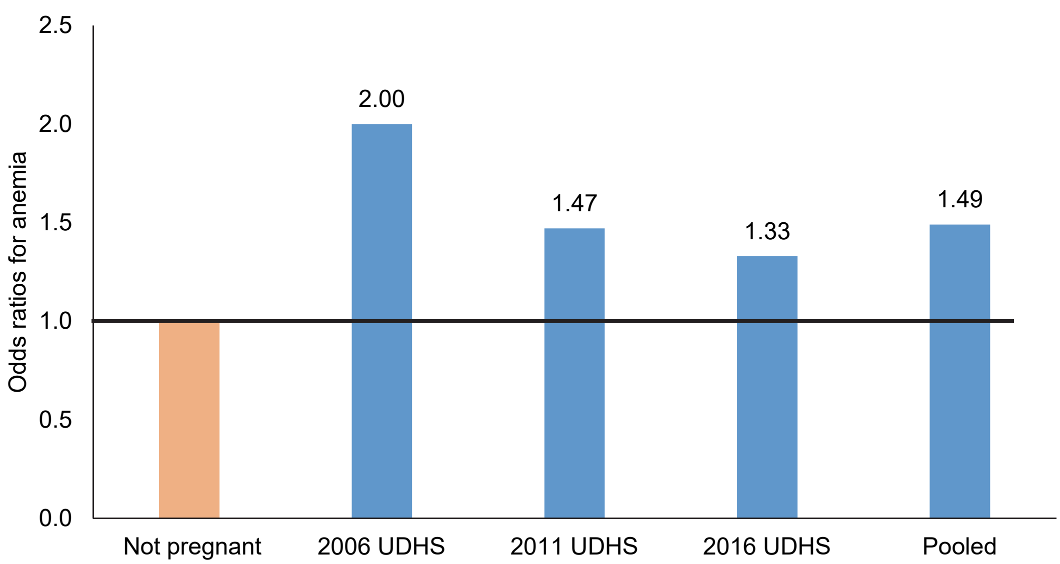
Continued...

Table 4—*Continued*

Age of mother (rc: 15-19)								
20-24	1.01	0.70 - 1.47	1.32	0.85 - 2.05	1.01	0.80 - 1.28	1.06	0.88 - 1.26
25-29	0.99	0.66 - 1.46	1.16	0.75 - 1.80	0.75*	0.57 - 0.99	0.88	0.72 - 1.07
30-34	0.95	0.65 - 1.39	0.93	0.57 - 1.52	0.88	0.64 - 1.20	0.91	0.73 - 1.12
35-39	1.19	0.77 - 1.84	1.99**	1.27 - 3.14	0.86	0.64 - 1.17	1.11	0.89 - 1.37
40-44	1.05	0.66 - 1.66	1.48	0.87 - 2.52	0.98	0.72 - 1.34	1.07	0.85 - 1.34
45-49	0.92	0.58 - 1.46	1.68	0.96 - 2.95	1.01	0.73 - 1.40	1.07	0.84 - 1.36
Mother's level of education (rc: None)								
Primary	0.89	0.71 - 1.12	0.89	0.64 - 1.25	0.85	0.69 - 1.04	0.88	0.76 - 1.01
Secondary	1.13	0.81 - 1.58	1.07	0.64 - 1.78	0.96	0.74 - 1.25	1.02	0.84 - 1.23
Higher	0.94	0.56 - 1.57	0.81	0.40 - 1.62	1.07	0.73 - 1.59	1.01	0.76 - 1.35
Woman currently pregnant (rc: No)								
Yes	2.00***	1.49 - 2.67	1.47*	1.02 - 2.10	1.33*	1.07 - 1.65	1.49***	1.28 - 1.73
Woman has ever given birth (rc: No)								
Yes	1.34	0.96 - 1.88	0.90	0.59 - 1.35	1.20	0.93 - 1.54	1.17	0.98 - 1.40
Woman involved in decision-making (rc: No)								
Yes	1.03	0.79 - 1.34	0.76	0.51 - 1.15	0.84	0.66 - 1.08	0.86	0.73 - 1.02
Missing	1.04	0.76 - 1.44	0.72	0.46 - 1.14	1.00	0.75 - 1.32	0.93	0.77 - 1.13
Distance to facility a problem to mother (rc: No)								
Yes	0.92	0.76 - 1.12	1.12	0.88 - 1.43	1.01	0.88 - 1.16	1.02	0.92 - 1.13
Survey year (rc: 2006)								
2011							0.30***	0.26 - 0.36
2016							0.47***	0.41 - 0.54
Total observations	**2,645**		**2,580**		**5,799**		**11,024**	

Level of significance *** p<0.001, ** p<0.01, * p<0.05
CI: Confidence interval
rc: Reference category

Figure 6 Adjusted odds for anemia among women by pregnancy status, UDHS 2006, 2011, 2016



4 DISCUSSION

This study shows that, although the prevalence of anemia in Uganda has declined for both children and women since the 2006 UDHS, it increased between the surveys in 2011 and 2016 and still affects a majority of children age 6-59 months. The overall prevalence of anemia among children was 73% in 2006, 50% in 2011, and 53% in 2016. Among women, anemia prevalence was 49% in 2006, 23% in 2011, and 32% in 2016. Common risk factors for anemia among children include mother's anemia status, sickness in the last 2 weeks, number of children in the household, weight at birth, deworming, household wealth, region, and age of the mother. Pregnancy, source of drinking water, age, residence, household wealth, and region are risk factors for anemia among women.

4.1 Anemia among Children

Maternal anemia increased the odds of anemia among children. As observed in related studies, anemia among mothers as a result of poor nutrition is manifested in their children as well (Kikafunda et al. 2009; Ntenda, Nkoka, Bass, and Senghore 2018). These results suggest that child nutrition is dependent on maternal nutrition. This is especially true for breastfeeding mothers whose breast milk supply and micronutrients will likely decrease if they are anemic (El-Farrash, Ismail, and Nada 2012; Kumar, Rai, Basu, Dash, and Singh 2008). Such mothers may not have enough breast milk for their babies, increasing the risk of anemia among these children. The situation is even worse for children who are exclusively breastfed. Anemia observed in mothers could be an indication that the household lacks enough food for its members, including children at risk of anemia, or the household might have enough food but the food is not rich enough in nutrients needed for bodily growth.

As reported in other studies (Ngesa and Mwambi 2014; Simbauranga et al. 2015), the results of the analysis showed that sicknesses in children like fever, diarrhea, and cough are predisposing factors for anemia, reflected in their high odds. Sickness leads to loss of blood, hence the need to increase the amount of blood in the body through good feeding or blood transfusion. In addition, sickness reduces bodily immunity, nutrient absorption, and appetite for food, and thus further predisposes such children to anemia. This points to the need for measures that reduce or prevent the risk of such sicknesses in children. Measures may include sleeping under insecticide-treated mosquito nets, improving household sanitation, regular medical checkups, and timely treatment for all childhood infectious illnesses.

Children in all regions except the Western and South Western had higher odds for anemia compared with children in Kampala. This could be explained by the fact that Kampala has better coverage of health services and less household poverty compared with other regions. Thus Kampala households can afford a better diet for their children compared with other regions. Furthermore, Kampala registers lower rates of malaria or fever than most of the noncentral regions (Uganda Bureau of Statistics – UBOS 2018). The national program on the distribution of insecticide-treated mosquito nets should prioritize malaria-endemic areas, since such areas also have high anemia prevalence. Nutrition services in the health sector such as infant and young children feeding programs should be strengthened, sensitizing mothers to early initiation of breastfeeding after childbirth and promoting the recommended breastfeeding of children for 2 years (World Health Organization and UNICEF 2003). In addition, sensitizing household members about the importance of a balanced diet should be undertaken (Price 2005).

The analysis showed that children in the poorest households had higher prevalence of anemia than children in wealthier households, as also observed in studies elsewhere (Ngnie-Teta, Kuate-Defo, and Receveur 2009; Stevens et al. 2013; World Health Organization 2011a). Poverty limits access to basic necessities including food and health care. Children who fall sick need medical attention and good diet. If the household cannot afford these, anemia risk increases for these children. Children born to teenage mothers showed more anemia than children born to mothers in the other age groups. This can be explained by the fact that teenage mothers are likely to have more challenges, including insufficient access to food, little health care, and birth-related complications (Emani and Shetty 2018; Gleeson, Robinson, and Neal 2006; Nguyen et al. 2017; World Health Organization 2011a). Gender norms in different communities are particularly a challenge because they affect the distribution of food and feeding within households. This is evident in many households, since teenagers usually have no decision-making power regarding nutrition and health.

In older surveys, women's decision-making, sex of the child, and birth weight were significantly associated with anemia in children. Women who participate in decision-making had lower odds for anemia compared with those who do not participate. This can be explained by the fact that women involved in decision-making regarding spending, visiting health facilities, and use of household assets are more likely to easily access health care, afford a good diet for their households due to ability to pay, and have access to information due to their level of exposure (Amugsi, Lartey, Kimani-Murage, and Mberu 2016; Woldemicael and Tenkorang 2009).

Female children had lower odds for anemia across the survey years compared with male children, as previous studies have revealed (Kassebaum et al. 2014; Ngesa and Mwambi 2014). This can be explained by the fact that the nutrition needs for male children are higher than for female children (Kikafunda et al. 2009). This implies that less food in the household is likely to strongly affect male children more than female children in such households.

As shown previously by Ajao, Ojofeitimi, Adebayo, Fatusi, and Afolabi (2010), our study found that the number of children in the household was associated with childhood anemia. Children in households with more children were at increased risk of anemia. The more children the household has, the more food and other resources needed for their nutrition and other health needs (Olayemi 2012; Pelto et al. 1991). There is therefore a need to promote family planning among households and to empower women through education so that they are able to have only the number children they can take care of adequately. Higher education for women was protective against childhood anemia. Education of the mother is a strong predictor for her wellbeing, health-seeking behavior, and empowerment (Bbaale and Mpuga 2011; Malik and Courtney 2011). Education also increases access to and awareness of health and nutrition information through radio and television, print media, Internet, and other sources.

4.2 Anemia among Women

Results show that the prevalence of anemia in women of reproductive age in Uganda was 32%, nearly the same as the global average of 33% in 2016 (World Health Organization 2011a). This rate remains high despite the interventions by the Ministry of Health, including the indoor residual spraying, distribution of free insecticide-treated mosquito nets, and iron and vitamin supplementation for pregnant women, among others (Ministry of Health 2013). This implies that substantial effort is needed to reduce the prevalence of anemia among women, since it affects maternal and child health and other development outcomes.

Pregnancy increased the odds of anemia in women. In pregnancy there is blood volume expansion (Ciliberto and Marx 1998), which consequently increases iron and folic acid demand. These physiological changes increase the risk of anemia, especially if the woman's dietary needs are not met. Anemia in pregnant women leads to poor fetal outcomes such as low birth weight and stillbirth, and can also lead to death of the mother (Kikafunda et al. 2009; USAID 2016). More effort is therefore needed to emphasize proper nutrition for women during pregnancy and breastfeeding. Intermittent preventive treatment doses of sulphadoxine-pyrimethamine should also be given to pregnant women, including in rural areas, to prevent malaria, since this is a predisposing factor for anemia (Briand, Cottrell, Massougbodji, and Cot 2007; Falade et al. 2007).

Similar to findings elsewhere, women in the poorest households had more anemia cases compared with women in wealthier households (Ali and Haidar 2019; Dey, Goswami, and Goswami 2010; World Health Organization 2011a). This could be explained by the inability of women in poorer households to afford a good diet (Oldewage-Theron, Dicks, and Napier 2006), pay for health care (Peters et al. 2008), and practice good sanitation compared with women in wealthier households. There is need to ensure that all women have access to health services and information on proper feeding, especially in rural areas. In addition, there is need to strengthen poverty alleviation programs and women's employment opportunities in order to improve their economic status.

Though Humphrey et al. (2019), in a study in rural Zimbabwe, reported that water, sanitation, and hygiene interventions are unlikely to reduce stunting or anemia in children, our study found that source of drinking water was significantly associated with anemia in women. Results showed more anemia cases among women who used unsafe water compared with those with safe sources. This points to the risk of waterborne diseases such as diarrhea, dysentery, and typhoid, which may increase the risk of anemia in households that draw water from nonimproved sources. There is therefore need for the government to ensure that all households have access to safe water sources, so that such diseases are prevented.

Women's age was associated with anemia prevalence. Higher levels of anemia were observed among older women. This may be explained by blood loss during childbirth, which increases the risk of anemia (Kassebaum et al. 2014). On the other hand, anemia among teenagers may be explained by the increased needs for iron during adolescence and blood loss during menstruation cycles (Mesías, Seiquer, and Navarro 2013; Story and Hermanson 2000). Family planning interventions should be strengthened to prevent early pregnancy through reaching out to adolescents in school and also those out of school. Further, all women of reproductive age should take iron and folic acid supplementation to prevent anemia (World Health Organization 2011a).

5 CONCLUSION

The results suggest that empowerment of women with economic resources, power to make decisions on spending household incomes, and access to health care should be prioritized in order to reduce anemia in both children and women. Households must treat sick children, as other sicknesses are predisposing factors for anemia. More focus should be given to nutrition during antenatal and postpartum visits to health facilities. Health facilities should encourage supplementary feeding for boosting immunity for pregnant mothers and children under age 5. This can be supported by setting up nutrition units in health facilities. Teenagers need to be continuously sensitized to the risks of teenage pregnancies and supported to stay in school. In cases of pregnancies, adolescent-friendly services should be available to support teenagers during pregnancy and motherhood. Family planning services should be extended to all women and teenagers who need them. Effective implementation of interventions to combat anemia in women and children will significantly reduce morbidity and mortality and other adverse consequences of anemia.

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