Anemia Estimates Using Venous and Capillary Blood Samples in the 2019–20 Rwanda DHS

Anemia occurs when there are not enough healthy red blood cells carrying oxygen to tissues in the body. In the 2019–20 Rwanda Demographic and Health Survey (2019–20 RDHS), anemia was tested in two subsamples using different blood sources—capillary and venous blood. This brief provides information on the anemia testing procedures and prevalence of anemia from these two blood sources, along with information to aid in interpreting the results. The brief is intended for policymakers, program managers, and other decisionmakers using Rwanda's anemia data.

Anemia data are important for policy and program decision-making. Anemia data can be used to assess the health situation in Rwanda and to track trends over time. Estimates can also be used to compare Rwanda to other countries. Anemia data are important for tracking the Sustainable Development Goal 2 to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture. Rwanda's First National Strategy for Transformation (NST1 2017–2024) calls for enhanced prevention and management of all forms of malnutrition.

Many factors can cause anemia, including iron and other micronutrient deficiencies, malaria, other infections, and hemoglobinopathies (Chaparro and Suchdev 2019). Characterizing the magnitude and causes of anemia is also important for designing and evaluating strategies and programs to reduce anemia. Data on several factors that can cause anemia were collected in the micronutrient component of the 2019–20 RDHS.

Current evidence on anemia testing in venous and capillary blood. The World Health Organization (WHO) recommends hemoglobin, a protein responsible for transporting oxygen in the blood, as the biomarker to assess population-based prevalence estimates of anemia (WHO 2017). Hemoglobin is assessed in a whole blood sample either using venous or capillary blood. Venous blood samples are collected from a vein, usually from the inside of the elbow or the back of the hand. Capillary blood samples are collected by pricking the skin of the finger or heel. Venous blood is the gold standard source of blood. However, until recently, capillary blood hemoglobin has been considered an accurate and reliable measure in field settings.

Capillary blood is collected by finger or heel prick

Venous blood is collected from a vein

New studies comparing venous and capillary hemoglobin results have revealed differences in anemia estimates using the two blood sources. These differences have been more pronounced in children and may be less of an issue for women (Stevens et al. 2022; Hruschka et al. 2020). Experiments comparing hemoglobin measured in capillary and venous blood collected at the same time in the same individual show that the difference in hemoglobin levels between the two blood types are variable, with capillary blood sometimes having higher hemoglobin levels and sometimes having lower hemoglobin levels as compared with venous blood (Neufeld et al. 2019). This variability can lead to different estimates of anemia prevalence in capillary blood compared with venous blood, in some cases resulting in a change in the public health significance classification of anemia in a country. These issues are discussed in more detail in the USAID Advancing Nutrition's Hemoglobin Measurement Project webinar.

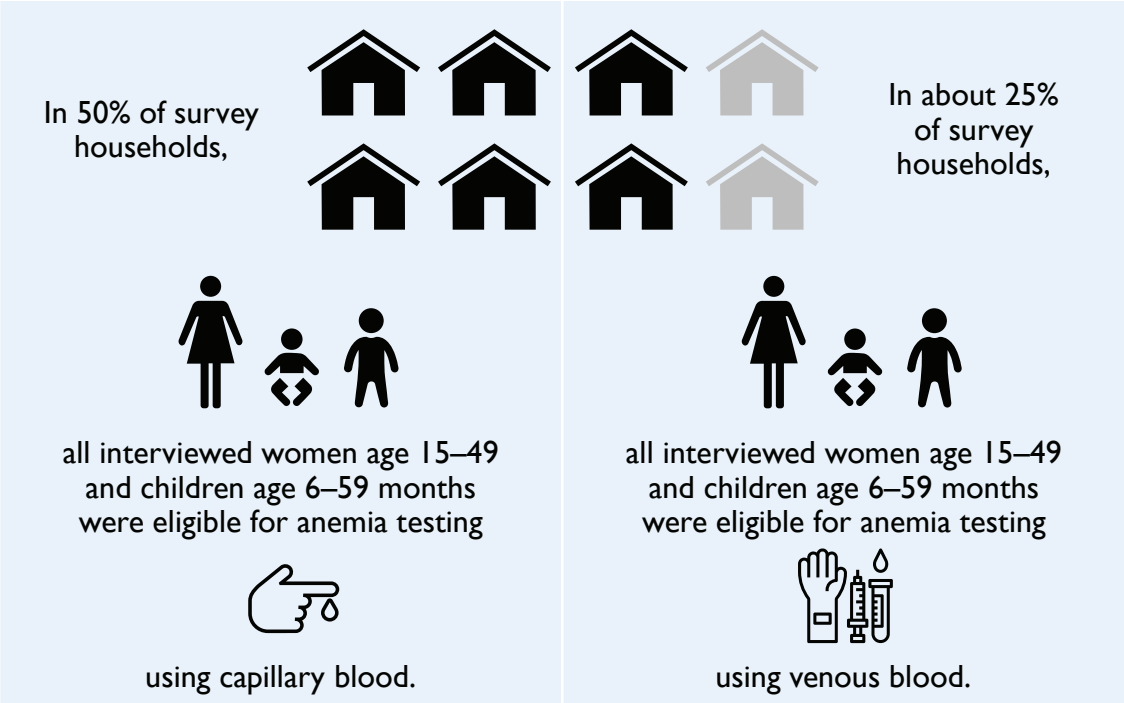
Future studies are needed to determine whether improvements in capillary blood collection protocols can improve the precision of capillary blood hemoglobin tests for better anemia prevalence estimates in household surveys.

Measurement of anemia in Rwanda in The DHS Program. In Rwanda, anemia testing has been included in surveys collected through The DHS Program since 2005. Rwanda DHS surveys that have included anemia testing used capillary blood and followed the standard DHS Program protocol. However, in the 2019–20 RDHS, anemia was measured using both capillary and venous blood that was tested on-site using a battery-operated portable HemoCue® 201+ device. Field teams, each of which included two technicians, carried out both the capillary and venous blood collection and anemia testing.

In a subsample of 50 percent of all households selected for the survey, all interviewed women age 15–49 and children age 6–59 months were eligible for anemia testing using capillary blood. A single drop of capillary blood was used to fill a microcuvette directly from a finger prick (or a heel prick in the case of children age 6–11 months).

Among households not selected for capillary testing, about half were selected as an additional subsample for venous blood collection for a micronutrient component of the 2019–20 RDHS. Within those households, all interviewed women age 15–49 and children age 6–59 months were eligible for anemia testing. The technicians collected venous blood into a tube containing an anticoagulant and performed anemia testing by dropping a few drops of whole blood from the tube onto a small piece of wax film, and then collecting the blood in a microcuvette.

Anemia Testing Protocol for the 2019–20 RDHS



The analysis of hemoglobin values involves first adjusting for altitude (and cigarette smoking among women, if known), and then applying standard cutoffs of <11 g/dL for children and pregnant women and <12 g/dL for non-pregnant women, to define any anemia (CDC 1998; WHO 2017). These adjustments are standard practice for The DHS Program and were applied in the same way to both capillary and venous anemia results.

Interpretation of anemia data measured using venous versus capillary blood. Venous blood samples provide a more accurate measurement of hemoglobin than capillary blood samples. Thus, venous blood results provide the best source of current anemia prevalence estimates in the 2019–20 RDHS. Prevalence estimates based on capillary and venous blood are not comparable and should not be used interchangeably. And there is currently no adjustment factor that can be applied to make anemia estimates comparable between samples collected with venous and capillary blood.

The extent to which variability in hemoglobin concentrations in capillary blood impacts the ability to interpret current anemia estimates and trends, especially in children, is unknown. There are two situations where it is not appropriate to use anemia data based on venous samples in the 2019–20 RDHS:

- First, the sample size is much larger in the capillary blood subsample than in the venous blood subsample (3,765 versus 2,001 for children; 6,831 versus 3,763 for non-pregnant women; and 434 versus 248 for pregnant women). The sample size from the venous subsample is insufficient for lower-level (for example, regional) anemia estimates, making estimates based on capillary blood samples the only available data source.

- Second, because the same method must be used to compare trends, the only DHS data available to understand whether anemia has increased or decreased as compared to previous surveys is with capillary blood because previous DHS surveys in Rwanda used capillary blood hemoglobin testing.

Response rates for anemia testing were similar for capillary and venous blood for women, but lower among children in the venous subsample. Anemia testing was successfully completed for 89.6% of eligible children using venous blood and 99.8% of eligible children using capillary blood. Anemia testing was successfully completed for 99.5% of eligible women

using venous blood and 99.7% of eligible women using capillary blood. By urban–rural residence, there is no difference in anemia testing response rates for children and women using capillary blood. Response rates were slightly lower in urban (86.3%) than rural (91.5%) areas among children, but not for women using venous blood. Response rates are similar by age in the capillary blood subsample for children and increased with age among children using venous blood—85.5% among children age 6–11 months and 90.1% among children age 48–59 months. Overall, percentage differences in response rates are small, so these nonresponse patterns are unlikely to impact anemia estimates or the differences observed between estimates from the capillary and venous subsamples.

Mean hemoglobin estimates are similar between blood sources, but anemia prevalence estimates are lower for children and women when using venous compared to capillary blood. Individuals in the separate subsamples for anemia measurement were selected using random sampling within the same communities. There may be small random differences in hemoglobin between the individuals in the subsample tested using capillary blood and those in the subsample tested using venous blood.

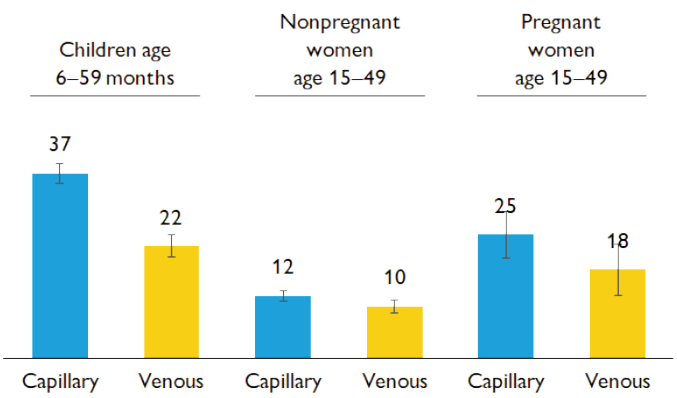
Among children age 6–59 months, the prevalence estimate for any anemia is 14.4 percentage points lower in the venous blood sample (22.2%) compared with the capillary blood sample (36.6%). This difference is statistically significant. The differences in prevalence estimates by blood source is smaller for women than it is for children. Among non-pregnant women age 15–49, the prevalence of anemia in the venous blood sample (10.3%) is 2.1 percentage points lower than in the capillary blood sample (12.4%). This difference is also statistically significant. Among pregnant women age 15–49, the prevalence of anemia in the venous blood sample (17.6%) is 6.9 percentage points lower than in the capillary blood sample (24.5%). This difference is also statistically significant.

Although estimates of anemia prevalence are different between the venous and capillary blood samples, the distributions of hemoglobin concentrations in the two samples are similar. The difference in average hemoglobin concentration between the venous and capillary blood samples is 0.4 g/dL for children, 0.0 g/dL for non-pregnant women, and −0.1 g/dL for pregnant women. The differences are statistically significant for children, but not for women.

The differences in mean hemoglobin and anemia estimates between the venous and capillary data in the 2019–20 RDHS is similar to those observed in other studies that compared estimates from near-in-time surveys using venous versus capillary blood samples (Stevens et al. 2022; Hruschka et al. 2020). The magnitude of this difference has varied depending on the survey in these studies, but the general pattern is more pronounced differences in children than in women.

Anemia Prevalence by Capillary and Venous Blood Collection

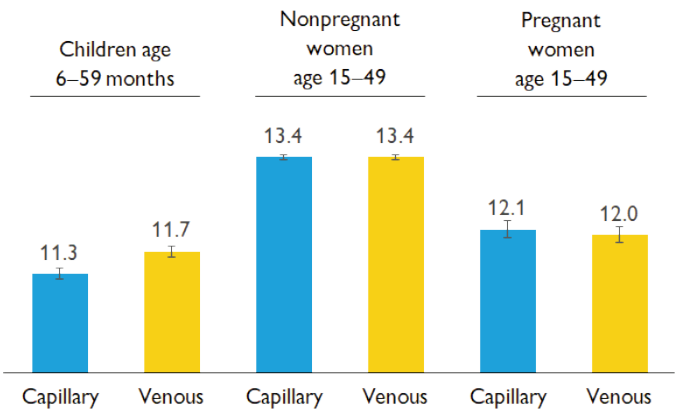
Percentage of children age 6–59 months and women 15–49 (nonpregnant and pregnant) classified as anemic by capillary and venous blood sources



Any anemia <11 g/dl for children and pregnant women
Any anemia <12 g/dl for nonpregnant women

Mean Hemoglobin Concentration (g/dl) by Capillary and Venous Blood Collection

Mean hemoglobin concentration of children age 6–59 months and women age 15–49 years (nonpregnant and pregnant) by capillary and venous blood sources



Any anemia <11 g/dl for children and pregnant women
Any anemia <12 g/dl for nonpregnant women

Look for full anemia results in the *2019–20 Rwanda DHS Final Report* and in the *2019–20 Rwanda DHS Micronutrient Report*. The anemia results from both samples are available in the 2019–20 RDHS Final Report. The results for anemia and other tests conducted in the micronutrient component are published in a separate report. In addition to anemia, the micronutrient report of the 2019–20 RDHS provides standard anthropometry measures for women age 15–49 and children age 0–59 months, and data on inflammation, iron, vitamin A, vitamin B12, folate status, and malaria among women age 15–49 and children age 6–59 months, and tests for iodized salt coverage.

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