Prevalence and Severity of Anemia in Haiti

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ABSTRACT

Anemia is a serious health concern worldwide, affecting about 25% of the world's population. Anemia is most common in financially underdeveloped countries, such as Haiti, where the lack of income and improper sanitation lead to nutritional deficiencies, gastrointestinal infections, and anemia. These conditions cause anemia from insufficient iron and vitamin intake, increased utilization of nutrients by the infectious organism, and blood loss. Reports of anemia prevalence in Haiti are few, represent select communities, and focus mostly on children. This study aimed to determine the prevalence and severity of anemia in Haiti by analyzing samples from a wider population, including mostly adults, and from multiple communities distributed across Haiti. These data include 1500 samples from adult participants residing in 15 communities distributed across most of Haiti. Either hematocrit or hemoglobin was measured depending on whether electricity was available. Hematocrit was measured by the microhematocrit method, and hemoglobin was measured by the MissionPlus Reflectance point-of-care instrument. Data were reported as hemoglobin, so hematocrit was converted to hemoglobin by dividing hematocrit by 3. Anemia was defined as hemoglobin below 12.4 g/dl and represented 49.27% of the study population. Anemia cases were then subdivided into mild (11.0–12.3 g/dl; 30.67%; $n = 460$), moderate (8.0–10.9 g/dl; 15.73%; $n = 236$), and severe (<8.0 g/dl; 2.87%; $n = 43$). This finding corroborates the high prevalence of anemia in Haiti reported by others using mostly pediatric subjects. According to the World Health Organization classification for public health significance of diseases, this level of anemia would be considered a severe public health problem in Haiti.

ABBREVIATIONS: RBC - red blood cell, WHO - World Health Organization.

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INTRODUCTION

Anemia is a condition characterized by decreased oxygen-carrying capacity of the blood and confirmed by measuring blood hemoglobin, erythrocyte count, and/or hematocrit. Mild anemia causes weakness, fatigue, headaches, and pallor. As anemia worsens, patients experience dyspnea, tachycardia, and dizziness. Severe anemia has been linked to poor cognitive function,[1] congestive heart failure,[2] and chronic kidney disease.[3] Severe anemia can also have devastating consequences on both a mother and fetus during pregnancy, including increased risks for maternal morbidity,[4] low birth weight, preterm birth, perinatal morbidity, and neonatal morbidity.[5]

Anemia is a serious health concern worldwide, affecting about 25% of the world's population. Virtually every country reports anemia to some degree.[6] Much of this burden is concentrated in financially underdeveloped countries. For example, 1.4% of all deaths from iron deficiency anemia worldwide occur in North America (developed), whereas 71% of deaths due to iron deficiency anemia occur in Africa and parts of Asia (underdeveloped).[7]

The cause of anemia in underdeveloped countries is multifactorial but linked to poverty. Low family income reduces the frequency and quality of food consumption, leading to nutritional deficiencies of iron, vitamin B_{12}, folic acid, and protein, all of which may cause anemia. Iron deficiency anemia is responsible for about 50% of anemia cases worldwide.[8] Insufficient funds within families and governments leads to improper sanitation, causing frequent and cyclical bacterial and parasitic infections resulting in anemia due to diarrhea, blood loss, and consumption of nutrients by the infectious organism.[8] Intestinal parasites contribute to anemia by causing intestinal bleeding resulting in blood loss. Vegetables and meats sold in markets of underdeveloped countries are often contaminated with intestinal parasites, such as *Ascaris lumbricoides* and *Entamoeba histolytica*.[9] Malaria is also a major etiology of anemia because the *Plasmodium* species cause increased destruction of parasitized and unparasitized erythrocytes as well as decreased red blood cell (RBC) production.[10] In one study, 22.1% of the study population was severely anemic at the end of the high malaria transmission season compared with 1.4% at the end of the low transmission season.[11]

Haiti, the poorest country in the Western hemisphere, has a population where 25% live in extreme poverty.[12] In 2017, Haiti was ranked as the 17th poorest country in the world based on per capita gross domestic product, adjusted for purchasing power parity.[13] Many Haitians face both geographical and economic barriers in accessing health care.[14]

Some travel hours to reach a hospital only to be sent away for being unable to pay for the services. Others give all they have to pay for the doctor appointment and later are unable to afford the medication they are prescribed. Given the circumstances, many people wait until they are severely ill before they attempt to seek health care. This state of weakened health combined with lack of income makes them more susceptible to infections and nutritional deficiencies, all of which can lead to anemia.

Knowing the prevalence and severity of anemia in Haiti can motivate governments, organizations, and hospitals to improve testing, treatment, and preventative measures to help alleviate the burden of anemia. However, reports of anemia prevalence in Haiti are few, represent select communities, and focus mostly on children. Thus, the purpose of this study was to analyze specimens from a wider population, including mostly adults, and from communities distributed across Haiti to determine the prevalence and severity of anemia.

MATERIALS AND METHODS

Specimens

Whole-blood specimens ($n = 1500$) were collected in EDTA over a 12-year period (2006–2018) from mostly adults visiting local clinics representing 15 communities distributed across most of Haiti. Hematocrit values were determined using the microhematocrit method by averaging the hematocrit values of 2 capillary tubes performed simultaneously. Hemoglobin values were determined using the MissionPlus Reflectance point-of-care instrument (ACON Laboratories, Inc; 10125 Mesa Rim Road, San Diego, CA 92121, USA). Results were reported as hemoglobin, so hematocrit values were converted to hemoglobin values using the rule of 3 (3 × hemoglobin values = hematocrit values). In all cases, blood specimens analyzed in this study were collected for clinical purposes. After all clinical testing was completed, blood specimens were deidentified by Haitian laboratory staff prior to analysis, qualifying the study as exempt of Institutional Review Board approval.

Determining Normal Reference Interval

Deidentified blood specimens could not be segregated by sex so that a single reference interval was generated as an average of male- and female-specific values. The hemoglobin reference interval of 12.4–14.6 g/dl was computed and applied using published reference intervals from African American children and adolescents[15] (14.0–14.35 g/dl for males, 11.94–12.55 g/dl for females, 13.0–13.45 g/dl was the average), normal Nigerian adults[16] (14.0–14.4 g/dl for males, 12.4–13.1 g/dl for females, 13.2–13.75g/dl was the average), healthy adults in Eastern and Southern Africa[17] (12.2–17.7 g/dl for males, 9.5–15.8 g/dl for females, 10.85–16.75g/dl was the average), and the World Health Organization (WHO) criteria[6] (<13.0 g/dl for males, <12.0 g/dl for females, 12.5g/dl was the average).

Determining Anemia Stratification Criteria

To stratify anemia into mild, moderate, and severe, a modification of WHO criteria was used (Table 1).[18] Because our data did not distinguish males and females, we used the values for nonpregnant women and men to determine anemia cutoffs as follows: mild anemia (11.0–12.3 g/dl), moderate anemia (8.0–10.9 g/dl), and severe anemia (<8.0 g/dl).

Data Analysis

Descriptive statistics were calculated, and a frequency polygon was constructed using Microsoft Excel version 14.7.2.

RESULTS

Based on the hemoglobin reference intervals used in this study, these data indicate that 49.27% of the population was anemic with 30.67% being mild ($N = 460$), 15.73% being moderate ($N = 236$), and 2.87% ($N = 43$) showing severe anemia (Figure 1). Based on WHO criteria to determine public health significance (Table 2), these data suggest

Table 1. World Health Organization criteria to stratify anemia based on hemoglobin levels (in g/dl)

		Anemia		
Population	**Nonanemia**	**Mild**	**Moderate**	**Severe**
Children, 6–59 months	11.0 or higher	10.0–10.9	7.0–9.9	Lower than 7.0
Children, 11–15 years	11.5 or higher	11.0–11.4	8.0–10.9	Lower than 8.0
Children, 12–14 years	12.0 or higher	11.0–11.9	8.0–10.9	Lower than 8.0
Nonpregnant women, 15+ years	12.0 or higher	11.0–11.9	8.0–10.9	Lower than 8.0
Pregnant women	11.0 or higher	10.0–10.9	7.0–9.9	Lower than 7.0
Men, 15+ years	13.0 or higher	11.0–12.9	8.0–10.9	Lower than 8.0
Study	12.4–14.6	11.0–12.3	8.0–10.9	Lower than 8.0

Note: Criteria varies based on age of the individual. To form the criteria to stratify mild, moderate, and severe anemia for the study, we took the average of the reference values for nonpregnant women and men 15+ years old.[18]

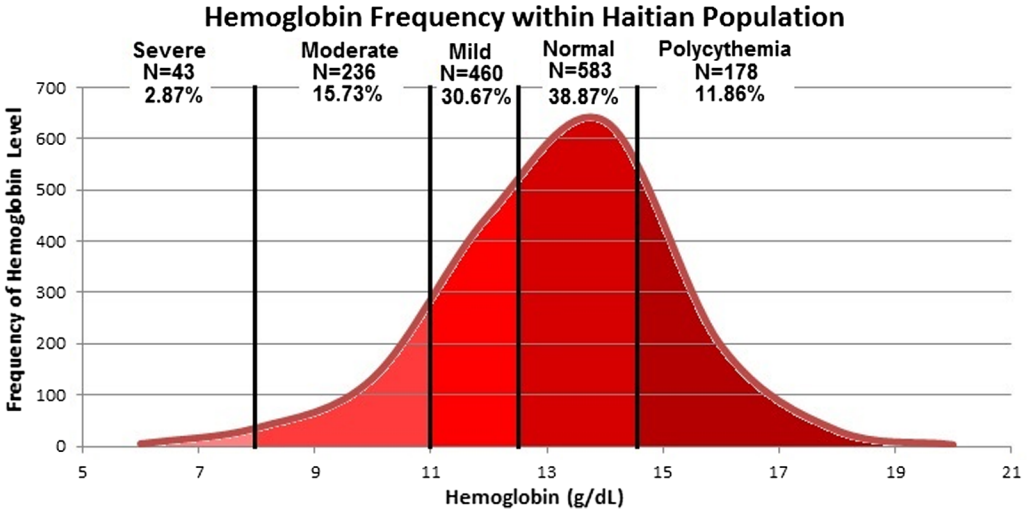

Figure 1. **Hemoglobin frequency and anemia stratification within Haitian study population.**
Note: **The graph is divided into severe, moderate, mild, normal, and polycythemic hemoglobin levels, with *N* being the number of individuals that fall into each category, and the percent being the percentage of the study population that falls into each category.**

Table 2. **World Health Organization criteria for public health significance of anemia**

Prevalence of Anemia, %	Category of Public Health Significance
≤4.9	No public health problem
5.0–19.9	Mild public health problem
20.0–39.9	Moderate public health problem
≥40.0	Severe public health problem

Note: The more prevalent the condition, the more severe it is seen as a public health problem within a population.[6]

that anemia at a rate of 49.27% of the study population represents a severe public health problem in Haiti.

DISCUSSION

Other studies have been conducted on the prevalence of anemia in Haiti, but prevalence varied based on the context of the study. One study on school-aged children in north Haiti found 70.6% were anemic, with 2.6% being severely anemic.[19] Another study performed on children 6–59 months old in south Haiti found 38.8% to be anemic, with 23.9% being mild, 14.7% being moderate, and 0.2% showing severe anemia.[20] One study focused on children 6–59 months old and adults ≥16 years in the Central Plateau of Haiti. For children 6–59 months old, 80.1% were anemic, with 51.8% being mild, 25.0% being moderate, and 3.3% being severely anemic.[21] For adults ≥16 years old, 63.6% were anemic, with 53.8% being mild, 8.0% being moderate, and 1.5% showing severe anemia.[21] All 3 published studies involved mostly or exclusively children. Though important, these reports did not address anemia in the adult population. In addition, all reports cited took place in a single area of Haiti reflecting anemia prevalence locally. This study evaluated all patients, regardless of age, seeking medical attention in clinics scattered across the country of Haiti. Therefore, these data represent a more balanced snap shot of anemia across Haiti where bias due to age or geographic location has been minimized.

Blood samples from clinic patients were used in this study because obtaining blood samples from volunteer research participants in Haiti was difficult. Haitian people were reluctant to donate blood because giving blood was perceived as a health risk. In addition, individuals were unwilling to walk long distances or spend money to travel to the location of blood collection, and this study did not provide remuneration for their blood samples.

A combination of hematocrit and hemoglobin measurements was used. Hematocrit was the preferred anemia measurement because it is accurate and low cost; however, it requires electricity for the microhematocrit centrifuge. In the presence of electricity, hematocrit was measured; in the absence of electricity, hemoglobin was measured using the battery-powered MissionPlus Reflectance instrument. The authors are aware that converting hematocrit to hemoglobin using the rule of 3 has the potential to introduce anemia classification errors for specimens whose values fall close to the anemia cut points. Microcytic RBCs would decrease and macrocytic RBCs would increase hemoglobin levels calculated from hematocrit values. The absence of mean corpuscular volume values made it impossible to determine the presence and magnitude of potential classification errors. Assuming the probability of both microcytic and macrocytic anemias being present among the participants tested, the degree of underestimation from microcytic anemias could be counterbalanced by the overestimation contributed by macrocytic anemias making the final estimation reflective

of the Haitian population throughout the country. In addition, the magnitude of anemia and distribution of anemia severity was similar to the cited report in which Haitian adults were also evaluated.[21]

The average of published male and female reference intervals was used in this study to generate the reference intervals because the study did not distinguish males and females. Papers that determined reference intervals using African populations were selected because Haitians are of African descent,[22] and some reports claim hemoglobin reference intervals differ between certain ethnic groups. Sex could not be distinguished from the deidentified specimens, so the reference interval represents the mean of the male and female reference intervals cited. The WHO criteria used to stratify anemia based on severity were the same for both males and nonpregnant females, so the cutoff values were applied directly from Table 1. The only exception to this was the interface between the upper end of the mild anemia reference interval (12.3 g/dl) and the lower end of the nonanemic (normal) interval (12.4 g/dl). The lower end of the reference interval used to determine mild anemia, created from published data, was greater than the anemia cutoff value for each of the groups published by WHO (Table 1) except for men. We realize that men with hemoglobin values between 12.4–13.0 g/dl could be erroneously classified as having mild anemia, but we believe an equal number of women and children with mild anemia may be classified as being nonanemic. Thus, these intervals represent a conservative estimate of mild anemia because women and children in Haiti seek medical attention more often than men.

We hypothesize that the group above the upper end of the reference interval (14.6 g/dl) in Figure 1 may represent 3 distinct subgroups. First, the reference interval was averaged for sex, creating a falsely lowered upper end of the reference interval resulting in some normal males appearing to have elevated hemoglobin levels. Second, dehydrated individuals have a smaller plasma volume, causing a false increase in hemoglobin and hematocrit. Dehydration caused by limited potable drinking water and excessive sweating in a tropical climate are chronic situations that may result in overestimation of relative polycythemia and underestimation of anemia. Third, some in this group may represent primary polycythemia.

CONCLUSION

These findings corroborate the high prevalence of anemia in Haiti reported by others in the scientific literature[19-21] and extend those findings to include adult participants living in areas across Haiti. A total of 49.27% of our study population was anemic, classifying it as a severe public health problem in Haiti by WHO standards (Table 2).[6] These findings contribute to the small library of existing knowledge about anemia prevalence in Haiti.

Future studies would involve determining the major causes of anemia in Haiti to include nutritional (iron deficiency, B_{12}/folate deficiency, protein deficiency), infections (parasitic, bacterial, malaria, tuberculosis, human immunodeficiency virus), hemoglobinopathies, or hemolytic anemias.

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