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The Role of Anemia in Maternal Mortality in African Countries: A Comparative Review

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ABSTRACT

Anemia in pregnancy is one of the most prevalent, multifactorial, and preventable contributors to maternal mortality in Africa. This comparative review synthesizes epidemiologic evidence, biological mechanisms, health-system determinants, and intervention strategies to examine how anemia exacerbates maternal mortality risks across diverse African contexts. Iron deficiency remains the leading cause globally, yet in Africa its impact is magnified by malaria, helminth infections, HIV, tuberculosis, nutritional deficiencies, and hemoglobinopathies such as sickle cell disease. The synergistic interaction between pre-existing anemia and obstetric hemorrhage is identified as a key pathway to maternal death. Comparative analysis highlights regional differences: malaria and SCD dominate in West Africa, hookworm and dietary insufficiencies in East Africa, HIV-related anemia in Southern Africa, and diet-driven anemia in North Africa. Health-system factors including limited antenatal care coverage, fragile blood transfusion services, and supply-chain gaps further amplify risks. While proven interventions exist, including iron–folic acid supplementation, intermittent preventive treatment in pregnancy, deworming, intravenous iron therapy, and strengthened blood systems, their impact is often undermined by low coverage, poor adherence, and systemic weaknesses. Addressing these challenges requires integrated, context-sensitive strategies, robust data systems, and sustained policy commitment. This review underscores anemia as a central determinant of maternal survival and proposes a pragmatic agenda for reducing preventable maternal deaths in Africa.

Keywords: Maternal mortality; anemia in pregnancy; iron deficiency; malaria; helminth infections.

INTRODUCTION

Maternal mortality continues to pose a major global health challenge, with Africa bearing a disproportionate share of this burden. Despite decades of international and regional efforts to reduce maternal deaths through strengthened health systems, improved antenatal care, and safer obstetric practices, maternal mortality ratios (MMRs) in many African countries remain unacceptably high compared to other regions of the world [1]. According to the World Health Organization (WHO), approximately 70% of global maternal deaths occur in sub-Saharan Africa, where fragile health systems, limited resources, and intersecting disease burdens compromise maternal survival [2]. Among the multiple factors contributing to these deaths, anemia in pregnancy has emerged as a particularly important, yet often underappreciated, determinant.

Anemia in pregnancy is defined by the WHO as a hemoglobin concentration below 11.0 g/dL, and it is both highly prevalent and highly consequential in African populations. The condition is multifactorial, arising from overlapping biological, nutritional, infectious, and genetic drivers [3]. Globally, iron deficiency is the leading cause of anemia; however, in the African context, this etiology is compounded by other risk factors such as malaria, hookworm infestation, schistosomiasis, HIV, tuberculosis, and inherited hemoglobinopathies such as sickle cell disease and thalassemia. Additionally, deficiencies in essential micronutrients like folate, vitamin B12, and vitamin A exacerbate the problem [4]. When superimposed on obstetric complications such as postpartum hemorrhage, a leading direct cause of maternal death, the presence of anemia magnifies the risk of fatal outcomes. Thus, anemia is not simply a background condition but a central factor in the pathway to maternal mortality [5].

The association between anemia and maternal outcomes has been long recognized, yet its significance is magnified in African countries due to the unique epidemiologic, ecological, and health-system contexts. In regions with high

malaria endemicity, for example, recurrent Plasmodium falciparum infection leads to hemolysis, sequestration of infected red blood cells, and chronic inflammation that contribute to persistent maternal anemia [6]. In areas with endemic helminth infections, intestinal blood loss and nutritional depletion further aggravate hemoglobin deficiency. Meanwhile, poverty-related food insecurity ensures that many women of reproductive age enter pregnancy with already compromised iron stores.

The burden is staggering: estimates suggest that more than 50% of pregnant women in sub-Saharan Africa are anemic, with a significant proportion experiencing moderate to severe forms. These conditions increase the likelihood of maternal death, low birth weight, preterm delivery, intrauterine growth restriction, and perinatal mortality. In addition, anemia impairs maternal work capacity, immunity, and recovery from childbirth [7]. Despite these well-documented risks, interventions such as iron-folic acid supplementation, malaria prevention strategies, and deworming programs often face implementation gaps, low coverage, and poor adherence [8].

Comparative data also show variations across African countries. For instance, in West Africa, malaria and sickle cell disease exert significant influence on anemia patterns, whereas in East Africa, hookworm and nutritional deficiencies are more prominent drivers. North Africa, with lower malaria transmission, tends to have anemia burdens linked more to dietary patterns and obstetric hemorrhage [9]. Understanding these regional nuances is crucial for tailoring interventions that are context-specific and effective.

Despite being one of the most preventable contributors to maternal death, anemia remains persistently high among African women of reproductive age. The persistence of this condition reflects both biomedical and systemic challenges: inadequate nutrition, recurrent infections, high fertility rates, and fragile health systems that fail to provide universal access to preventive and curative interventions [10]. Current maternal health policies often prioritize direct obstetric causes such as hemorrhage, eclampsia, and sepsis, but underestimate the role of underlying chronic conditions like anemia that exacerbate these immediate threats. Consequently, opportunities for prevention and risk reduction are missed. Moreover, data collection systems in many African countries are weak, making it difficult to accurately quantify anemia-related maternal mortality and design evidence-based strategies [11]. This problem is further compounded by inequities in healthcare access. Rural and marginalized populations, who are at greater risk of anemia due to poverty and infectious diseases, often have limited access to antenatal care, diagnostic testing, and life-saving blood transfusion services. Without urgent attention to anemia, Africa is unlikely to meet the Sustainable Development Goal (SDG) target of reducing the global maternal mortality ratio to less than 70 per 100,000 live births by 2030 [12]. This comparative review seeks to investigate the role of anemia in maternal mortality across African countries by examining its prevalence, distribution, and region-specific risk factors. It aims to analyze the biological mechanisms through which anemia heightens maternal mortality risks, particularly when combined with obstetric complications such as hemorrhage, and to assess health-system challenges affecting prevention, diagnosis, and management. Furthermore, the study evaluates the effectiveness of current interventions including supplementation, malaria prophylaxis, and deworming, blood transfusion, and health education, while highlighting contextual factors that shape their success or limitations. Guided by critical research questions, the review explores the extent and causes of anemia in pregnancy, systemic weaknesses in healthcare delivery, the efficacy of interventions, and remaining research and policy gaps that hinder maternal survival outcomes. The significance of the study lies in its ability to reframe anemia as a central determinant of maternal mortality in Africa and to provide actionable insights for policy and practice. By adopting a comparative, multi-level lens, the review not only underscores the urgency of integrating anemia-focused strategies into maternal health programs but also emphasizes broader societal benefits, including improved family health, economic productivity, and progress toward global maternal survival targets.

Epidemiology and Comparative Burden

Anemia in pregnancy remains a pressing public health issue across Africa, with prevalence patterns showing both high overall burden and striking regional variation. In many African countries, more than one in three pregnant women are affected, a prevalence that escalates further in malaria-endemic zones, areas with intense helminth transmission, and regions marked by chronic food insecurity [13]. West and Central Africa consistently record the heaviest burden, driven by high malaria transmission, significant sickle cell gene frequency, and weak coverage of iron–folic acid supplementation; in these contexts, the effectiveness of seasonal malaria chemoprevention and intermittent preventive treatment in pregnancy plays a decisive role. Central African settings such as the Democratic Republic of Congo and Cameroon illustrate how conflict, displacement, and fragile supply chains exacerbate nutritional deficits and undermine antenatal care provision. East African countries show mixed malaria endemicity, with anemia also shaped by hookworm, schistosomiasis, and limited dietary iron bioavailability due to cereal-based diets high in phytates. Southern Africa has comparatively lower malaria but faces the challenge of HIV-related anemia, despite widespread antiretroviral therapy. North Africa, though less affected by infectious causes, continues to grapple with iron deficiency linked to dietary quality and socioeconomic inequality. Data limitations including

incomplete surveillance, underreporting, and misclassification of maternal deaths hamper precise burden estimates, yet evidence underscores anemia's critical role in maternal vulnerability [14].

Biological Mechanisms Linking Anemia to Maternal Mortality

Anemia contributes to maternal mortality through a complex interplay of biological mechanisms that compromise a woman's ability to withstand the physiological stresses of pregnancy, labor, and delivery. The most direct pathway is the reduction in oxygen-carrying capacity, as hemoglobin deficiency limits tissue oxygen delivery, thereby diminishing maternal cardiorespiratory reserve. This becomes critical during labor or concurrent infections when metabolic demands sharply increase. A second mechanism is the interaction between anemia and obstetric hemorrhage, one of the leading direct causes of maternal death in Africa [15]. Women who enter labor with pre-existing anemia have little physiological buffer, so even moderate blood loss can precipitate rapid decompensation, hypovolemic shock, and death. Anemia also weakens maternal immunity: iron deficiency and anemia of inflammation impair cellular and innate immune functions, leaving mothers more vulnerable to severe infections and sepsis. In addition, severe anemia places excessive strain on the cardiovascular system, requiring increased cardiac output to maintain oxygen delivery; in late pregnancy, this demand may precipitate heart failure, especially in women with underlying cardiac conditions. Finally, in extreme cases, severe anemia is associated with coagulopathy and platelet dysfunction, which compound bleeding risks and exacerbate poor outcomes when obstetric emergencies occur.

Etiologic Drivers in African Settings

In African settings, the etiologic drivers of maternal anemia are complex and often overlapping, reflecting a convergence of nutritional, infectious, and genetic factors. Iron deficiency remains the most prominent cause, arising from low dietary intake of bioavailable iron, high phytate consumption that inhibits absorption, and increased iron requirements during pregnancy [16]. Malaria in pregnancy (MiP) further contributes through hemolysis, dyserythropoiesis, and placental sequestration of parasites, which not only reduces maternal hemoglobin levels but also impairs fetal growth and survival. Helminth infections, particularly hookworm, cause chronic intestinal blood loss, while schistosomiasis leads to anemia through mucosal bleeding and inflammation. Hemoglobinopathies such as sickle cell disease exacerbate maternal risks by increasing hemolysis and precipitating painful crises, while heterozygous states interact with malaria epidemiology to shape vulnerability. HIV and other chronic infections add another dimension, causing anemia of chronic disease, direct bone marrow suppression, and side effects from antiretroviral or antimicrobial therapy. Beyond iron, deficiencies in essential micronutrients like folate and vitamin B12 contribute to megaloblastic anemia, while vitamin A deficiency impairs iron mobilization and utilization. Collectively, these etiologic drivers create a multifactorial burden of anemia that undermines maternal health, complicates pregnancy outcomes, and heightens the risk of maternal morbidity and mortality in African countries [17].

Measurement, Diagnosis, and Pathophysiological Pathways

Accurate measurement and timely diagnosis of anemia in pregnancy are critical for reducing maternal mortality in African settings, where overlapping causes frequently complicate management. Routine hemoglobin assessment at the first antenatal booking and again in the third trimester remains the cornerstone of early detection, and the increasing availability of point-of-care hemoglobin meters has expanded access to decentralized screening, even in resource-limited facilities. A comprehensive etiological workup is equally important: ferritin assays, adjusted for inflammation using C-reactive protein or α-1-acid glycoprotein, help distinguish iron deficiency from anemia of chronic disease; soluble transferrin receptor and hepcidin testing, though largely confined to research or tertiary centers, provide additional precision [18]. Parasitic and infectious contributors can be identified through stool or urine microscopy for helminths, malaria rapid diagnostic tests or microscopy, and HIV testing following national guidelines, while hemoglobin electrophoresis remains essential in areas with high sickle cell disease prevalence. Classification of anemia severity allows clinicians to stratify risk, with urgent management and structured birth planning prioritized for women whose hemoglobin falls below 8 g/dL, supported by clear escalation pathways. Without such systematic approaches, anemia directly fuels maternal deaths through synergistic interactions with postpartum hemorrhage, hypertensive disorders, puerperal sepsis, and, in extreme cases, cardiopulmonary collapse.

Health Systems and Care Quality Determinants

The effectiveness of anemia prevention and management in pregnancy is heavily shaped by the strength of health systems and the quality of care delivered at different levels. A persistent challenge across many African settings is commodity security, where frequent stock-outs of essential interventions such as iron–folic acid (IFA) tablets, deworming medicines, intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine-pyrimethamine, and even lifesaving blood products undermine continuity of care [19]. Antenatal care (ANC) coverage and quality remain equally critical. Early booking and adherence to the WHO-recommended eight-contact model create opportunities for consistent anemia screening, supplementation, and counseling. However, gaps in counseling on side effects such as gastrointestinal intolerance to IFA often discourage adherence, reducing intervention effectiveness. Blood availability and transfusion safety represent another systemic bottleneck, especially in rural and

district hospitals where donor recruitment, laboratory capacity for group and screen, crossmatching, and emergency release protocols are limited. Furthermore, weak referral and transport systems delay timely transfer of women with severe anemia or obstetric complications, exacerbating mortality risk. Finally, inadequate data systems hamper evidence-based action: integrating anemia indicators into ANC registers and strengthening maternal death surveillance and response (MDSR) to capture anemia as a contributory cause are essential for guiding policy and resource allocation [20].

Comparative Case Illustrations (Hypothetical Syntheses)

A comparative lens highlights how the burden and drivers of anemia in pregnancy, as well as the effectiveness of interventions, vary widely across African countries. For instance, in Nigeria, anemia is strongly influenced by malaria transmission and the prevalence of sickle cell disease (SCD), making malaria control and genetic counseling central strategies; whereas in Ethiopia, hookworm infestation and dietary insufficiencies are more pronounced, positioning deworming and nutrition-sensitive agricultural programs as higher-yield interventions [21]. Similarly, Uganda's lake-region populations face significant schistosomiasis alongside variable malaria transmission, necessitating an integrated package that combines intermittent preventive treatment in pregnancy (IPTp) with routine deworming. Ghana, in contrast, benefits from stronger facility delivery coverage, offering opportunities to scale intravenous (IV) iron therapy and postpartum hemorrhage (PPH) bundles if supply chains are strengthened. In South Africa, where malaria prevalence is comparatively lower, HIV-associated anemia and diet-related deficiencies dominate the landscape, while in Tanzania, the challenge is balancing malaria prevention, deworming, and adoption of IV iron within higher-level facilities. Together, these comparisons underscore that the anemia–maternal mortality nexus is shaped not only by biologic and epidemiologic profiles but also by health-system readiness and policy prioritization, pointing toward the necessity of context-specific intervention bundles [22].

Policy and Programmatic Directions for Anemia Reduction

Global and regional policy frameworks provide a clear roadmap for tackling anemia in pregnancy, but their impact depends on context-specific adaptation and sustained implementation. WHO guidelines recommend daily iron–folic acid supplementation as the global standard, with intermittent dosing where adherence is low, deworming in high-prevalence areas, intermittent preventive treatment in pregnancy (IPTp) with sulfadoxine–pyrimethamine in malaria-endemic regions, and intravenous (IV) iron for moderate to severe iron-deficiency anemia after the first trimester [23]. Complementary regional initiatives emphasize commodity security through pooled procurement, strengthening blood services, and integrating anemia metrics into maternal death surveillance and response (MDSR) systems. Looking ahead to 2025–2030, programmatic priorities include preconception and adolescent interventions such as school-based supplementation and food fortification, universal hemoglobin screening during antenatal care, and adoption of IV iron algorithms for oral iron nonresponders. Strengthening malaria and helminth control, ensuring robust blood systems, and integrating sickle cell disease care into maternal health platforms are also critical. Equally important is data-driven quality improvement using dashboards that link anemia control to postpartum hemorrhage fatality rates. However, key research gaps persist, including the need for better iron status diagnostics, pragmatic trials of IV iron versus transfusion, operational strategies for improving adherence, and context-specific cost-effectiveness analyses [24].

CONCLUSION

Anemia in pregnancy remains a central, yet often underestimated, driver of maternal mortality in African countries, acting through a complex interplay of biological, infectious, nutritional, and systemic factors. This review demonstrates that while iron deficiency is the leading cause, malaria, helminth infections, hemoglobinopathies, HIV, and obstetric hemorrhage synergistically amplify maternal risks. Comparative insights across regions highlight that the anemia–mortality nexus is deeply shaped by epidemiologic context, health-system readiness, and policy prioritization. Although effective interventions exist including iron–folic acid supplementation, deworming, malaria prevention, IV iron therapy, and strengthened blood systems coverage gaps, weak adherence, and fragile supply chains continue to undermine progress. Addressing anemia requires a comprehensive approach spanning preconception to postpartum, integrating biomedical, nutritional, and systemic strategies. With strengthened surveillance, context-sensitive policies, and sustained investment, African countries can substantially reduce anemia-related maternal deaths, accelerate progress toward global maternal survival targets, and deliver broader benefits for women, families, and communities.

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