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Integrating and coordinating programs for the management of anemia across the life course

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Abstract

Anemia is a major global public health concern with a complex etiology. The main determinants are nutritional factors, infection and inflammation, inherited blood disorders, and women's reproductive biology, but the relative role of each varies between settings. Effective anemia programming, therefore, requires evidence-based, data-driven, contextualized multisectoral strategies, with coordinated implementation. Priority population groups are preschool children, adolescent girls, and pregnant and nonpregnant women of reproductive age. Opportunities for comprehensive anemia programming include: (i) bundling interventions through shared delivery platforms, including antenatal care, community-based platforms, schools, and workplaces; (ii) integrating delivery platforms to extend reach; (iii) integrating anemia and malaria programs in endemic areas; and (iv) integrating anemia programming across the life course. Major barriers

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AUTHOR CONTRIBUTIONS

D.L.d.R., M.A., and L.M.R. planned and designed the review. D.L.d.R., A.M., and J.M.G. searched for and acquired the data and information included in the manuscript. D.L.d.R., J.M.G., and A.M. drafted the manuscript and all authors reviewed and provided final approval of the version to be published. All authors agree to be accountable for all aspects of the work.

COMPETING INTERESTS

The authors declare no competing interests.

DISCLAIMER

This manuscript on anemia programs was developed as an input paper for the *Comprehensive framework for integrated action on the prevention, diagnosis and management of anemia* led by the World Health Organization (WHO). This paper is being published individually but will be consolidated with other manuscripts as a special issue of Annals of the New York Academy of Sciences, the coordinator of which was Maria Nieves Garcia-Casal. This special issue will serve as working papers providing insights to help diagnose anemia and its causes with acceptable accuracy and precision in individuals and populations, and to prioritize and maintain actions to accelerate reductions in the prevalence of anemia. The special issue is the responsibility of the editorial staff of Annals of the New York Academy of Sciences, who delegated to the coordinator preliminary supervision of both technical conformity to the publishing requirements of Annals of the New York Academy of Sciences and general oversight of the scientific merit of each article. This work was supported by the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), USA; the United States Agency for International Development (USAID), USA; and the Bill & Melinda Gates Foundation, USA. The authors alone are responsible for the views expressed in this paper. The findings and conclusions in this report are those of the authors and are not attributable to or represent the official position of the World Health Organization, the Centers for Disease Control and Prevention, the sponsors, publisher, or editorial staff of Annals of the New York Academy of Sciences.

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to effective anemia programming include weak delivery systems, lack of data or poor use of data, lack of financial and human resources, and poor coordination. Systems strengthening and implementation research approaches are needed to address critical gaps, explore promising platforms, and identify solutions to persistent barriers to high intervention coverage. Immediate priorities are to close the gap between access to service delivery platforms and coverage of anemia interventions, reduce subnational coverage disparities, and improve the collection and use of data to inform anemia strategies and programming.

Keywords

adolescents; anemia programs; coordination; coverage; integration; maternal and child health; multisectoral

INTRODUCTION

Anemia, defined by insufficient levels of hemoglobin in the blood according to age-, sex-, and pregnancy-status criteria,[1] is a major global public health concern. Analysis of data from the Global Burden of Disease project estimated that there were approximately 1.8 billion prevalent cases of anemia in 2019, resulting in 50.3 million years lost to disability.[2] The burden of anemia is greatest among young children and women of reproductive age (WRA), including menstruating adolescent girls,[2] with negative consequences for health and survival, physical and cognitive development in children, birth outcomes, and adult work productivity.[3–7] Globally, progress in reducing anemia has been minimal over the past two decades, with the prevalence declining from 41% to 37% among pregnant women and from 48% to 40% among children 6–59 months of age from 2000 to 2019.[8] Significant regional variations exist within these global data; in 2019, the prevalence of anemia among children 6–59 months of age exceeded 70% in 11 countries.[8] One of the Global Nutrition Targets established by the World Health Assembly is to reduce the prevalence of anemia in all WRA by 50% by 2025, but few countries are expected to achieve this.[8,9] On the contrary, the prevalence of anemia in WRA slightly increased between 2012 and 2019 (28.5% vs. 29.9%), and a continued increase to 31.2% is expected by 2025.[9]

Anemia has a complex etiology, with major causes including: (i) nutritional factors, notably iron deficiency as well as deficiencies in folate, vitamin A, and other micronutrients; (ii) inflammation and infection, including malaria, intestinal parasites, HIV, and tuberculosis; (iii) inherited blood disorders, such as hemoglobinopathies, sickle cell trait, and glucose-6-phosphate dehydrogenase (G6PD) deficiency; and (iv) women's reproductive biology, including menstruation, hemodilution during pregnancy, and postpartum hemorrhage.[2,10] Current knowledge and issues regarding the causes and contributing factors of anemia are discussed in detail in a separate paper in this series of input papers,[11] which have been developed in support of the *Comprehensive framework for integrated action on the prevention, diagnosis and management of anemia* led by the World Health Organization (WHO). The aim of the present paper is to provide a broad overview of the state of country programs to address the burden of anemia across the life course, as well as common challenges and opportunities to strengthen integration and coordination for improved

outcomes. The issues and examples discussed in this paper focus on young children, adolescent girls, and WRA as the population groups with greatest physiological and social vulnerability to anemia, and on low- and middle-income countries as the settings with the highest burden of anemia.

A range of interventions have been shown to be effective for improving hemoglobin concentrations and reducing anemia prevalence by addressing determinants related to nutrition, infection, and reproductive health.[12,13] A separate input paper in this series discusses anemia prevention and control interventions in detail.[14] To summarize, dietary intakes of iron, folate, and other micronutrients can be improved through staple food fortification, targeted fortification for children through the use of micronutrient powders (MNPs) or specialized food products, dietary diversification, and micronutrient supplementation of vulnerable population groups.[15,16] In malaria-endemic areas, malaria control significantly reduces anemia; preventive interventions include insecticide-treated bednets (ITNs), residual indoor spraying of insecticide, and intermittent preventive treatment of malaria during pregnancy (IPTp).[12,17] Prophylactic deworming of children, adolescents, and WRA, including pregnant women after the first trimester, contributes to anemia control in settings affected by helminth infection.[18] Reproductive health care, including birth spacing and access to modern contraception methods, effective management of postpartum hemorrhage, and delayed umbilical cord clamping following childbirth reduce maternal and infant anemia risk.[12,19] Underlying these direct interventions, improvements in sanitation, gender equity, and women's empowerment, education, and household economic resources are important drivers of anemia reduction.[19] Not all interventions are required in all settings; the choice will depend on the prevalence and main determinants of anemia in each specific context.

Effective anemia prevention and control, therefore, requires the development and implementation of contextualized multisectoral strategies, with actions implemented synchronously to address the multiple determinants of anemia.[10,20] This depends on coordination within and across sectors as well as the high quality and coverage of all priority interventions. Delivery platforms for anemia interventions commonly include antenatal care (ANC), in which standard protocols include the provision of iron and folic acid (IFA) supplementation for daily consumption, with a minimum target of 90+ IFA tablets, as well as prophylactic deworming and IPTp in contexts endemic for helminths and/or malaria. ANC and other reproductive health care services may distribute ITNs and also support birth spacing and delayed umbilical cord clamping following childbirth. Community events, such as Child Health Days, are another delivery platform, designed to concurrently deliver several health interventions. These events frequently combine the delivery of vitamin A supplementation and deworming, and may also provide a platform for distribution of ITNs and/or MNPs if required by the context. Malaria control programs implement ITN distribution, indoor residual spraying, and/or surveillance and treatment. Staple food fortification (mandatory or voluntary) is implemented through the food system. School feeding programs can include the use of fortified foods or MNPs, and school-based delivery is increasingly being explored for other anemia interventions targeting adolescents, including weekly IFA supplementation (WIFAS) and deworming. Community-based platforms are also important for reaching nonpregnant WRA and adolescents not

attending school with WIFAS and deworming, and for reaching caregivers of young children with infant and young child feeding counseling, including distribution of MNPs. Despite the high global burden of anemia and the suite of platforms available for service delivery, critical policy and programmatic gaps persist.[20] There are programs implementing various subsets of anemia interventions, but to date, there are no examples of nationally scaled, coordinated, synchronous implementation of a full package of contextually appropriate anemia prevention and control interventions across the life course.[12]

STATE OF MULTISECTORAL STRATEGIES AND PROGRAMS FOR ANEMIA PREVENTION AND CONTROL

Multisectoral strategies

Given the complex, multifactorial etiology of anemia, a coordinated, contextualized, and multisectoral response is required to address it.[10,20] Historically, potentially relevant interventions have been included in the strategies and action plans of various sectors, but may not be explicitly linked to anemia control or integrated with one another. Encouragingly, an increasing number of countries are developing national anemia policies and/or strategies or incorporating anemia prevention and control within larger multisectoral nutrition plans. For example, the government of Uganda enacted a National Anemia Policy in 2002, establishing the reduction of mortality and morbidity due to anemia as a national priority, and calling for an integrated, multisectoral approach to attain this goal, with interventions delivered through existing sectoral platforms.[21] Building on the foundation laid by this policy, a National Anemia Working Group (NAWG) was established in Uganda in 2014, with high-level political support, participation from multiple sectors (health, agriculture, education, industry, etc.), and facilitation assistance from USAID's Strengthening Partnerships, Results, and Innovations for Nutrition Globally (SPRING) Project.[22] The NAWG leads the coordination of anemia activities at the national level, including strategy development, data generation and analysis, and development and roll-out of training curricula. A national anemia strategy was launched in 2017, emphasizing shared ownership of anemia targets across sectors, with prioritization of key actions within sectoral mandates.[22] Sierra Leone also launched a National Anemia Control Strategy in 2018, grounded in data from the 2013 National Micronutrient Survey.[23] Anemia is incorporated into multisectoral nutrition plans in countries, such as Nepal and the Philippines.[24,25] It will be important to assess the effects of these coordination initiatives on anemia programming and outcomes.

These are examples of positive developments, but in many cases, the formulation of multisectoral anemia strategies is hampered by a shortage of contextualized data on the determinants of anemia needed to inform intervention priorities.[26] In the absence of adequate data, intervention prioritization usually favors iron supplementation and fortification, reflecting global guidelines and reports that iron deficiency is the major global cause of anemia.[2] A strong focus on iron nutrition has been effective in reducing anemia prevalence in some settings,[27] but global progress in reducing anemia has been minimal. This relates in part to inadequate implementation as discussed below, but also to the increasing evidence that the contribution of iron deficiency to the global burden of anemia

may be lower than previously estimated, and varies by setting and infection burden.[10,28–30] These issues and the associated data gaps are discussed in detail in the input paper on anemia determinants.[11]

Tools and guidelines have been developed to support national and district-level landscape analysis and the development of contextualized, multisectoral anemia control strategies, although some tools were developed more than a decade ago and may require updating.[5,31,32] Experiences using these tools in several countries with support from SPRING showed the value of the anemia landscaping process as a means to increase engagement and communication across sectors, contributing to the formation of coordination mechanisms as well as the development of national anemia strategies.[33]

Although critical data gaps persist,[11,26] an increasing number of countries have conducted nationally representative micronutrient and health surveys.[34] These provide more of the nuanced data that is needed to understand local anemia control priorities, particularly when statistical modeling is conducted to examine the relative contribution of different determinants. For example, a recent national cross-sectional survey in Ethiopia found 17% prevalence of anemia in WRA and 22% in children 6–59 months, with low serum ferritin contributing to 11% of cases in WRA and 22% in children; low serum folate was associated with 25% of anemia cases in WRA, while less than 10% of cases were attributed to inflammation and malaria.[35] Sierra Leone's 2013 National Micronutrient Survey (NMNS) found a very high burden of anemia in both preschool children (76%) and WRA (45%).[36] Malaria and inflammation were identified as key determinants, with iron deficiency also contributing to anemia in WRA.[36] These data were used in conjunction with a national landscape analysis to develop a national anemia strategy (2018–2025) led by a multisectoral National Anemia Working Group.[23] Strategic objectives address infection prevention and control, reproductive health, micronutrient status, and education of women and girls, reflecting context-specific and multisectoral anemia prevention and control priorities. However, the key determinants of anemia identified through the 2013 NMNS only explained 25% of the population-attributable anemia risk, indicating a need for a more comprehensive assessment, including additional potential causes of anemia, such as genetic blood disorders and other parasitic infections.[36]

The Ghana NMNS conducted in 2017 included an analysis of micronutrient status, malaria, inflammation, and genetic blood disorders.[37] The available data explained 69% and 53% of the burden of anemia in preschool children and nonpregnant WRA, respectively.[37] Major determinants of anemia were iron status and inflammation, and for children, malaria parasitemia, with regional variations. Conclusions of the analysis include the need for implementation planning at the subnational level and for the inclusion of additional potential causes of anemia, such as intestinal parasites, in future surveys.[37] Analysis of NMNS data for Nepal showed that the factors most strongly associated with anemia in WRA were G6PD and hemoglobinopathies, while significant modifiable factors included iron and vitamin A status, living in a home with a dirt floor, and not using hormonal contraception.[38]

These examples demonstrate that efforts are required to improve the collection and utilization of data on anemia determinants across affected countries, in order to inform

national intervention priorities and ensure the efficient use of resources for anemia control.[20] In addition, a significant strengthening of implementation is required to improve coverage and quality of service delivery, and to realize synergies between priority interventions.

Implementation coverage

Global guidance recommends the delivery of anemia prevention and control interventions through existing platforms and programs, rather than establishing separate structures.[39] In most cases, anemia interventions are incorporated into sectoral action plans, but inadequate implementation coverage and quality are persistent issues contributing to the mismatch between anemia strategies and outcomes.[20] This is illustrated by coverage data for several priority interventions.

Iron or IFA supplementation for pregnant women is one common pillar of anemia control programs, but coverage remains low. Analysis of coverage data from 17 countries with two data collection points in the period 2008–2018 showed that only one-third of pregnant women consumed 90+ IFA tablets (half the recommended regimen of 180 tablets), with very minimal improvement between the two time points.[40] Wide disparities in coverage by subnational region have also been identified, and are more significant than between-country or rural–urban differences.[41] The barriers to improved IFA coverage have been well documented, and include both supply and demand issues (see later section on Gaps and Challenges).[42,43]

A recent analysis of Demographic and Health Survey (DHS) data from 50 countries found overall 33% deworming coverage among eligible preschool children, with significant subnational variations in coverage, including in 30 of the 31 countries with national rates meeting the WHO target of >75% coverage.[44] Among 25 countries in Asia and sub-Saharan Africa with DHS data collected since 2015, 40% of pregnant women received deworming, but coverage ranged from <2% in Pakistan and Tajikistan (2017) to 83.5% in Sierra Leone (2019).[45]

Malaria prevention and control activities have been strengthened in the past two decades, particularly through the distribution of ITNs. According to the World Malaria Report (2021), 65% of households in sub-Saharan Africa owned at least one ITN, and ITNs were used by 49% of pregnant women and children 6–59 months of age.[46] However, these figures represent a decline in coverage of about 10% since 2017, and renewed efforts are required to increase and sustain high coverage of ITN ownership and use. Similarly, coverage of IPTp recently declined in sub-Saharan Africa (n = 33 countries reporting data) after steady improvement from 2010 to 2019, with 57% of pregnant women receiving the first dose, 46% receiving two doses, and 32% receiving three doses in 2020, compared with 42%, 30%, and 1%, respectively, in 2010.[46] Indoor residual spraying covered 2.6% of the at-risk population in 2020, a decrease from 5.8% in 2010, and a reduction in the absolute number protected from 161 million to 87 million.[46]

Fortification of staple foods with iron, folic acid, and other micronutrients is an important foundational strategy for improving micronutrient intakes and reducing nutritional anemia risk at the population level.[16,47,48] Currently, there are 90 countries with mandatory wheat

flour fortification; coverage data are available for 10 of these and range from 98% in the United Kingdom to ≤1% in Costa Rica and Uzbekistan, with many data sources more than 5 years old.[49] In Costa Rica, maize flour and milk are also fortified with iron. In children 1–7 years old, iron deficiency decreased from 27% to 7%, and anemia declined from 19% to 4% over the first decade of the national fortification strategy.[50] Anemia remains a mild public health problem for both preschool children and WRA.[51] A 2017 national survey in Uzbekistan found that one-third of women consumed additional iron through fortified wheat flour, but this was not associated with reductions in iron deficiency or anemia, likely due to low bioavailability of the fortificant in use at the time.[52] Large-scale fortification coverage data collected from eight countries between 2013 and 2015 showed variation between and within countries, with more vulnerable households least likely to benefit despite their potential for greater impact in terms of anemia reduction.[53] Analysis of coverage data from four African countries determined that iron-fortified wheat flour contributed up to 13% of the Recommended Nutrient Intake for WRA, but could be increased to 65% if flour was consistently fortified to standard levels.[54] The missed opportunity to improve nutritional status through large-scale fortification was also highlighted by Kancherla et al., who identified 18 countries in Africa and Asia with immediate potential to benefit from large-scale fortification of wheat flour and/or rice with iron and/or folic acid, resulting in an estimated 34% reduction in anemia among WRA.[55]

Integrated programs

In addition to the clear need to strengthen equitable, high-quality coverage of sectoral interventions, there are strategic opportunities for integrated service delivery and shared ownership of anemia reduction goals, with the potential to accelerate progress. These approaches include bundling of services through shared delivery platforms, integrating complementary service delivery platforms, integrating anemia and malaria programming in endemic areas, and coordinating service delivery across the life course. Wherever feasible, integrated programming is recommended to maximize coverage of a full suite of health and anemia interventions, harnessing synergistic benefits and mitigating potential harms of uncoordinated or incomplete service delivery.[10,12]

Intervention bundling through shared delivery platforms

Most interventions will continue to be delivered within sectoral programs, but coordinated, multisectoral colocation of services with bundling through shared delivery platforms increases efficiency and is likely to improve effectiveness. When delivery platforms are well functioning and comprehensively resourced, this approach ensures that the same households and individuals have timely access to all anemia interventions, enabling the various services to work in concert to reduce the burden of anemia. Delivery platforms with the potential for anemia intervention bundling include ANC, community-based platforms, schools, and workplaces.

Antenatal care—ANC services are the key delivery platform for pregnant women, and a particular gap exists in the coverage of ANC interventions directly impacting anemia (IFA supplementation, deworming, and IPTp). WHO now recommends a minimum of eight ANC contacts, beginning in the first trimester, although monitoring surveys still assess

adherence to the previously recommended minimum of four ANC visits.[56] There is a need for improvement in coverage of 4+ ANC visits, but an immediate priority is to ensure full coverage of all interventions for women who do attend ANC.[41] Analysis of national survey data for the period 2013–2018 showed approximately 50% coverage of 4+ ANC visits but only 30% coverage of 90+ IFA in low-income countries ($n = 10$).[41] In lower-middle income countries, coverage of 4+ ANC rose to 70%, but 90+ IFA only increased to 38% ($n = 12$), and the gap widened further to 82% and 40% in upper-middle income countries ($n = 5$).[41] Another recent analysis using data from 17 low- and middle-income countries showed around 67% coverage of 4+ ANC but only 34% coverage of 90+ IFA.[40] The same issue applies to IPTp: among 33 African countries reporting data in 2020, 74% of pregnant women attended at least one ANC visit but only 57% received the first IPTp dose.[46] Implementation research is needed to understand and address these coverage gaps in different settings.

In addition to comparing coverage of ANC visits with coverage of specific interventions, it is useful to examine the proportion of pregnant women receiving combinations of anemia interventions. This more detailed analysis was conducted by the SPRING Project using Uganda DHS data, and showed that only 35% of pregnant women reported receiving all three anemia interventions in 2011, with an additional 27% receiving two (most commonly IFA supplementation and either deworming or IPTp).[57]

ANC and other reproductive health services are also important delivery platforms for counseling regarding birth spacing, access to modern contraception, and delayed umbilical cord clamping integrated with birthing and early postnatal care. Survey data from 51 countries (2013–2018) showed coverage of facility-based delivery as 70% or higher, indicating the potential for high coverage of delayed umbilical cord clamping.[41] However, the lack of a reliable monitoring indicator and the resulting absence of data are an impediment to supporting the scale-up of this intervention, and community-based platforms also need to be explored for deliveries occurring outside of health facilities.[40]

Community-based platforms—For preschool-aged children, anemia interventions, such as vitamin A supplementation and deworming, may be delivered through a variety of community-based platforms. Distribution of ITNs and MNPs may also be included depending on the context. The SPRING analysis for Uganda examined combined coverage of three childhood anemia interventions (deworming, vitamin A supplementation, and ITNs), and found that in 2011, 27% of children aged 12–59 months had participated in all three interventions, 34% participated in two, 28% participated in one, and 12% participated in none.[57] Although these specific findings are no longer current, they remain a unique example of analyzing combined intervention coverage for anemia prevention and control. This is an important analytic approach for highlighting programming gaps and developing strategies to close them.

Infant and young child feeding programs are an important community-based platform for the distribution of iron-containing MNPs to caregivers of young children, in conjunction with counseling on appropriate use as well as on other recommended breastfeeding and complementary feeding practices.[58] Integrated programs with a strong focus on behavior

change communication (BCC) have shown a potential to achieve high coverage of MNPs as well as improving a variety of child feeding practices.[59] However, analysis of survey data from five countries where MNPs or fortified complementary foods were integrated within infant and young child feeding programs showed wide variations in coverage, from negligible (<1%) to very high (>80%), reflecting differences in program models and implementation quality.[60] Sustaining high intervention fidelity is a recognized challenge for implementation at scale.[61]

Community-based delivery platforms also have the potential for reaching women with anemia interventions. This was demonstrated through an initiative in Yen Bai province, Viet Nam, in which WRA received WIFAS and twice-yearly deworming, from 2006 to 2012.[62] Prospective data collection (n = 389) showed that the prevalence of anemia in WRA decreased from 38% at baseline to 19% after 12 months, and declined further to 14% after 72 months of the intervention.[63] Hookworm infection prevalence was reduced from 76% to 10% from baseline to endline.[63] Overall, this project showed the potential for integrated community-based delivery of anemia interventions. However, despite being embedded in the Ministry of Health systems, the project relied on external resources, particularly for the WIFAS purchasing costs.[63] This has implications for continuity as well as replication in other settings.

Schools—For adolescents, schools are a key delivery platform in many countries. Widely implemented programs with relevance to anemia prevention and control include school meals (especially where fortified foods or MNPs are provided) and school-based deworming programs. Where national school health and nutrition programs are already in place, additional anemia interventions, such as WIFAS, can be integrated. This was achieved in West Java, Indonesia, through a process that began with government policy mandating WIFAS for adolescents, then engaged multisectoral stakeholders of the national school health program in formative research, training, and coordination for the new WIFAS intervention.[64] In Ghana, WIFAS is provided to adolescent girls aged 10–19 years within a national school health and nutrition program that also emphasizes malaria prevention.[65] Evaluation of the first phase of this program showed a reduction in anemia from 25% to 20% over 1 school year, but only 21% of students consumed at least 27 doses of WIFAS, which was determined to be the minimum effective number.[66] School-level factors, such as school size, educator perceptions of the program, and record-keeping accuracy, were found to be the main impediments to adherence, indicating the potential for further gains in anemia with strengthened program implementation.[65,67] In India, the Anemia Mukt Bharat initiative includes school-based delivery of an integrated package of anemia interventions (WIFAS, twice-yearly deworming, BCC, and annual anemia screening) for all 10- to 19-year-olds.[68] Comparison of Health Management Information System data from 2017 to 2018 and 2019 to 2020 showed that national-level IFA coverage for school-going adolescents doubled following the initiation of Anemia Mukt Bharat, reaching at least 40% for both males and females.[69] These are impressive gains, but there are significant state-level disparities in coverage, and a gap remains between coverage of WIFAS and school-based deworming.[70]

Workplaces—Workplaces are an underexplored platform with the potential for delivering anemia interventions to WRA in some settings. The Workforce Nutrition Alliance led by The Global Alliance for Improved Nutrition (GAIN) and The Consumer Goods Forum is engaged in advocacy, partnership building, and evidence generation for workplaces as a platform to improve health and nutrition, including reducing anemia.[71] One current program example is the Healthy Diets for Tea Communities initiative (2020–2023) led by GAIN and the Ethical Tea Partnership, which aims to improve access to nutritious foods and nutrition knowledge among tea plantation workers in Kenya, Malawi, and the Assam state of India.[72] The only relevant published research identified for this paper is from a quasi-experimental study conducted in Bangladesh with nonpregnant workers (n = 1310) at four garment factories already providing monthly health and nutrition BCC.[73] Two intervention packages were investigated over a 10-month period, each implemented in one factory with one comparison factory. Adjusted difference-in-differences analysis showed that anemia prevalence decreased by 32-percentage points and mean hemoglobin increased by 10 g/L with the provision of WIFAS, a nutrient-dense hot lunch including fortified rice, and enhanced BCC curriculum, in comparison with the regular factory lunch and BCC modules. In factories not providing lunch, the provision of twice-weekly IFA and the enhanced BCC curriculum was associated with a 12-percentage point reduction in anemia and 4 g/L increase in mean hemoglobin, in comparison with the group receiving the regular BCC activities only. This study provides preliminary evidence of the potential for workplace delivery of anemia interventions to WRA, and further research is warranted, including cost–benefit analyses.

Integrating delivery platforms

Another form of integrated programming involves the coordination of delivery platforms to extend coverage and/or provide a full package of services. The program for WRA in Viet Nam integrated community-based WIFAS distribution with facility-based deworming, with 85% deworming coverage and 72% of participants reporting taking at least 75% of WIFAS after 72 months of implementation.[63] Integrating facility- and community-based delivery platforms has been shown to be successful for improving coverage and adherence of IFA for pregnant women, as well as increasing ANC attendance.[74,75] For example, Nepal initiated an Iron Intensification Program to improve IFA coverage through community-based delivery complementing ANC services.[76] The initiative was scaled up over 10 years, reaching all districts by 2014 through more than 50,000 community health volunteers (CHVs). The CHVs distribute IFA to pregnant women through monthly women's groups, remind women to consume the IFA, provide counseling on the management of side effects, and encourage ANC attendance for deworming and other services. National survey data showed a dramatic increase in coverage of 90+ IFA, from 6% in 2001 to 71% in 2016. Attendance at 4+ ANC visits also increased markedly, from 14% to 69%, and the gap between attending ANC at least once and receiving any IFA decreased from 26% to 3%. Coverage of deworming for pregnant women increased from 26% in 2006 to 69% in 2016. However, despite these gains in implementation coverage through the integration of service delivery platforms, anemia prevalence among pregnant women remained over 40% from 2006 to 2016. These data, in conjunction with analysis of anemia determinants in Nepal, suggest the need to strengthen

the response to the other context-specific causes of anemia, while sustaining high coverage of IFA and deworming for pregnant women.[38,76]

The Anemia Mukt Bharat initiative in India primarily reaches adolescents through schools as noted above, but also conducts community outreach to deliver WIFAS and deworming to non-school-going adolescent girls through community-based Anganwadi childcare centers. Although a coverage gap remains, the proportion of non-school-going adolescent girls receiving WIFAS increased more than three-fold (6–23%) in the first 2 years of the initiative.[69] Opportunities to reach adolescent girls outside the school system with WIFAS through community-based health services have also been explored in Ethiopia and Kenya, but engagement has been challenging and alternative models are needed, such as the use of "motivator" girls in Ethiopia.[77] There is a need for implementation research to investigate a variety of community-based platforms with the potential to reach non-school-going adolescents in different settings.[78]

Integrating anemia and malaria interventions in malaria-endemic areas

Pregnant women and young children are the groups most at risk for both iron deficiency and malaria, which are inter-related contributors to the high burden of anemia in endemic settings.[79] However, a desk review of malaria prevention and control policies in 11 high-burden countries found that most did not mention anemia and did not specify anemia prevention and control actions or include IFA protocols.[80] This is concerning as there is a need for the integration of iron supplementation and malaria control activities due to complex interactions between iron and the malaria parasite which can exacerbate morbidity.[79,81] In addition, folic acid supplementation must be limited when IPTp is administered as sulfadoxine-pyrimethamine, as folic acid counteracts the antimalarial effects of this drug.[82,83] The WHO-recommended IFA formulation for pregnant women (60 mg iron plus 0.4 mg folic acid) meets this requirement, but in some countries, folic acid may be provided separately from iron, and/or at a higher dosage not compatible with sulfadoxine-pyrimethamine.[83] Given these concerns, an integrated approach to anemia prevention and control in malaria-endemic areas is required to prevent harm and achieve synergistic benefits for anemia, malaria, and nutritional outcomes.

A WHO policy brief provides guidance on integrating malaria prevention and treatment with IFA delivery through ANC services.[83] In addition, much policy debate has centered on the provision of iron to children in areas of high malaria transmission. Screening individuals for iron deficiency so as to only supplement those with a need for additional iron is not a practical option. If contextual data show a need for increased iron intake, preventive iron supplementation and MNPs can be safely implemented as a public health measure in conjunction with malaria surveillance, prevention, and control interventions.[84,85] Current guidance is that iron interventions should only be provided to children with access to malaria prevention and treatment services.[58,84] Where feasible, codistribution of iron and malaria interventions would ensure that individuals do not receive supplemental iron without concurrent malaria prevention and control.[85]

Coordinated intervention delivery across the life course

The burden of anemia is highest among preschool-aged children and WRA, with relationships between life stages as well as shared household and community-level risk factors, such as inadequate nutrition, sanitation, and access to health services.[10] Comprehensive anemia control programs, therefore, require an integrated life course approach to prevention and treatment. Christian illustrates this as a pyramid, with micronutrient fortification of staple foods and WIFAS for adolescents and WRA in high-burden areas as the foundational, population-level strategies.[48] The second tier of the pyramid is targeted interventions for pregnant women, including daily IFA in all settings, with deworming and/or IPTp where appropriate. The top level of the pyramid is the provision of therapeutic, high-dose iron for pregnant women with moderate or severe anemia. This model focuses on anemia in WRA but could be expanded to the full life course, including delayed cord clamping for newborns and micronutrient-rich complementary foods (including MNPs) as universal interventions, along with deworming, vitamin A supplementation, and ITNs as contextually appropriate. In malaria-endemic areas, an integrated life course approach will reduce the need for iron supplementation of children as women will be iron-replete entering pregnancy and infants will be born with adequate iron stores, enabling their additional iron needs during early childhood to be met through complementary foods and/or MNPs.[85]

MAJOR GAPS OR CHALLENGES

Reach of programs

Many anemia interventions are affected by common issues related to weak delivery systems. These include insufficient financial and human resource capacity to equitably deliver high-quality nutrition, malaria, infection control, and reproductive health programs.[20,41,46] Some interventions carry significant costs, and all require a dedicated workforce of trained, supervised, and motivated staff. Unreliable supply chains are another major system-level barrier, as many interventions require a regular product supply. For example, costs, supply chain issues, and inadequate human resource capacity are key barriers to the reach of ITN distribution strategies.[86] Disruptions in supply are a widely reported reason for pregnant women not consuming sufficient IFA.[42,43,87] Similar challenges have been identified for IPTp delivery through ANC services,[88] and for delivery of MNPs through both health system and community platforms.[89] Programmatic factors related to the training and motivation of implementers as well as supply chain disruptions were identified as the main barriers to high and equitable coverage of WIFAS through secondary schools in Ghana.[65] In addition, the recommended formulation for WIFAS is distinct from IFA for pregnant women,[90] which has implications for logistics management. In order to facilitate effective implementation and extend the reach of these programs, inclusion of the WIFAS formulation in the WHO's Model Essential Medicine List is recommended, as this guides national priorities for procurement and supply management.[91]

On the demand side, several studies have examined barriers to coverage and full consumption of IFA during pregnancy. Factors identified relate to poor quality and accessibility of ANC services, side effects of IFA, difficulty remembering to consume IFA

daily, knowledge and beliefs regarding anemia risk, and desire to maintain privacy regarding pregnancy status, which delays ANC attendance.[27,42,43,87] Lack of knowledge regarding malaria as well as barriers to seeking ANC services also compromise IPTp coverage.[88] Community-based platforms integrated with facility-based ANC are a recommended strategy to address some of these barriers[74–76] and could also be used to deliver WIFAS and deworming to nonpregnant WRA.[63] Evaluations of MNP programs have similarly found demand-side factors to influence reach and uptake, particularly related to caregivers remembering to use the MNPs as directed and managing perceived changes in the taste or appearance of food with MNPs added.[89] Access to education and counseling by trained personnel is a key contributor to the successful implementation of MNPs and other anemia interventions, but is often lacking or not adequately prioritized and supported.[42,87,89] Intervention costs to participants, both direct and indirect, are another consideration.[42] Even where services are provided free of charge, costs may be incurred in transportation to access delivery platforms and/or in time away from economically productive activities.[92]

Barriers to high coverage and impact of food fortification programs include an inappropriate choice of the food vehicle, insufficient fortificant levels, and lack of mandatory regulatory monitoring resulting in poor compliance with fortification standards.[93] Strengthening quality control and monitoring both fortification processes and consumption of target foods in the population are recommended to leverage the potential of food fortification for reducing nutritional anemia.[93,94]

Barriers to integration of programs

In addition to challenges associated with intervention delivery, there are persistent barriers to the effective coordination and integration of programs. Foundational to these is a lack of data, poor use of available data, and lack of coordination.

Adequate data are needed for determining contextual priorities for anemia programs and for monitoring and evaluation of anemia strategies for different groups, as discussed in the input paper on determinants of anemia.[11] Specific data needs include: (i) nationally and regionally representative surveys that include assessment of micronutrient deficiencies, infection burden, and genetic blood disorders; (ii) monitoring of anemia prevalence and intervention coverage among adolescents below 15 years of age; (iii) monitoring coverage of IFA supplementation to nonpregnant WRA and delayed umbilical cord clamping; and (iv) monitoring of anemia intervention package coverage (i.e., the proportion of target populations receiving combinations of interventions).[20,26,40,95] There is also a need for sharing of relevant indicators across sectoral programs, enhancing shared ownership of anemia reduction targets.[20]

Poor use of data is another related barrier to the effective integration of programs.[20] Neither existing nor additional data are of value unless utilized to inform policies and drive program delivery and enhancements. This requires strong coordination both within and across sectors.[20,96]

Coordination is essential for all aspects of multisectoral programming. Effective coordination mechanisms are built from the foundation of policy and strategy guidance, are

needed at both national and local levels, and must engage all relevant stakeholders.[20,97] Facilitation of this process requires dedicated staffing and a significant investment in dialogue to build shared understanding and ownership of anemia control programs.[64,96,97] Coordination is enhanced through high-level political support and fostering personal relationships between staff within and across different sectors, and it is hampered by insufficient financial and human resources, including a lack of technically skilled personnel and competing demands for staff time.[64,97]

WAYS FORWARD

Strategy and coordination

Multisectoral action for nutrition has received significant attention and support over the past decade through the Scaling Up Nutrition (SUN) movement, with many countries launching integrated national nutrition plans.[98] In some cases, anemia programming is embedded within these plans, and for others, the multistakeholder coordination platforms established through SUN could be leveraged or extended to develop contextualized anemia strategies. For countries not engaged in SUN and to address the additional causes of anemia, a process of data generation, stakeholder engagement, and strategy development will be needed, with sustained coordination to oversee intervention planning implementation, monitoring, and evaluation.[96] Detailed tools and guidelines are available to support these actions and process, as well as examples of country experiences with multisectoral coordination and strategy development.[5,31,32,96,99,100] As most multisectoral anemia strategies are fairly recent, there is limited evidence of effective implementation of integrated anemia programs. The Exemplars in Global Health initiative is currently investigating promising examples related to reducing anemia in WRA, with findings forthcoming.[101] Preliminary analyses show the importance of multiple sectors for driving reductions in anemia among WRA.[11]

Strengthening intervention delivery through established and promising platforms

In terms of implementation, the immediate priority is to close gaps between service access and anemia intervention delivery through established platforms.[41] This includes ensuring that all pregnant women who access ANC receive a full supply of IFA supplements with counseling regarding the importance of daily consumption and the management of side effects, as well as provision of a full course of deworming and/or IPTp and ITNs in settings where these are included in ANC protocols. Prevention and prompt treatment of infections should also be promoted. The process used by the Alive & Thrive program to strengthen the integrated delivery of maternal nutrition interventions (including IFA) through ANC services in four countries provides a model that could be applied to anemia interventions.[75] Contextualized solutions were developed through a rigorous process of assessment, analysis, stakeholder engagement, capacity building, and system strengthening appropriate to the local health delivery platforms and key barriers to integrated programming in the four countries.[75] Similarly, there is a need to ensure that all eligible children accessing platforms, such as Child Health Days, receive both deworming and vitamin A supplementation (and MNPs, ITNS, and other interventions as relevant), and to monitor coverage of bundled interventions.

Integrating community-based platforms with facility-based ANC services has been shown to effectively improve coverage of both ANC and 90+ IFA, and should be considered for inclusion in national strategies, with a sufficient and sustained allocation of resources for training and support of both facility-based and community-level personnel.[42,74–76] Workplaces are another potential delivery platform for reaching WRA with integrated anemia control interventions in settings with high rates of female employment.[73] As anemia compromises productivity, investment in effective workplace programs to address it should be attractive to employers.[102]

In addition to closing coverage gaps for integrated services, there is a need to address subnational disparities in service delivery, and to strategically target districts with a disproportionate burden of anemia and its determinants.[41,44,103,104] In some countries, there is also a need to implement subnational intervention packages based on regional differences in anemia prevalence and determinants.[37] In settings where genetic blood disorders are an important determinant of anemia, there is a need to strengthen the assessment and design of public health interventions to address them.[12]

Expanding implementation and strengthening quality control of large-scale food fortification has the potential to significantly reduce micronutrient deficiencies and nutritional anemia in multiple countries, and should be prioritized as a foundational approach to improving population nutrition and health.[48,55,93] This requires establishing and enforcing fortification standards to address key nutrient gaps, using bioavailable and WHO-recommended iron fortificant compounds, and monitoring coverage and impact to ensure that programs are equitable and effective.[93,94] There is also a need to strengthen quality control and program learning for effective and sustained MNP implementation within infant and young child feeding programs.[61] Additional delivery platforms that have been explored for MNPs include the health system, early childhood education programs, school health, nutrition and feeding programs, and public–private partnerships; further development of these and evaluation of the potential for delivery at scale, as well as consideration of other innovative approaches is needed.[40,89]

In settings with high rates of secondary school attendance, schools have been shown to be an effective platform for reaching adolescent girls with WIFAS and deworming as well as health and nutrition education.[66,77] Continued investment, technical support, and research are needed to address implementation challenges and to expand these initiatives.[64,65,77] There is also a need to identify alternative community-based platforms through which adolescents not attending school can be reached with WIFAS and deworming.[105] Current evidence on effective approaches for this is limited, and implementation research that includes the perspectives of affected adolescents is needed to identify, test, and refine context-appropriate solutions.[77,78,105]

Digital platforms hold promise for supporting improved reach and engagement with anemia programs.[40] Social media and other online platforms are widely used in many countries and are particularly relevant platforms for reaching adolescents through cocreated content that will resonate with their unique interests and concerns.[105] Other digital tools, such as text or voice messaging services, are an effective means of increasing knowledge and

improving adherence to episodic behaviors, such as ANC attendance and IFA or MNP consumption.[106,107] Well-designed job aid apps for health workers have been shown to strengthen providers' confidence, improve the quality and consistency of health and nutrition counseling, and increase clients' receptivity and health behaviors.[106] Digital solutions can also contribute meaningfully to system strengthening through functions supporting supply chain management, client registration and monitoring, and data collection, management, and reporting.[108] Digital applications require contextualized design, including appropriate technology selection, adequate user training, and ongoing technical support.[106,108]

Overall, systems-strengthening approaches are needed to build and sustain effective, coordinated delivery mechanisms to achieve national and global anemia targets. There is also a need for implementation science approaches to determine how to better leverage existing and promising delivery systems for proven anemia interventions.[40] This includes understanding and resolving barriers and bottlenecks to bundling and coadministration of inter-related services in order to efficiently achieve high coverage and quality implementation of a comprehensive package of interventions. Research to understand the interactions between interventions is also needed, so that synergies can be enhanced and unintended harms prevented.[12] To date, there has been limited research on integrated anemia intervention delivery, despite the complex etiology of anemia and recommendations for a multisectoral response.[12] Accelerating efforts to build the evidence regarding effective approaches for comprehensive programming holds great potential to enhance global efforts to reduce the burden of anemia.

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