

## **Anemia and Women's Health: Expanding Access to Accurate Screening, Iron Assessment, and Gynecologic Triage**

Anemia remains one of the most common clinical conditions globally, disproportionately affecting young children, adolescents, women of reproductive age, pregnant women, and lactating mothers. The World Health Organization (WHO) emphasizes that accurate hemoglobin measurement and appropriate population-specific cutoffs are foundational for clinical care and public health surveillance.<sup>1</sup> Yet in many low- and middle-income countries (LMICs), routine testing is limited by invasive sampling, supply-chain fragility, device downtime, and weak referral laboratory access. These constraints result in missed or delayed identification of anemia at the point of first contact.

Non-invasive screening tools suitable for community-level outreach and primary-care triage as a first step in the diagnostic pathway could expand coverage and enable repeat testing without the barriers of fingerstick or venipuncture. However, systematic reviews and recent multi-country evaluations demonstrate that current non-invasive hemoglobin technologies vary in accuracy across settings, skin tones, perfusion states, and environmental conditions.<sup>2,3</sup> Field-deployable solutions must meet clinically usable performance thresholds under real-world LMIC conditions, with durability, calibration stability, and quality controls appropriate for decentralized use. WHO guidance further underscores the need for standardized hemoglobin measurement approaches when testing is scaled nationally.<sup>1</sup> Durable device-based platforms and novel sensing modalities, including optical, spectroscopic, or multimodal systems, are of particular interest if they can provide reliable, rapid results suitable for high-throughput screening.

Hemoglobin alone does not establish etiology. Iron deficiency anemia (IDA) remains the leading cause globally, but anemia in LMIC settings frequently reflects mixed etiologies, including inflammation, infection, malaria, helminths, hemoglobinopathies, and nutritional deficiencies beyond iron.<sup>4</sup> The BRINDA analyses demonstrate that inflammation can substantially distort ferritin interpretation, reinforcing the need for assessment strategies that work well in the context of a high inflammatory background.<sup>5</sup> WHO guidance on ferritin similarly highlights the importance of context-specific interpretation and appropriate biomarker selection.<sup>6</sup>

A second priority use case is minimally invasive point-of-care (POC) diagnostics capable of distinguishing iron deficiency from other causes and supporting severity assessment and repeat testing in key pathways, including antenatal care (ANC), postpartum follow-up, and evaluation of heavy menstrual bleeding (HMB). WHO ANC recommendations stress routine anemia detection during pregnancy as critical to reducing maternal and neonatal risk.<sup>7</sup> Clinical guidance for HMB also recommends hemoglobin evaluation to guide management and referral decisions.<sup>8</sup> Technologies of interest include low-cost assays or modular platforms capable of measuring hemoglobin alongside iron-status biomarkers such as ferritin (with inflammation adjustment), soluble transferrin receptor, reticulocyte hemoglobin content, or other validated signatures, provided they remain operationally feasible and economically scalable in decentralized settings.

Finally, heavy menstrual bleeding (HMB) is a common and debilitating women's health condition with multifactorial causes and major quality-of-life and anemia implications. Standardized clinical framing (FIGO PALM-COEIN) distinguishes structural etiologies (polyps, adenomyosis, leiomyoma, malignancy/hyperplasia) from non-structural causes, supporting more consistent triage and management.<sup>9</sup> NICE guidance emphasizes structured assessment and investigation to identify cause and guide treatment, but in many LMIC settings timely imaging and specialist evaluation are limited.<sup>8</sup> This creates a strong opportunity for point-of-care triage tools that can rule out key structural etiologies and flag possible ovarian abnormalities requiring referral.

Across these priorities, innovations must balance analytical validity, operational robustness, and affordability. Solutions that enable frequent, repeat testing; support differentiation of iron deficiency from other causes; and function reliably in primary care and community settings could materially improve women's, maternal, child, and adolescent health outcomes in LMICs.

## References

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