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Research Article

Preconception Hidden Hunger among Women and Adolescent Girls in Northern Nigeria: A Narrative Review and Proposed Conceptual Framework

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ABSTRACT

Micronutrient deficiency, often described as hidden hunger, is a substantial public health problem among women of reproductive age in low- and middle-income countries, yet nutrition programming in Nigeria has concentrated largely on pregnancy and the first 1,000 days. This critical narrative review examines evidence on micronutrient status before pregnancy among women and adolescent girls in Northern Nigeria, the life-course and structural pathways through which vulnerability accumulates, and the intervention options available. Literature published from 2013 onwards, with selected earlier landmark studies, was identified from PubMed/MEDLINE, Scopus, Web of Science and the Cochrane Library and from international agency and Nigerian government sources. No formal risk-of-bias assessment or meta-analysis was conducted, and the original search strings and dates were not archived. National anaemia estimates depend on measurement method: the 2018 Nigeria Demographic and Health Survey reported 57.8% using capillary blood, and the 2021 National Food Consumption and Micronutrient Survey (NFCMS) reported 23.0% using venous blood; these are not a time trend. The NFCMS also reported folate deficiency, based on red blood cell folate, in more than nine in ten non-pregnant women and adolescent girls aged 10–14 years, and higher thinness in women and stunting in children in the North West and North East than nationally. Zonal micronutrient biomarker data for women are not consistently available, so conclusions specific to Northern Nigeria rest largely on national biomarker data and zonal anthropometric indicators. The rationale for acting before conception rests mainly on mechanistic and observational evidence; a preconception supplementation trial has been reported from other countries, and none from Nigeria was identified. A five-pillar framework is proposed as an author-derived conceptual model, not empirically tested, to support stakeholder consultation and implementation research.

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INTRODUCTION

Malnutrition encompasses undernutrition, micronutrient deficiency, and overweight and obesity, and these forms frequently coexist within the same country, community and household (Black *et al.*, 2013). Micronutrient deficiencies are of particular concern during the reproductive years because a woman's nutritional status at conception is relevant to her own health, to gametogenesis and early embryonic development, and to the course of any subsequent pregnancy. The developmental origins of health and disease (DOHaD) literature holds that exposures around conception and in early development may shape later health trajectories (Gluckman *et al.*, 2008). Despite this, nutrition programming in many low- and middle-income countries remains concentrated on pregnancy and the first 1,000 days, so the months and years preceding conception receive comparatively little programmatic attention.

Evidence from sub-Saharan Africa points to widespread micronutrient vulnerability among women of reproductive age. A systematic review of national and subnational data from Ethiopia, Kenya, Nigeria and South Africa found appreciable deficiencies of iron, vitamin A, iodine, folate and zinc in this group (Harika *et al.*, 2017). Nigeria is a useful setting in which to examine the preconception period. It has a large population, pronounced regional inequality, and two recent nationally representative surveys that assessed nutritional status in women by different methods (Table 1). The 2018 Nigeria Demographic and Health Survey (NDHS) reported anaemia in 57.8% of women of reproductive age from capillary blood (National Population Commission [NPC] & ICF, 2019), whereas the 2021 National Food Consumption and Micronutrient Survey (NFCMS) reported 23.0% from venous blood (Federal Government of Nigeria [FGoN] & International Institute of Tropical Agriculture [IITA], 2024). The surveys differ in specimen type, instrument model, sampling design and population definition, so the two estimates are not a time series and the gap between them should not be read as a fall in burden.

Northern Nigeria faces structural constraints that bear directly on diet and on access to preventive services: recurrent food insecurity, climate variability, conflict and displacement in parts of the North East, poverty, gender-related barriers to resources and care, and a primary health-care system of uneven reach. These conditions plausibly affect dietary diversity, access to micronutrient-rich foods and continuity of nutrition services, although the subnational biomarker evidence needed to quantify their nutritional consequences is limited. This review synthesises evidence relevant to nutrition before pregnancy in Northern Nigeria, examines the life-course and structural pathways through which nutritional vulnerability accumulates, distinguishes what the evidence supports from what remains conjectural, and sets out a conceptual framework intended to organize policy discussion and implementation research.

Approach to the Review

This article is a critical narrative review. It was not conducted or reported as a systematic review: no protocol was registered, no formal risk-of-bias or certainty-of-evidence assessment was performed, no duplicate screening was undertaken, and no meta-analysis was carried out. The Scale for the Assessment of Narrative Review Articles (SANRA; Baethge *et al.*, 2019) was used as a writing and self-checking guide, not as a formal quality assessment. Peer-reviewed literature was identified through PubMed/MEDLINE, Scopus, Web of Science and the Cochrane Library, supplemented by targeted searching of World Health Organization (WHO), Food and Agriculture Organization (FAO) and Nigerian government or institutional sources. (WHO, 2015; FAO, 2025; FGoN & IITA, 2024; NPC & ICF, 2019). Searching covered literature published from 2013 onwards, with selected policy and guidance documents consulted to describe the contemporary policy setting and landmark earlier studies retained where they underpin the biological rationale.

Search concepts included preconception nutrition, micronutrient deficiency, hidden hunger, women of reproductive age, adolescent nutrition, life-course nutrition, DOHaD, food systems and Nigeria. Priority was given to systematic reviews, meta-analyses, randomised controlled trials, nationally representative surveys and authoritative policy documents, and reference lists of key papers were screened for further sources. Material was considered where it

related to women of reproductive age, adolescent girls, preconception or periconception nutrition, maternal nutrition, food systems, or programme implementation in Nigeria and comparable settings. Formal exclusion criteria were not defined in advance.

What was and was not documented. The databases, search concepts, date window, priority evidence types and eligibility rationale above are those stated in the original submission. The exact search strings, calendar dates of searching, language restrictions, numbers of records retrieved and screened, and reasons for exclusion were not archived at the time of the original search, and they have not been reconstructed here. The cited literature is predominantly in English; whether a language restriction was applied is not documented. In October 2026, during revision, limited additional targeted searches (not systematic) were run to check survey methods and indicators against the original survey reports and to identify preconception supplementation trials, food-security analyses and mobile-access data. These supplemented, and did not replace, the original search.

Source selection. One author led the search and selected sources; interpretation and critical revision were shared with a second author. No independent duplicate screening or formal consensus procedure was undertaken. Steps that limited, but cannot eliminate, selection bias were the prioritisation of systematic reviews, trials, nationally representative surveys and authoritative documents; citation chasing; reporting of survey estimates separately where methods differ; and, during revision, checking survey figures against the original reports where accessible. Selection and interpretation bias remain possible.

Evidence was synthesized thematically across four domains: burden and determinants; life-course and biological rationale; intervention evidence; and policy and implementation. Where national surveys used different methods, estimates are reported separately rather than pooled or presented as a trend. The five-pillar framework was developed by the authors from this synthesis and is presented as a conceptual proposal.

Hidden Hunger and the Preconception Period

Hidden hunger refers to deficiency of essential vitamins and minerals arising from inadequate intake, absorption or utilization, and it may occur where energy intake appears sufficient. Diets built largely on cereals and starchy staples tend to be low in bioavailable minerals, because phytate and other compounds in these foods reduce the absorption of iron and zinc. Diets in northern Nigeria are generally cereal-based, with maize, millet and sorghum among commonly consumed staples. NFCMS 2021 Annex 10, top foods contributing to energy intake of non-pregnant women by geopolitical zone (FGoN & IITA, 2024). Dietary patterns vary substantially by household, season, livelihood and location, and this variation is poorly captured by national averages. Nationally, only 27.7% of non-pregnant women achieved minimum dietary diversity in the NFCMS (FGoN & IITA, 2024).

The preconception period has no single agreed definition. It is generally taken to cover the months preceding conception, during which nutritional status can realistically be modified, and more broadly the years of reproductive life in which micronutrient stores are established or depleted. The wider definition is the more useful one in settings where a substantial proportion of pregnancies are unplanned and where the first contact with antenatal services occurs well after organogenesis. Under those conditions, a woman's micronutrient status at conception is largely determined by what preceded it rather than by anything a pregnancy-based programme can alter in time.

Burden of Micronutrient Deficiency among Women and Adolescent Girls

Anaemia illustrates why measurement context must be stated alongside any national figure. Table 1 summarizes what could be confirmed about each survey. The 2018 NDHS used on-site HemoCue haemoglobin measurement from finger-prick capillary blood and reported 57.8% anaemia among women of reproductive age (NPC & ICF, 2019). The 2021 NFCMS used whole venous blood, with a wider biomarker panel analyzed in field and reference laboratories, and reported 23.0% among women of reproductive age (FGoN & IITA, 2024). These values should not be read as a time series. The more useful inference is that anaemia prevalence

in Nigeria is sensitive to how it is measured, and that surveillance and target-setting require methods to be specified.

Table 1. Methods of the two national surveys that produced the anaemia estimates

Feature	**2018 NDHS (NPC & ICF, 2019)**	**2021 NFCMS (FGoN & IITA, 2024)**
Design and population	Nationally representative household survey (fieldwork August–December 2018). Of the women aged 15–49 years eligible for haemoglobin testing, 14,617 had haemoglobin measurements available for the anaemia analysis. Final Report	Nationally representative cross-sectional survey stratified by six geopolitical zones (390 enumeration areas; fieldwork January–September 2021); women of reproductive age 15–49 years, with pregnant women reported separately; 14,820 respondents selected across all target groups.
Specimen	Capillary blood (finger prick)	Whole venous blood
Haemoglobin method	On-site HemoCue photometer (201+ model reported in secondary analyses of the survey data)	On-site HemoCue Hb-301 on whole venous blood (other biomarkers analyzed in field and reference laboratories)
Adjustment	Haemoglobin adjusted for altitude (the DHS variable is documented as adjusted for altitude and smoking)	Inflammation adjustment (CRP, AGP) was applied to micronutrient biomarkers; it is not documented here as applied to haemoglobin.
Anaemia threshold	Haemoglobin <12.0 g/dL non-pregnant; <11.0 g/dL pregnant (as used in secondary analyses of the survey)	Non pregnant; Haemoglobin <120 g/L (<12.0 g/dL) anaemic, with mild anaemia at 110-119 g/L (11.0-11.9 g/dL), moderate anaemia at 80-109 g/L (8.0-10.9 g/dL), and severe anaemia below 80 g/L (8.0 g/dL). Pregnant; Haemoglobin <110 g/L (11.0 g/dL) anaemic, with mild anaemia at 100-109 g/L (10.0-10.9 g/dL), moderate anaemia at 70-99 g/L (7.0-9.9 g/dL), and severe anaemia below 70 g/L (7.0 g/dL).
Estimate for women of reproductive age	57.8%	23.0% (Table 233)

Table note. The estimates come from different survey designs, instruments, specimen types and population definitions and are not comparable as a trend.

The NFCMS also separated anaemia from its causes. Iron deficiency affected 10.0% of women of reproductive age and iron deficiency anaemia 4.6%, indicating that anaemia in this group is not explained by iron deficiency alone. The survey linked anaemia in women to deficiencies of iron, vitamin A, zinc and folate, and to inflammation and malaria (FGoN & IITA, 2024).

The NFCMS assessed folate status using red blood cell (RBC) folate in whole-blood lysate, with serum folate reported separately (FGoN & IITA, 2024, Tables 242–243 and 250–251). RBC folate deficiency was defined as a concentration below 624 nmol/L, whereas RBC folate insufficiency associated with increased risk of neural tube defects was defined as a concentration below 748 nmol/L. Using the

deficiency threshold, RBC folate deficiency was reported in 95.4% of non-pregnant women of reproductive age and 91.2% of adolescent girls aged 10–14 years

The distinction matters. RBC folate reflects folate status over the preceding months, approximating the lifespan of red cells, whereas serum folate responds to recent intake. Published cut-offs for RBC folate deficiency vary with guidance and assay, and WHO recommends a much higher population threshold (above 906 nmol/L) for neural tube defect prevention in women of reproductive age (WHO, 2015); prevalence below the higher threshold would be expected to be considerably greater. The figures therefore indicate a very high prevalence of low folate status by the survey's definition. They should not be read as clinical folate deficiency or as neural tube defect risk unless the threshold is confirmed, and by themselves they cannot show cumulative preconception depletion or cause.

National evidence versus evidence specific to Northern Nigeria. The anaemia, iron, folate and other biomarker figures above are national estimates, and they cannot be assumed to apply to the North West or North East. The NFCMS reports zonal disaggregation for several anthropometric and dietary indicators. Thinness (body mass index below 18.5 kg/m² in women aged 20 years and over; BMI-for-age z-score below −2 in those under 20) among women of reproductive age was 14.2% nationally, 21.7% in the North West and 20.9% in the North East. Stunting among children under five (height-for-age z-score below −2) was 33.8% nationally and 48.6% in the North West, the highest of any zone (FGoN & IITA, 2024). These are separate indicators from the 21.7% national stunting prevalence among adolescent girls aged 10–14 years reported later; the identical value is coincidental. Zonal anthropometry is not equivalent to zonal micronutrient biomarker data. Comparable zonal biomarker estimates for micronutrient status in women are not consistently available in the sources consulted, so the extent to which the northern zones differ from national figures on folate, zinc or vitamin A status cannot be established from existing surveys. This materially limits the strength of every conclusion in this review that is specific to Northern Nigeria.

Biological Pathways

The biological case for attending to nutrition before conception rests on gametogenesis, early embryonic and placental development, one-carbon metabolism and immune function. Folate, iron, zinc, iodine and vitamin A participate in cell division, haemopoiesis, thyroid function and gene regulation, and each has a plausible role in early development. The strength of the underlying evidence differs considerably across these pathways (Table 2), and mechanistic plausibility should not be treated as demonstration of clinical or population-level causality.

Studies of the Dutch Hunger Winter show that prenatal nutritional deprivation can be associated with persistent epigenetic differences, including differences in IGF2 methylation decades later (Heijmans *et al.*, 2008). This supports the general proposition that periconceptional nutrition can leave a durable biological signature. It does not establish that any particular micronutrient deficiency before conception produces a specific epigenetic change or adult disease outcome, and the exposure studied was severe acute famine rather than the chronic marginal deficiency common in Northern Nigeria. Animal models supply further mechanistic evidence, but their translation to human populations remains uncertain.

Table 2. Biological pathways relevant to preconception nutrition and the evidence supporting each

Pathway	Key nutrients	Evidence categories present	Preconception-specific human evidence	Interpretation	Key references
Gametogenesis and fertility	Zinc, selenium, folate, iron	M, O	None identified in this review	Biological plausibility; causal effect of preconception status not established	Agarwal et al. (2015); Wessells and Brown (2012)
One-carbon metabolism and epigenetic regulation	Folate, choline, methionine, riboflavin, vitamin B12	M, O, I (indirect)	Folate and neural tube defects: WHO sets an RBC folate threshold for women of reproductive age; epigenetic outcomes of preconception status not established	Strongest for folate and neural tube defects; uncertain for other outcomes	WHO (2015); Heijmans *et al.* (2008)
Placental development and embryogenesis	Folate, iron, zinc, iodine, vitamin A	M, O, I (pregnancy; one preconception trial elsewhere)	One multi-country trial of a lipid-based supplement started at least 3 months before conception reported greater birth length than no supplement; nutrient-specific effects cannot be separated	Pregnancy supplementation evidence does not establish preconception effect	Keats *et al.* (2019); Hambidge *et al.* (2019)
Immune and developmental programming	Vitamin A, zinc, iron and other micronutrients	M, O	None identified in this review	Supports plausibility; long-term causal pathways incompletely defined	Gluckman *et al.* (2008); Victora *et al.* (2008)

Table note. Evidence categories: M = mechanistic or experimental (animal, in vitro or physiological) evidence; O = observational human evidence; I = human intervention (trial) evidence, direct or indirect as stated. Entries are the authors' narrative appraisal of the sources cited in this review; they are not a formal certainty grading (for example GRADE) and do not imply causal effects.

Life-course Accumulation of Risk

Nutritional status at conception reflects cumulative exposure across childhood and adolescence as well as conditions in the months immediately before pregnancy. Early childhood undernutrition is associated with reduced growth,

schooling and adult human capital (Victora *et al.*, 2008). Adolescence then brings rapid skeletal and soft-tissue growth and, after menarche, recurrent menstrual iron losses, at a point when dietary intake often does not increase correspondingly. Girls who marry and conceive during adolescence may enter pregnancy while their own growth is incomplete, so that maternal and fetal requirements compete.

Survey data are consistent with cumulative disadvantage in the northern zones, though they cannot demonstrate it directly. Stunting among children under five was 37% in the 2018 NDHS (NPC & ICF, 2019) and 33.8% in the 2021 NFCMS, reaching 48.6% in the North West; these figures come from different surveys and are not presented as a trend. In the NFCMS, stunting among adolescent girls aged 10–14 years was 21.7% nationally (FGoN & IITA, 2024). Childhood stunting should not be presented as an inevitable precursor of poor maternal nutrition; it is one observable marker of accumulated nutritional disadvantage within a life-course framework, and the longitudinal studies that would link childhood status to preconception micronutrient status in this population have not been conducted.

Adolescent girls are therefore a defensible intervention population, on two distinct grounds that are worth separating. The first is that adolescence is a period of high requirement in its own right, and adolescent nutrition warrants attention independently of any future pregnancy. The second is that intervening before first pregnancy offers an opportunity to improve micronutrient status that antenatal contact cannot provide. Programmes framed solely around future maternal roles risk both an instrumental view of girls' health and a delivery model keyed to school attendance. School platforms offer structure and reach where enrolment is high, but community-based approaches are necessary for girls who are out of school or living where attendance is disrupted, and these groups are likely to carry higher nutritional risk.

Food Systems, Gender and Structural Determinants

Food-system conditions determine whether households can obtain diverse, nutrient-rich diets. In northern Nigeria, climate variability, seasonal production, water constraints, market access and food prices are likely to affect the availability and affordability of animal-source foods, fruits and vegetables. Food insecurity is tracked through the Cadre Harmonisé, the consensus food and nutrition security analysis prepared with FAO and the Federal Ministry of Agriculture and Food Security (FAO, 2025). The World Food Programme, summarizing the analysis for the June–August 2026 lean season, reported nearly 35 million people nationally projected to face severe food insecurity, including nearly six million in Borno, Adamawa and Yobe projected to be in Crisis or worse, and described conflict as intensifying displacement and disrupting farming and food supply (WFP, 2025). Analysts also report that data cannot be collected in inaccessible areas of Borno, Adamawa and Yobe (FAO, 2025). These are food-security and humanitarian indicators. No nutritional biomarker data from conflict-affected or displaced women were identified, and this review does not infer micronutrient status from them; populations in these settings are largely absent from the biomarker surveys on which national estimates rest.

Nutrition-sensitive agriculture can contribute to dietary quality where it is combined with nutrition education, attention to women's control of resources and appropriate market support (Ruel *et al.*, 2013). Biofortification is potentially useful for populations dependent on staple crops, but its effect at population level depends on varietal adoption, functioning seed systems, consumer acceptability, market access and sustained availability. The NFCMS found low consumption of biofortified foods nationally (3.4% for yellow cassava, 4.7% for orange-fleshed sweet potato and 13.5% for orange maize, including derived foods; FGoN & IITA, 2024). Food-system interventions therefore complement rather than substitute for direct nutrition services.

Gender and socioeconomic conditions shape nutrition through several routes. Limited decision-making power over household resources, early marriage, low educational attainment, poverty and distance from services all constrain a woman's ability to obtain a varied diet or to seek preventive care. Interventions addressed to individual knowledge alone are unlikely to alter these constraints, which is an argument for combining nutrition activities with

measures that act on household and community structures.

Intervention Options and the Strength of the Evidence

Several interventions could plausibly improve micronutrient status before pregnancy, and they differ in how well that expectation is evidenced. Large-scale food fortification reaches populations without requiring individual behaviour change, though the NFCMS found coverage of fortified foods uneven across food vehicles in Nigeria (FGoN & IITA, 2024). Biofortification raises the nutrient density of commonly consumed staples. Dietary diversification remains the foundational approach but is constrained by food prices, seasonality and poverty. Supplementation is an additional option for groups with demonstrated deficiency or high risk. Table 3 sets these out with the supporting sources and separates global, Nigerian and Northern Nigerian evidence.

Preconception supplementation

The evidence should be read in four layers. First, pregnancy supplementation: multiple micronutrient supplementation during pregnancy improves outcomes including low birth weight and small-for-gestational-age birth compared with iron and folic acid alone (Keats *et al.*, 2019), which supports continued investment in antenatal supplementation but does not show that the same regimen would work before conception. Second, preconception supplementation elsewhere: the Women First trial, conducted in the Democratic Republic of the Congo, Guatemala, India and Pakistan, compared a lipid-based micronutrient supplement (with additional protein-energy supplement for women with low body mass index) started at least three months before conception, started late in the first trimester, or not provided; supplementation before conception or in late first trimester improved birth length-related outcomes, and preterm birth did not differ between arms (Hambidge *et al.*, 2019). The intervention differed from standard iron and folic acid regimens, the populations were not Nigerian, and the trial does not show an effect in Northern Nigeria. Third, Nigerian evidence: no Nigeria-specific preconception supplementation trial was identified in the searches described in the Approach, and the only Nigerian trial discussed here, IVON, enrolled pregnant women (see Synthesis). Fourth, Northern Nigeria-specific evidence: none was identified. Implementation research would be needed to determine regimen, delivery platform, adherence strategies and safety, including in malaria-endemic areas where iron supplementation requires particular care.

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Delivery platforms and digital approaches

Community health workers, schools, family-planning services and other primary-care platforms offer routes to reach women and adolescent girls before pregnancy, and their comparative reach, cost and acceptability in northern settings have not been established. Digital approaches are treated here as proposed research options rather than evidence-based interventions. Options include voice-based counselling or interactive voice response, SMS reminders, offline-capable counselling or job-aid applications used by health workers, and digital programme monitoring; smartphone applications aimed directly at girls and women are the least likely to be suitable where smartphone access is limited. Feasibility depends on literacy, phone ownership, network coverage, local-language content and gendered access to phones. Across low- and middle-income countries, women are about 14% less likely than men to use mobile internet (GSMA, 2025), but equivalent estimates specific to Northern Nigeria, including for adolescent girls, were not established in this review. No evidence was identified here that such approaches improve nutritional status among Nigerian women or girls, so their feasibility, equity of reach and effect require local evaluation rather than assumption

Table 3. Intervention options relevant to preconception nutrition in Northern Nigeria

Intervention	**Potential role**	**Key constraints**	**Global evidence**	**Nigeria-specific evidence**	**Northern Nigeria-specific evidence**	**Sources**
Large-scale food fortification	Population-level delivery of selected micronutrients	Variable compliance, informal processing, uneven coverage across food vehicles	Established strategy; effect depends on implementation quality	Coverage uneven by food vehicle (NFCMS)	Zonal coverage tables exist; not appraised here	Bhutta *et al.* (2013); FGoN & IITA (2024)
Biofortification	Raises nutrient density of staples	Seed systems, varietal adoption, consumer acceptance, market linkages	Efficacy and effectiveness evidence supports the potential of selected biofortified crops to improve micronutrient intake and status; effects vary by crop, nutrient, population and implementation context.	Consumption low nationally (NFCMS)	NFCMS findings indicate geographical variation, with consumption of the assessed biofortified crops highest in the North East. Uptake was limited nationally; these consumption data do not establish effects on micronutrient status in Northern Nigeria.	Bouis and Saltzman (2017); FGoN & IITA (2024); Onyeneke *et al*., (2019)
Preconception iron–folic acid or other supplementation	Builds or maintains micronutrient reserves in high-risk groups	Adherence, targeting, commodity supply, safety in malaria-endemic settings	One multi-country RCT of a lipid-based supplement (not Nigeria); pregnancy trials are	No preconception trial identified	None identified	Hambidge *et al.* (2019); Keats *et al.* (2019)

			separate evidence			
Dietary diversification	Improves overall nutrient adequacy	Food prices, seasonality, availability of nutrient-dense foods	Foundational strategy; needs multisectoral support	Low diversity nationally (27.7% MDD-W)	Zonal values not extracted here	Bhutta *et al.* (2013); Ruel *et al.* (2013); FGoN & IITA (2024)
Community-based delivery	Reaches rural and out-of-school populations	Training, supervision, commodity supply, referral systems	Recognized delivery platform	Comparative effectiveness for this population not identified	None identified	Bhutta *et al.* (2013)
Social protection with nutrition education	Addresses economic barriers to diet quality and service use	Targeting, financing, household control of transferred resources	Nutrition-sensitive evidence; effect depends on design	None identified in this review	None identified	Ruel *et al.* (2013)
Digital approaches (voice, SMS, offline tools, monitoring)	Support counselling, reminders and programme data	Connectivity, literacy, device access, gender gap in access, language	No effect on nutritional status established here; LMIC mobile gender gap documented	None identified	None identified; local access data needed	GSMA (2025)

Table note. 'None identified' means none was found in the searches described in the Approach; it does not mean that none exists. Entries are narrative appraisal, not a formal grading.

A Proposed Conceptual Framework

Drawing on the synthesis above and on the contextual constraints described, we propose five complementary areas of action for preconception nutrition in Northern Nigeria: adolescent nutrition; preconception micronutrient supplementation; food-system strengthening; community engagement; and digital approaches to counselling and monitoring. The framework is an author-derived conceptual model. It has not been empirically validated, its components have not been evaluated together, its sequencing has not been established, and the indicators listed are illustrative of what evaluation would need to capture rather than validated measures. It is intended for policymakers, primary health-care planners, nutrition programme implementers, researchers and development partners as a basis for consultation and implementation research, not as a package ready for programme adoption without local evaluation.

The pillars are not equally evidence-based, and this matters more than the symmetry of the framework suggests. Table 4 classifies each pillar into one of four tiers: established elsewhere (supported by trials or systematic reviews in other settings, with local effectiveness still to be shown); plausible strategy (supported by indirect evidence); implementation research priority (some trial evidence elsewhere but no Nigerian evaluation); and untested proposition. Fortification and dietary diversification within

pillar three rest on substantial evidence from other settings, and antenatal supplementation is a reference point for pillar two. Adolescent platforms in pillar one are plausible but unevaluated for preconception outcomes in Nigeria. Pillar five is an untested proposition. Presenting these as five parallel pillars is a way of organizing discussion across sectors; it is not a claim that the five are equally ready for implementation.

Table 4. Proposed conceptual framework for preconception nutrition in Northern Nigeria (author proposal; not empirically validated**)**

Pillar	**Objective**	**Possible delivery approaches**	**Illustrative evaluation indicators**	**Evidence tier**
1. Adolescent nutrition	Support healthy development and build nutritional reserves before first pregnancy	School-based and community platforms; adolescent-friendly services; outreach to out-of-school girls	Service coverage; anaemia prevalence; dietary diversity; retention	Plausible strategy; unevaluated for preconception outcomes in Nigeria
2. Preconception micronutrient supplementation	Improve micronutrient status among women and girls at nutritional risk	Primary health care, family-planning and community platforms; phased implementation research	Commodity availability; uptake; adherence; biomarker outcomes where feasible	Implementation research priority; trial evidence elsewhere, none in Nigeria
3. Food-system strengthening	Increase access to diverse, nutrient-rich foods	Fortification, biofortification, agricultural extension, market linkages, social protection	Dietary diversity; varietal adoption; fortification compliance; food affordability	Established elsewhere (fortification, diversification); plausible (biofortification, social protection); local effect unproven
4. Community engagement	Increase demand for services and address social barriers	Religious and traditional leaders, women's groups, male engagement, radio and community mobilisation	Knowledge; service uptake; male participation; acceptability	Plausible strategy; transferability open
5. Digital approaches	Test scalable methods for counselling and monitoring	Voice-based and offline-capable tools with local-language adaptation	Reach; acceptability; data quality; equity of access; fidelity	Untested proposition; research priority

Figure 1 shows the framework as a logic model. Intermediate and long-term outcomes are hypothesized pathways that would need to be tested, not demonstrated effects.

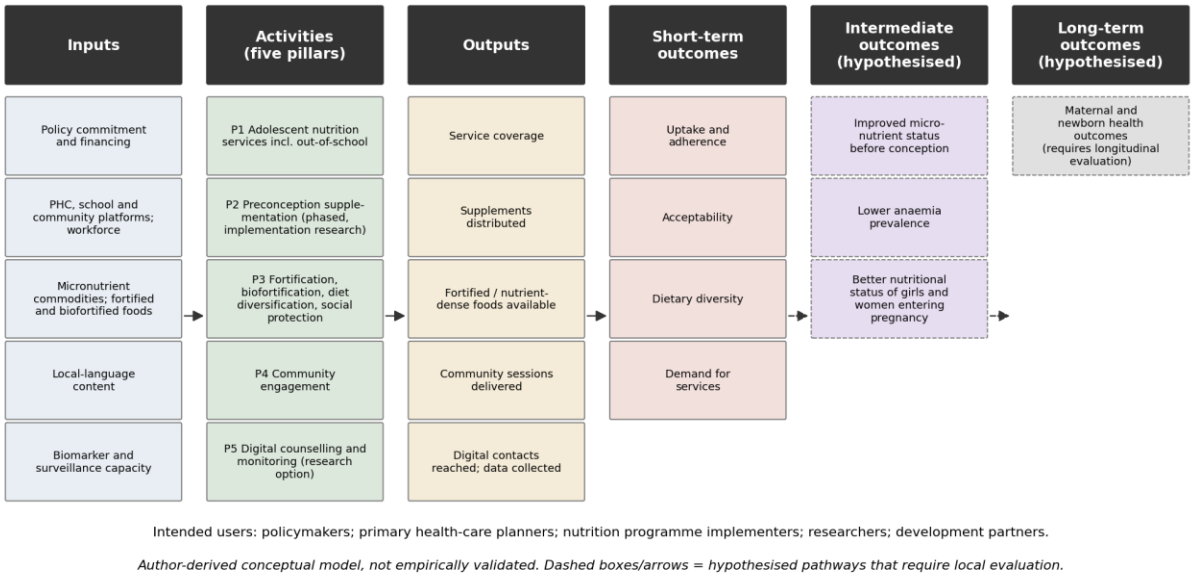


Figure 1. Logic model of the proposed five-pillar framework (author-derived conceptual model; not empirically validated).

Synthesis and Implications

Three points emerge from this synthesis. The first concerns measurement. A single national prevalence figure cannot adequately describe micronutrient status in Nigeria, because estimates depend on blood collection method, biomarker, threshold and adjustment, and because nutritional status varies by zone and by season. The divergence between the NDHS and NFCMS anaemia estimates is the clearest illustration, and it has practical consequences: programme targets and progress assessments anchored to one survey method are not comparable with those anchored to another.

The second concerns the balance between pregnancy and pre-pregnancy programming. The implication of this review is not that antenatal nutrition is ineffective or should be deprioritized, but that pregnancy-based contact is a narrow window for altering micronutrient status that took years to establish. The IVON trial is informative here and is also easy to overinterpret. It enrolled pregnant women aged 15–49 years with haemoglobin below 10 g/dL at 20–32 weeks' gestation in 11 facilities in Lagos and Kano, and compared a single dose of intravenous ferric carboxymaltose with oral ferrous sulphate (Afolabi *et al.*, 2024). Intravenous iron reduced the prevalence of iron deficiency to a greater extent than oral iron, but overall anaemia at 36 weeks' gestation did not differ significantly between arms (58% and 61%, respectively). This shows that correcting iron deficiency alone does not eliminate anaemia where other causes are present, which is consistent with the NFCMS finding that iron deficiency accounts for a minority of anaemia in women of reproductive age. The trial did not study women before conception, did not test any preconception strategy, and does not show that preconception depletion explains the residual anaemia or that pregnancy-based interventions are inherently inadequate. It argues for broader aetiological assessment and for earlier prevention; it is not evidence of a preconception treatment effect.

The third concerns transferability. Multisectoral coordination, attention to women's control of resources, nutrition education and community engagement have strengthened nutrition-sensitive programmes elsewhere (Ruel *et al.*, 2013; Bhutta *et al.*, 2013). Whether these models transfer to Northern Nigeria is an open question

rather than a settled one, given security conditions, patterns of school attendance, health-system fragmentation, social norms around marriage and childbearing, and food-system characteristics that differ from the settings in which much of the evidence was generated. Evidence from elsewhere establishes what is worth testing here, not what will work here.

Evidence Gaps and a Research Agenda

The gaps below follow from the literature reviewed and from the limits of national data, not from a claim that no relevant study exists. Table 5 converts them into a research agenda, ordered so that each design follows logically from the gap it addresses.

Table 5. Research agenda for preconception nutrition in Northern Nigeria

S/No	Evidence gap	Suggested design	Population	Key considerations
1	Zonal and state-level micronutrient biomarker data for women and girls are not consistently available	Biomarker surveillance with representative sampling in the North West and North East	Adolescent girls and non-pregnant women of reproductive age	Specified specimen, assay, thresholds and inflammation adjustment; harmonized with national surveys; seasonal timing
2	No prospective data on micronutrient status before conception followed through pregnancy and postpartum	Prospective preconception cohort	Women planning pregnancy or newly married	Long follow-up; attrition; biomarker timing; links life-course inference to observation
3	No Nigerian trial of preconception supplementation	Feasibility and phased implementation trials, then effectiveness trials if warranted	Women and girls at nutritional risk	Regimen and dose; adherence; safety including malaria-endemic settings; costing
4	School, community and primary-care delivery platforms not compared	Delivery-platform comparison study (for example cluster-randomised or stepped-wedge)	Girls in and out of school; married adolescents; adult women	Reach, cost, acceptability and equity; out-of-school girls prioritized
5	Conflict-affected and displaced populations absent from biomarker surveys	Population survey or sentinel biomarker assessment adapted to humanitarian access	Women and girls in affected areas of the North East	Security and ethics; feasibility of venous sampling; avoid inferring status from food-security data
6	Feasibility and equity of digital approaches unknown	Mixed-methods feasibility study of voice, SMS and offline tools, with phone-access assessment	Girls and women, including those without personal phones	Literacy, language, network coverage, gendered phone access; compare with non-digital counselling
7	Paternal and couple nutrition: human	Observational studies distinguishing association from	Couples attending preconception services	Do not extrapolate from animal models; keep focus on women and girls

	evidence sparse, mostly preclinical	causation; lower priority than 1–6		

Limitations of this Review

This is a narrative rather than a systematic review. Studies were selected and interpreted by the authors without a registered protocol, duplicate screening or formal risk-of-bias assessment, and source selection was led by one author, so selection and interpretation bias cannot be excluded and the completeness of the search cannot be assumed. The exact search strings, search dates and record counts were not archived, so the search cannot be reproduced. The evidence synthesized is heterogeneous in design, population definition and biomarker method, which limits comparison across sources and precludes quantitative pooling. Subnational biomarker data specific to Northern Nigeria are limited; several arguments rest on national estimates or on zonal indicators that do not measure micronutrient status directly, which weakens Northern Nigeria-specific conclusions. The interpretation of the folate figures depends on thresholds that should be confirmed against the survey tables. Evidence labels in the tables are narrative appraisal rather than formal grading. A number of the interventions discussed are supported mainly by evidence from other countries. The five-pillar framework and logic model are author-derived, have not been empirically tested or validated, and require local evaluation before programme use.

CONCLUSION

Nutritional vulnerability before pregnancy in Northern Nigeria plausibly reflects both cumulative life-course exposure and current conditions affecting diet, health services and household resources. National surveys indicate substantial anaemia and low folate status among women and adolescent girls, though prevalence estimates vary with survey method and must be read alongside the methods that produced them. Zonal indicators place the North West and North East above national levels for thinness in women and stunting in children, while direct biomarker evidence for these zones remains limited. Greater attention to adolescent nutrition and to the period before conception would complement rather than replace existing antenatal and child nutrition programmes. The five-pillar framework proposed here is an author-derived conceptual model, not empirically validated, offered as a basis for policy dialogue and implementation research; its components differ in how far current evidence supports them, and it requires local evaluation. Future progress will require stronger subnational biomarker surveillance and locally evaluated preconception intervention studies.

Ethical Approval

This review is based entirely on previously published literature and publicly available survey and policy reports. It did not involve human participants or animals, and ethical approval was therefore not required.

Conflict of Interest

The authors declare no conflict of interest.

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Author Contributions

All authors contributed to the conception and design of the review. All authors contributed to the literature review, synthesis and interpretation of the evidence, and preparation of the manuscript. All authors critically reviewed and revised the manuscript and approved the final version for submission.

Data Availability

No new primary data were generated for this review. The evidence synthesized is available from the published and institutional sources cited in the manuscript.

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