

Micronutrients: Health Essentials

Understanding their role in overall well-being.

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What are Micronutrients?



Essential Nutrients

Required in small amounts daily.



Include Vitamins

A, D, E, K, and B-complex.



Trace Minerals

Iron, zinc, iodine, and others.



Crucial Functions

Energy, immunity, blood, neurological development.

Importance of Micronutrients

Prevent Diseases
Avoid deficiency-related illnesses.

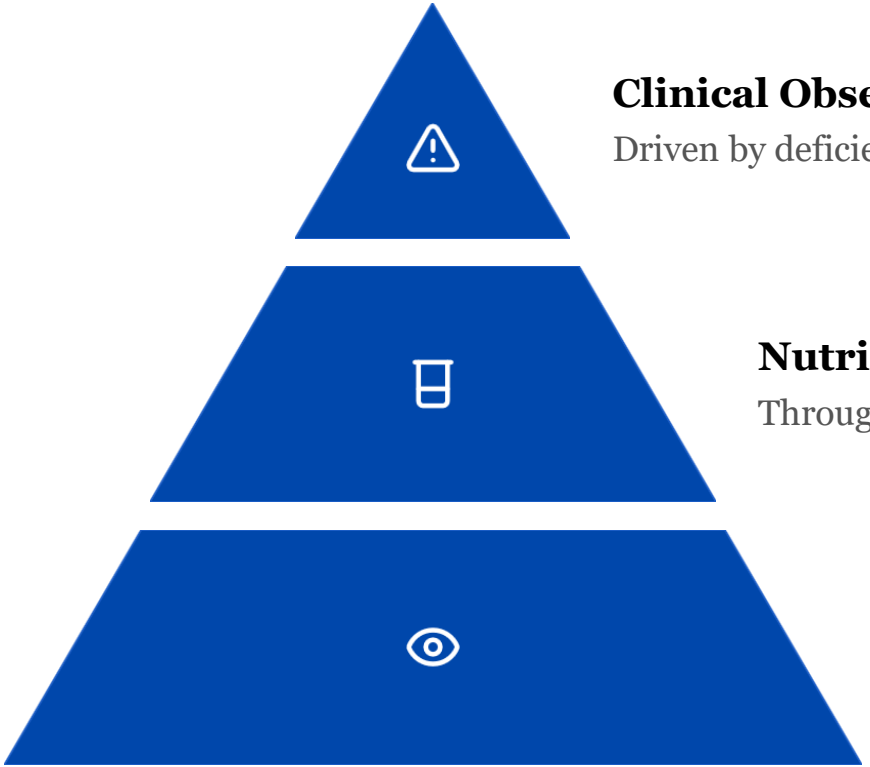
Support Growth
Especially in children, pregnant women.

Maintain Health
Optimal metabolic functions.

Promote Prevention
Higher quality of life.



Micronutrient Discovery History



Clinical Observations

Driven by deficiency syndromes.

Nutrient Identification

Through focused research efforts.

Early Recognition

Based on disease symptoms.



Deficiency Examples

Scurvy

Vitamin C deficiency in sailors.

Rickets

Vitamin D deficiency, bone development.

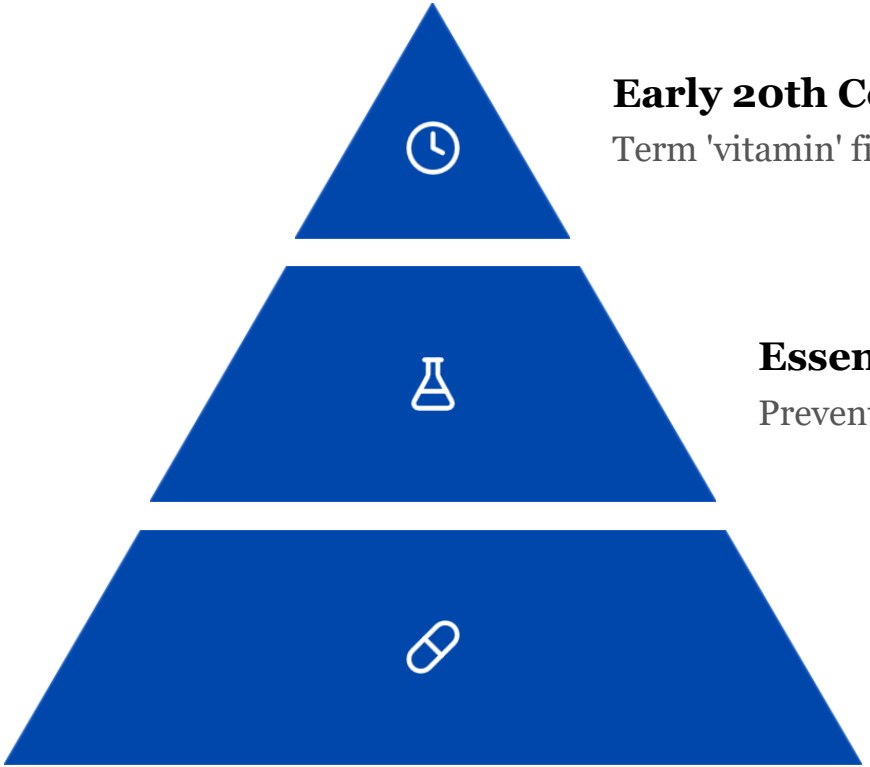
Beriberi

Thiamine deficiency, rice consumption.

Anemias

Iron, B12, folate deficiencies.

Introducing 'Vitamin' Term



Early 20th Century

Term 'vitamin' first used.

Essential Factors

Preventing deficiency symptoms.

Disease Prevention

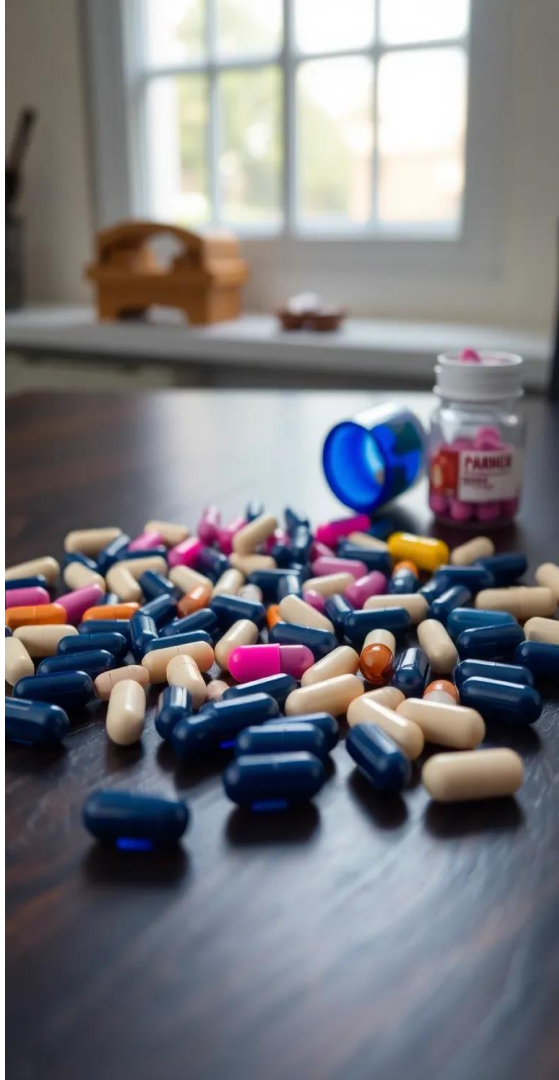
Through specific nutrients.

Micronutrient Classification

Water-Soluble
Vitamin C, B-complex vitamins.

Fat-Soluble
Vitamins A, D, E, K.

Influences
Absorption, storage, toxicity risk.



Nutritional Requirements



Age and Sex

Considering age, sex, status.



EAR

Estimated Average Requirement.



RDA

Recommended Dietary Allowance.



Upper Level

Maximum safe intake level.



Assessment of Status

Biochemical

Serum retinol, ferritin biomarkers.

Dietary

Evaluations of food intake.

Cutoff Values

Ranges preferred for deficiencies.

Inflammation

Markers adjust biomarker levels.

Dietary Challenges



Fortified Foods

Obscure true micronutrient intake.



Food Patterns

Cluster around food groups.



Animal Foods

Predicts broad deficiencies.



ASA24 Tool

Aids dietary data collection.



Micronutrient Deficiencies

Assessment, requirements, deficiencies, and interventions globally.

Historical Context

1980s Focus

Iodine, vitamin A, and iron deficiencies.

Vitamin A Trials

34% mortality reduction in preschoolers.

Global Programs

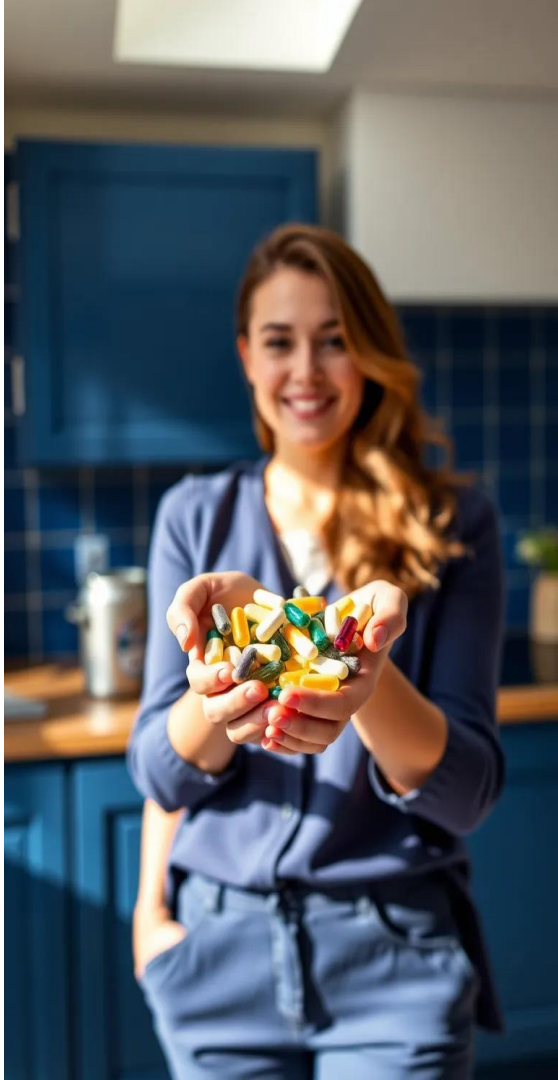
Rise of global nutrition programs.

Public Health Interventions

Supplementation
Tablets, capsules, lipid-based supplements.

Food Fortification
Fortification of staple foods.

Nutrition Education
Educating about healthy diets.



Global Fortification



Legislated Countries

Fortification legislated in 94 countries.



Wheat Flour

Fortification of wheat flour.



Maize Flour

Fortification of maize flour.

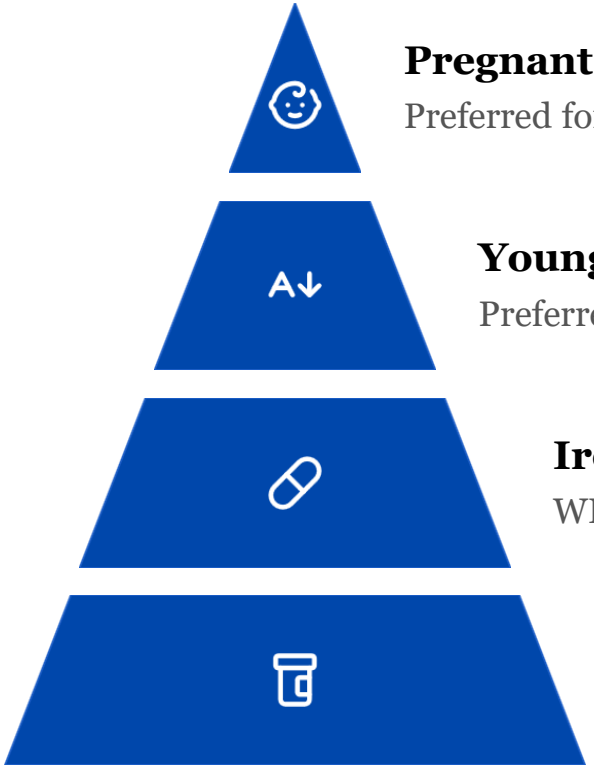


Rice

Fortification of rice.



Supplementation Focus



Pregnant Women

Preferred for pregnant women.

Young Children

Preferred for young children.

Iron-Folic Acid

WHO recommends iron-folic acid.

Multiple Nutrients

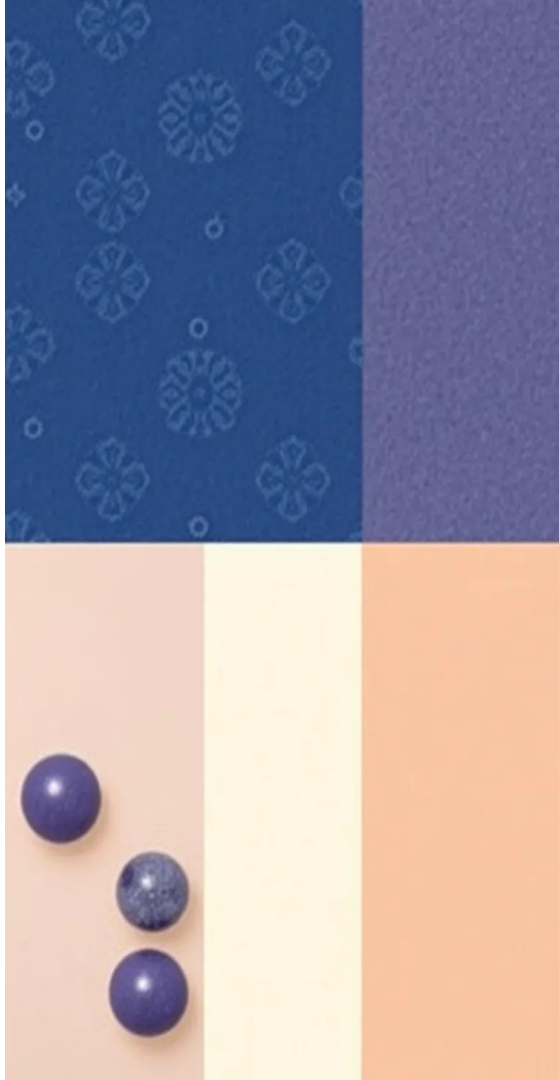
Growing use of multiple nutrients.

Micronutrients in Pregnancy

Low Birth Weight
Reduce low birth weight by 9-14%.

Limited Effect
Limited effect on other outcomes.

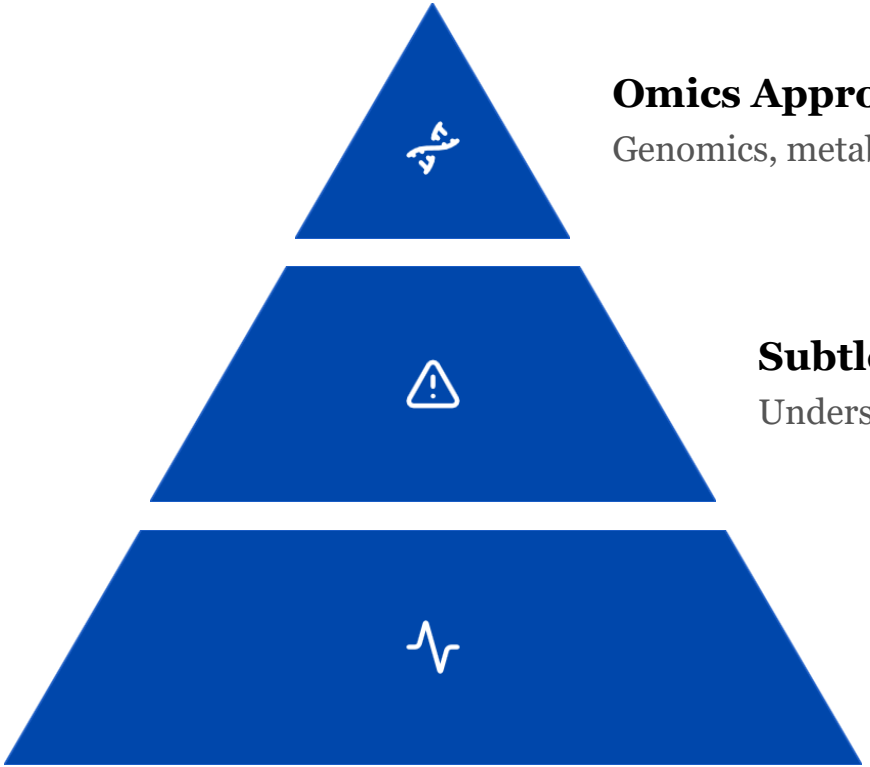
Rigorous Research
WHO supports use in research.





Future Opportunities

The Rise of Omics



Omics Approaches

Genomics, metabolomics, proteomics are growing.

Subtle Deficiencies

Understand nonclinical deficiencies effects.

Track Effects

Track metabolism, gene expression.

Research Findings: Zinc

Zinc Deficiency
GSTO1 identified as biomarker.

Needs Validation
Further studies are needed.



Research Findings: Vitamin B12

Older Adults

Vitamin B12 supplementation effects.

Increased Plasmalogens

Key in brain structure.



Research Findings: Vitamin D

Vitamin D Deficiency
Affects lipid metabolism processes.

Supplementation
Decreased acylcarnitines concentration.

Animal Studies: Iron Deficiency



Infant Monkeys

Early metabolic changes detected.



Early Detection

Tool for iron-related disorders.



Animal-Human Models

Highlights use in controlled trials.

Public Health: Unveiling Impacts

Trial Samples
Multiomic analysis of stored samples.

Hidden Impacts
Reveal nutrient deficiencies effects.

Long-Term Benefits
Show interventions long-term benefits.



Public Health: Overlooked Nutrients

20%

Riboflavin

Often overlooked due to symptoms.

15%

Thiamine

Subtle symptoms are often ignored.

50%

Data-Driven Policies

Promotes personalized nutrition policies.



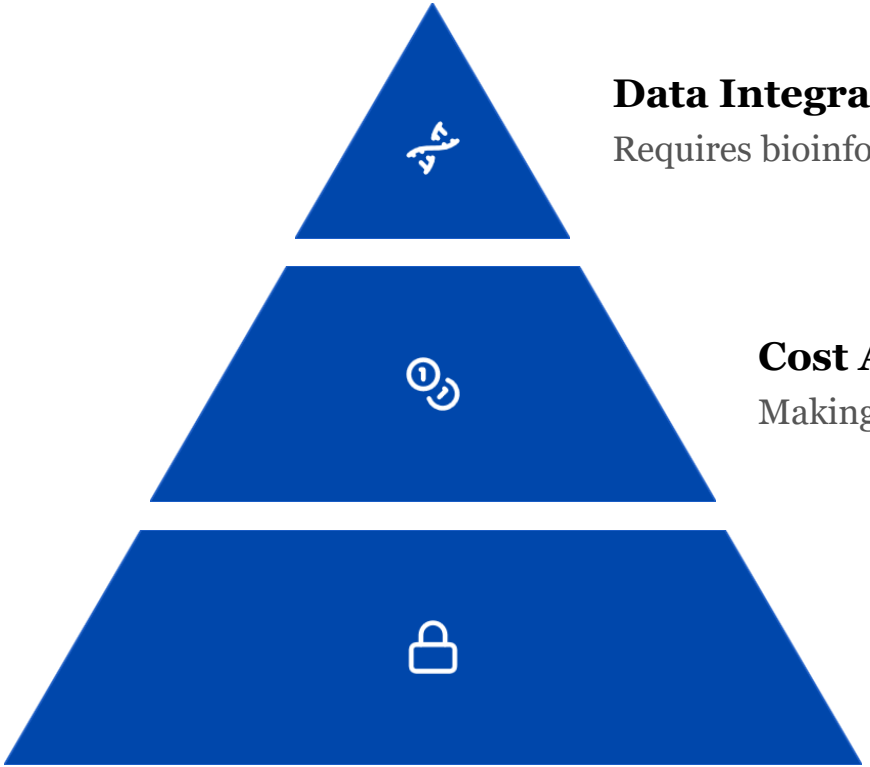
Future: Personalized Nutrition

Tailoring Interventions
Based on metabolic profiles.

Early Changes
Detect early changes markers.

Public Health
Integrating data into strategies.

Challenges and Opportunities



Data Integration

Requires bioinformatics tools.

Cost Accessibility

Making multiomics affordable research.

Ethical Considerations

Ensuring data privacy use.

Future of Research

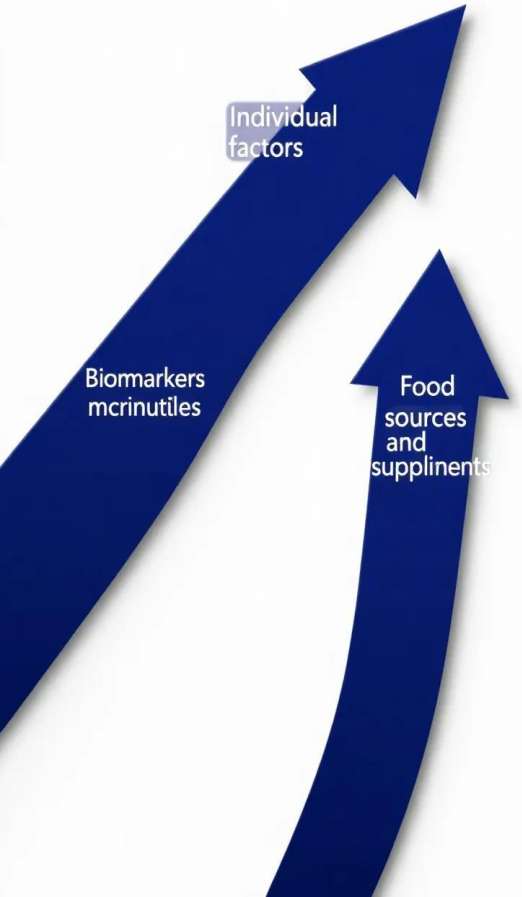
Powerful Approach
Understanding micronutrient deficiencies.

Revolutionize Health
Potential to revolutionize nutrition.

Collaboration
Essential for realizing potential.



Assessing Adequacy



Challenges

Data accuracy and individual factors.

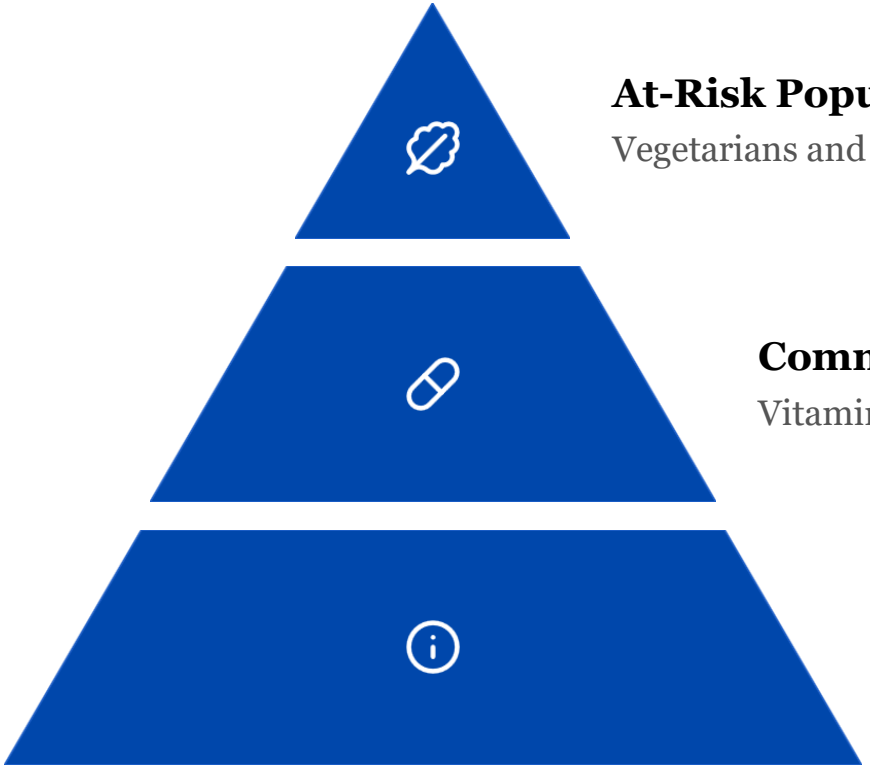
Biochemical Indicators

Biomarkers for specific micronutrients.

Dietary Intake

Food sources and supplements.

Micronutrient Status in U.S.



At-Risk Populations

Vegetarians and dietary restrictions.

Common Supplements

Vitamin D, Calcium, Folic Acid.

Office of Supplements

Information resource for supplements.

Primary Concern in U.S.

Vitamin B12
Risk factors and importance.

Vitamin D
Widespread deficiency implications.

Iron
Prevalence of deficiency.



Vitamin D: Deficiency



Supplementation

Ongoing research and guidelines.



Dietary Sources

Role of sunlight.



Deficiency Prevalence

Prevalence of deficiency.



Vitamin B12: Risks

Deficiency Risks

Malabsorption increases deficiency risks.

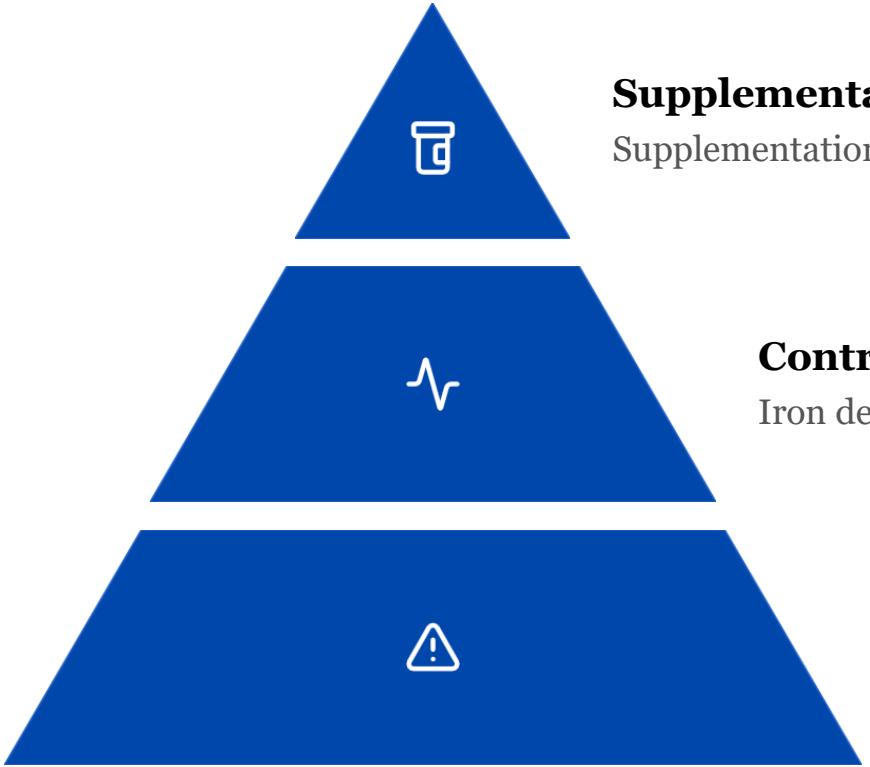
Absorption Mechanisms

Factors affecting B12 levels.

Dietary Sources

Animal products and fortified foods.

Iron: Strategies



Supplementation

Supplementation guidelines.

Contributing Factors

Iron deficiency in populations.

Iron Deficiency

Iron deficiency causes anemia.

Folate and Antioxidants

Specific Uses
Macular degeneration uses antioxidants.

Antioxidants Benefits
Limited benefits in disease prevention.

Folic Acid
Impact on neural tube defects.



Global Initiatives



Fortification Initiative

The Food Fortification Initiative.



Public Health Programs

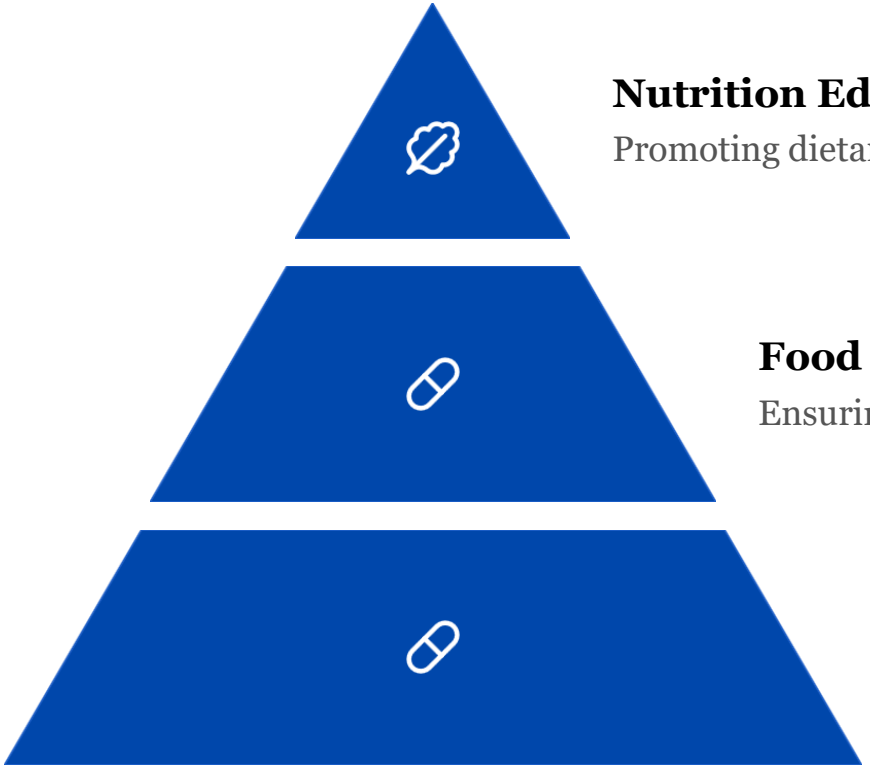
Supplementation, fortification, biofortification.



Historical Focus

Focus on iodine, vitamin A, iron.

Intervention Strategies



Nutrition Education

Promoting dietary diversity.

Food Fortification

Ensuring adequate intake.

Supplementation

Targeted vs. indiscriminate use.



Supplementation Strategies

LNS Effectiveness

Effectiveness of LNS.

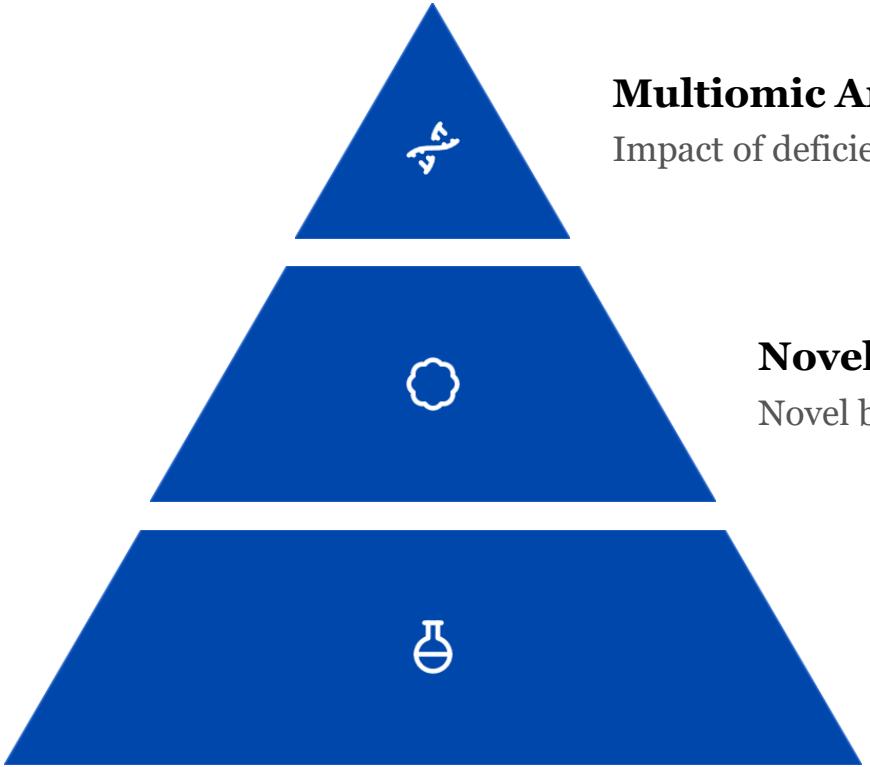
Multiple Supplements

Benefits and considerations.

Targeted Supplementation

Targeted for women and children.

Future Directions



Multiomic Analysis

Impact of deficiencies.

Novel Biomarkers

Novel biomarkers identification.

Exploring Effects

Marginal deficiencies effects.

Multiomic Examples

Plasmalogen Levels
Vitamin B12 and plasmalogen levels.

GSTO1 Biomarker
Zinc deficiency biomarker.

Multiomic Approaches
Examples and potential.



Healthcare Practitioners

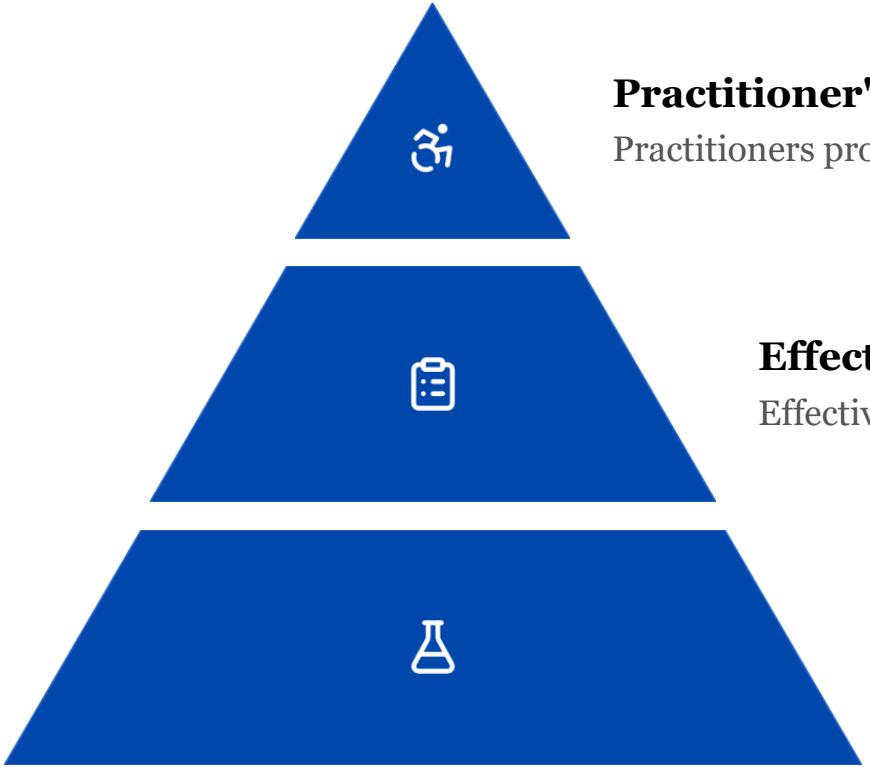
Staying Informed
Staying informed about research.

Recommendations
Personalized recommendations.

Assessing Status
Assessing individual status.



Optimizing Status



Practitioner's Role

Practitioners promote micronutrient status.

Effective Assessment

Effective assessment and interventions.

Micronutrients Essential

Micronutrients are essential.



Micronutrient Overview

Overview of micronutrient assessment, requirements, deficiencies, and interventions for healthcare.

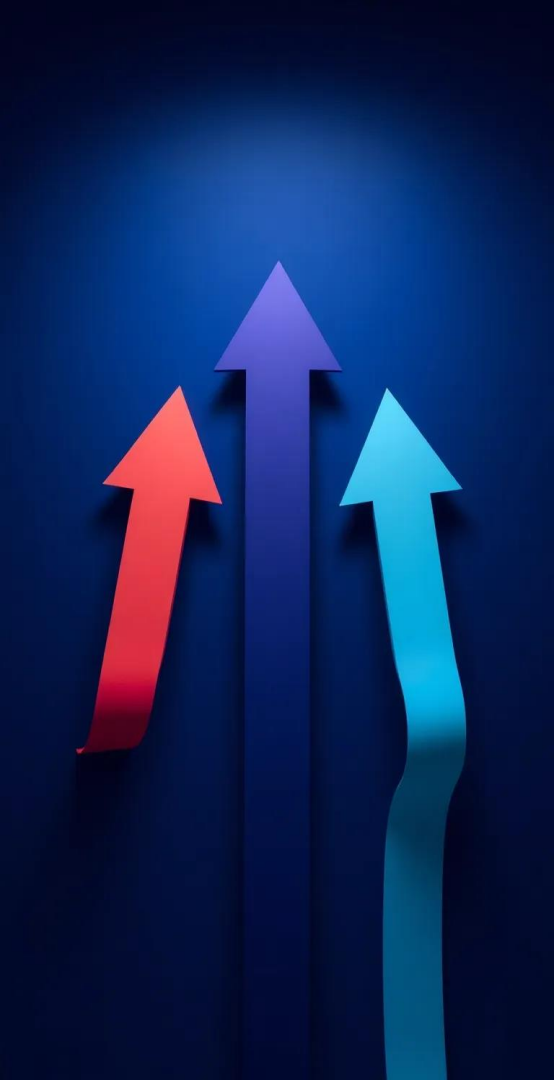
Micronutrient Requirements

NASEM and EFSA
Role of NASEM and EFSA.

Defining Requirements
Defining EAR, RDA, and UL.

Setting Challenges
Challenges in setting requirements.





Biomarkers Status

Common Biomarkers

Commonly used biomarkers.

Zinc Challenges

Challenges with zinc biomarkers.

Adjusting Inflammation

Adjusting for inflammation.

Micronutrient Status

Dietary Supplements
Role of Dietary Supplements.

Common Deficiencies
Common deficiencies.

Fortification Impact
Impact of fortification.



Supplements Benefits



Bone Health

Bone health benefits.



Preventing Defects

Preventing defects.



Heart Disease

Heart disease benefits.



Macular Degeneration

Macular degeneration benefits.



Micronutrients Concern

Academy Stance

Academy stance on supplementation.

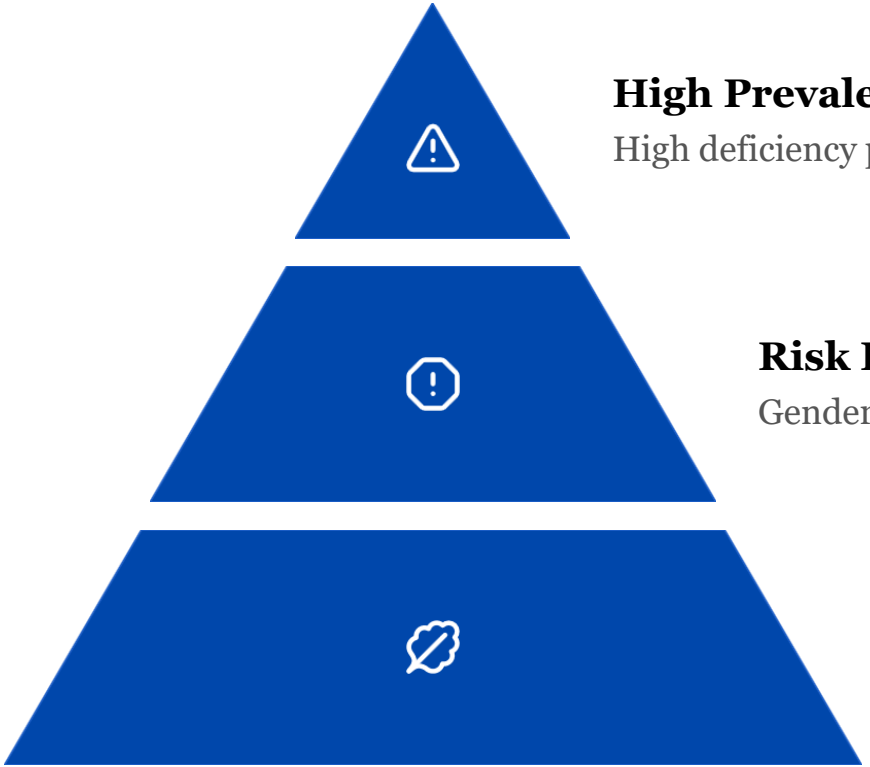
Deficiency Risks

Risk factors for deficiencies.

Supplement Patterns

Supplement use patterns.

Vitamin D Deficiency



High Prevalence

High deficiency prevalence.

Risk Factors

Gender, race, season risks.

Dietary Sources

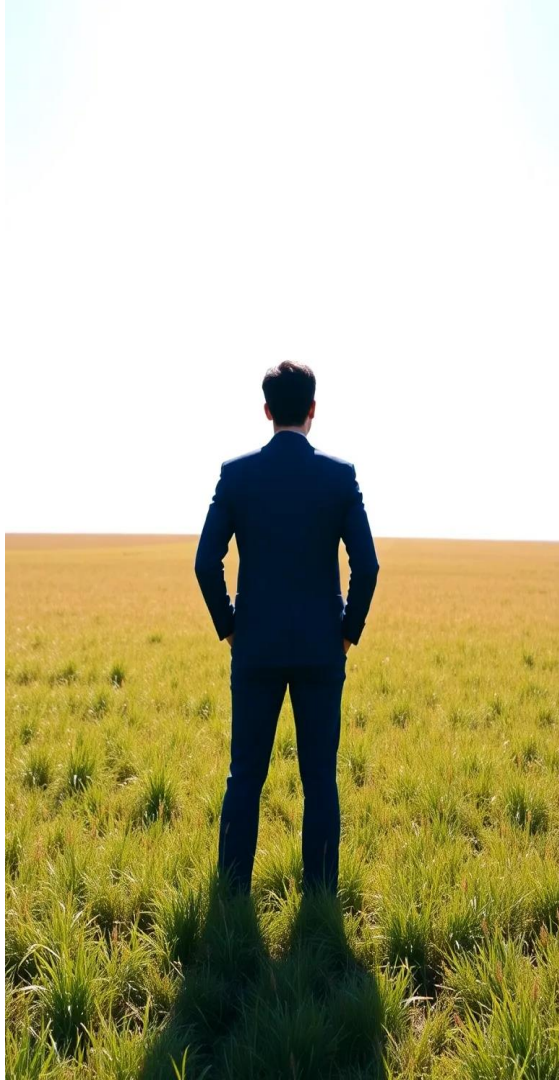
Dietary sources.

Vitamin D Supplementation

Serum Concentrations
Optimal serum concentrations debate.

Trial Results
Clinical trial results.

Potential Benefits
Potential benefits.



Vitamin B12 Deficiency



B12 Sources

B12 sources and vegan risks.



Maternal Depletion

Maternal depletion consequences.



Absorption Issues

Absorption issues.



Vitamin B12 Supplementation

Absorption Types

Active vs passive absorption.

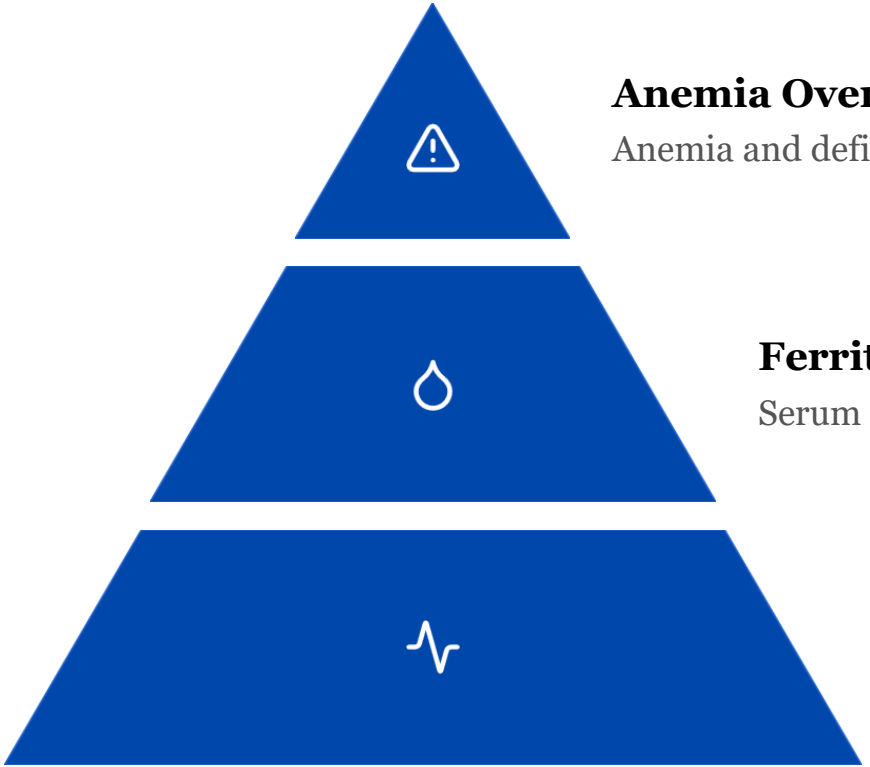
High-Dose Supplementation

High-dose supplementation.

Cognitive Decline

Preventing cognitive decline.

Iron Deficiency



Anemia Overview

Anemia and deficiency.

Ferritin Indicator

Serum ferritin indicator.

Causal Factors

Causal factors.

Iron Supplementation

Iron Bioavailability
Ferrous iron bioavailability.

Side Effects
Side effects of high doses.

Maternal Status
Maternal iron status.



Folate Impact



Fortification Impact

Fortification impact.



Low Prevalence

Low deficiency prevalence.



Upper Level

Upper level concerns.



Antioxidants Evidence

Clinical Trials

Clinical trials on vitamins.

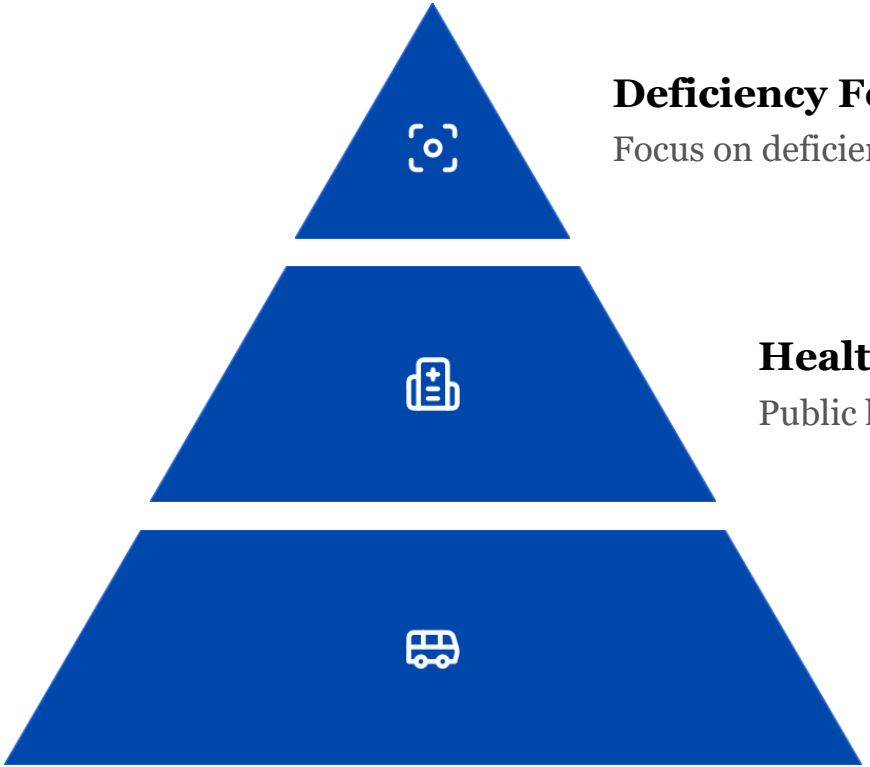
Lack of Benefits

Lack of proven benefits.

Antioxidants Role

Specific antioxidants role.

Micronutrient Programs



Deficiency Focus

Focus on deficiencies.

Health Programs

Public health programs.

Delivery Methods

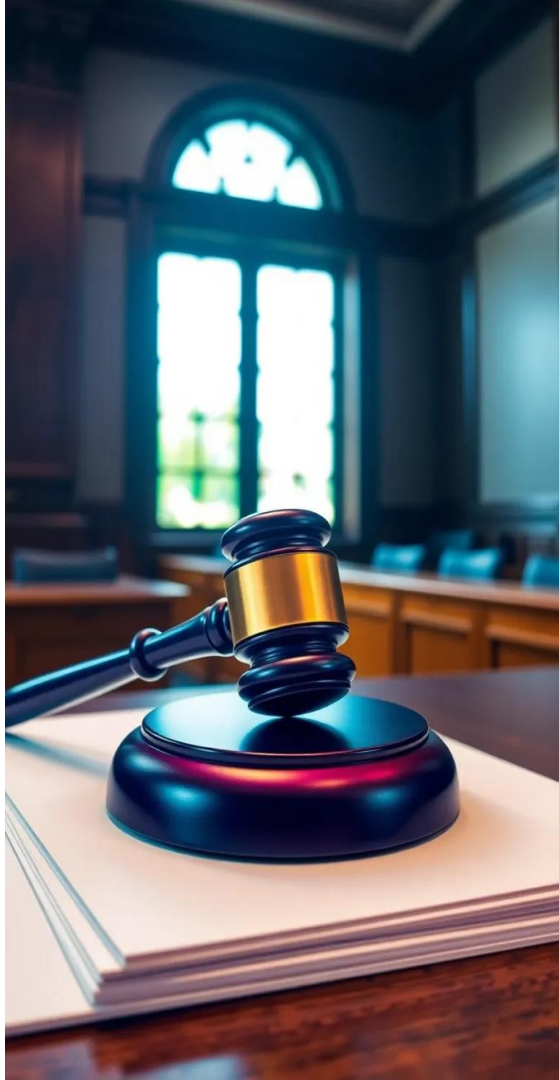
Delivery methods.

Food Fortification

Fortification Laws
Legislation for fortification.

Initiative Role
Food Fortification Initiative.

Monitoring Decisions
Monitoring and decisions.



Supplementation LMICs



Pregnant Women

Pregnant women intervention.



Iron Supplements

Iron-folic acid supplements.



Multiple Supplements

Multiple-micronutrient supplements.



Nutrient Supplements

Small-Quantity LNS

Small-quantity LNS for children.

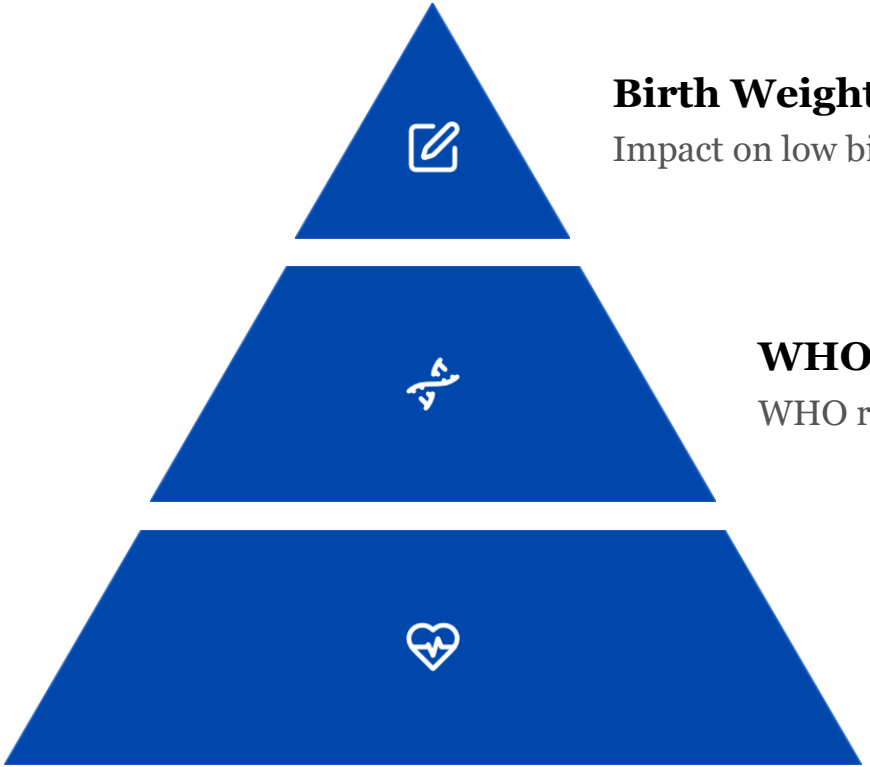
Mortality Impact

Impact on mortality rates.

LNS Assessment

Assessment of LNS.

Multiple Supplements



Birth Weight Impact

Impact on low birth weight.

WHO Recommendations

WHO recommendations.

Research Needed

Rigorous research needed.

The Power of Omics

Marginal Deficiencies
Investigating marginal deficiencies.

Omic Analyses
Metabolomics, genomics, proteomics.

Novel Biomarkers
Identifying novel biomarkers.



Zinc Deficiency



GSTO1 Biomarker

GSTO1 as biomarker.



Further Research

Further research needed.



Improved Assessment

Improved assessment.



Vitamin B12 Health

B12 Impact

B12 impact on plasmalogen.

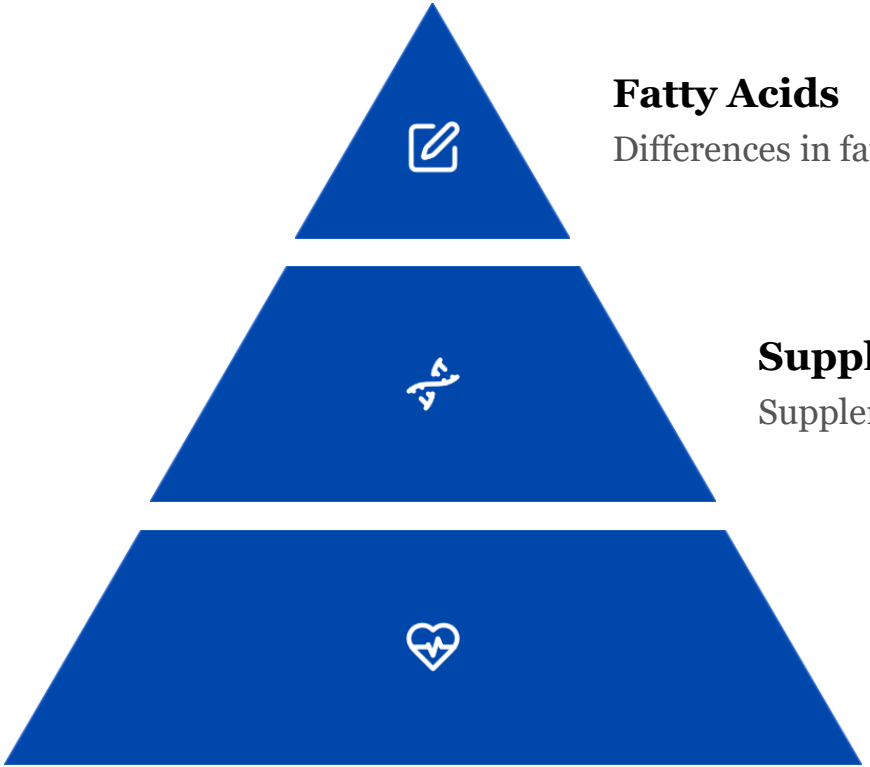
Plasmalogens Role

Plasmalogens role.

Improved Function

Improved function.

Vitamin D Profiles



Fatty Acids

Differences in fatty acids.

Supplementation Impact

Supplementation impact.

Personalized Interventions

Personalized interventions.

Iron Deficiency

Metabolite Changes
Changes in metabolites.

Early Detection
Early detection potential.

Preventing Problems
Preventing problems.



Riboflavin Thiamine



Widespread Deficiencies

Widespread deficiencies.



Limited Concern

Limited public concern.



Analysis Potential

Multiomic analysis potential.



Leveraging Data

Analyzing Samples

Analyzing stored samples.

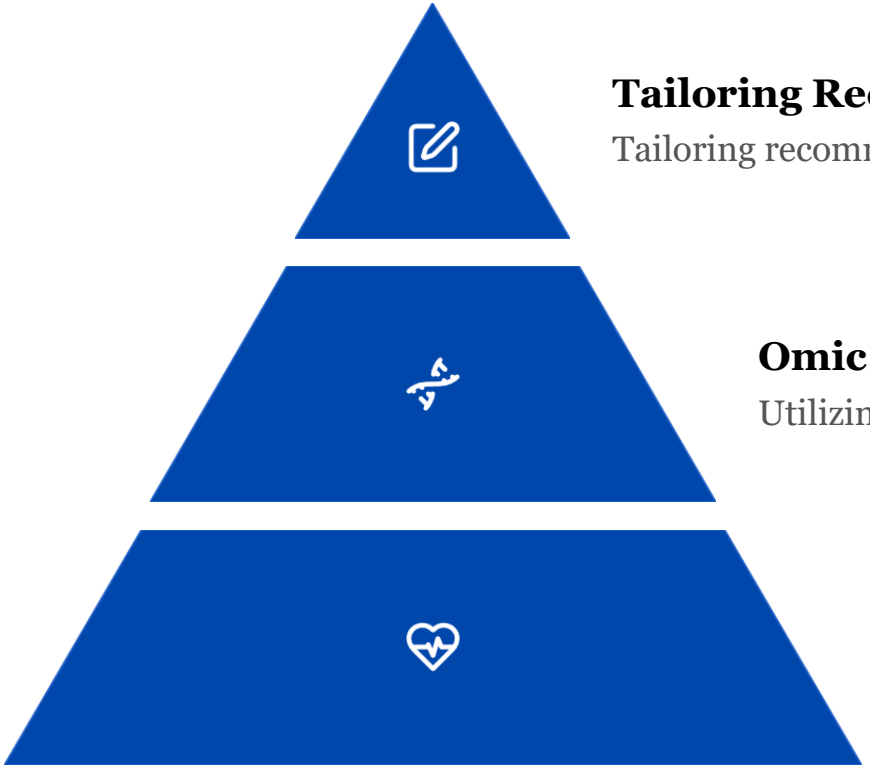
Identifying Consequences

Identifying consequences.

Assessing Interventions

Assessing interventions.

Future Directions



Tailoring Recommendations

Tailoring recommendations.

Omic Data

Utilizing omic data.

Health Outcomes

Improving health outcomes.

Conclusion

Preventing Disease
Preventing disease.

Promoting Health
Promoting optimal health.

Research Efforts
Continued research efforts.

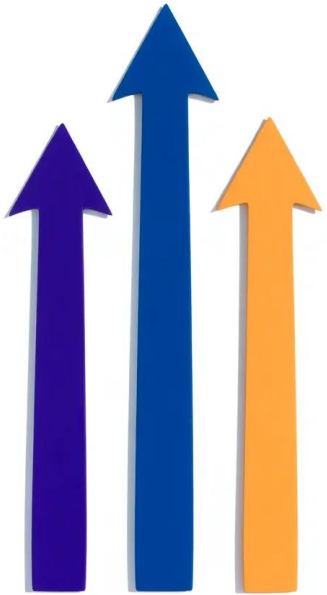




Micronutrients Overview

Assessment, requirements, deficiencies, and interventions related to essential micronutrients.

Micronutrient Requirements



EAR

Median requirement for a group.

RDA

Covers needs of 97.5% of group.

Upper Level

Highest intake with no adverse effects.

Adequate Intake

Used when EAR or RDA lacking.

Assessment Approaches

Dietary Intake
Based on intake from foods.

Biomarkers
Based on biochemical indicators.

Complementary
Both approaches are useful.



Micronutrient Status in US



Supplements

Supplements improve health in US.



Bone Health

Calcium and vitamin D reduce loss.



Birth Defects

Folic acid lowers risk of defects.



Heart Health

Omega-3s reduce heart disease risk.

Vitamin D Deficiency

Prevalence
Common micronutrient deficiency in US.

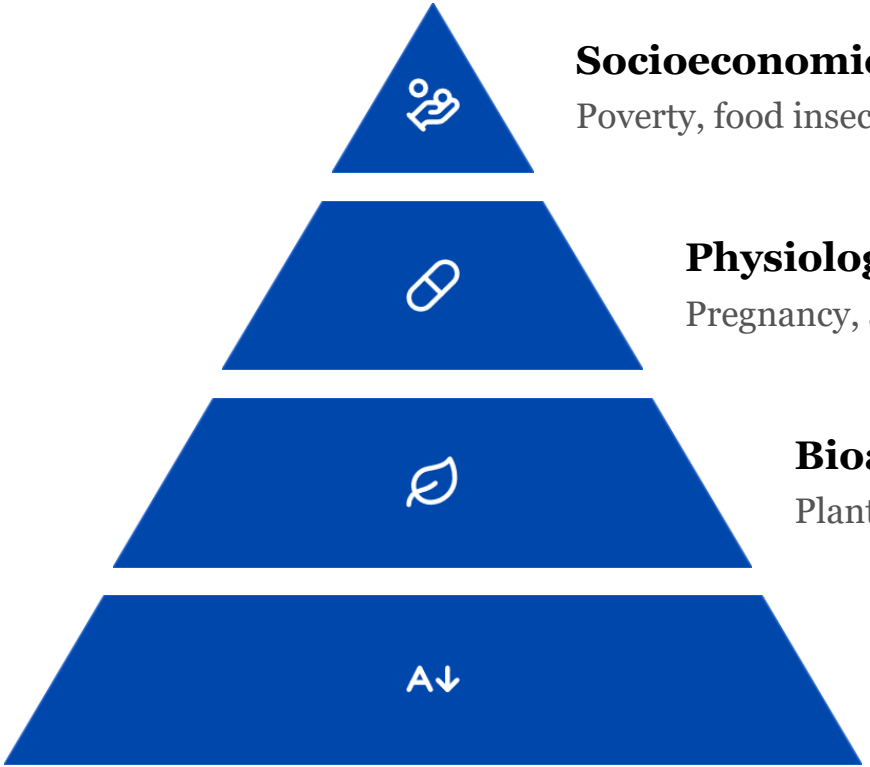
Risk Groups
Women and Black Americans more affected.

Dietary Sources
Oily fish, eggs, fortified foods.

Potential Benefits
Supplementation benefits under investigation.



Factors Influencing Status



Socioeconomic Factors

Poverty, food insecurity, cultural practices.

Physiological States

Pregnancy, aging, illness, medications.

Bioavailability

Plant-based diets inhibit mineral absorption.

Absorption Efficiency

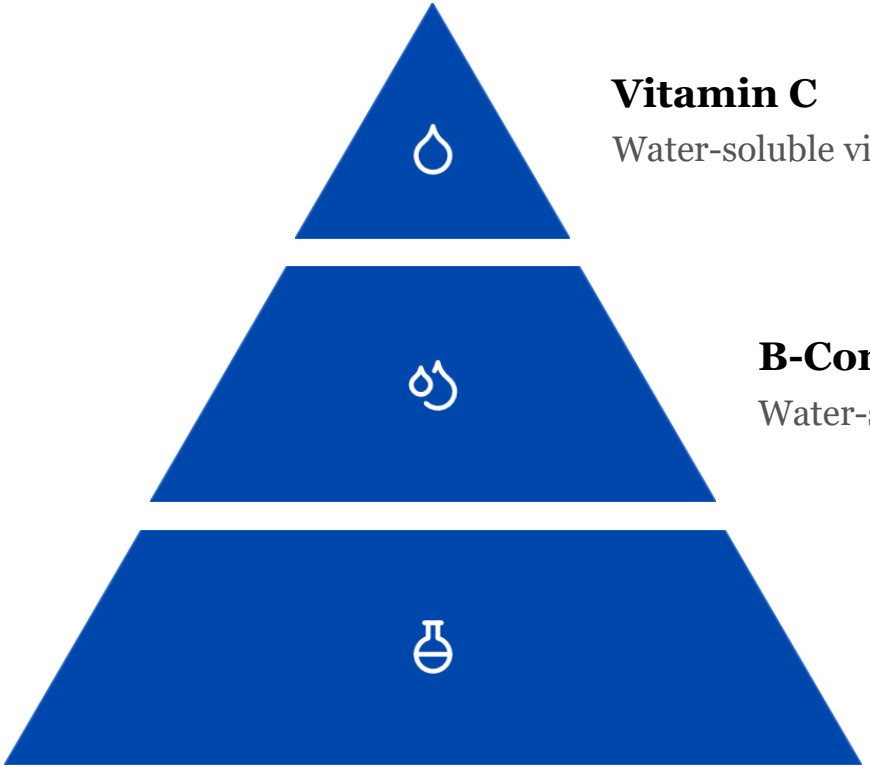
Malabsorption, surgeries impair uptake.

Micronutrient Essentials

Assessment, requirements, deficiencies, and interventions.



Micronutrient Classification



Vitamin C

Water-soluble vitamin

B-Complex Vitamins

Water-soluble vitamins

Vitamins A, D, E, K

Fat-soluble vitamins



Classification Influences

Absorption

Influenced by solubility

Storage

Fat-soluble vitamins stored

Toxicity Risk

Fat-soluble vitamins higher risk

Nutritional Requirements

EAR Definition
Median requirement for group

RDA Definition
Meets 97.5% of needs

Upper Level
Maximum safe intake

Requirements Established

Estimated Average Requirement

Median requirement

Recommended Dietary Allowance

Meets 97.5% of needs

Tolerable Upper Intake

Maximum safe intake

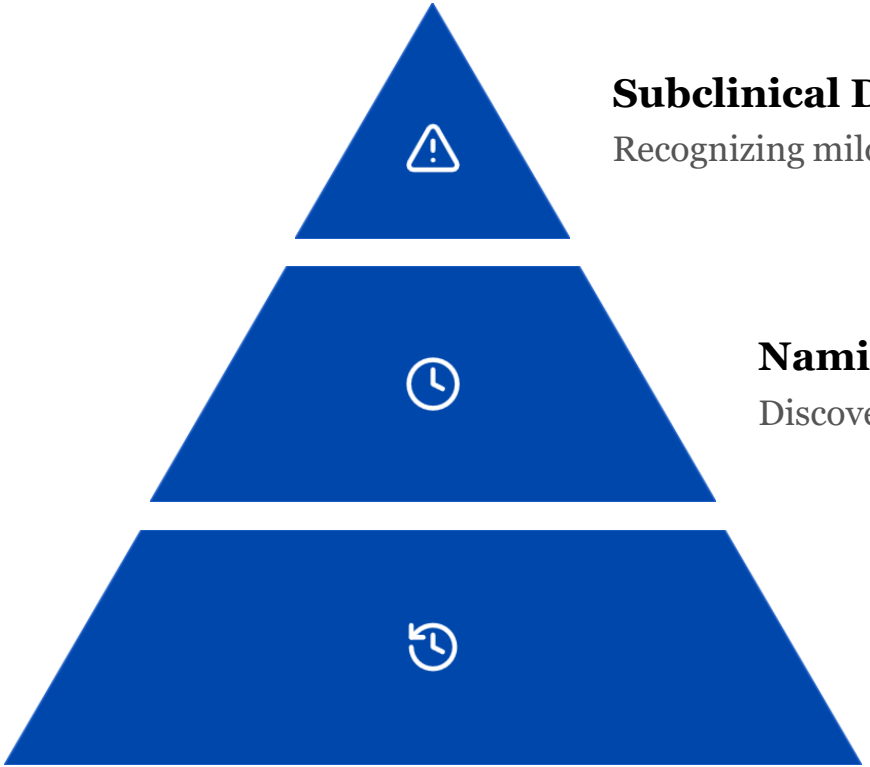




Micronutrients: Key Aspects

Assessment, requirements, deficiencies, and interventions.

Historical Context



Subclinical Deficiencies

Recognizing milder deficiencies impact.

Naming Vitamins

Discovery in the 20th century.

Deficiency Diseases

Historical identification of diseases.



Micronutrient Requirements

Guiding Interventions

EAR guides interventions needed.

Assessing Inadequacy

EAR assesses inadequacy.

Adequate Intake

Data for EAR/RDA unavailable.

Tolerable Level

Explanation of Upper Intake Level.

Assessing Status



Food Avoidance

Consider dietary patterns.



Supplements

Challenges in assessment.



Biomarkers

Cutoff values and interpretation.



Dietary Intake

Strengths and limitations.

Status in the U.S.

Specific Needs
Identifying at-risk groups.

Supplement Use
Common food sources.

Role of ODS
ODS and NIH role.





Key Deficiencies

Addressing Deficiencies
Through diet and supplementation.

Common Supplements
Multivitamins, vitamin D, calcium.

Risk Factors
Growth, disease, medication, aging.

Vitamin D Deficiency



Prevalence

High prevalence in the U.S.



Sunlight Exposure

Factors contributing deficiency.



Optimal Levels

Debate on serum levels.



Recommendations

Intake and supplementation.

B12 and Iron

Supplementation
Strategies for both.

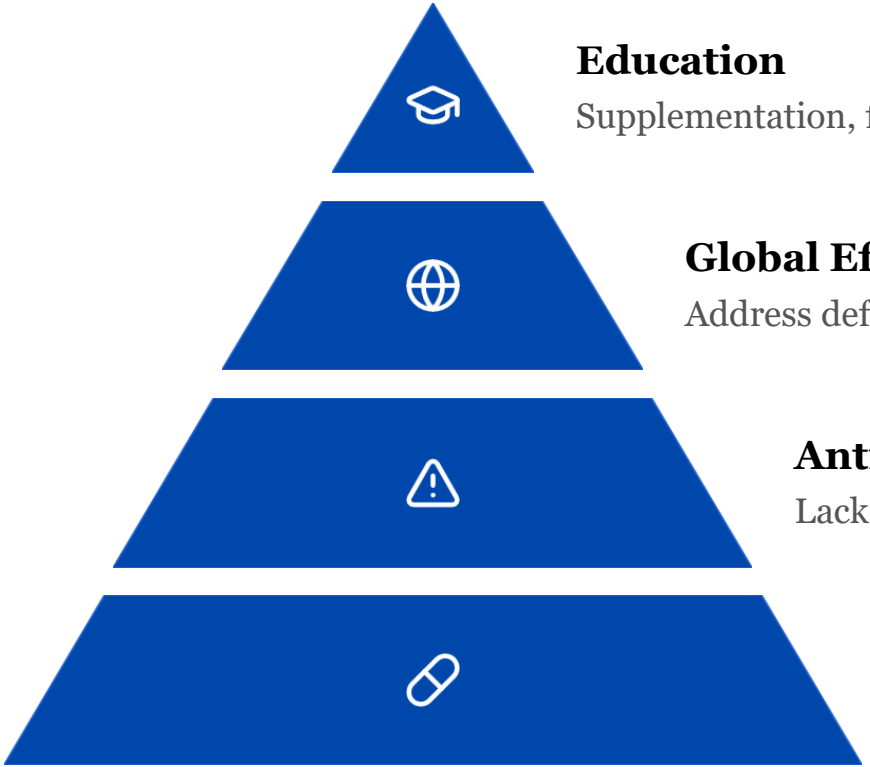
Maternal Status
Importance for infant health.

Iron Risks
Menstruation, pregnancy, intake.

B12 Risks
Vegan diets, malabsorption.



Global Programs



Education

Supplementation, fortification.

Global Efforts

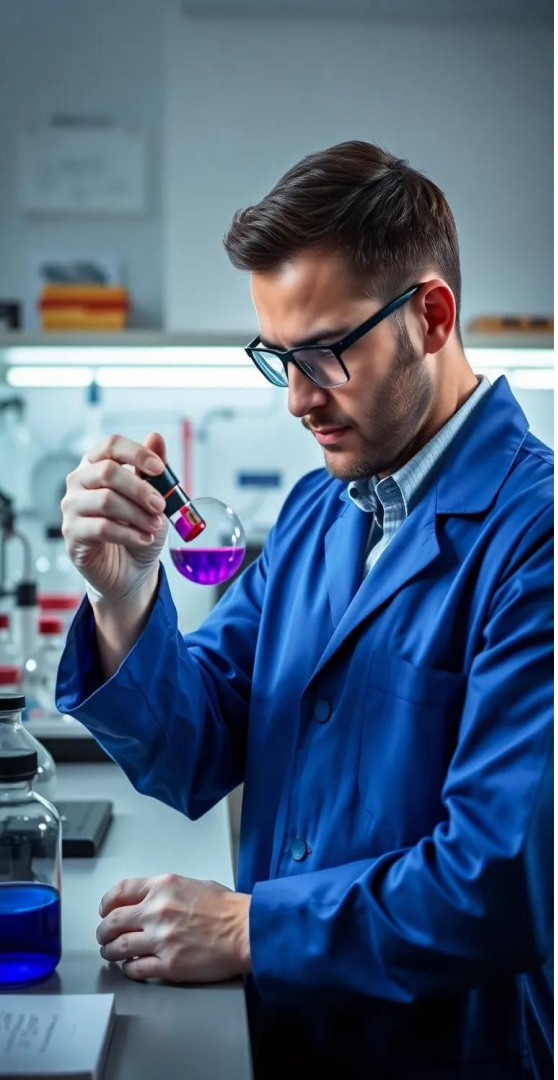
Address deficiencies.

Antioxidants

Lack of evidence.

Folic Acid

Impact on defects.



Future Research

Trial Data
Uncover hidden benefits.

Novel Biomarkers
Identify mechanisms.

Omics Studies
Examples of studies.

Omics Tech
Study deficiencies.



Micronutrients Overview

Assessment, requirements, deficiencies, interventions, and research overview.

Micronutrient Requirements

Estimated Average Requirement

Median requirement for a group.

Recommended Dietary Allowance

Covers needs of 97.5% of group.

Tolerable Upper Intake

Highest intake without adverse effects.

Adequate Intake

Used when EAR or RDA is lacking.



Assessment Methods

Dietary Intake
Tools, challenges, and limitations considered.

Biochemical Indicators
Interpretation and cutoff values are key.

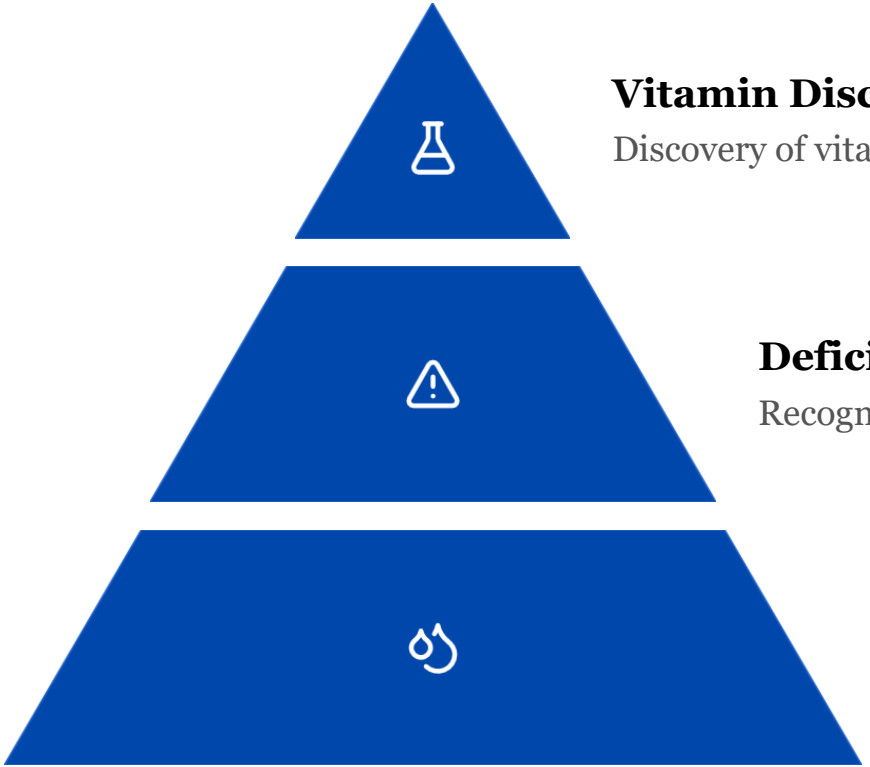
Complementary Use
Dietary and biochemical data combined.



Micronutrients: Assessment

Overview of micronutrient assessment, deficiencies, and interventions for practitioners.

Historical Development



Vitamin Discovery

Discovery of vitamins prevents symptoms.

Deficiency Symptoms

Recognizing severe deficiency symptoms.

Micronutrient Defined

Essential nutrients in trace amounts.



Key Points

Future Research

Need sensitive assessment methods.

Supplementation Trials

Trials needed for supplementation benefits.

Deficiency Risk

Clinical factors increase deficiency risk.

Dietary Assessment

Dietary pattern is important.

Micronutrient Requirements

Planning Interventions
Planning effective interventions.

Assessing Inadequacy
Assessing inadequacy.

Adequate Intake
Adequate intake when EAR lacks.

Reference Values
EAR, RDA, upper intake level.



Assessment of Adequacy



Inflammation Correction

Correction for inflammation.



Cutoff Values

Debatable cutoff values.



Biomarker Challenges

Challenges with biomarkers.



Assessment Basis

Intake from foods and biomarkers.

Assessing Intake

24

ASA Tool

NIH's Dietary Assessment Tool.

2

Vegan Diets

Vegan diets considerations.

1

Dietary Patterns

Dietary patterns indicate risks.

Status in Higher-Income

Improve Health
Improve health with supplements.

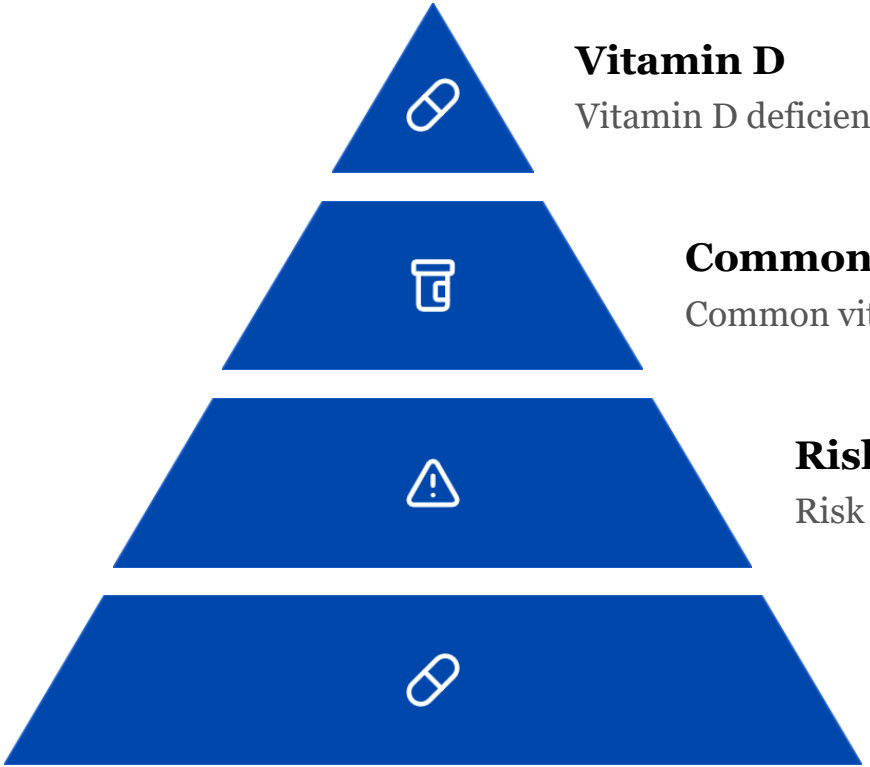
Common Intake
Fortification and supplement intake.

Food Data
Calculator and food data.

Reliable Source
Reliable information source.



Micronutrients of Concern



Vitamin D

Vitamin D deficiency is common.

Common Supplements

Common vitamin supplements.

Risk Factors

Risk factors for deficiencies.

Supplements Warranted

Supplements warranted if needed.



Specific Deficiencies

Maternal Iron

Maternal iron affects infants.

Iron Deficiency

Iron deficiency and anemia.

Vitamin B12

B12 risks: veganism, malabsorption.

Research in Low-Income

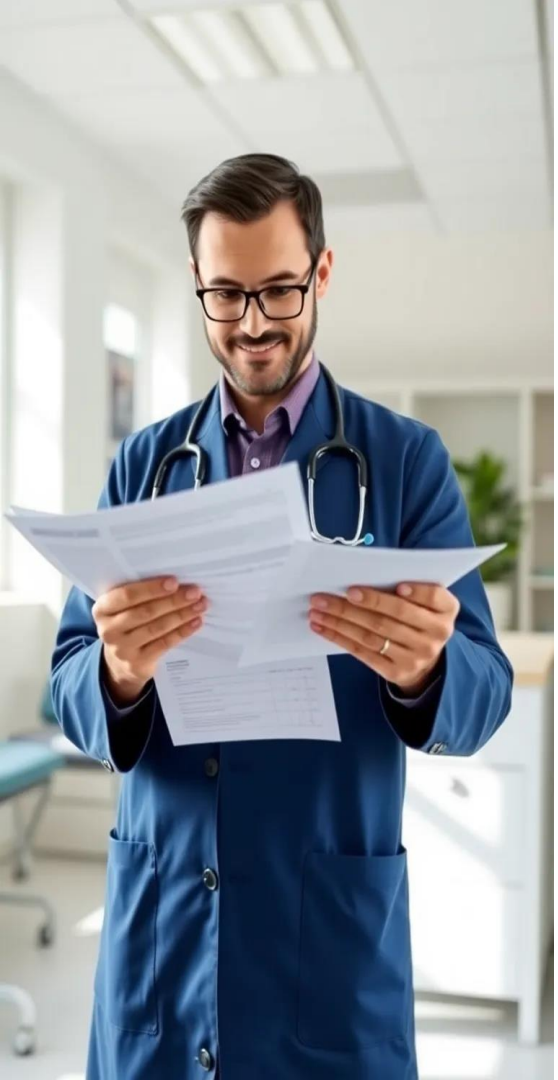
Child Mortality
Impact on child mortality.

Multiple Supplements
Pregnant women and children.

Strategies
Supplementation and fortification.

Focus on Deficiencies
Focus on deficiencies.

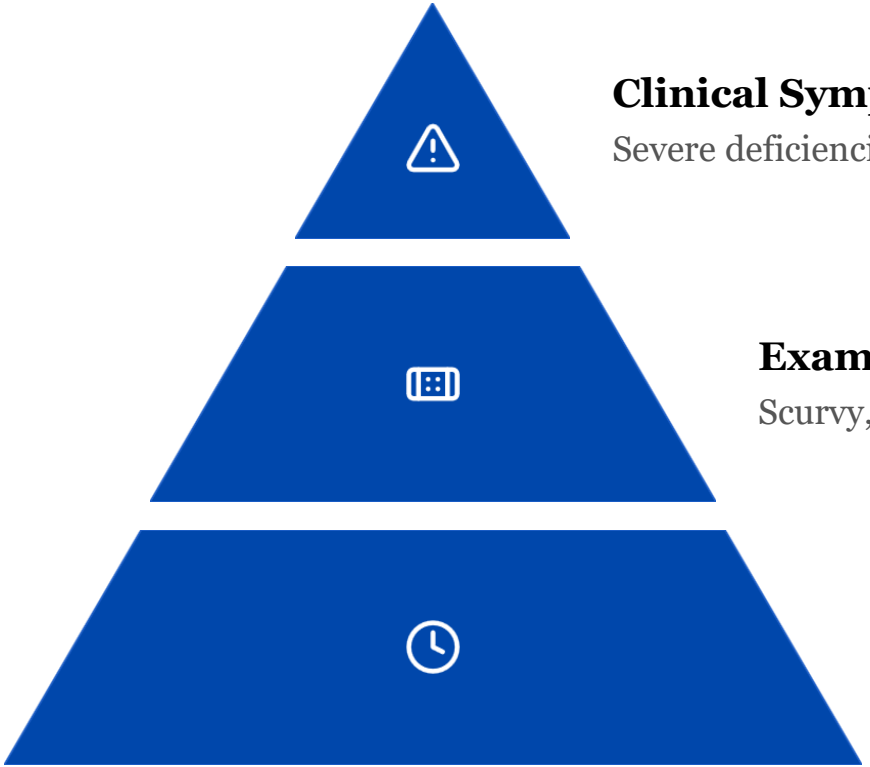




Micronutrients: Assessment and Interventions

Overview of assessment, interventions, and research issues.

Historical Development



Clinical Symptoms

Severe deficiencies cause clinical symptoms.

Examples

Scurvy, Rickets, and Beriberi.

Milder Depletion

Recognized in the 1980s.



Micronutrient Requirements

Authorities

Established by NASEM and EFSA.

EAR

Estimated Average Requirement.

RDA

Recommended Dietary Allowance.

Upper Level

Tolerable Upper Intake Level.

Assessment of Adequacy

Intake Sources
Foods and other sources.

Biomarkers
Biochemical indicators.

Dietary Patterns
Food group considerations.



Higher-Income Resources



ODS

Office of Dietary Supplements.



DRI Calculator

Dietary Reference Intake.



USDA Data

Food Composition Data.

Supplementation

Calcium
Reduce bone loss.

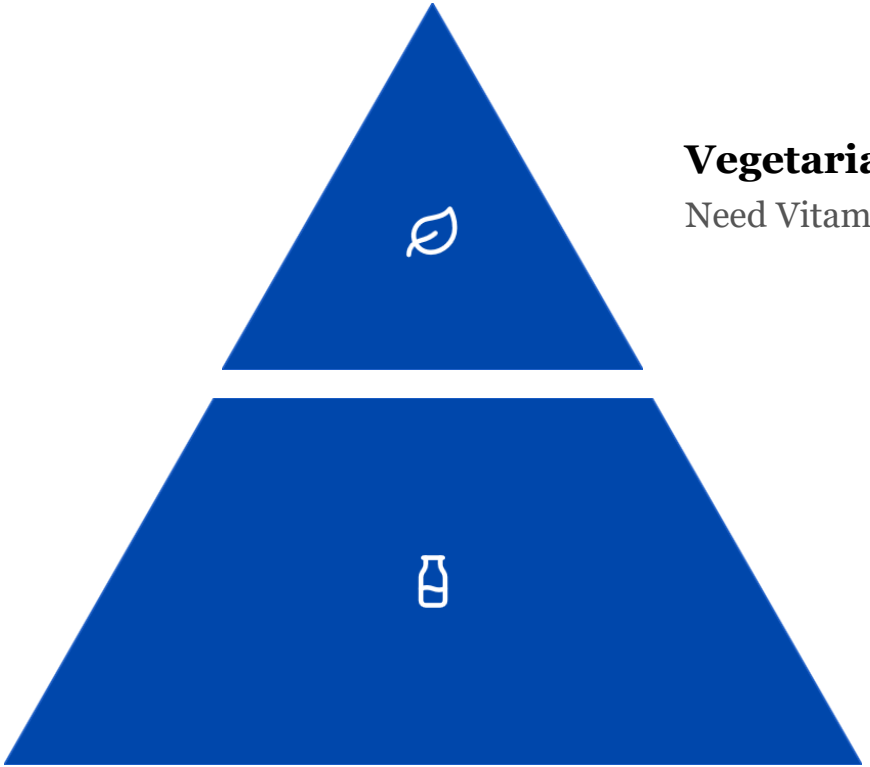
Folic Acid
Prevent birth defects.

Omega-3s
Reduce heart disease.

Vitamins C/E
Slow macular degeneration.



At-Risk Groups



Vegetarians

Need Vitamin B12.

Dairy Avoiders

Need Riboflavin, Calcium, D.

NHANES Data: Inadequacy

5

Copper

Less than 5% inadequacy.

5

Iron

Less than 5% inadequacy.

5

Seleniu m

Less than 5% inadequacy.

25

Zin c

25% inadequacy.

NHANES Data: Inadequacy

90

Choline

90% inadequacy.

100

Vitamin D

100% inadequacy.

45

Vitamin C

45% inadequacy.

55

Vitamin K

55% inadequacy.

NHANES Data: Deficiencies

1

6

Vitamin B6

16-23% deficiency.

5

Vitamin D

5-7% deficiency.

2

Vitamin B12

2-4% deficiency.

Supplement Impact

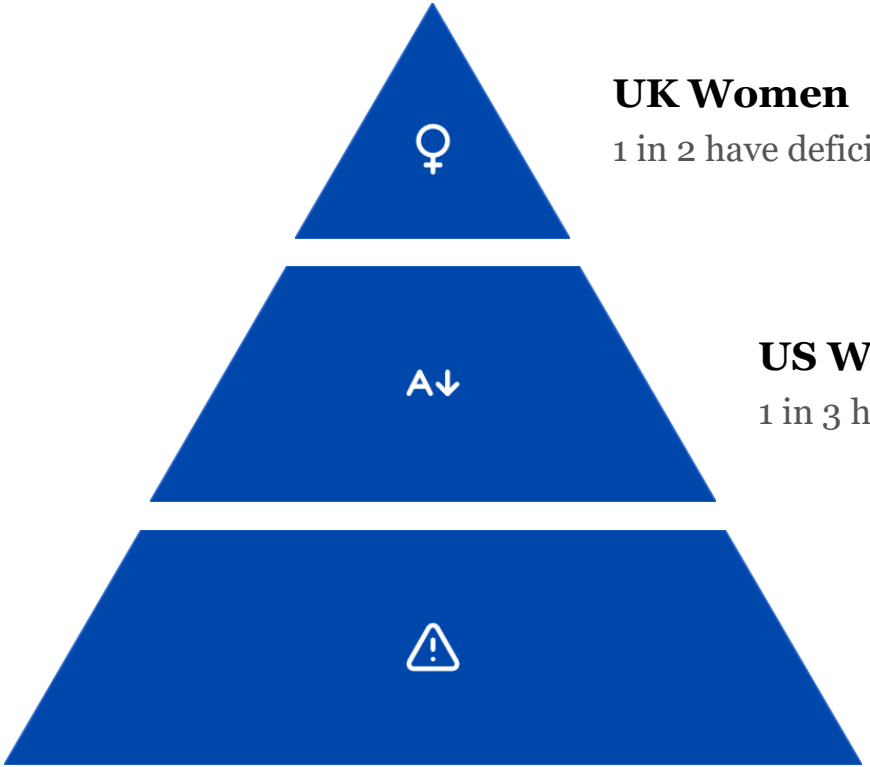
Increased Levels
B6, D, Folate, Selenium, B12.

No Change
Iron, Copper, Zinc.

Low Exceedance
Calcium, Folic Acid, Zinc.



Global Deficiencies



UK Women

1 in 2 have deficiency.

US Women

1 in 3 have deficiency.

Iron

Most common deficiency.

Micronutrients of Concern

Vitamin D
Common deficiency.

Vitamin B12
Vegans and older adults.

Iron
Pregnant women.






Specific: Vitamin D



Cutoff Values

Debate about serum levels.



Recommendations

National Academy of Medicine.



Supplementation

Benefits under investigation.

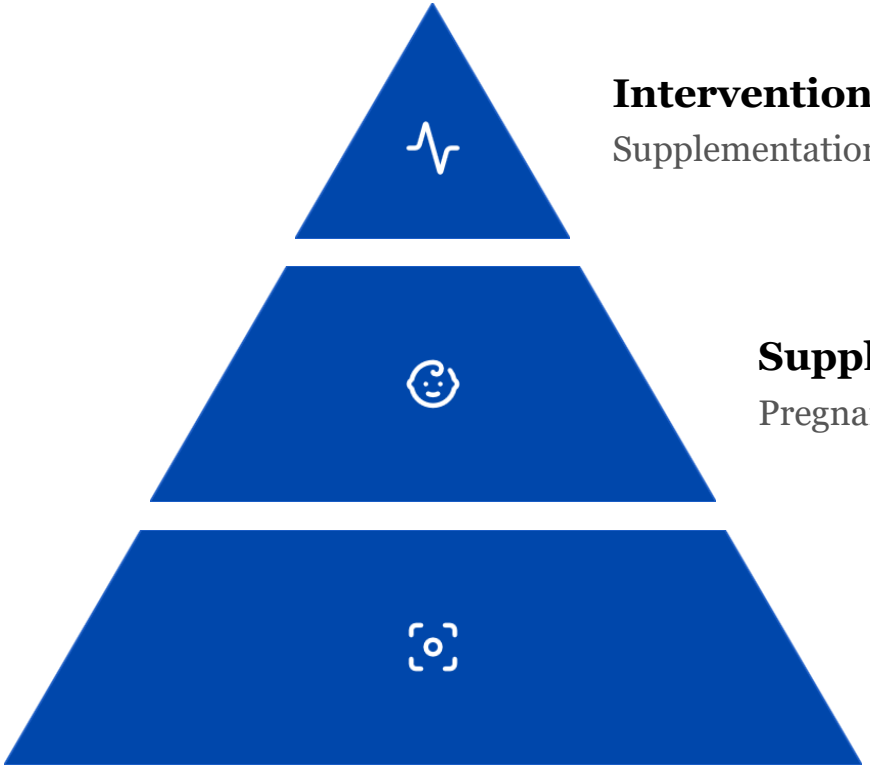
Specific: B12 and Iron

Vitamin B12
Supplement for vegans.

Iron
Anemia in pregnancy.



Low-Income Programs



Interventions

Supplementation, fortification, education.

Supplements

Pregnant women and children.

Focus

Iodine, A, and iron.

Future: Omic Analyses

Investigate Effects
Marginal deficiencies.

Identify Biomarkers
For deficiencies.

Analyze Samples
From trials.





Academy Recommendations

Warranted Use

Requirements not met.

Increased Needs

Growth, disease, pregnancy.

Not Recommended

Routine, indiscriminate use.

Common Supplement Use

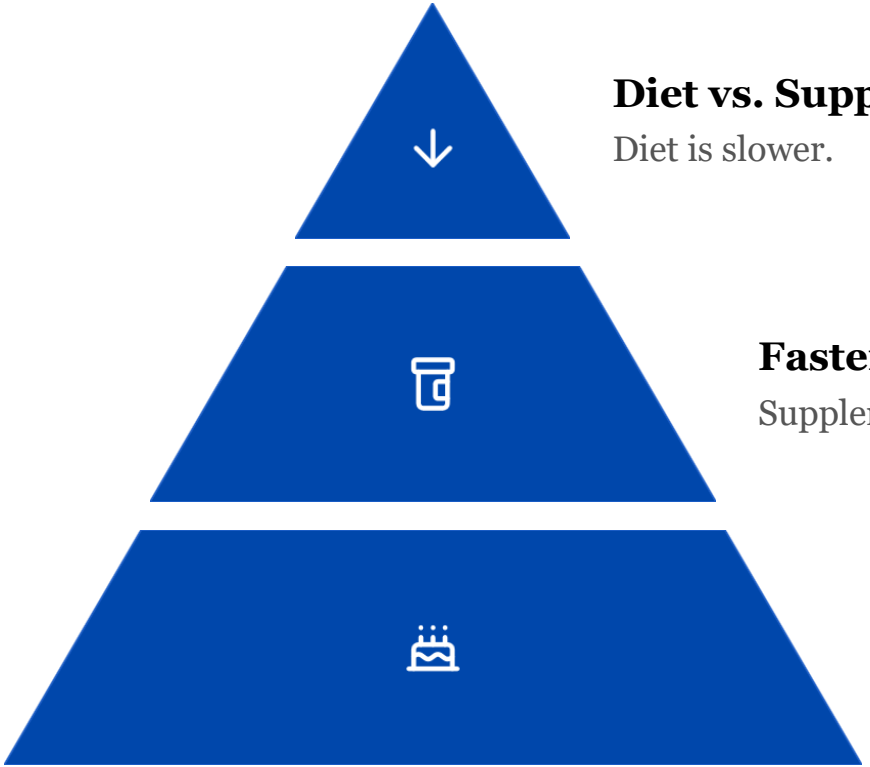
Adults
Over half use supplements.

Common Types
Multivitamins, D, Calcium, B.

Pregnant Women
75% take multivitamins.



Correcting Deficiencies



Diet vs. Supplements

Diet is slower.

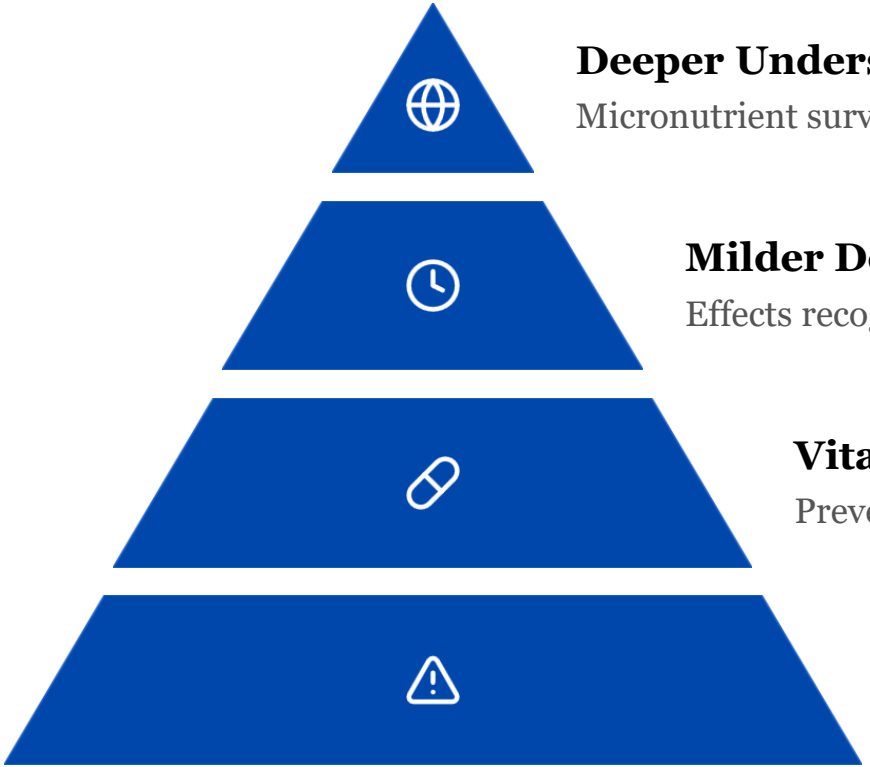
Faster Correction

Supplements and fortification.

Breakfast Cereals

Important source for children.

Historical Development



Deeper Understanding

Micronutrient surveillance programs globally.

Milder Depletion

Effects recognized in the 1980s.

Vitamin Roles

Preventing diseases identified.

Severe Symptoms

Early recognition of deficiencies.



Micronutrient Requirements

Adequate Intake
When EAR/RDA is undetermined.

Upper Intake
Supplement safety considered.

Dietary Allowance
Recommended dietary intake.

Average Requirement
Estimated average intake.

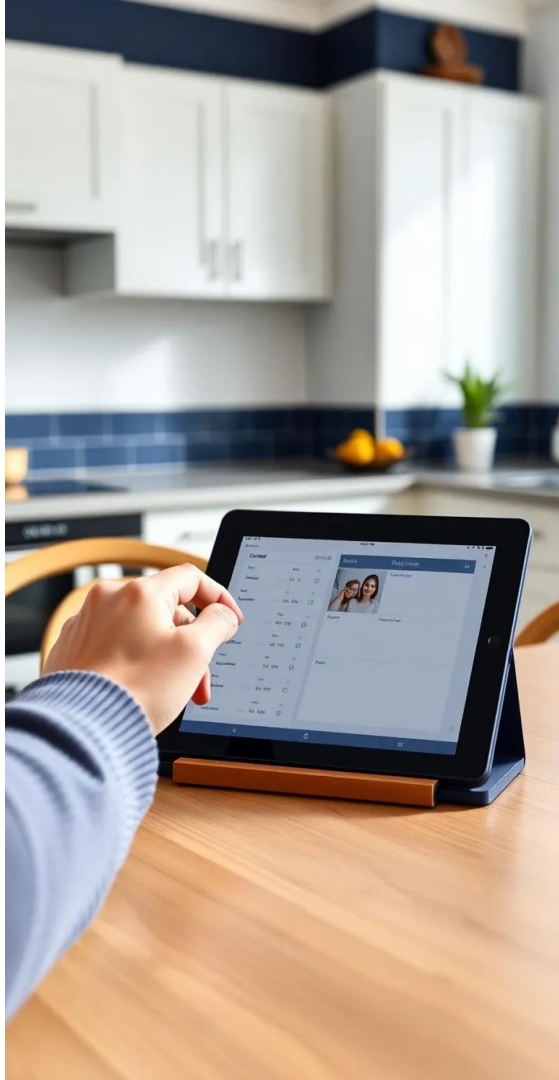
Dietary Intake Assessment

Data Collection
NIH's ASA24 tool.

Dietary Patterns
Food group consumption matters.

Poor Absorption
Food composition errors.

Food Intake
Assessing adequacy.



Biochemical Indicators



Inflammation Correction

Using C-reactive protein.



Biomarker Limits

Serum retinol limitations.



Cutoff Values

Deficiency or depletion.



Biomarkers Usage

Assess micronutrient status.

Supplementation in US

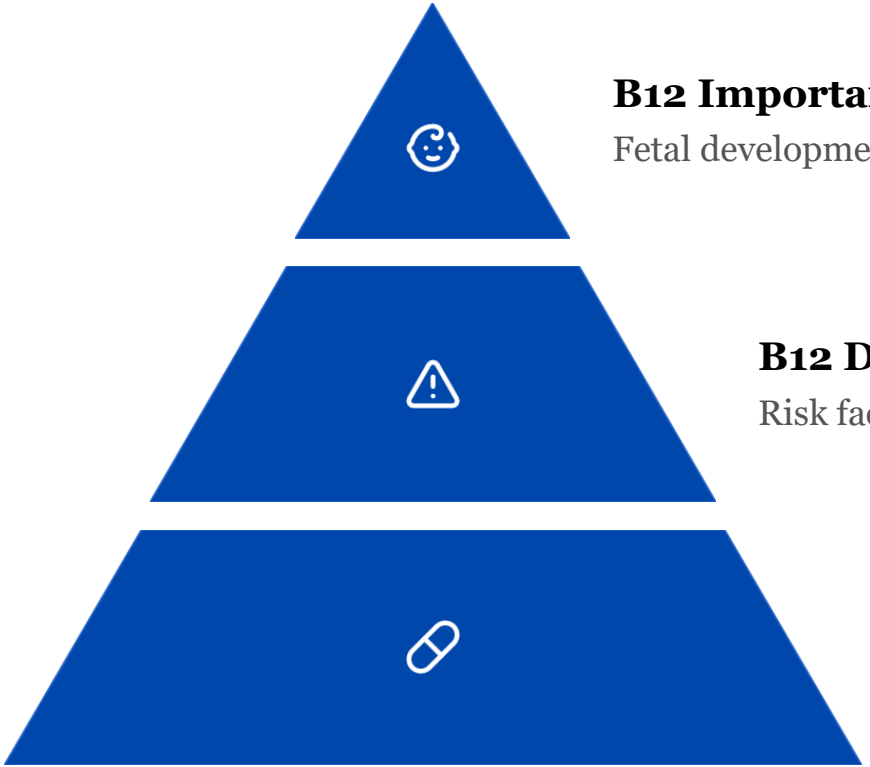
Common Supplements
Multivitamins, vitamin D, calcium.

Increased Needs
Growth, disease, pregnancy.

Dietary Needs
Supplementation warranted.



Specific Deficiencies



B12 Importance

Fetal development, adults.

B12 Deficiency

Risk factors, treatment.

Vitamin D Intake

Prevalence, risk factors.



Iron and Folate

Antioxidant Evidence
Lack of chronic prevention.

Folate Impact
Fortification concerns.

Iron Deficiency
Causes of anemia.

Future Research



Deficiency Consequences

Multiomic analysis potential.



Global Efforts

Address deficiencies.

Assessment Approaches

Dietary Intake
Based on intake from foods.

Biomarkers
Based on biochemical indicators.

Complementary
Both approaches are useful.

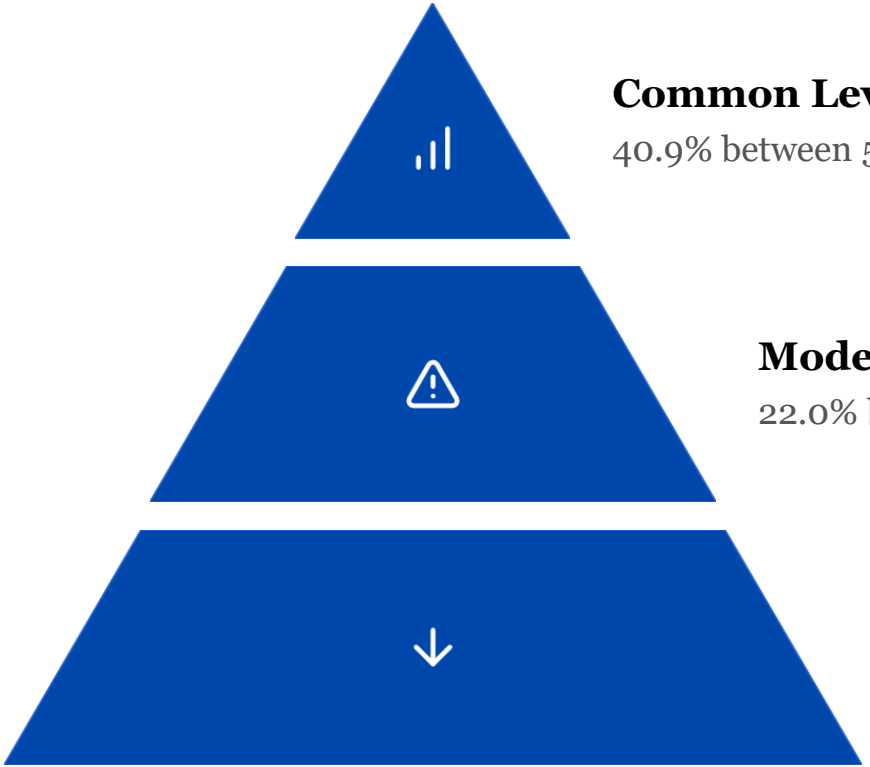




Micronutrients: Deficiencies and Interventions

Overview of micronutrient deficiencies, supplementation, and dietary recommendations in the U.S.

Vitamin D: Prevalence



Common Levels

40.9% between 50–75 nmol/L

Moderate Deficiency

22.0% between 25–50 nmol/L

Severe Deficiency

2.6% had less than 25 nmol/L



Vitamin D: Risk Factors

Sunlight
Low sunlight exposure

Dairy Intake
Low dairy intake

Season
Winter season

Ethnicity
Non-Hispanic Black individuals

Age Group
Young adults (20–29)

Vitamin D: Recommendations

Endocrine Society
≥75 nmol/L for optimal benefit

Adequate Level
≥50 nmol/L is adequate

Deficient Level
<30 nmol/L is deficient

RDA (71+)
800 IU/day (71+ years)

RDA (1-70)
600 IU/day (ages 1–70)



Vitamin D: Supplement Findings



Cancer Mortality

25% cancer mortality reduction



Bone Fractures

No prevention of fractures



Depression

No prevention of depression



Cardiovascular Disease

No prevention of CVD



Cancer Prevention

No prevention of cancer

Vitamin D: Supplement Safety

4000 IU/day

Excess Intake

Kidney stones, GI symptoms

27%

D3 Supplement

More effective than D2

400 IU/day

Infant Adherence

Recommended for infants

Vitamin B12: Deficiency Risk

GI Disorders
GI disorders or bariatric surgery

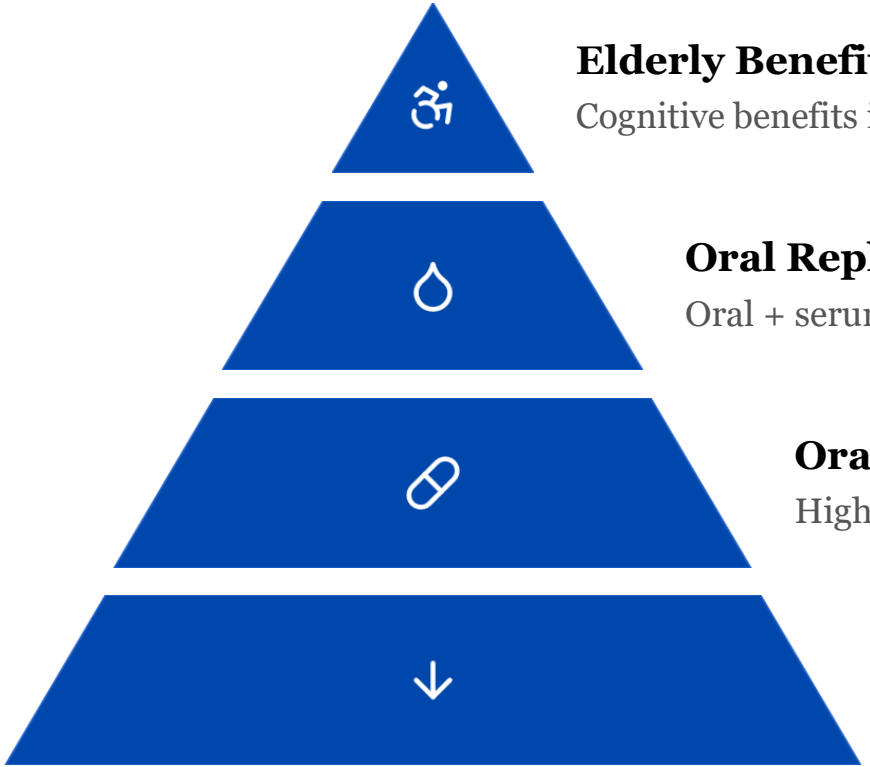
Older Adults
Older adults

Vegetarians
Vegetarians

Vegans
Vegans



Vitamin B12: Supplementation



Elderly Benefits

Cognitive benefits inconclusive

Oral Replacement

Oral + serum monitoring

Oral Supplements

High-dose oral supplements help

Normal Absorption

Normal intake absorbed ~50%



Iron: Deficiency Impact

Poor Diet
Poor diet (low heme iron)

Pregnancy
Pregnancy

Menstrual Loss
Menstrual loss

High Deficiency
77.5% (cutoff: 50 µg/L)

Deficiency Rate
38.6% deficient (cutoff: 15 µg/L)

Iron: Global Context

Other Causes
Hemoglobinopathies

Parasites
Parasites

Malaria
Malaria

Iron Deficiency
Only ~50% due to iron



Folate & Antioxidants



AMD Benefit

Some benefit in AMD



Adverse Effects

High doses cause adverse effects



No Prevention

No strong evidence for prevention



Reduced Defects

Reduced neural tube defects



Folic Acid

Folic acid fortification

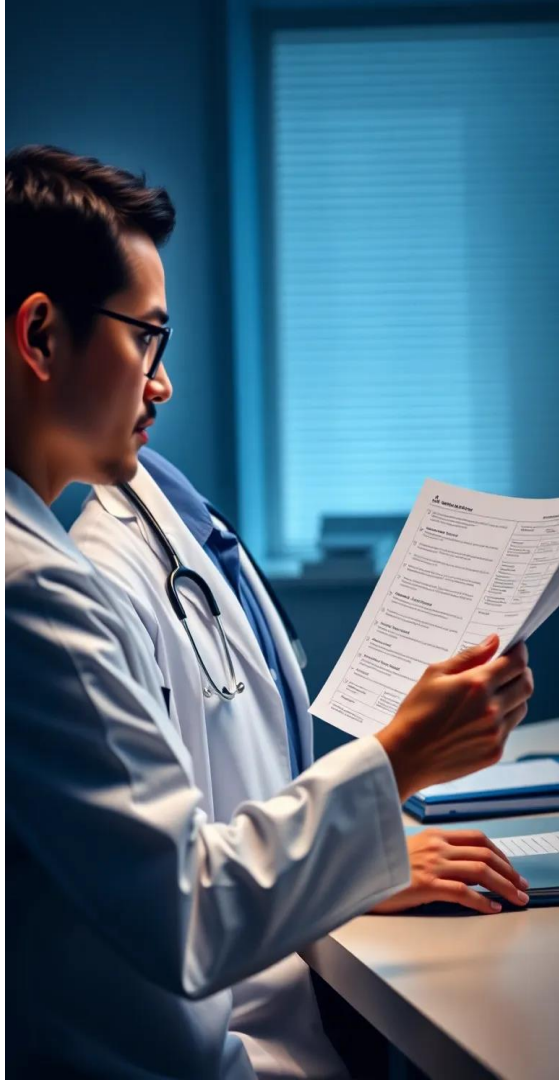
Micronutrient Considerations

Improve Outcomes
Improve outcomes

Refine Recommendations
Refine recommendations

Tailor Interventions
Tailor interventions

Address Deficiencies
Assess and address deficiencies

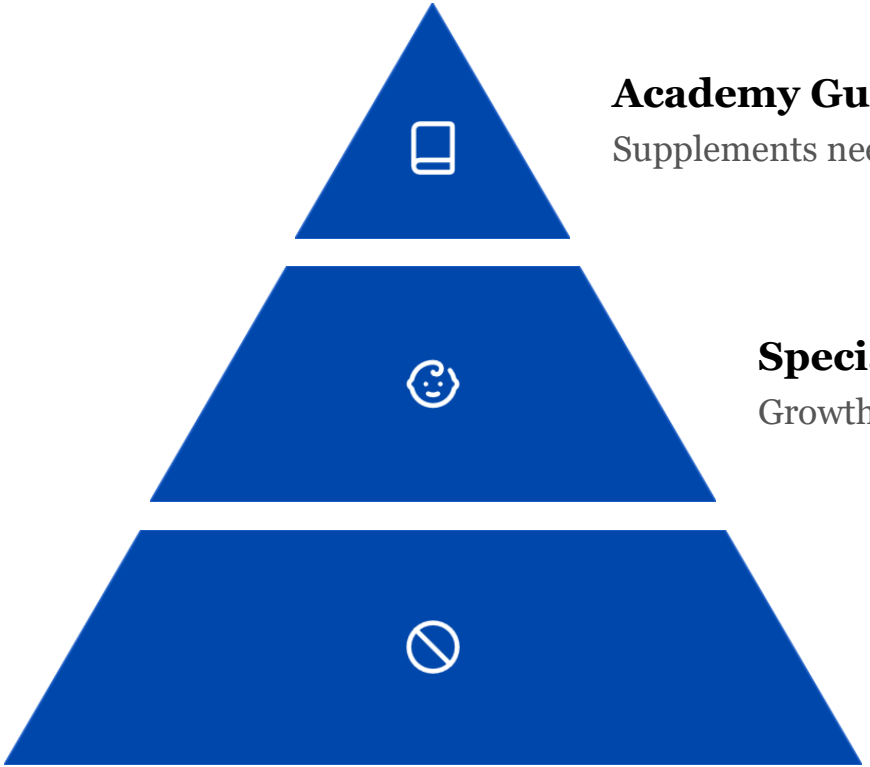




Supplementation Policy in the U.S.

Overview of micronutrient supplementation guidelines and usage in the U.S.

Supplementation Policy



Academy Guidelines

Supplements needed when diet insufficient

Special Risk Groups

Growth, disease, meds, malabsorption, aging

Routine Use

Not recommended for chronic disease prevention



Usage Trends

Adult Supplement Use

50% of U.S. adults use supplements

Common Supplements

Multivitamins, D, calcium, B complex, C

User Perception

Users see supplements as beneficial

Healthier Diets

Users generally have healthier diets

Pregnancy and Lactation

Pregnant Women
~75% take multivitamins

Lactation Needs
Nutrient demands are higher

Maternal Impact
Diet impacts breast milk



Role of Fortified Foods



Key Source

Fortified cereals for children



Micronutrient Gaps

Helps address common gaps



Common Fortification

Iron, folic acid, B vitamins

Supplementation vs. Diet

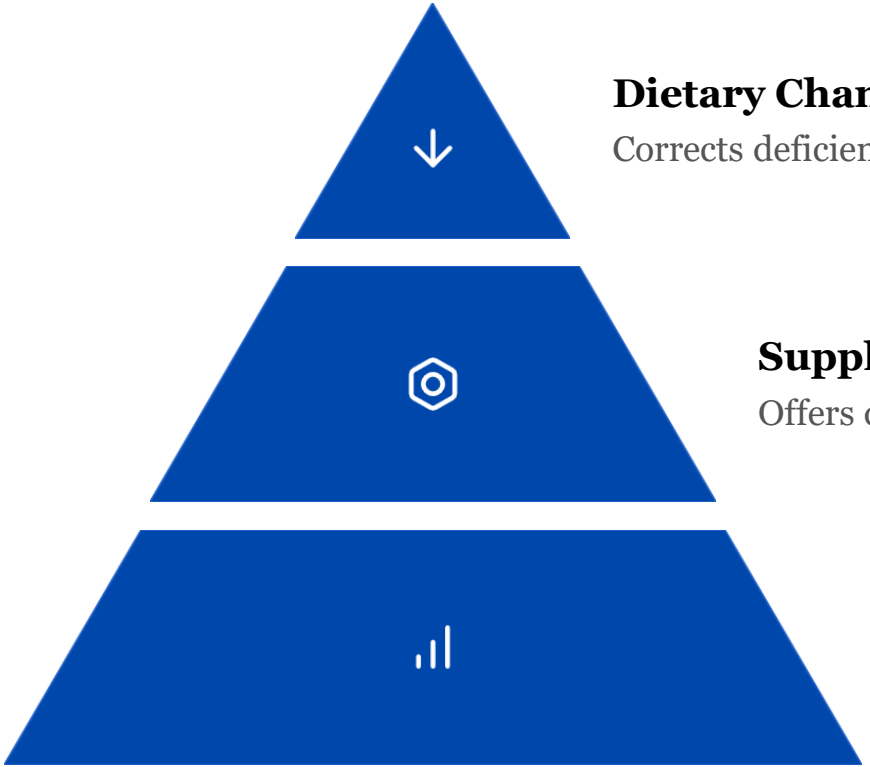
Dietary Change
Corrects deficiencies slowly

Supplementation
Offers quicker results

Balanced Approach
Diet quality and supplements



Supplementation vs. Diet



Dietary Change

Corrects deficiencies slowly

Supplementation

Offers quicker results

Balanced Approach

Diet quality and supplements

Key Statistics

50%

Adults Using Supplements

Percentage of adults using supplements

75%

Pregnant Women Using Supplements

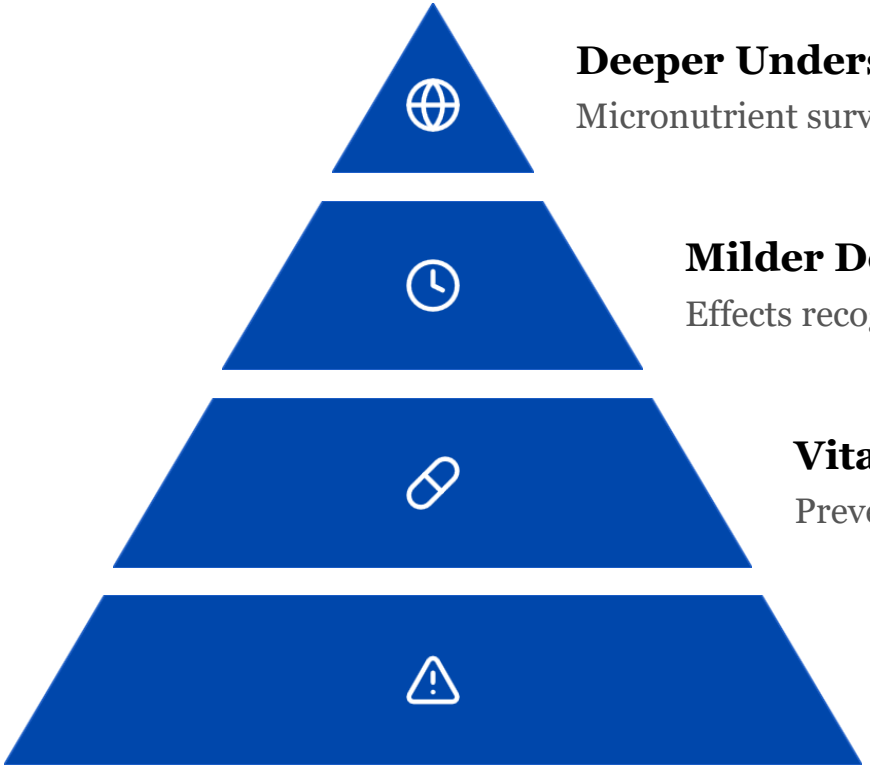
Percentage of pregnant women using supplements

60%

Fortified Cereals

Percentage of children consuming fortified cereals

Historical Development



Deeper Understanding

Micronutrient surveillance programs globally.

Milder Depletion

Effects recognized in the 1980s.

Vitamin Roles

Preventing diseases identified.

Severe Symptoms

Early recognition of deficiencies.



Micronutrient Requirements

Adequate Intake
When EAR/RDA is undetermined.

Upper Intake
Supplement safety considered.

Dietary Allowance
Recommended dietary intake.

Average Requirement
Estimated average intake.

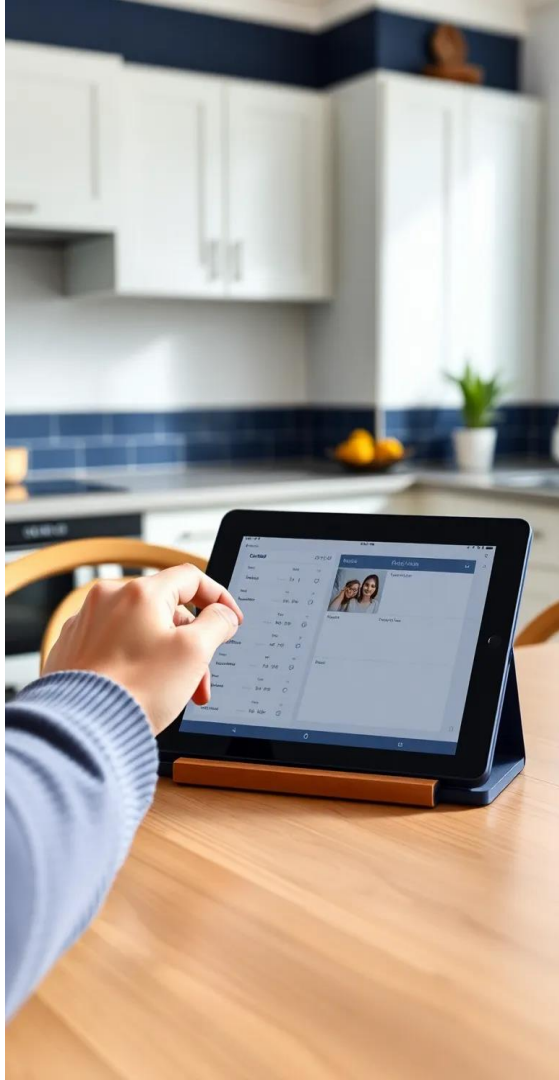
Dietary Intake Assessment

Data Collection
NIH's ASA24 tool.

Dietary Patterns
Food group consumption matters.

Poor Absorption
Food composition errors.

Food Intake
Assessing adequacy.



Biochemical Indicators



Inflammation Correction

Using C-reactive protein.



Biomarker Limits

Serum retinol limitations.



Cutoff Values

Deficiency or depletion.



Biomarkers Usage

Assess micronutrient status.

Supplementation in US

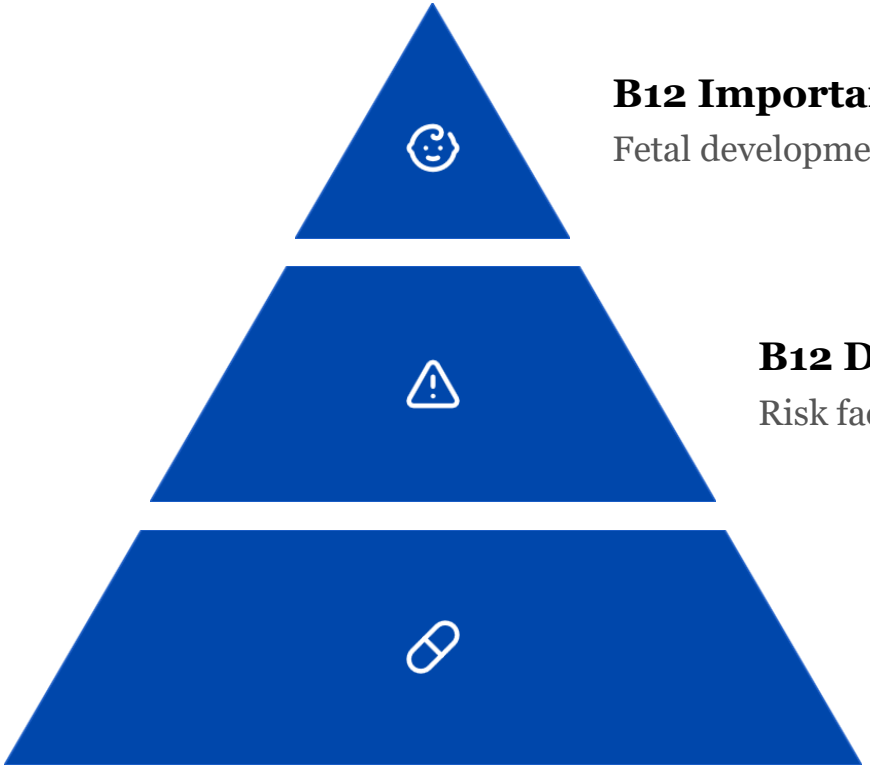
Common Supplements
Multivitamins, vitamin D, calcium.

Increased Needs
Growth, disease, pregnancy.

Dietary Needs
Supplementation warranted.



Specific Deficiencies



B12 Importance

Fetal development, adults.

B12 Deficiency

Risk factors, treatment.

Vitamin D Intake

Prevalence, risk factors.



Iron and Folate

Antioxidant Evidence
Lack of chronic prevention.

Folate Impact
Fortification concerns.

Iron Deficiency
Causes of anemia.

Future Research



Deficiency Consequences

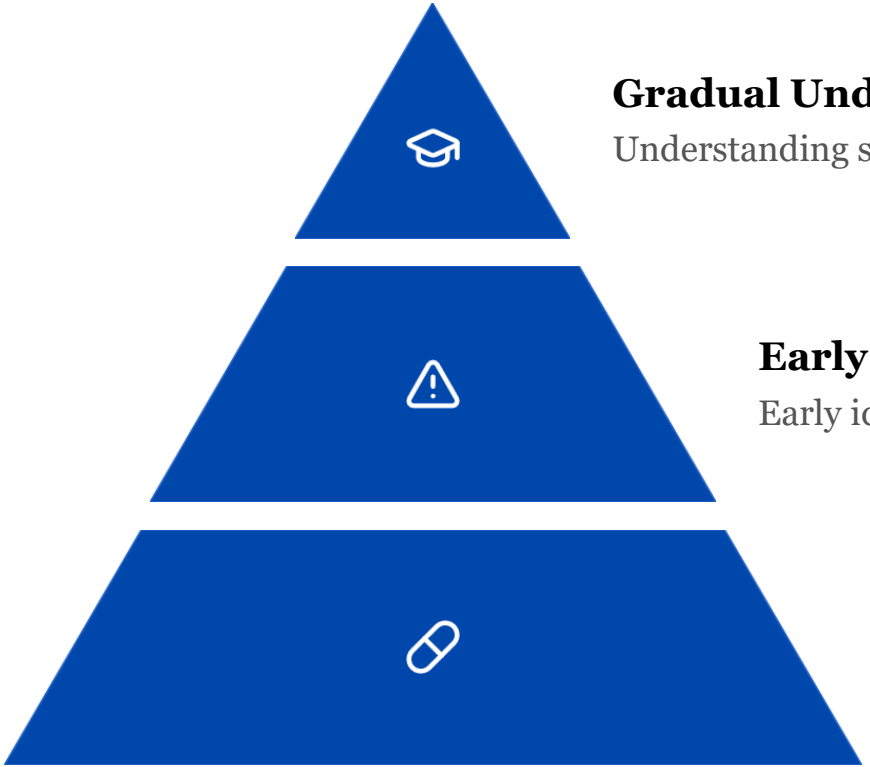
Multiomic analysis potential.



Global Efforts

Address deficiencies.

Historical Perspective



Gradual Understanding

Understanding specific micronutrient roles.

Early Identification

Early identification of deficiency diseases.

Evolution of Treatment

Treating deficiencies to addressing depletions.

Key Considerations

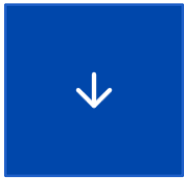
Dietary Assessment
Dietary assessment identifies deficiencies.

Uncommon Deficiencies
Deficiencies uncommon in the U.S.

Complementary Information
Assessments provide complementary information.



Micronutrient Requirements



EAR Importance

Assessing inadequacy within populations.



Adequate Intake

Adequate Intake



Tolerable Level

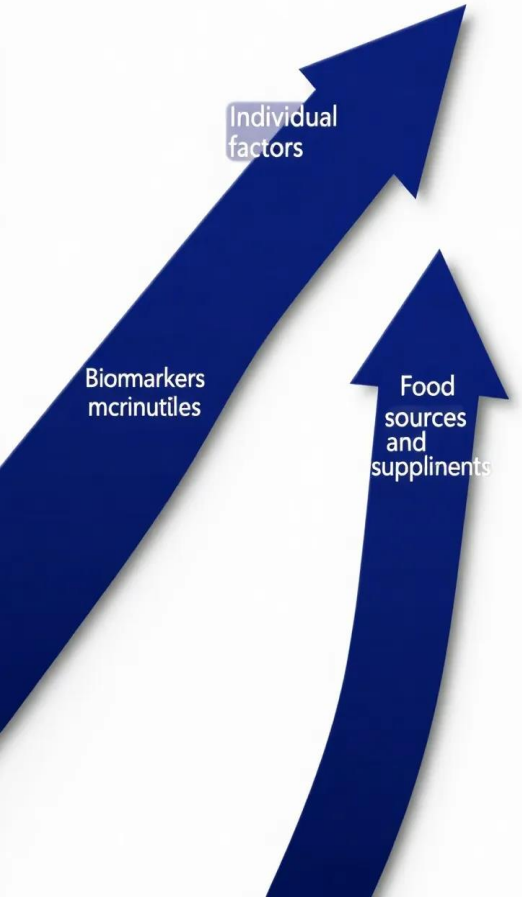
Tolerable Upper Intake Level



Key Values

EAR, RDA Key Values

Assessing Adequacy



Challenges

Data accuracy and individual factors.

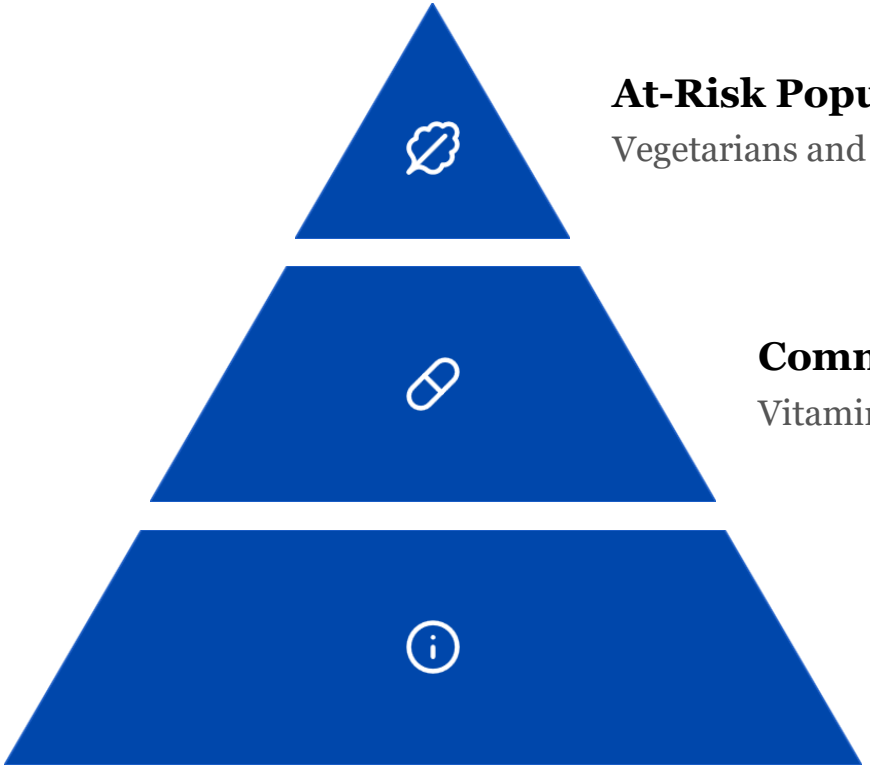
Biochemical Indicators

Biomarkers for specific micronutrients.

Dietary Intake

Food sources and supplements.

Micronutrient Status in U.S.



At-Risk Populations

Vegetarians and dietary restrictions.

Common Supplements

Vitamin D, Calcium, Folic Acid.

Office of Supplements

Information resource for supplements.

Primary Concern in U.S.

Vitamin B12
Risk factors and importance.

Vitamin D
Widespread deficiency implications.

Iron
Prevalence of deficiency.



Vitamin D: Deficiency



Supplementation

Ongoing research and guidelines.



Dietary Sources

Role of sunlight.



Deficiency Prevalence

Prevalence of deficiency.



Vitamin B12: Risks

Deficiency Risks

Malabsorption increases deficiency risks.

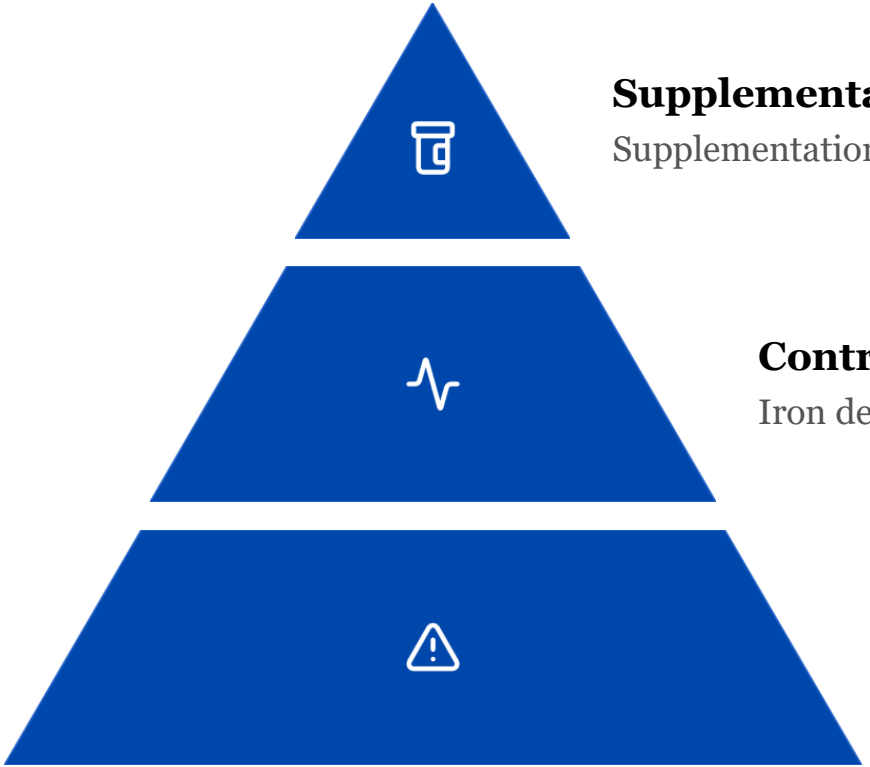
Absorption Mechanisms

Factors affecting B12 levels.

Dietary Sources

Animal products and fortified foods.

Iron: Strategies



Supplementation

Supplementation guidelines.

Contributing Factors

Iron deficiency in populations.

Iron Deficiency

Iron deficiency causes anemia.

Folate and Antioxidants

Specific Uses
Macular degeneration uses antioxidants.

Antioxidants Benefits
Limited benefits in disease prevention.

Folic Acid
Impact on neural tube defects.



Global Initiatives



Fortification Initiative

The Food Fortification Initiative.



Public Health Programs

Supplementation, fortification, biofortification.



Historical Focus

Focus on iodine, vitamin A, iron.



Supplementation Strategies

LNS Effectiveness

Effectiveness of LNS.

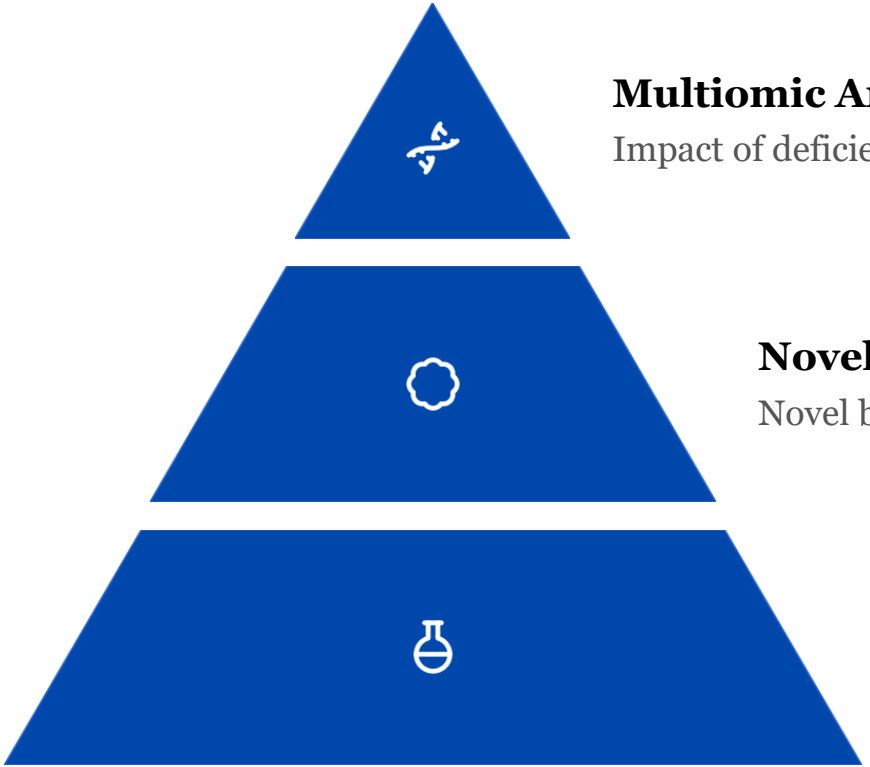
Multiple Supplements

Benefits and considerations.

Targeted Supplementation

Targeted for women and children.

Future Directions



Multiomic Analysis

Impact of deficiencies.

Novel Biomarkers

Novel biomarkers identification.

Exploring Effects

Marginal deficiencies effects.

Multiomic Examples

Plasmalogen Levels
Vitamin B12 and plasmalogen levels.

GSTO1 Biomarker
Zinc deficiency biomarker.

Multiomic Approaches
Examples and potential.



Insights from Data



Identifying Benefits

Identifying benefits of interventions.



Understanding Deficiencies

Understanding deficiencies consequences.



Analyzing Samples

Analyzing stored samples.



Assessment Challenges

Need for Methods

Need for sensitive methods.

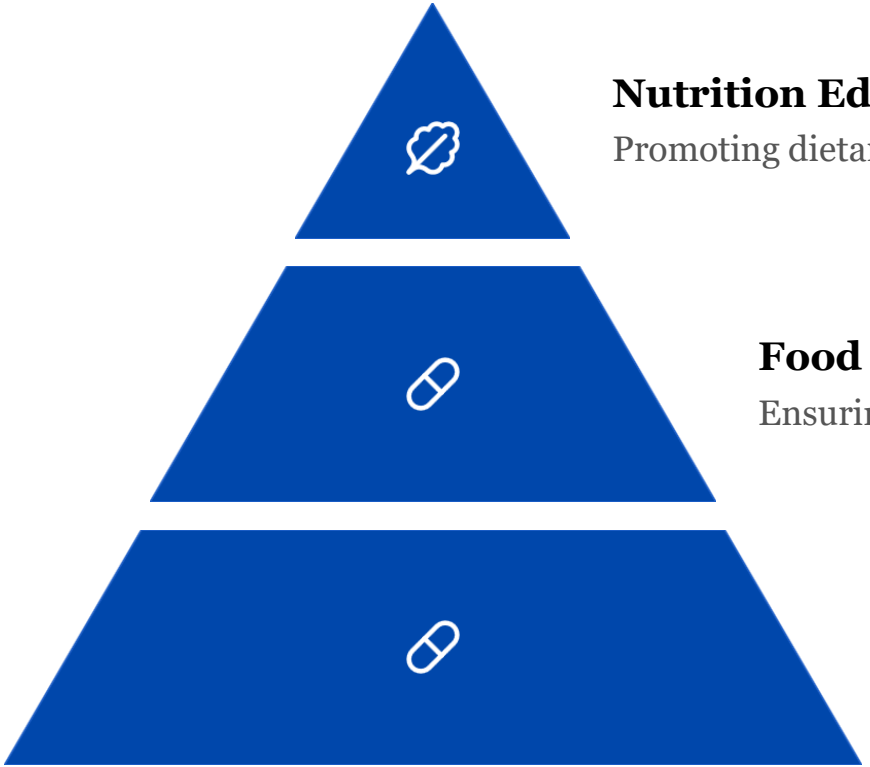
Limitations of Biomarkers

Limitations of current biomarkers.

Variability in Intake

Variability in dietary intake.

Intervention Strategies



Nutrition Education

Promoting dietary diversity.

Food Fortification

Ensuring adequate intake.

Supplementation

Targeted vs. indiscriminate use.

Healthcare Practitioners

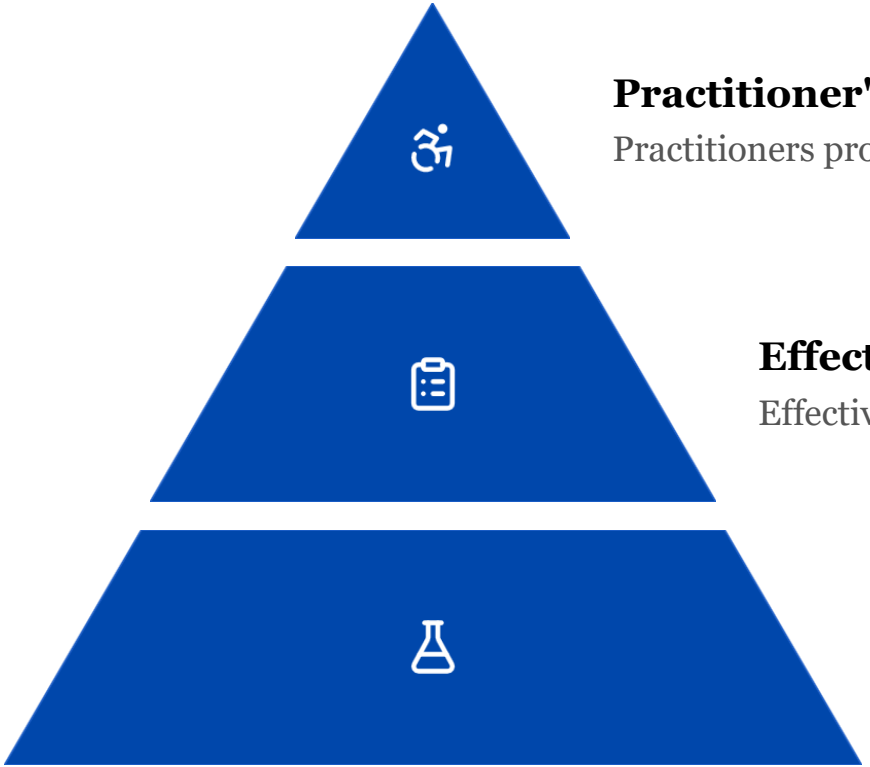
Staying Informed
Staying informed about research.

Recommendations
Personalized recommendations.

Assessing Status
Assessing individual status.



Optimizing Status



Practitioner's Role

Practitioners promote micronutrient status.

Effective Assessment

Effective assessment and interventions.

Micronutrients Essential

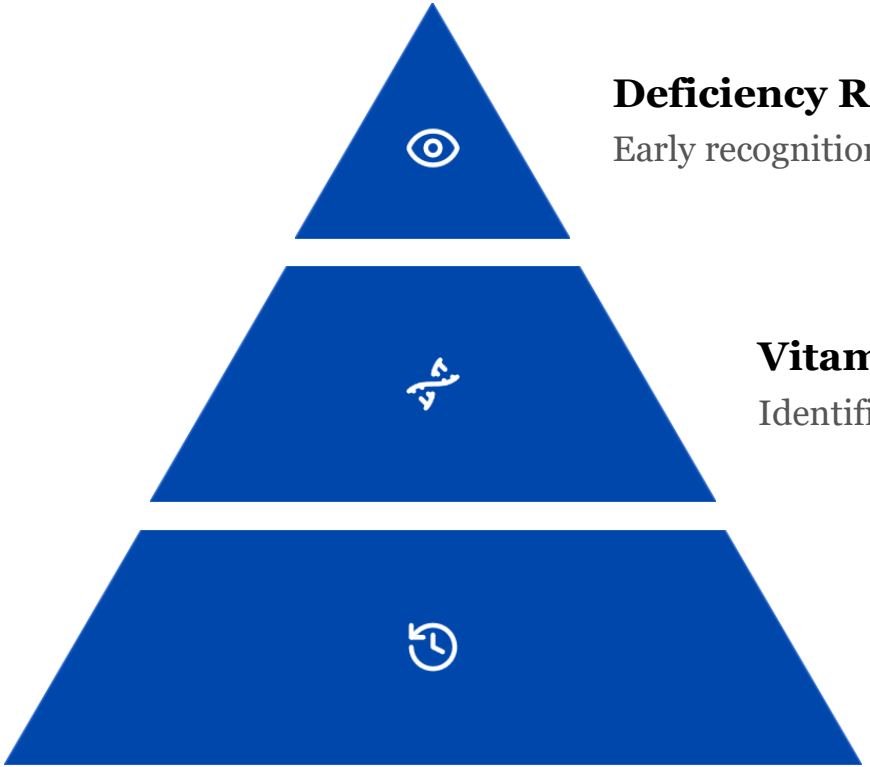
Micronutrients are essential.



Micronutrient Overview

Overview of micronutrient assessment, requirements, deficiencies, and interventions for healthcare.

Historical Perspective



Deficiency Recognition

Early recognition of deficiency diseases.

Vitamin Identification

Identification of specific vitamins.

Evolving Understanding

Evolution of understanding micronutrient importance.

Micronutrient Requirements

NASEM and EFSA
Role of NASEM and EFSA.

Defining Requirements
Defining EAR, RDA, and UL.

Setting Challenges
Challenges in setting requirements.



Micronutrient Assessment



Dietary Assessment

Dietary assessment importance.



Biochemical Indicators

Biochemical indicators importance.



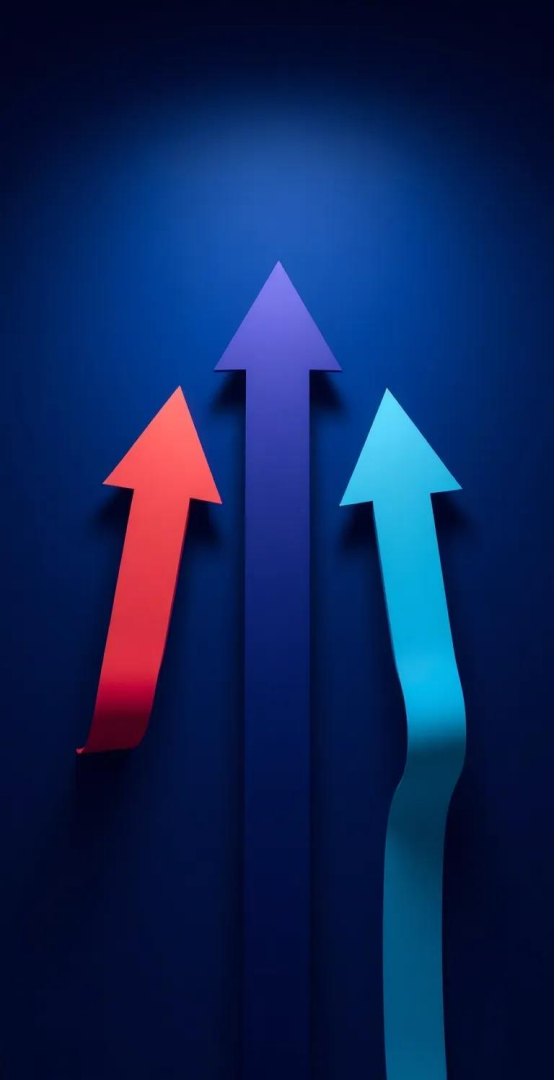
Discrepancy Reasons

Reasons for discrepancies.



Complementary Methods

Assessment methods are complementary.



Biomarkers Status

Common Biomarkers

Commonly used biomarkers.

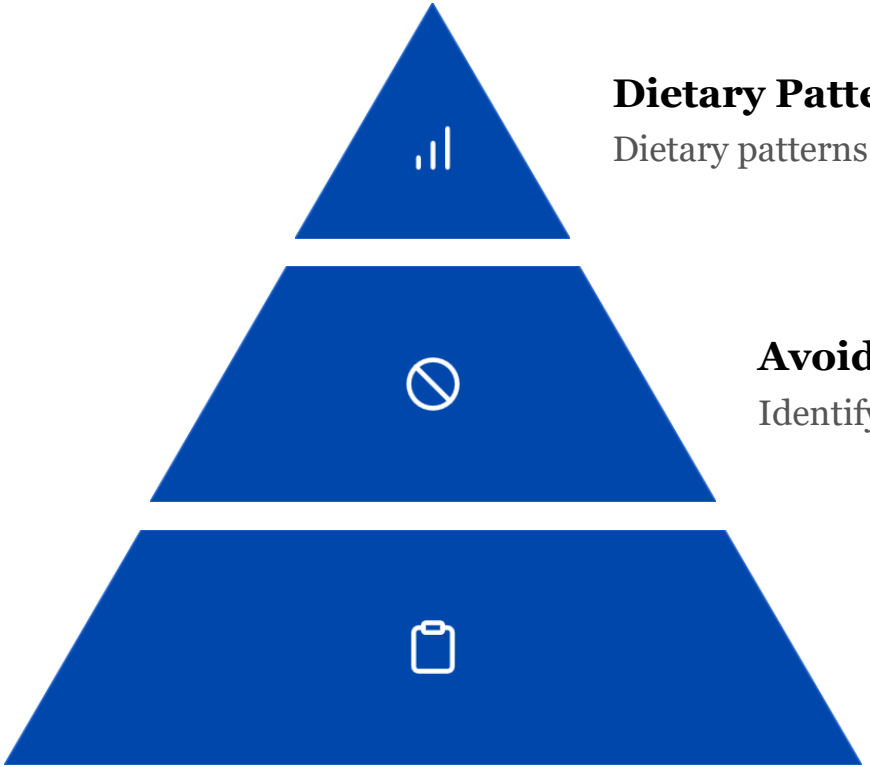
Zinc Challenges

Challenges with zinc biomarkers.

Adjusting Inflammation

Adjusting for inflammation.

Dietary Assessment



Dietary Patterns

Dietary patterns importance.

Avoided Groups

Identifying avoided food groups.

NIH ASA24 Tool

Utilizing NIH ASA24 tool.

Micronutrient Status

Dietary Supplements
Role of Dietary Supplements.

Common Deficiencies
Common deficiencies.

Fortification Impact
Impact of fortification.



Supplements Benefits



Bone Health

Bone health benefits.



Preventing Defects

Preventing defects.



Heart Disease

Heart disease benefits.



Macular Degeneration

Macular degeneration benefits.



Micronutrients Concern

Academy Stance

Academy stance on supplementation.

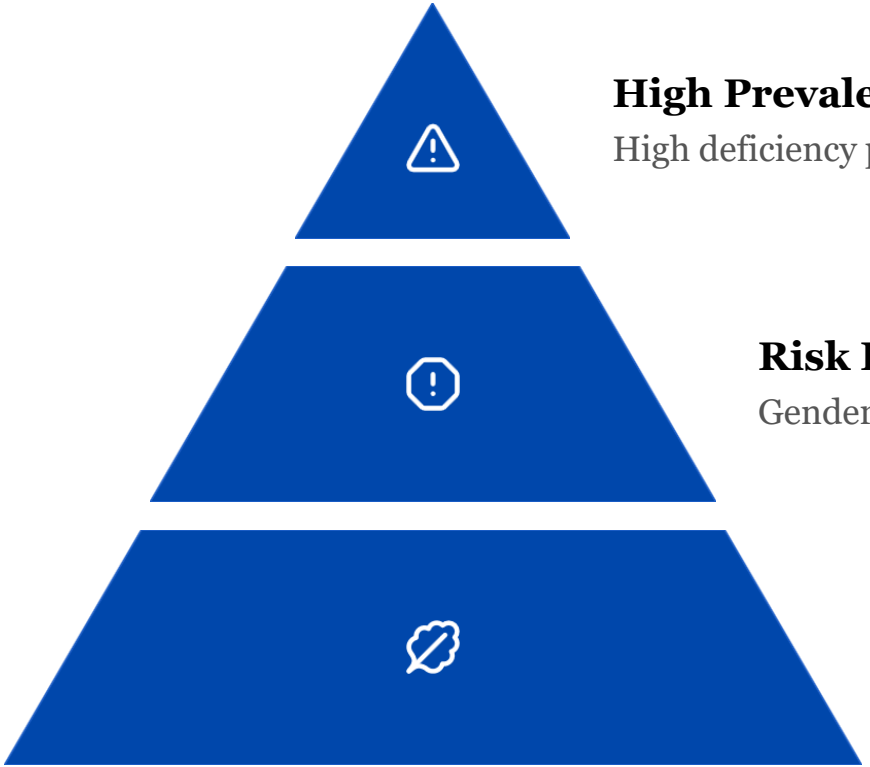
Deficiency Risks

Risk factors for deficiencies.

Supplement Patterns

Supplement use patterns.

Vitamin D Deficiency



High Prevalence

High deficiency prevalence.

Risk Factors

Gender, race, season risks.

Dietary Sources

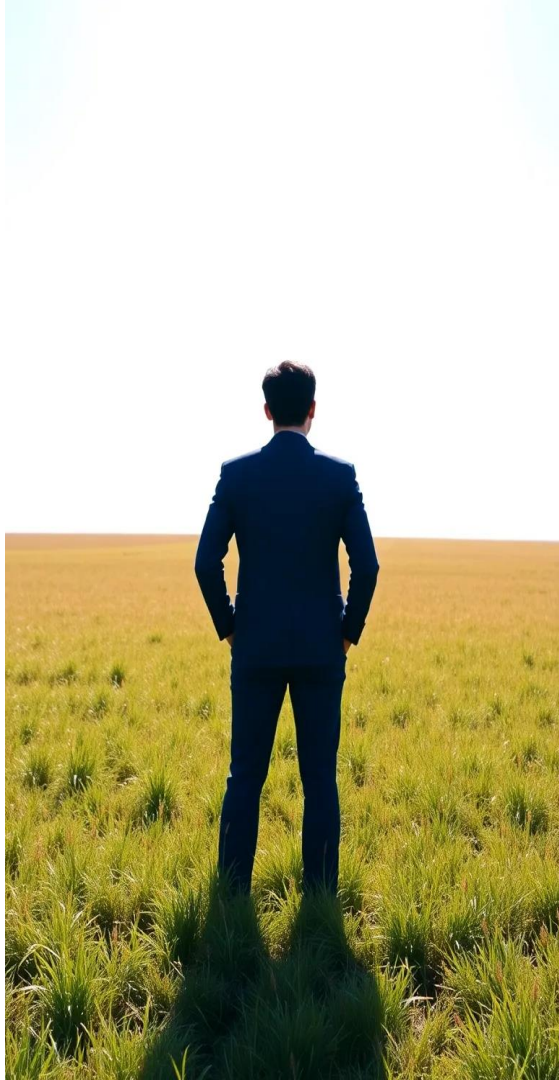
Dietary sources.

Vitamin D Supplementation

Serum Concentrations
Optimal serum concentrations debate.

Trial Results
Clinical trial results.

Potential Benefits
Potential benefits.



Vitamin B12 Deficiency



B12 Sources

B12 sources and vegan risks.



Maternal Depletion

Maternal depletion consequences.



Absorption Issues

Absorption issues.



Vitamin B12 Supplementation

Absorption Types

Active vs passive absorption.

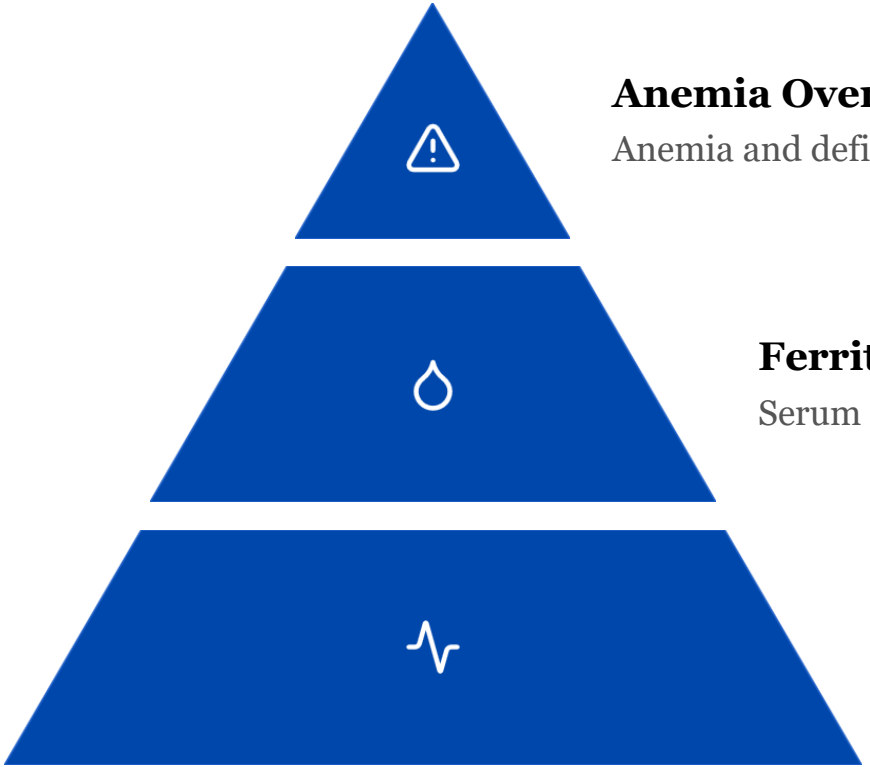
High-Dose Supplementation

High-dose supplementation.

Cognitive Decline

Preventing cognitive decline.

Iron Deficiency



Anemia Overview

Anemia and deficiency.

Ferritin Indicator

Serum ferritin indicator.

Causal Factors

Causal factors.

Iron Supplementation

Iron Bioavailability
Ferrous iron bioavailability.

Side Effects
Side effects of high doses.

Maternal Status
Maternal iron status.



Folate Impact



Fortification Impact

Fortification impact.



Low Prevalence

Low deficiency prevalence.



Upper Level

Upper level concerns.



Antioxidants Evidence

Clinical Trials

Clinical trials on vitamins.

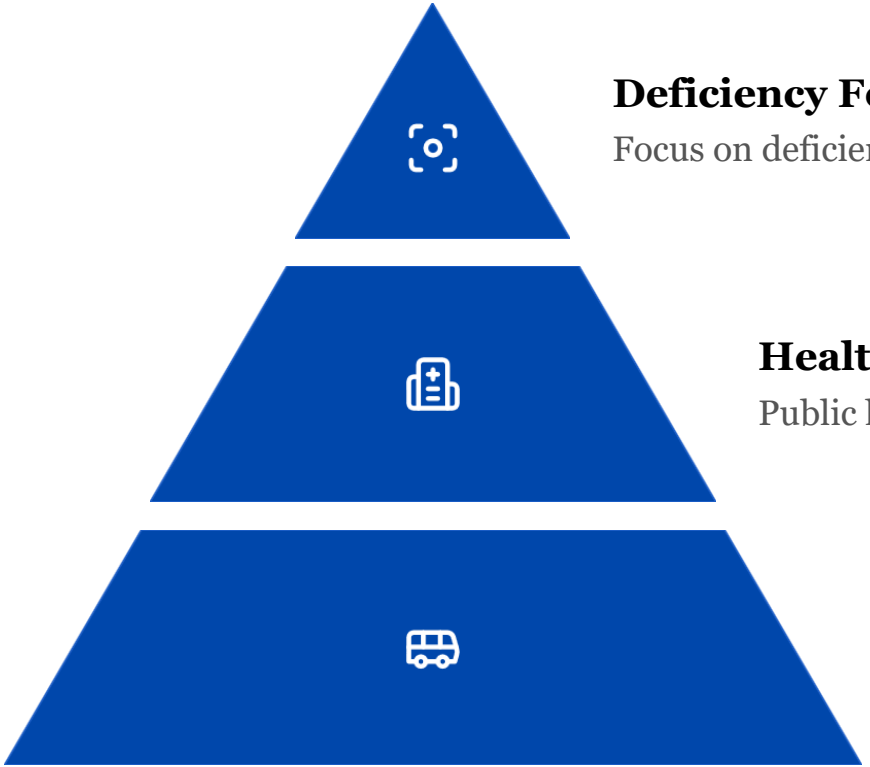
Lack of Benefits

Lack of proven benefits.

Antioxidants Role

Specific antioxidants role.

Micronutrient Programs



Deficiency Focus

Focus on deficiencies.

Health Programs

Public health programs.

Delivery Methods

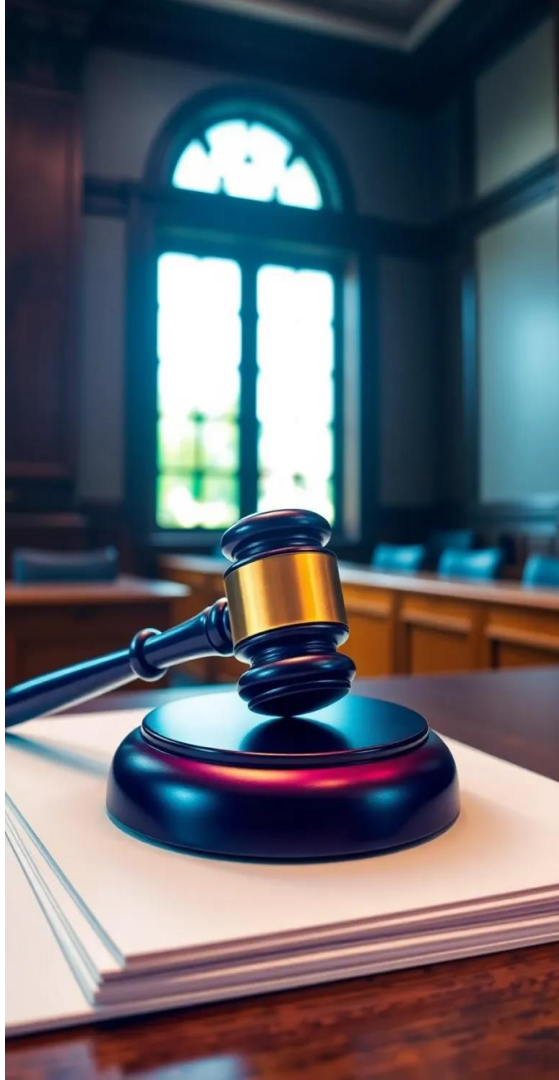
Delivery methods.

Food Fortification

Fortification Laws
Legislation for fortification.

Initiative Role
Food Fortification Initiative.

Monitoring Decisions
Monitoring and decisions.



Supplementation LMICs



Pregnant Women

Pregnant women intervention.



Iron Supplements

Iron-folic acid supplements.



Multiple Supplements

Multiple-micronutrient supplements.



Nutrient Supplements

Small-Quantity LNS

Small-quantity LNS for children.

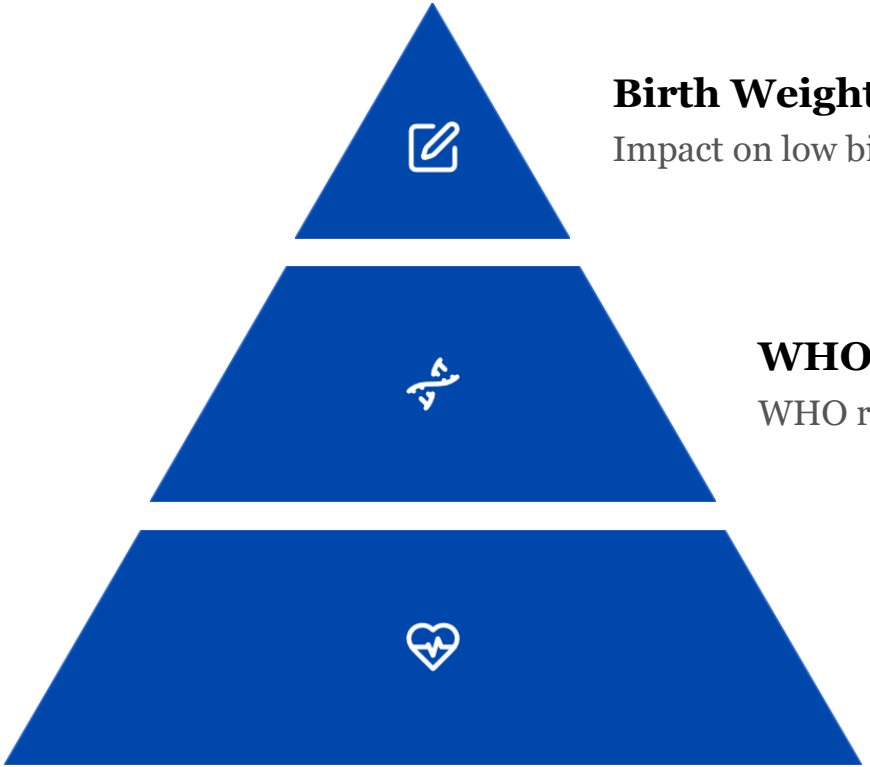
Mortality Impact

Impact on mortality rates.

LNS Assessment

Assessment of LNS.

Multiple Supplements



Birth Weight Impact

Impact on low birth weight.

WHO Recommendations

WHO recommendations.

Research Needed

Rigorous research needed.

The Power of Omics

Marginal Deficiencies
Investigating marginal deficiencies.

Omic Analyses
Metabolomics, genomics, proteomics.

Novel Biomarkers
Identifying novel biomarkers.



Zinc Deficiency



GSTO1 Biomarker

GSTO1 as biomarker.



Further Research

Further research needed.



Improved Assessment

Improved assessment.



Vitamin B12 Health

B12 Impact

B12 impact on plasmalogen.

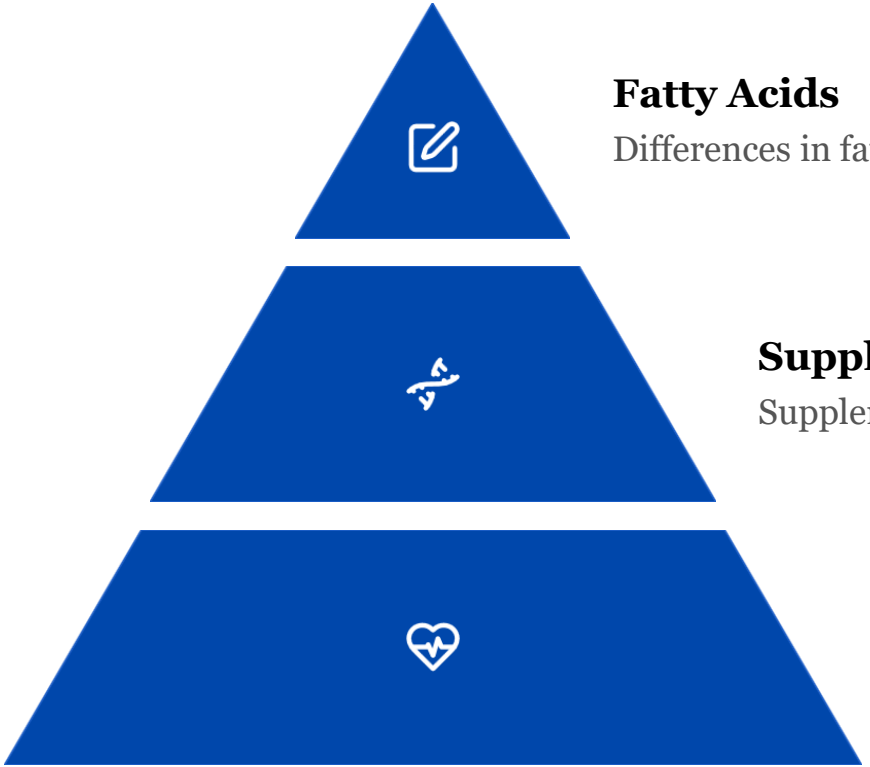
Plasmalogens Role

Plasmalogens role.

Improved Function

Improved function.

Vitamin D Profiles



Fatty Acids

Differences in fatty acids.

Supplementation Impact

Supplementation impact.

Personalized Interventions

Personalized interventions.

Iron Deficiency

Metabolite Changes
Changes in metabolites.

Early Detection
Early detection potential.

Preventing Problems
Preventing problems.



Riboflavin Thiamine



Widespread Deficiencies

Widespread deficiencies.



Limited Concern

Limited public concern.



Analysis Potential

Multiomic analysis potential.



Leveraging Data

Analyzing Samples

Analyzing stored samples.

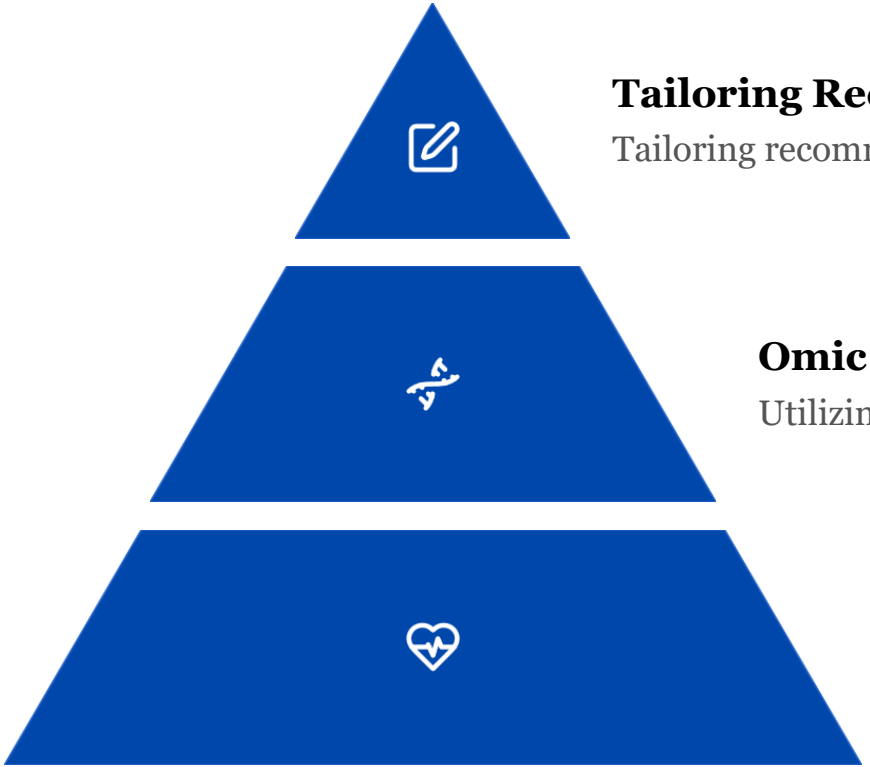
Identifying Consequences

Identifying consequences.

Assessing Interventions

Assessing interventions.

Future Directions



Tailoring Recommendations

Tailoring recommendations.

Omic Data

Utilizing omic data.

Health Outcomes

Improving health outcomes.

Conclusion

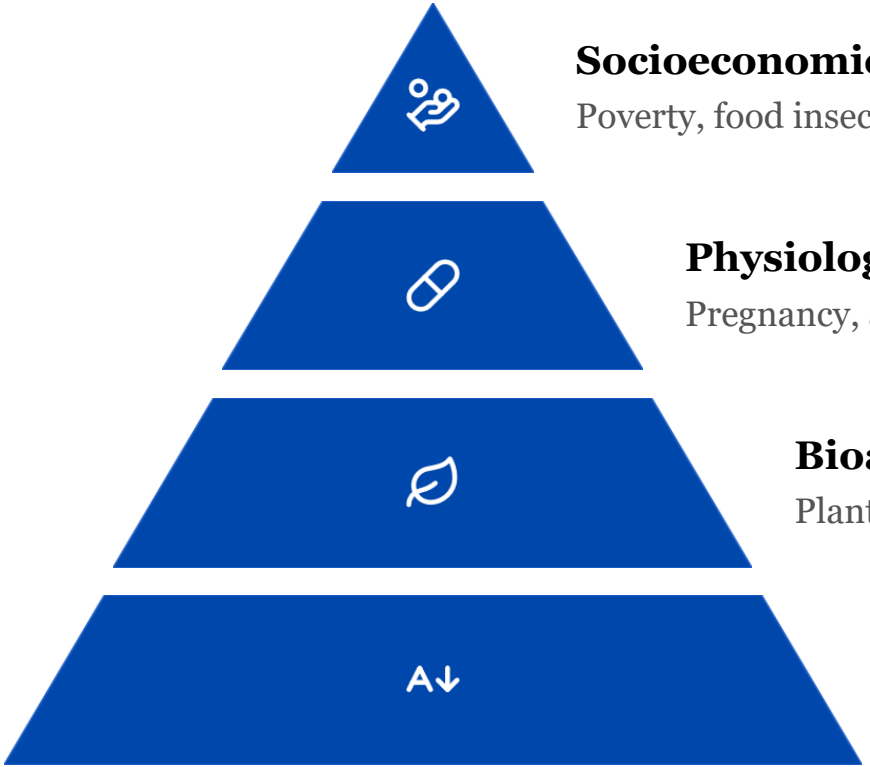
Preventing Disease
Preventing disease.

Promoting Health
Promoting optimal health.

Research Efforts
Continued research efforts.



Factors Influencing Micronutrient Status



Socioeconomic Factors

Poverty, food insecurity, cultural practices.

Physiological States

Pregnancy, aging, illness, medications.

Bioavailability

Plant-based diets inhibit mineral absorption.

Absorption Efficiency

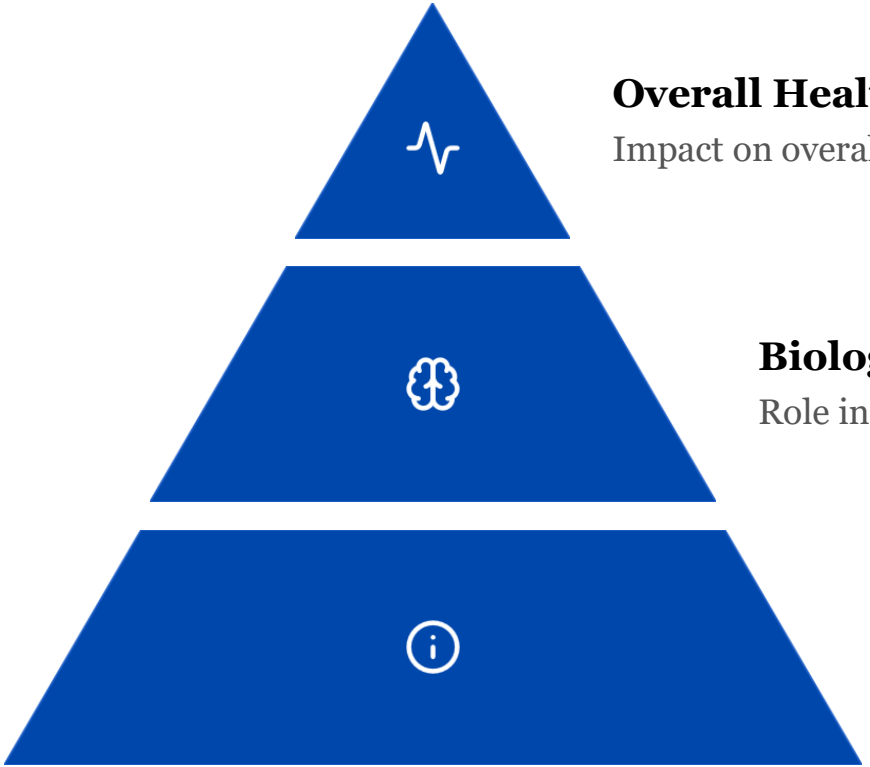
Malabsorption, surgeries impair uptake.



Micronutrients: Essential Nutrients

Overview of micronutrient assessment, deficiencies, and interventions for healthcare practitioners.

Micronutrients: Essential Nutrients



Overall Health

Impact on overall health.

Biological Functions

Role in vital biological functions.

Micronutrient Definition

Definition and importance of micronutrients.



Historical Perspective

Control Programs

Development of control programs.

Milder Depletions

Addressing milder depletions.

Treating Deficiencies

Shift from treating deficiencies.

Micronutrient Identification

Identification of micronutrients.

Establishing Requirements

Harmonizing Values
Harmonizing nutrient reference values.

Guiding Interventions
Guiding micronutrient interventions.

Assessing Inadequacy
Assessing inadequacy and interventions.

Reference Values
Key reference values.



Scientific Approach



Harmonizing Challenges

Challenges in harmonizing values.



Guiding Interventions

Guiding micronutrient interventions.



Assessing Inadequacy

Assessing inadequacy and interventions.



Reference Values

Key reference values.

Micronutrient Status

50%

Supplement Usage

Percentage of adults using supplements.

75%

Pregnant Women

Percentage of pregnant women taking supplements.

90%

Choline Intake

Percentage with inadequate choline intake.

Higher-Income Populations

At-Risk Groups
Vegetarians, those avoiding dairy products.

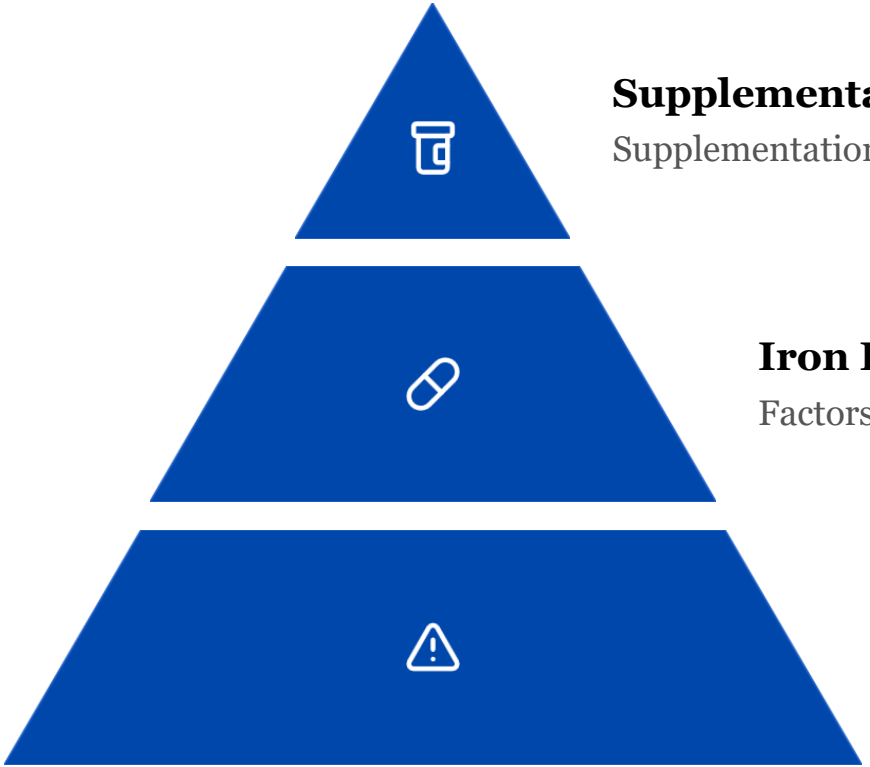
Improve Health
Calcium, Vitamin D, Folic Acid.

Fortified Foods
Importance of fortified foods.

Dietary Supplements
Resources from NIH.



Specific Deficiencies



Supplementation

Supplementation recommendations.

Iron Deficiency

Factors contributing to deficiency.

Vitamin B12 Risk

Risk for vegans, older adults.



Global Programs

Micronutrient Education

Education and awareness programs.

Biofortification

Biofortification of crops.

Food Fortification

Food fortification efforts.

Supplementation

Supplementation programs.



Key Considerations

Dietary Assessment

Focus on food groups and omissions.

Risk Factors

Malabsorption, medications, dietary restrictions matter.

Complementary Assessment

Dietary intake vs. biochemical markers.

Causality Challenges

Determining causality with cross-sectional data.

Establishing Requirements

NASEM and EFSA
Role of scientific authorities in setting standards.

Reference Values
EAR, RDA, Tolerable Upper Intake Level.

Adequate Intake
Used when EAR/RDA cannot be determined.

Assessing Inadequacy
Importance of EAR for planning interventions.



Clinical Implications



Vitamin D

Bone health, immune function support.



Vitamin B12

Neurological function, red blood cells.



Iron

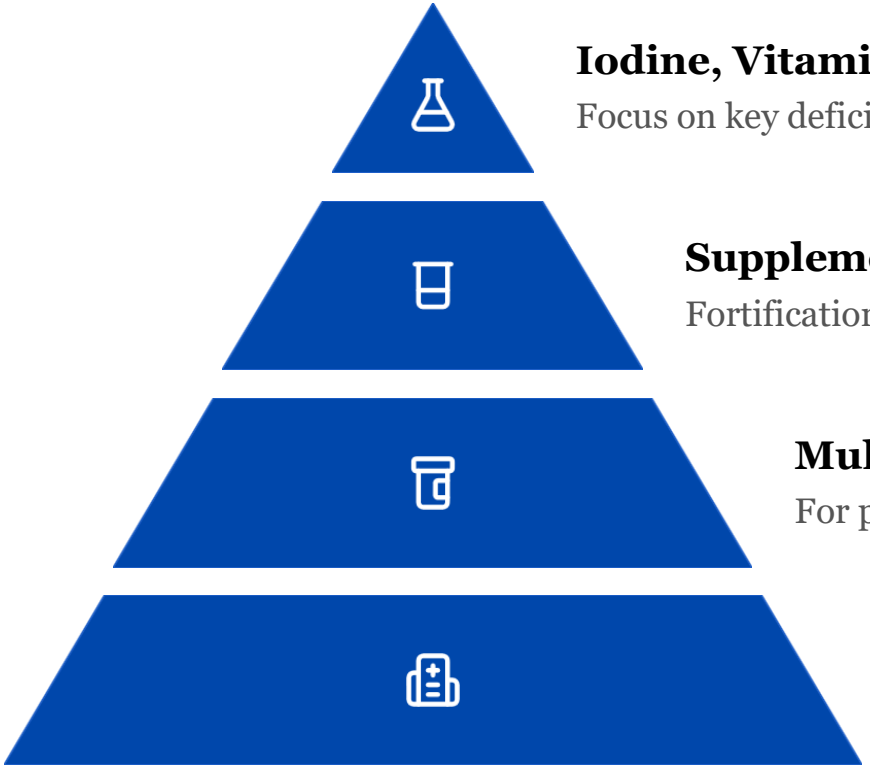
Anemia, fatigue, cognitive development.



Folate

Prevention of neural tube defects.

Low-Middle Income Interventions



Iodine, Vitamin A

Focus on key deficiencies.

Supplementation

Fortification, biofortification strategies used.

Multiple Supplements

For pregnant women and children.

Targeted Programs

Public health programs are important.

Future Opportunities

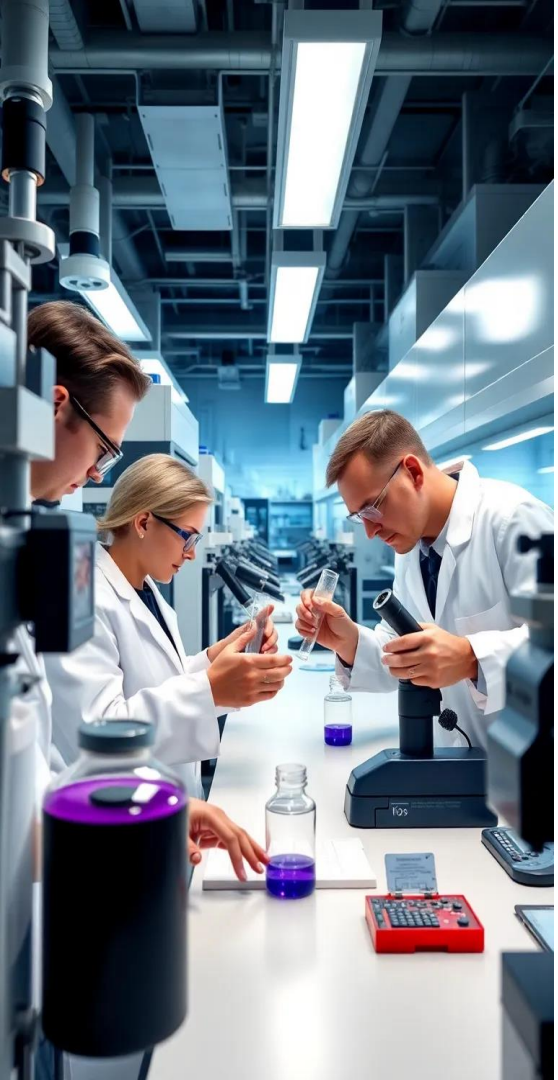
Multiomic Analysis
Potential for multiomic analysis.

Metabolomic Analysis
Metabolomic analysis of deficiencies.

Zinc Biomarker
Biomarker for zinc deficiency.

Omic Analyses
Investigate marginal deficiencies.





Future Research

Omics Technologies

Genomics, proteomics, metabolomics utilized.

Novel Biomarkers

Identifying new status biomarkers.

Marginal Deficiencies

Impact on health outcomes investigated.

Personalized Nutrition

Approaches based on individual needs.