

Prevention in Focus Webinar Series

Global Food Security: Research to Inform Evidence-Based Policies and Practices



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NIH Prevention in Focus Webinar Series
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E3 Nutrition Lab

Research on **maternal and young child nutrition** to derive and test innovative, prevention solutions that embrace the 3 E's:

Equity

Evolution

Environment

Ecuador, Haiti, Kenya, Madagascar
Global (WHO, FAO, UN Nutrition)



Presentation Outline

1. Introduction
 - Global food insecurity situation
 - Nutrition in first 1,000 days of life
2. Evidence-based policies & practices
 - Conceptual frameworks
 - Food environment evidence: availability, affordability, diet quality, & food promotion
3. E3 Nutrition Lab Research
 - Haiti, Ecuador, Kenya
4. Conclusion
 - Translation → policies & practices

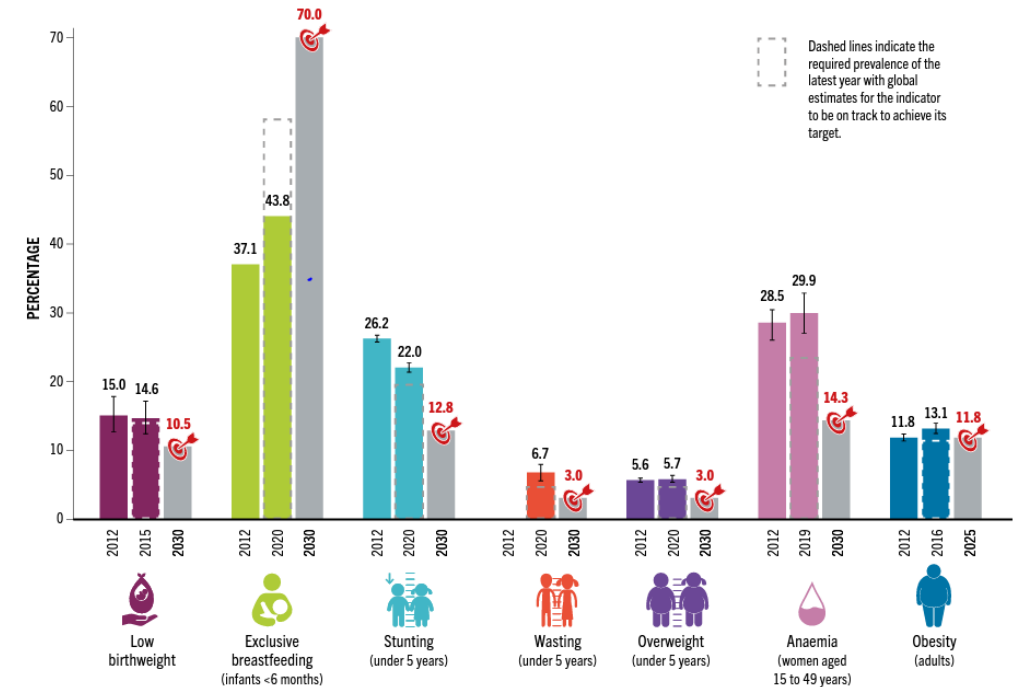


Photo by Whitney Curtis

World nutrition and food security situation

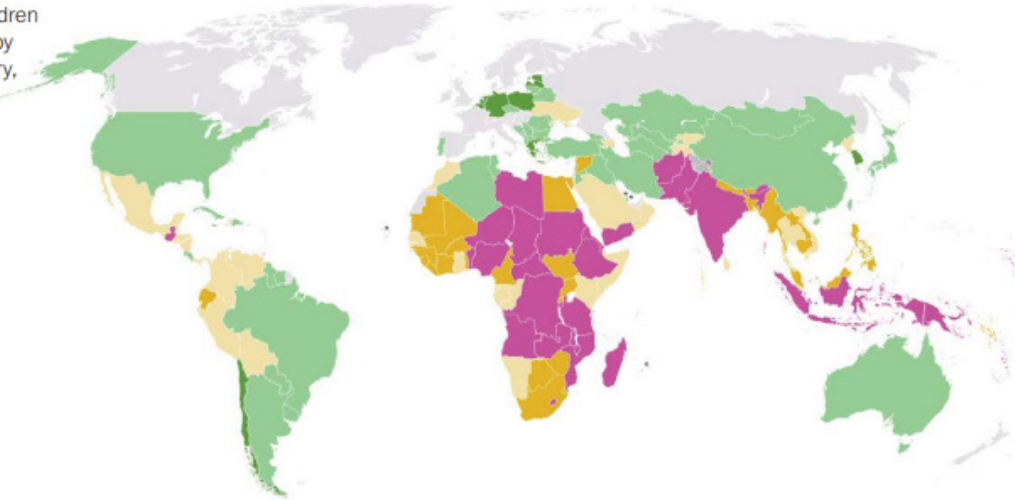
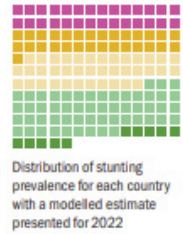
- 148.1 million (22.3%) young children with stunted growth
- 45 million (6.8%) wasted
- 2 billion people overweight and obese (37 million children)
- 2 billion people experience micronutrient deficiencies (56% of young children with deficiencies in vitamin A, iron, and/or zinc)

Figure A-1. Progress towards World Health Assembly global nutrition targets

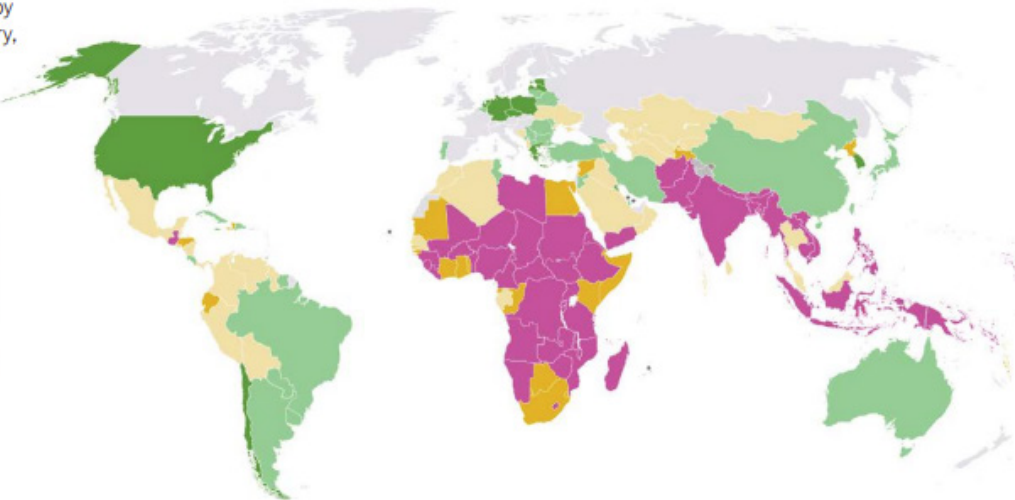
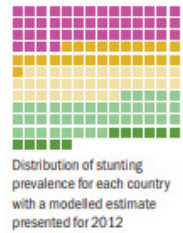


Progress on World Health Assembly nutrition targets achieved, but distance remains

Percentage of children under 5 affected by stunting, by country, 2022



Percentage of children under 5 affected by stunting, by country, 2012

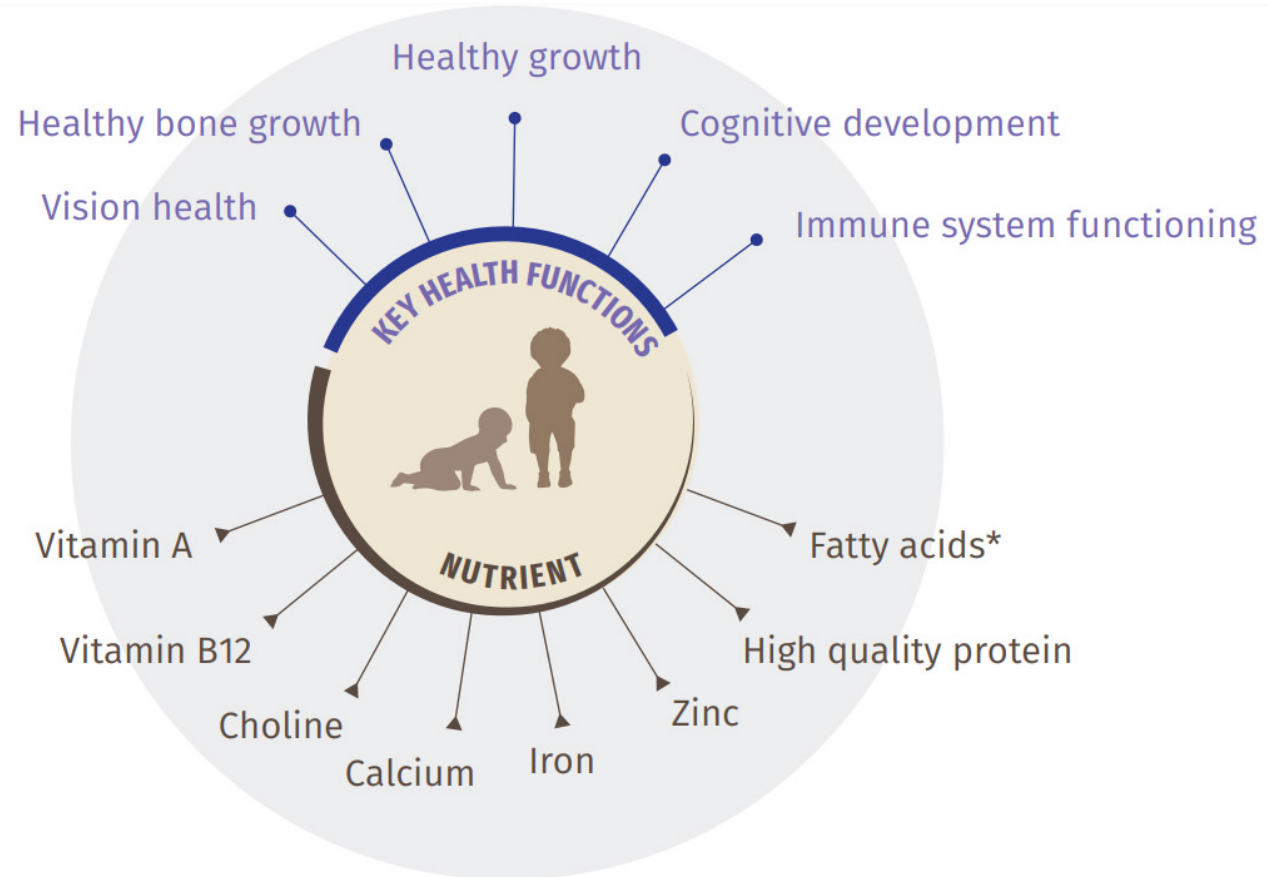


Stunted growth (HAZ<-2) among young children (UNICEF et al. 2023)

- Concentrated in Sub-Saharan Africa, Southeast Asia, Oceania
- Invisible disparities within countries
- Little progress since 2012

Nutrition in the life course

- Different phases of the life course have unique nutritional requirements
- Important life course phases
 - Women during pregnancy and lactation (including fetus and breastfeeding child)
 - Infants and young children
 - School age children and adolescents
 - Older adults

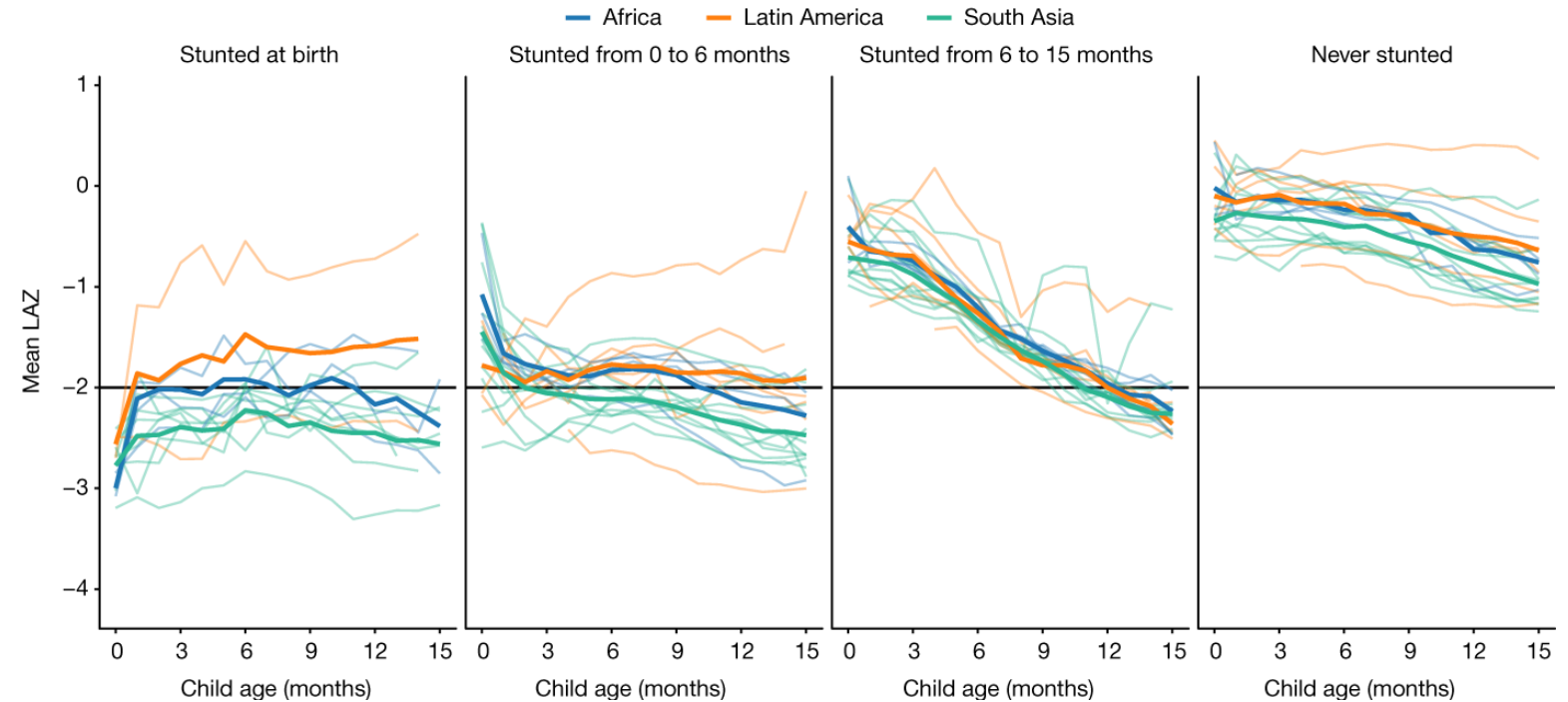


**Docosahexaenoic acid, Ratio Linoleic to Alpha-Linolenic Acids*

First 1,000 days...

Data from 32 cohorts
LMIC (n=52,640 very
young children)

- Early incidence of stunting (birth, 0-6m or 6-15m) shows plateauing or declining trends
- Reversal is rare and in cases of reversal, relapse risk high
- Stunting incidence at birth highest in South Asia



Mean LAZ stratified by age of incident stunting from birth to the age of 15 months

...and beyond

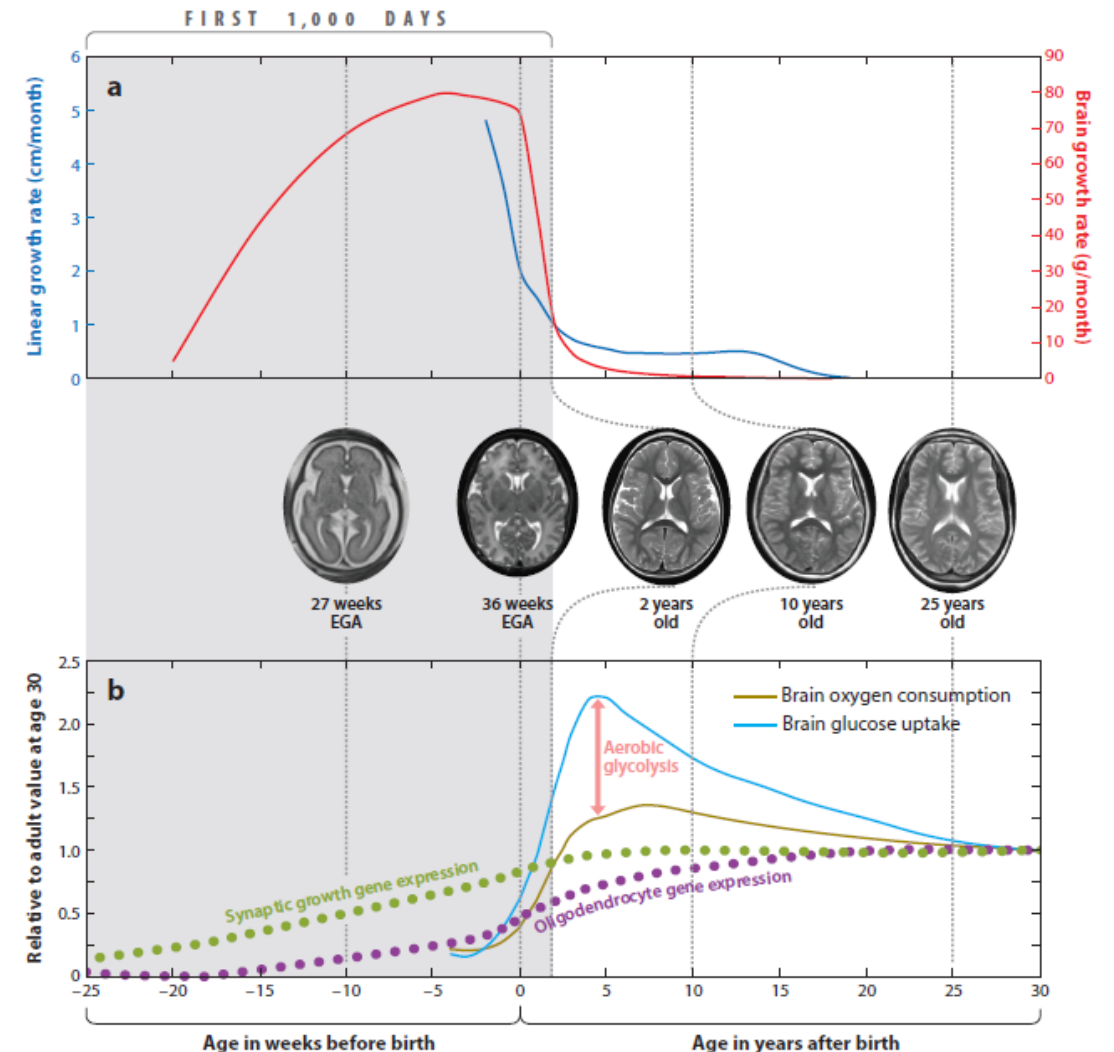
Brain growth prenatally rapid (red line)

By 2 yrs, a child's brain is structurally similar to adult brain (scan images)

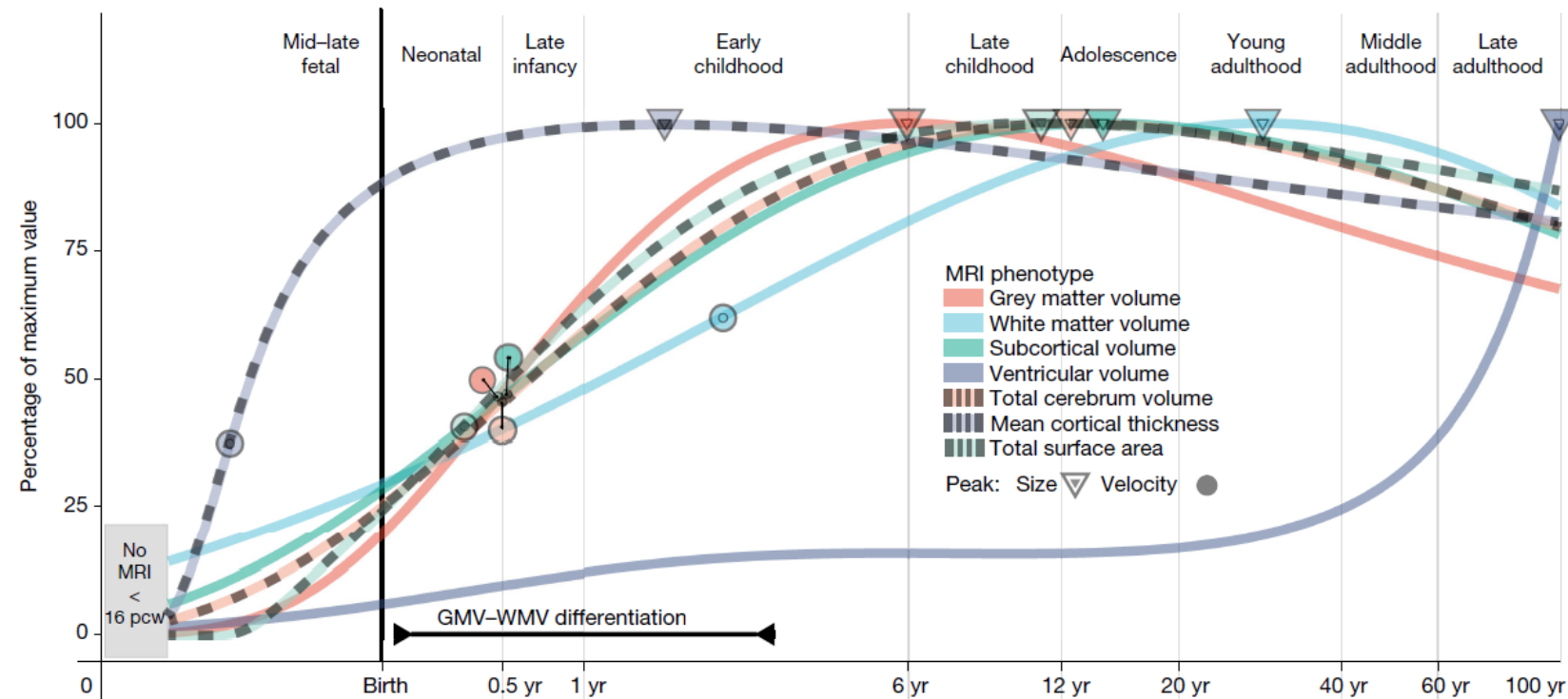
Synaptic growth (green dotted line) peaks and plateaus ~2 yr

Myelination related gene expression (purple dotted line) continues to rise until adolescence and then plateaus

Glucose (blue line) and **oxygen consumption** (straw line) peaks ~ 5-7 yrs and then falls



Peak growth velocity in brain structures – converges at 6 months



Bethlehem et al. *Nature* 2022

Nutrient effects on brain development

- Nutrients affect: neuroanatomy, neurochemistry, neurophysiology, and neuronal performance

DHA → neurogenesis, neurotransmission, myelination, synaptic plasticity, etc.

Iron → dopaminergic function, myelin production, hippocampus, striatal frontal, etc.

Zinc → neurotransmission at synaptic cleft, DNA/RNA synthesis, etc.

Choline → synthesis/function of acetylcholine and sphingomyelin, DNA methylation, etc.

Other bioactive factors

Brain-derived neurotrophic factor

Key drivers of global food insecurity

- Poverty & economic shocks
 - 3.1 billion people cannot afford a healthy diet (SOFI 2020)
 - COVID-19
- Armed conflict & political instability
 - Food as weapon of war
 - Global report on food crises (2023) 58 territories acute food insecurity
 - > 40% residing in the Democratic Republic of the Congo, Ethiopia, Afghanistan, Nigeria, and Yemen
 - Central African Republic, Haiti, Middle East, Somalia, Sudan, Ukraine
- Climate change
 - Drought, flooding, hurricanes, other extreme weather events
 - Trends show increases food insecurity, especially in LMIC

Environmental footprint: food systems

Food production

- 30% of greenhouse gas emissions
- 70% of freshwater withdrawals
- 40% of land use (Clark *PNAS* 2019)

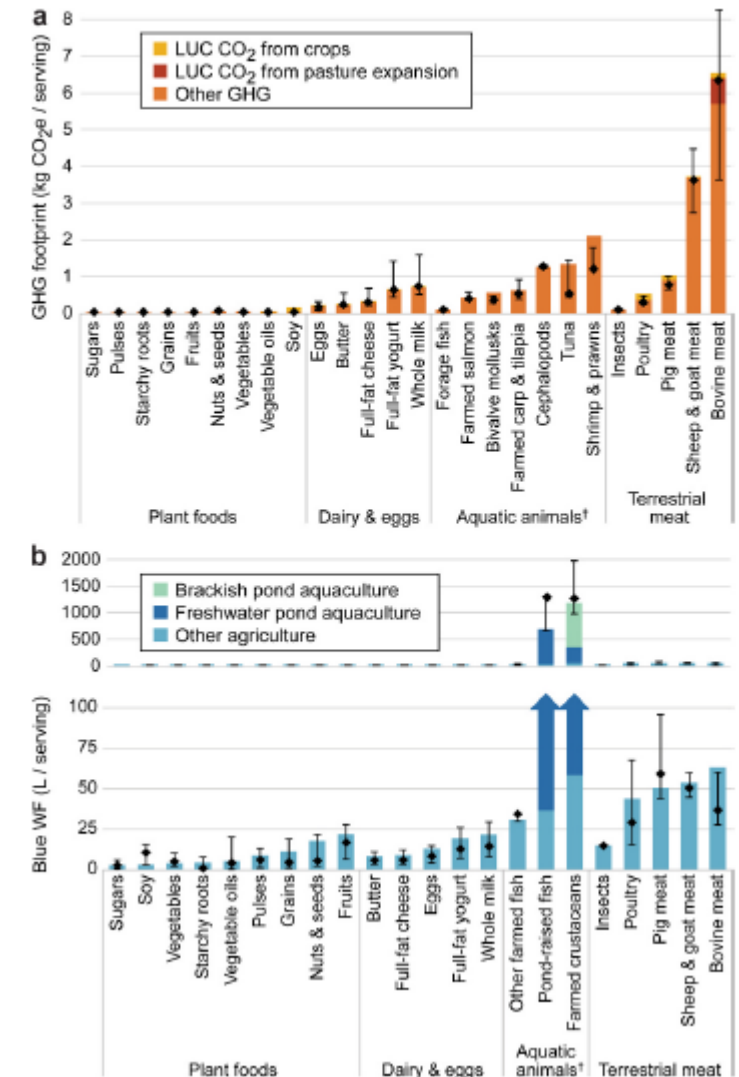
Food waste

- 31% of food produced wasted
- Produces 8-10% of GHG ~4.4 GtCO₂ eq, costing US\$411 billion

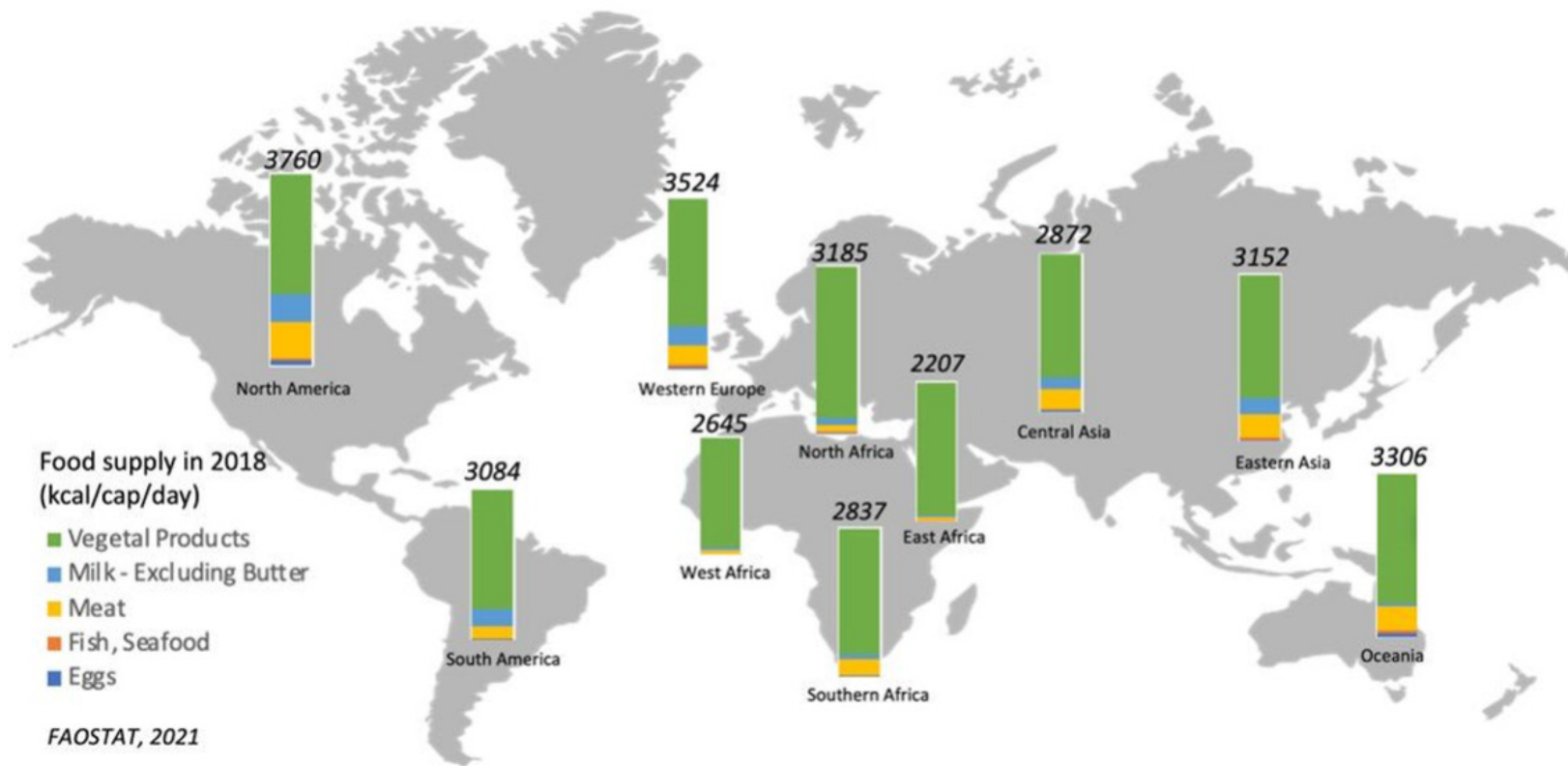
Food type, footprint per serving (Kim et al. 2020)

- Ruminant meats highest for GHG
- Pond and farmed crustaceans highest for blue water
- Low-food chain animals - forage fish (sardines and herring), bivalve mollusks, and insects relatively small footprints

Global Environmental Change 62 (2020) 101926



Increasing homogenization of food supplies



3 plants - *rice, maize, and wheat* – comprise 60% of calories globally (EAT-Lancet 2019)

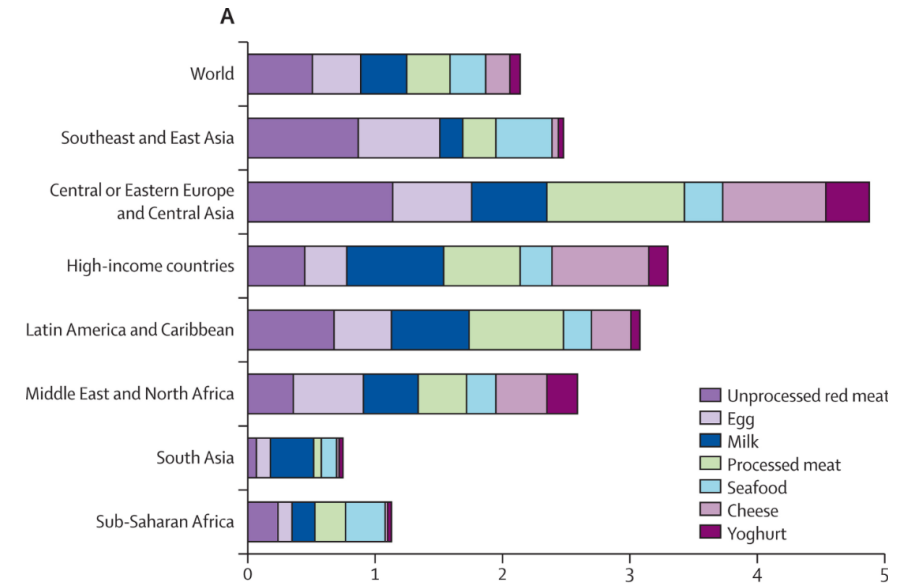
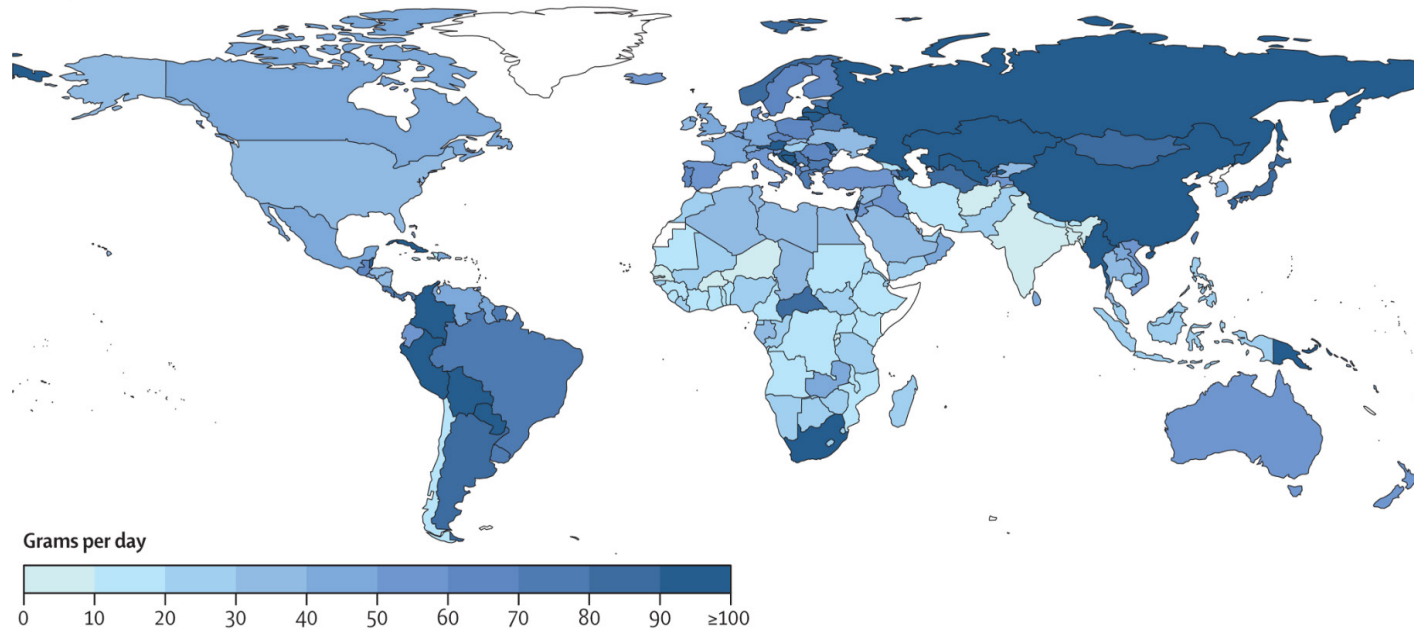
Variation between countries' food supplies has declined by ~70% (Khoury et al. 2014)

Concurrent related losses in biodiversity and diet diversity

Global disparities in ASF consumption

National mean intake (g/d) of unprocessed red meat

B Unprocessed red meat

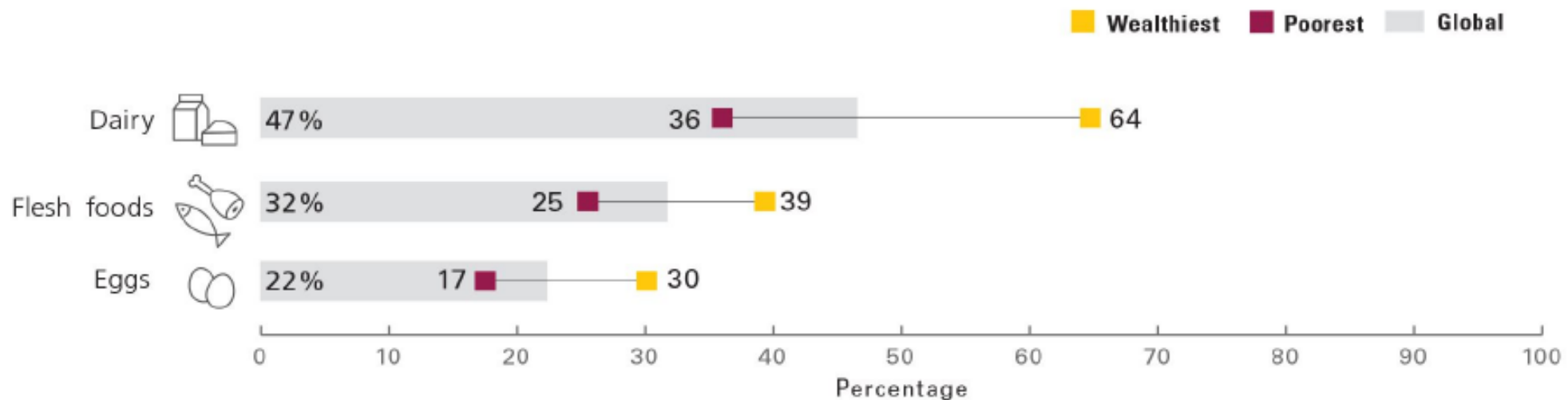


Mean global and regional consumption of ASF

Source: Miller et al. *Lancet Planetary Health* 2024

Young child animal source food consumption, by income quintile

Figure A7. Percentage of children between 6 and 23 months consuming TASF, by poorest and wealthiest quintile relative to the global average



Notes: “Flesh foods” in the figure refers to meat, fish, poultry and organ meats. Data from UNICEF global databases, 2021, based on multiple indicator cluster survey (MICS), demographic and health surveys (DHS) and other nationally representative sources.

Source: Adapted from UNICEF. 2021. Fed to fail: 2021 Child Nutrition Report. In: UNICEF DATA. [Cited 14 December 2021].

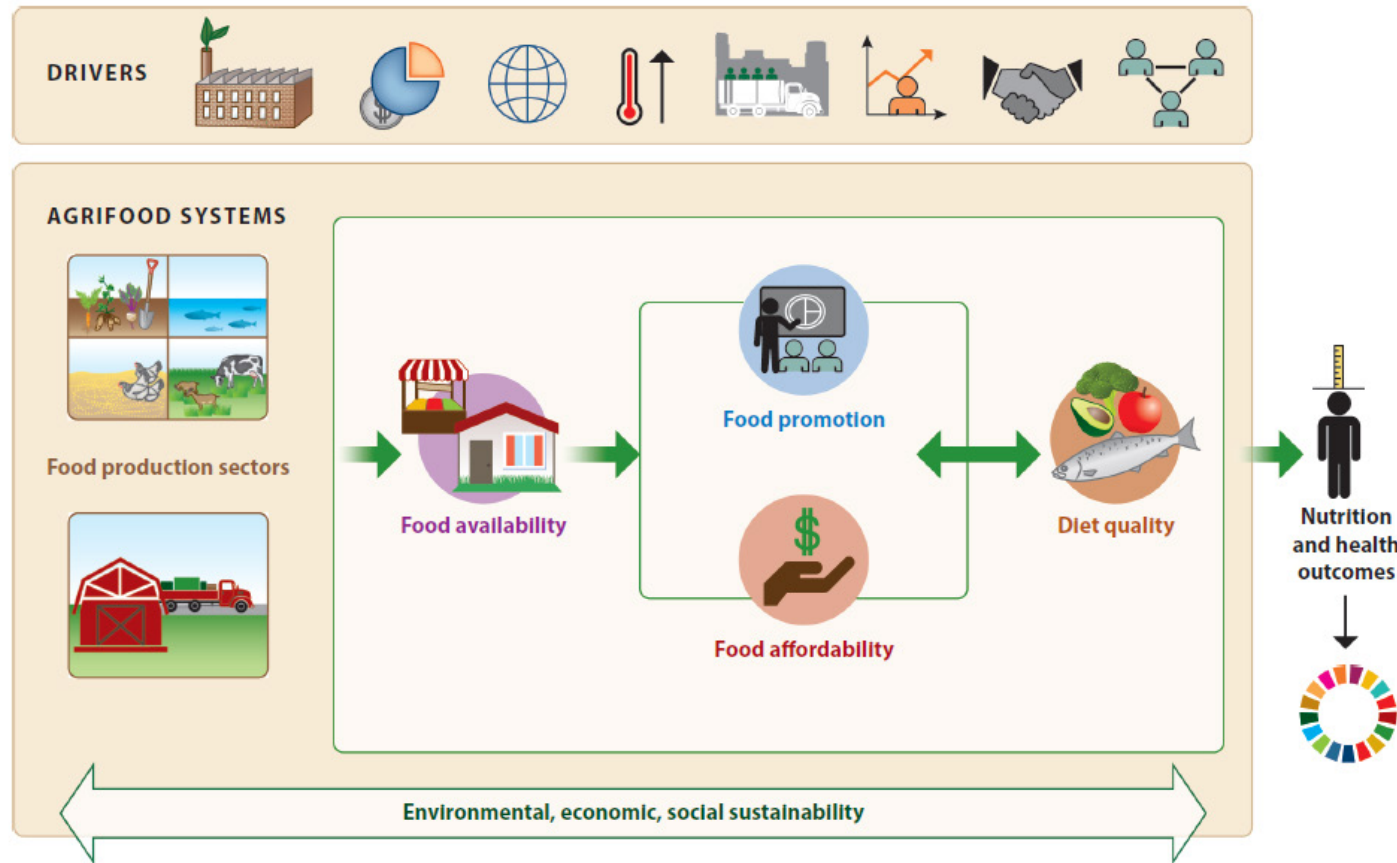
<https://data.unicef.org/resources/fed-to-fail-2021-child-nutrition-report/>.

A vibrant market stall with various fresh fruits. In the foreground, there are trays of bright red strawberries and dark raspberries. Behind them, there are baskets of yellow and orange peaches, and a large pile of brown kiwis. To the right, a person wearing a blue apron is partially visible, standing behind a counter with more produce. The background is slightly blurred, showing more of the market environment.

Evidence-based policies & practices

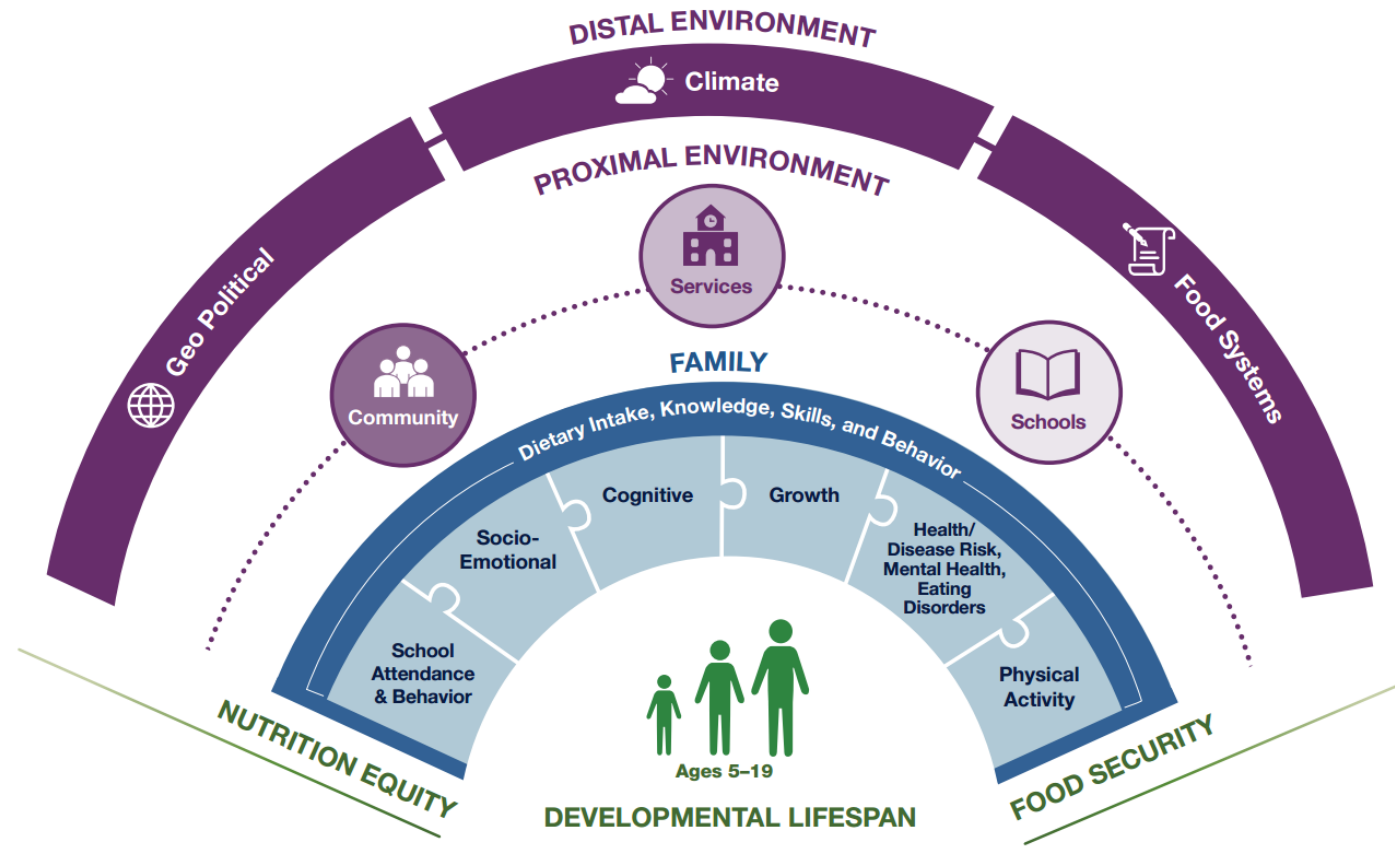
Food environment elements

Agrifood system framework: food environment elements



High-level panel of Experts on Food Security and Nutrition, Committee on World Food Security (Iannotti et al. *Annual Reviews Public Health* 2024)

NICHD BOND-Kids: Nutrition Ecology Framework



Food availability

- **Definition:** the presence of food items in a given area as influenced by agriculture and food systems; physical access (proximity)
- **Key findings**
 - Global massive investments in staple foods - maize, wheat, rice, roots, & tubers
 - Implications for human nutrition (low quality foods) and the environment (e.g., monoculture)
- **Evidence**
 - Fiscal subsidies & price incentives for food producers MHICs (e.g., ag inputs, extension services, R&D)
 - Social protection policies, consumer price controls, and school feeding in LICs
- **Gaps**
 - Agroecological approaches - horticulture, agroforestry, aquaculture, fisheries, etc.
 - Women and small-holder agriculture, despite producing >75% of food
 - Pastoralism practiced on 25% of land globally but not supported

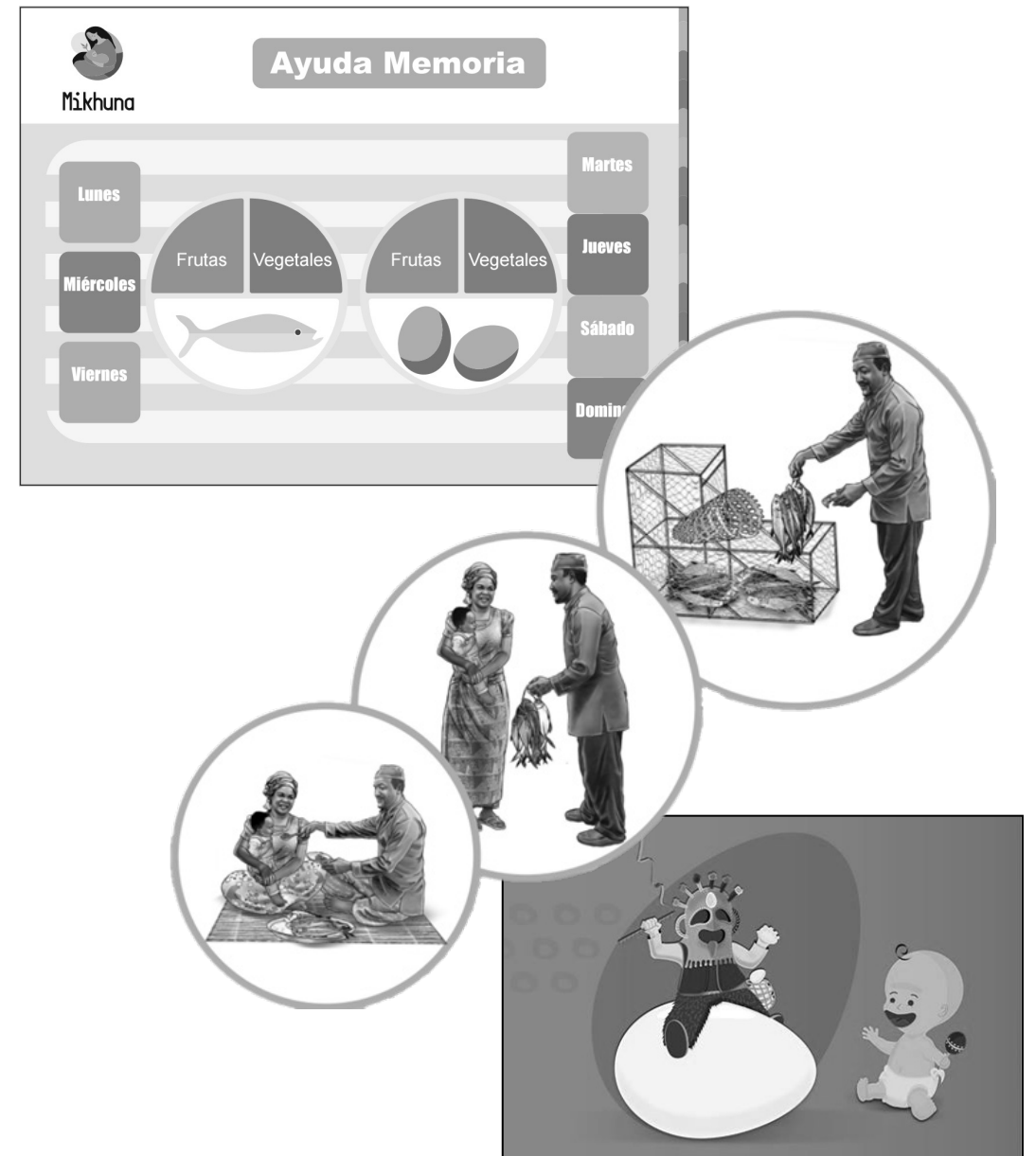


A black and white line drawing of a hand holding a 100 Euro banknote, surrounded by various food items like lemons, cheese, and herbs, all within a circular frame.

- **Definition:** an individual's capacity to purchase food based on their economic and physical resources; economic/physical access
- **Key finding:** Preponderance of evidence in support of **social protection policies and programs** (e.g., conditional or unconditional cash transfer) to mitigate food security among vulnerable
- **Evidence**
 - Fiscal measures used to incentivize healthy foods largely studied in MHICs
 - **Food aid programs** can be effective in addressing food insecurity, but challenges remain for cost of high- quality foods and securing food locally
- **Gaps:**
 - Fiscal measures in LIC to increase access to high quality foods
 - Food preservation techniques to ensure access to affordable high-quality foods in remote areas (e.g., fish)

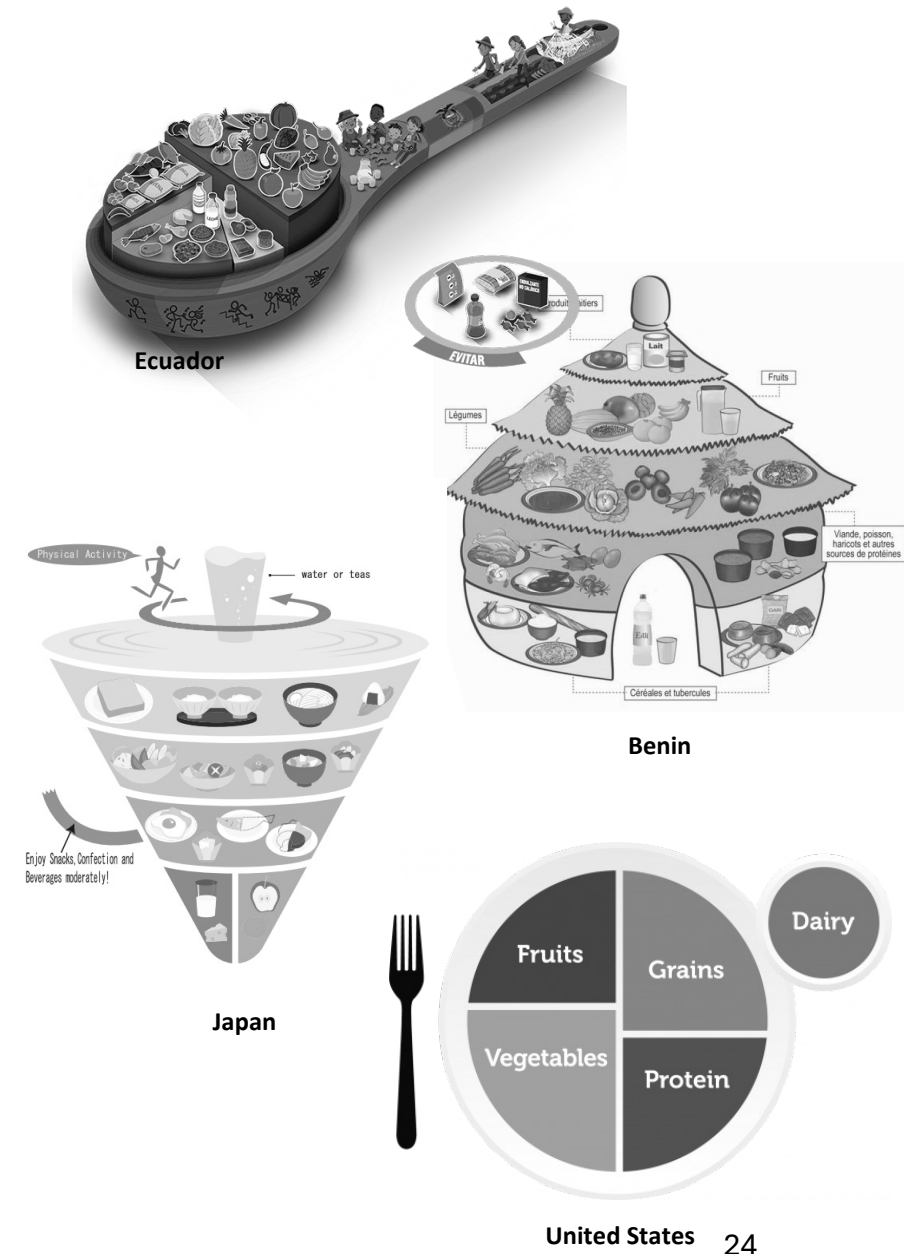
Food promotion

- **Definition:** the marketing and presentation of food items to impact their appeal; other terms used for this element are nutrition education and social behavioral change
- **Evidence**
 - **Social behavior change** strategies: audience segmentation; targeted messaging; appropriate channels; and trusted information source
 - Public information campaigns largely unstudied but thought to be ineffective without food access
- **Gaps**
 - Ultimately, research is need to holistically address all domains of food environment through integrated approaches



Diet quality

- **Definition:** the nutritional value, safety, and freshness of food items and resulting diet quality in terms of diversity, adequacy, moderation, and overall balance
- **Key finding:** Diet quality considerations especially important during particular phases of the life course – complementary feeding period, pregnancy and lactation
- **Evidence**
 - Food-based dietary guidelines generally include 4 elements – health considerations, nutrient and energy intakes, and dietary behaviors- but did not always include sustainability, foodborne contaminants, and relevance for special population groups. FBDGs have been found to misalign with food supply.
- **Gaps:**
 - Critical gaps in the evidence for **diet diversity**, though recognized in FBDGs



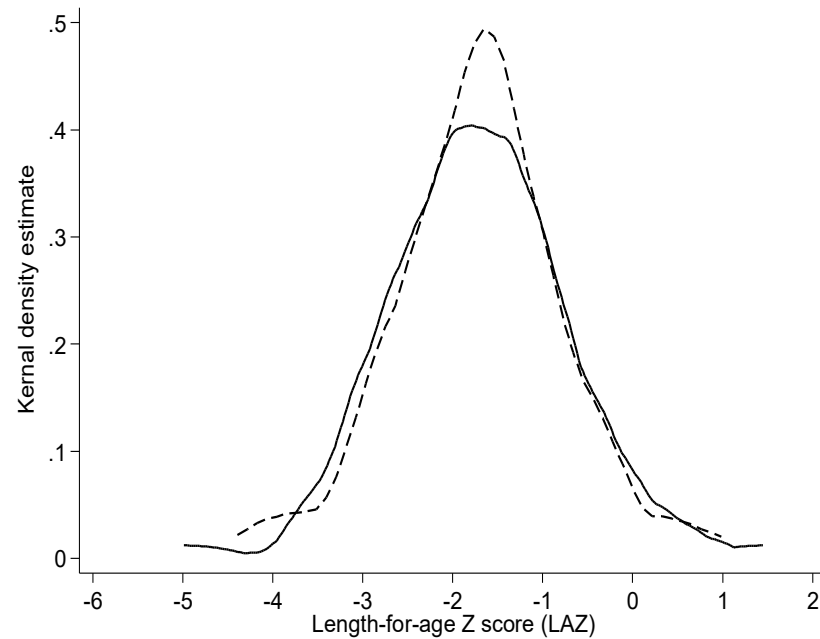


E3 Nutrition Lab

Early life nutrition for growth and development

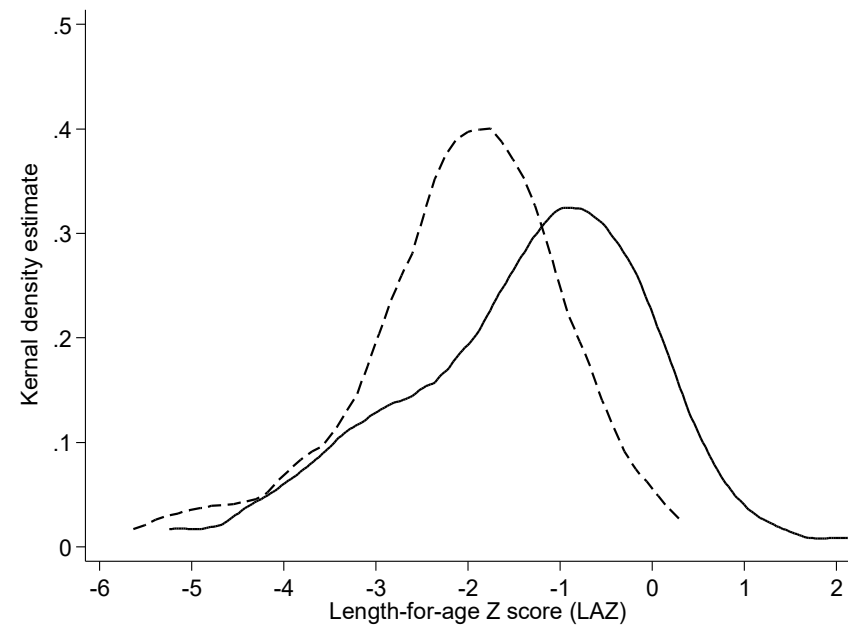
Lulun Project: 1 egg/d for 6 mo increased linear growth by 0.63 LAZ and reduced stunting by 47%

Control group



baseline (dashed); endline (solid)

Egg group



Choline → 0.35 (95% CI: 0.12, 0.57)

Docosahexaenoic acid (DHA) → 0.43 (95%CI: 0.13, 0.73)

Grandi Byen: Haiti

- **Population:** urban poor, young children in Cap-Haïtien
- **Design:** 3-arm longitudinal RCT 1) control; 2) egg; 3) *Grandi Byen* (parenting + egg) (n=600)
- **Aims**
 - 1) Demonstrate **reproducibility and feasibility of egg intervention** on stunting and development
 - 2) Investigate incremental benefit of *Grandi Byen* **parenting intervention**
 - 3) Explore impact pathways: biological (nutrient biomarkers, bone age, and enteric disease); psychosocial (cognition, responsive parenting, mental health); and environmental (hygiene, sanitation) factors
- **Funding:** PAR-18-480 NICHD R01-Clinical Trial



GRANDI BYEN !

Mikhuna: Ecuador

- **Population:** mixed indigenous pregnant women in El Quinche
- **Design:** RCT during 2nd and 3rd trimesters: 1) control; 2) evolutionary diet of fish, eggs, and fruits/veggies (n=200)
- **Aims**
 - 1) Compare efficacy of evolutionary diet on fetal/newborn linear growth
 - 2) Examine metabolic pathways mitigate fetal/newborn growth outcomes
 - 3) Characterize change in fetal/newborn brain morphology using field-friendly imaging techniques
- **Preliminary findings:** Intervention showed greater growth in sub-cortical structures (corpus callosum and GTO) and improved maternal nutrition status of DHA
- **Funding:** Children's Discovery Institute



Samaki Salama: Kenya

Population: small fishing households rural, coastal Kenya

Design: cluster RCT 1) control; 2) social marketing for nutrition behavior change; 3) social marketing plus modified fishing traps (n=400)

Aims

- 1) Compare efficacy of **12-mo bundled intervention** on young child growth
- 2) Examine impacts on: fisheries yield and biomass (species varieties, efficiencies); fisheries earning; and changes in diet diversity and fish consumption

Findings: win-win-win; 1) improved young child nutrition – HAZ; 2) increased income; 3) improved markers of ecosystem health

Funding: USAID Feed the Future Fish Innovation Lab



Findings: child growth & diet

Regression models (DiD analyses) showed significantly improved:

↑ height-for-age Z

↑ dietary diversity

↑ child fish consumption

Table 1. Regression models for child growth and dietary effects

	FULL	STRATIFIED		
	All groups	Control vs Group 2 (social marketing)	Control vs. Group 3 (social marketing plus traps)	Group 2 (social marketing) vs Group 3 (social marketing plus traps)
	β coefficient (SE) adjusted R ²			
GROWTH EFFECTS				
Height-for-Age Z ¹	0.07 (0.03) P=0.04	NS	0.18 (0.07) P=0.009	0.19 (0.08) P=0.02
Weight-for-Age Z ²	-0.08 (0.03) P=0.002	-0.17 (0.05) P=0.002	-0.14 (0.05) P=0.009	NS
Weight-for-height Z ³	-0.13 (0.03) <P=0.001	-0.16 (0.07) P=0.01	-0.27 (0.07) <P=0.001	NS
CHILD DIET EFFECTS				
Child dietary diversity score ⁴	0.39 (0.06) <P=0.001	0.54 (0.12) <P=0.001	0.78 (0.12) <P=0.001	NS
Child fish consumption, g ⁵	21.90 (2.65) <P=0.001	17.80 (4.56) <P=0.001	44.06 (5.21) <P=0.001	28.05 (7.55) <P=0.001

¹Adjusted for child age; baseline CDDS; baseline HAZ; fish frequency at endline; maternal height; maternal education; number of children in the household; and number sharing toilet.

²Adjusted for child age, WAZ at baseline; change in days with diarrhea; and maternal education.

³Adjusted for child age; WHZ at baseline; and change in days with diarrhea.

⁴Adjusted for child age; baseline CDDS; maternal education; number of children in the household; and acute diarrhea at baseline.

⁵Adjusted for child age; child fish consumption at baseline; maternal education; and acute diarrhea at baseline.

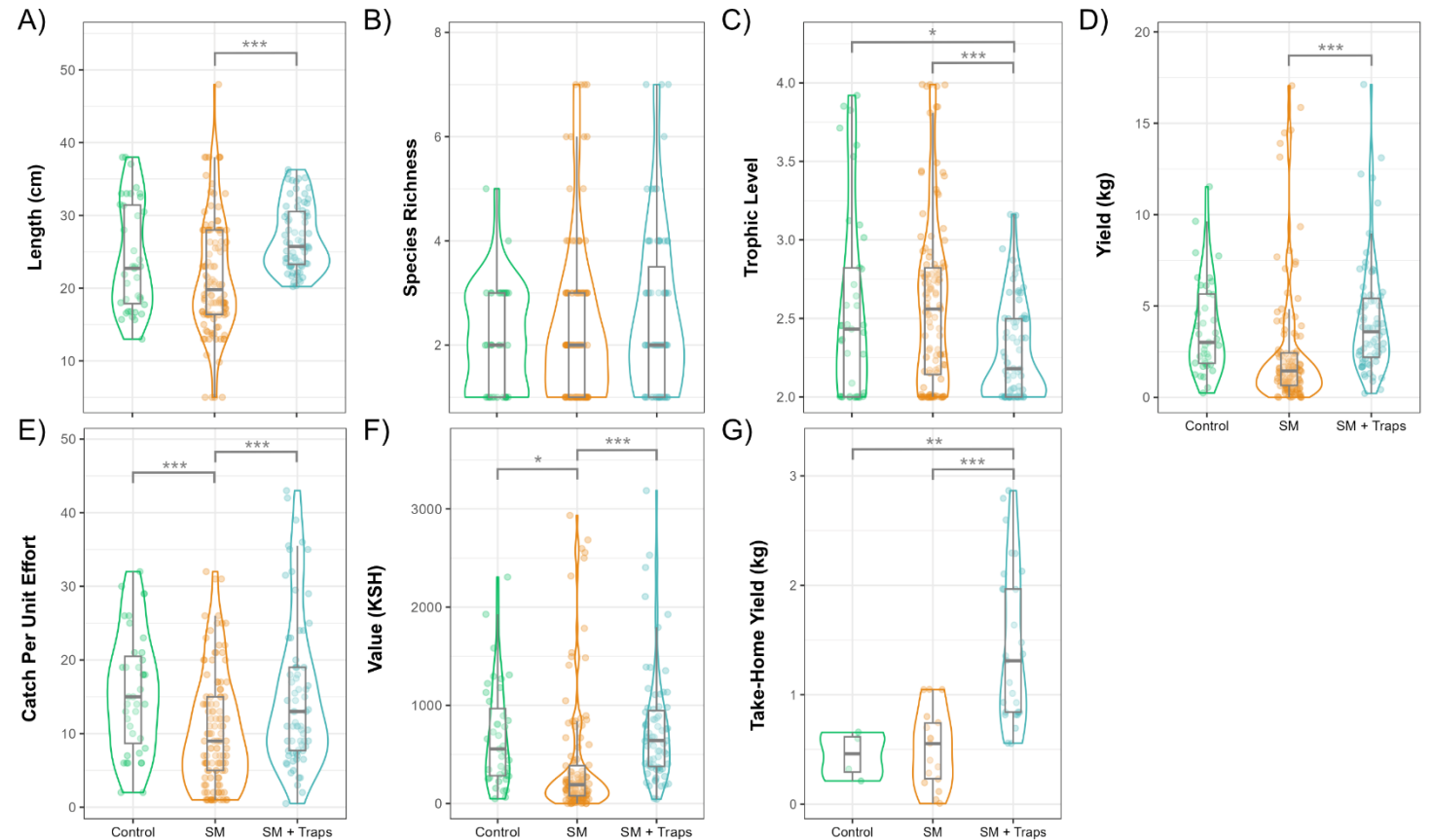
Findings: sustainable fisheries & livelihoods

↑ fish length, species
richness

↑ biomass, revenue, and
catch value

↑ protein, omega-3,
calcium, iron, selenium,
and zinc

↑ take-home catch





Conclusion

Summary

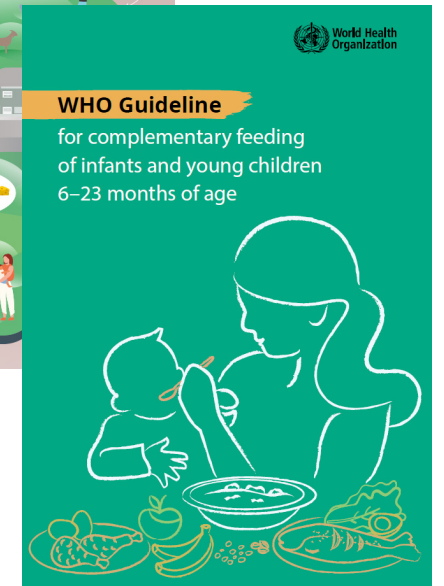
- Food insecurity and hidden hunger affects communities around the world differentially; key drivers are **poverty, conflict, and climate change**
- Protecting nutrition and stunting prevention in the first 1,000 days of life is crucial for preventing multiple health outcomes
- Evidence across the food environment domains suggest **integrated approaches** that target food availability, affordability, diet quality, and promotion can effectively and sustainably mitigate food insecurity
- Research in low-resource settings from the E3 lab and others point to solutions for preventing malnutrition during crucial life course phases



Photo by Whitney Curtis

Horizon: policy, practice, and research

- Policy & practice translation
 - *WHO Complementary Feeding Guidelines (2023)*
 - *FAO Contribution of terrestrial animal source food to health outcomes (2023)*
 - Food-based dietary guidelines
 - Integrated strategies to prevent stunting across contexts
- Research needs
 - **Dietary patterns** on early growth and brain development
 - International **comparative analyses** to understand contextual barriers and opportunities
 - Approaches to linking agroecology (horticulture, agroforestry, fisheries/aquaculture) to **diet quality and diversity**



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E3 Nutrition Lab

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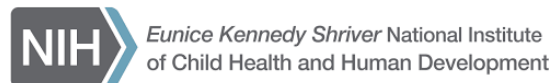
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Thank you!