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The Role of Micronutrients in Child Growth and Development

May 19, 2021

Shawn Baker Lynne Ausman Andrew Thorne-Lyman Omar Dary

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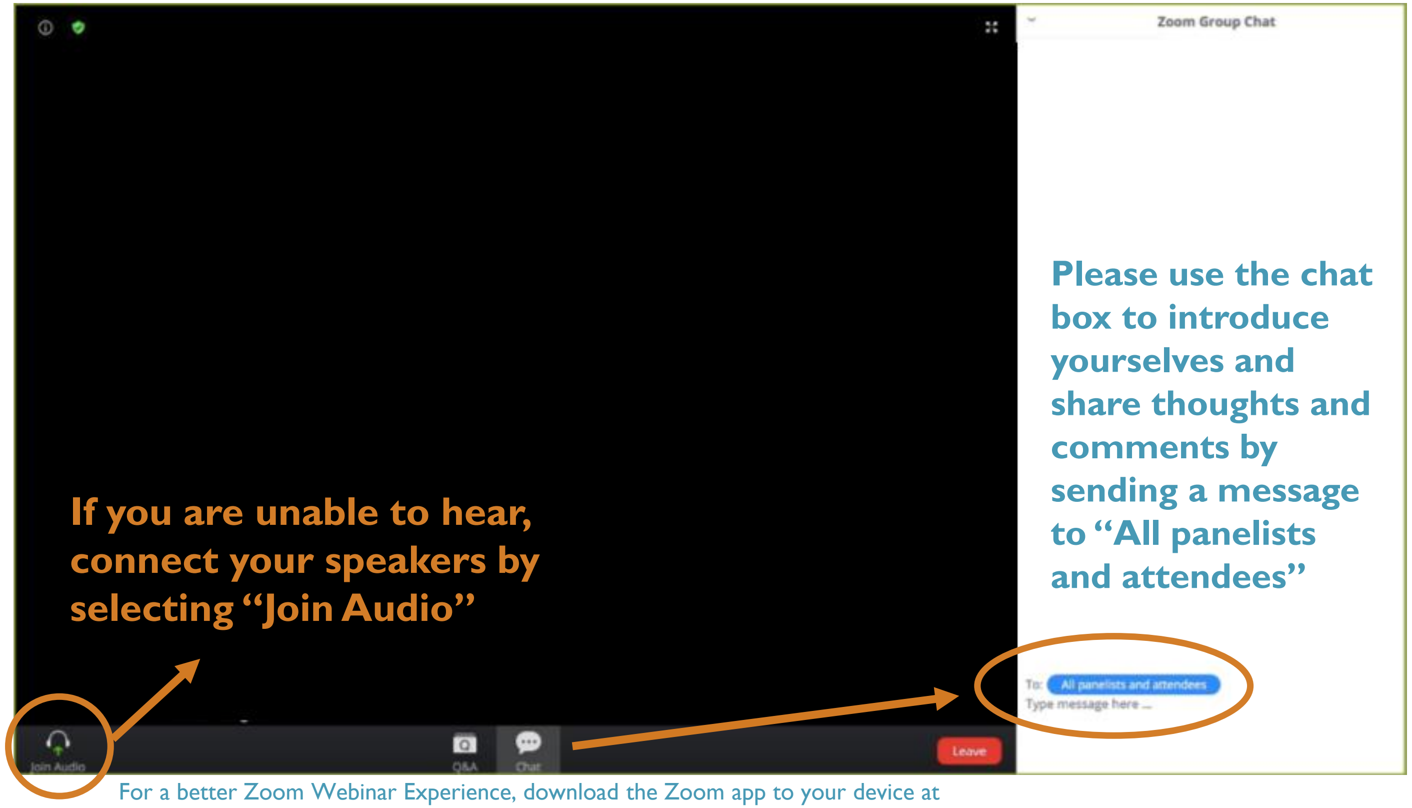

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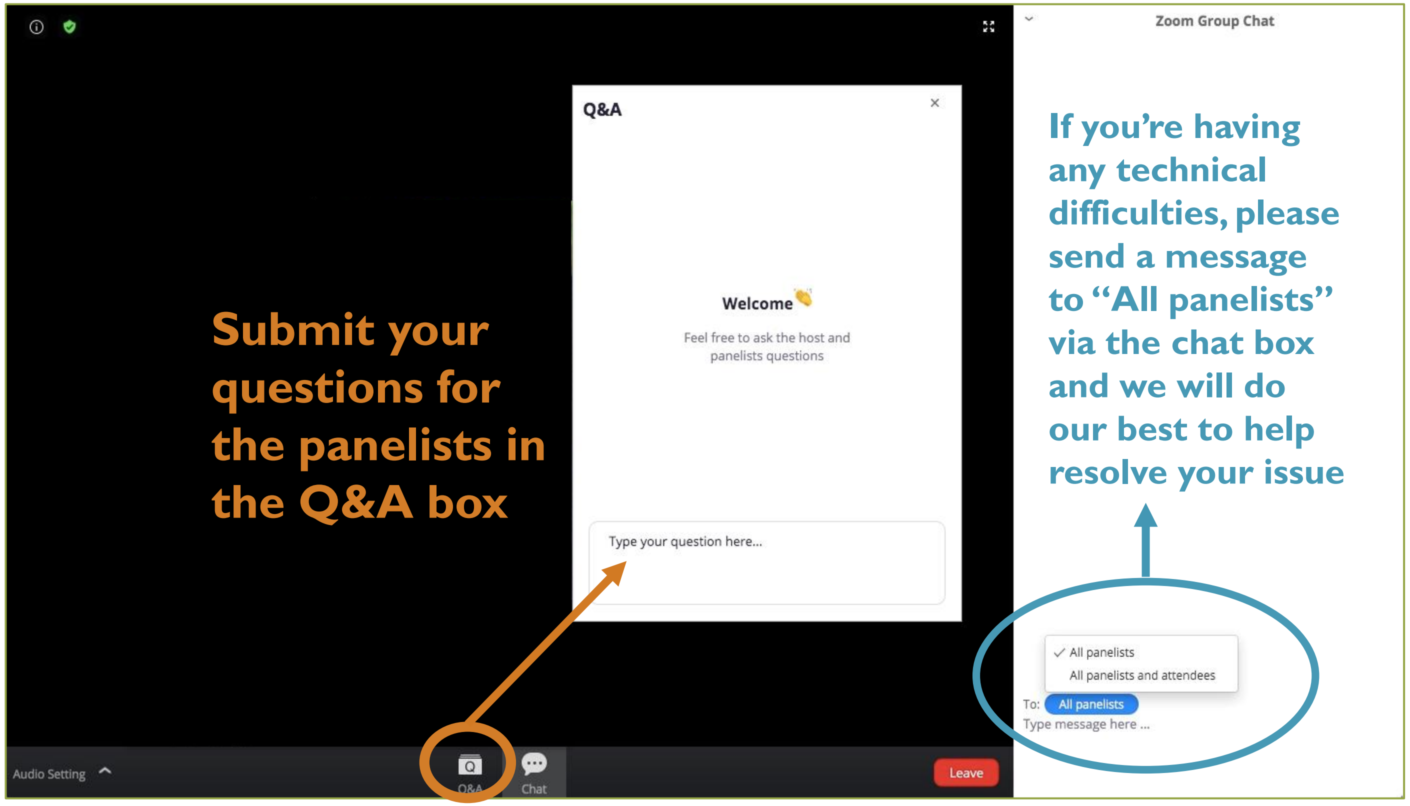
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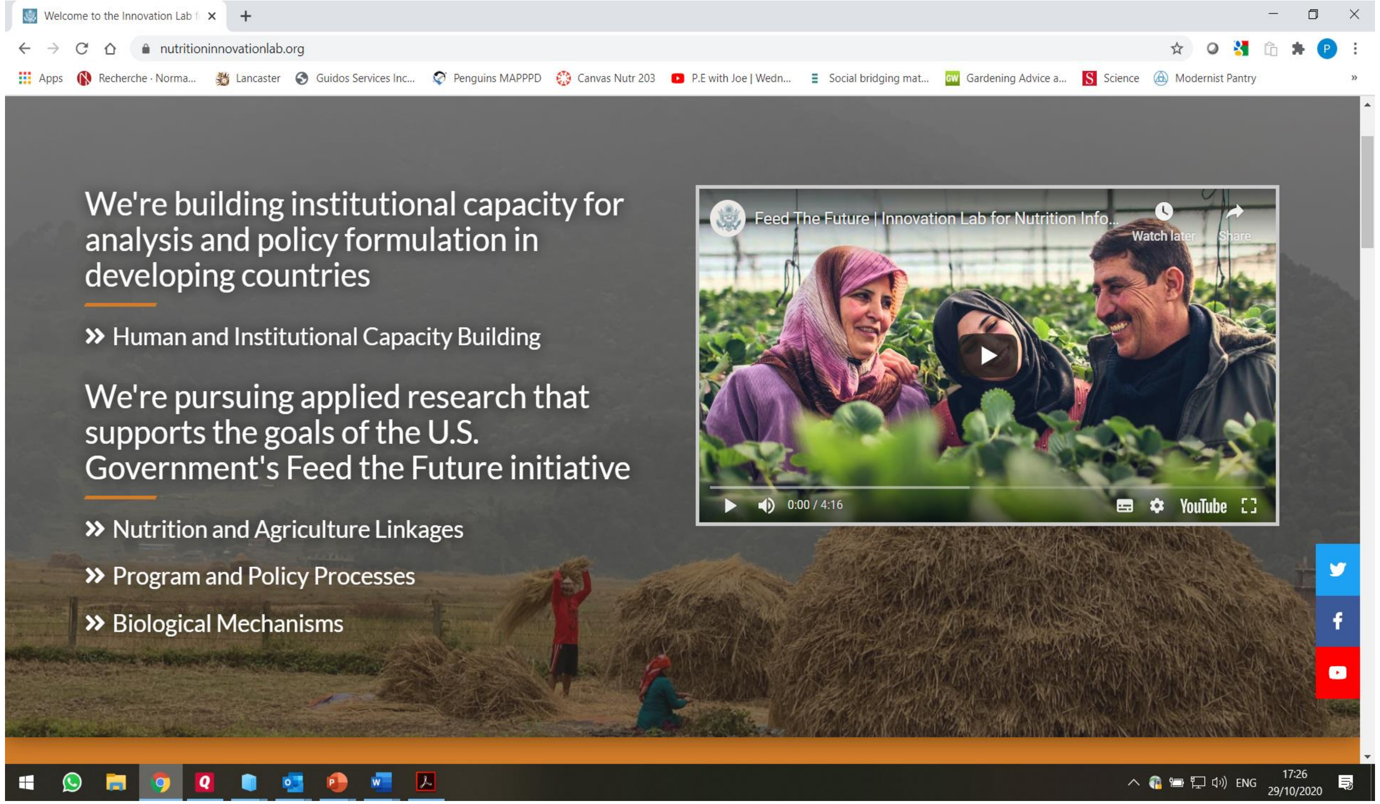

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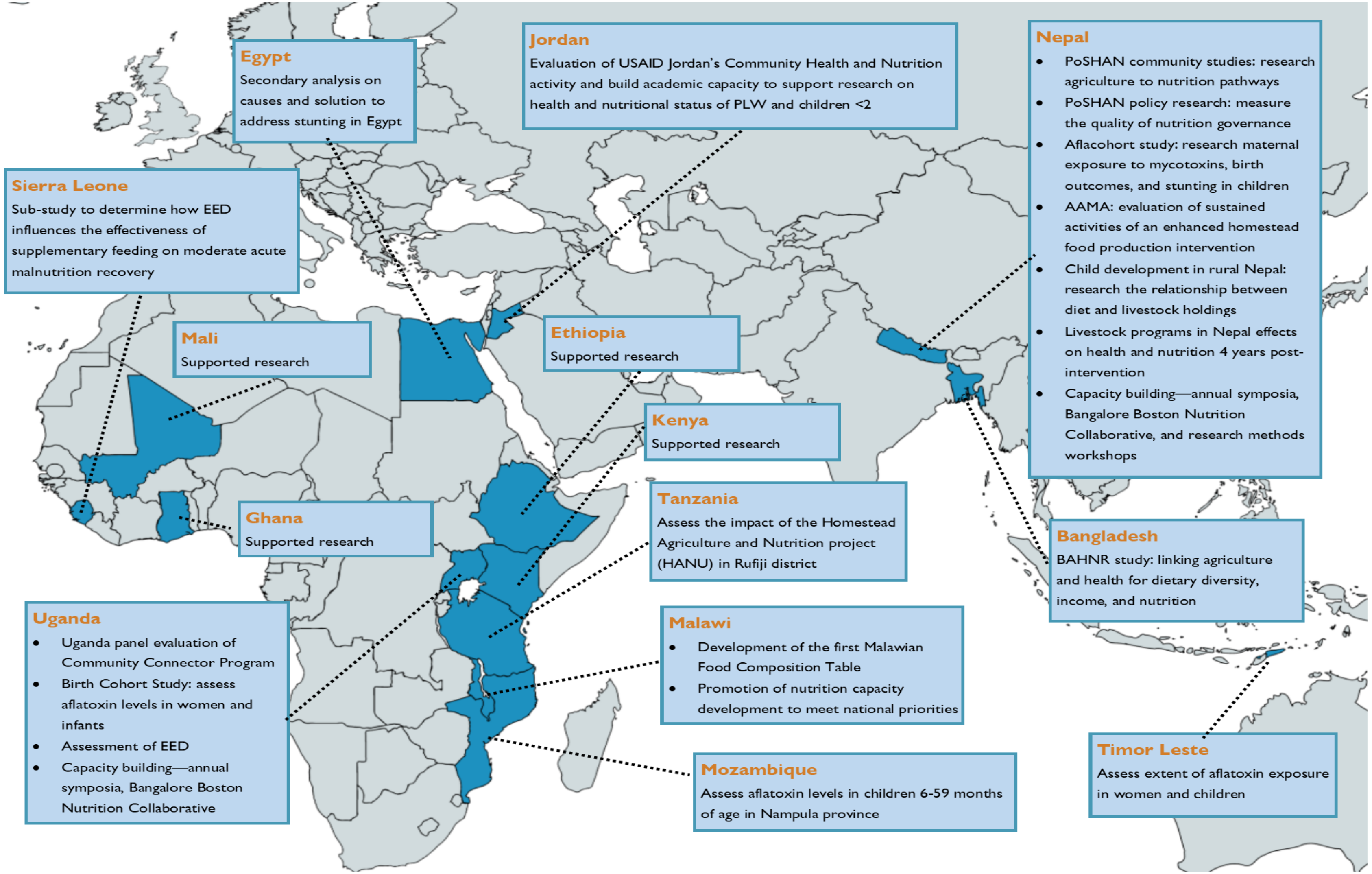

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9:00AM - 10:30AM (ET)

The Role of Micronutrients in Child Growth and Development

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Iron and Vitamin A Levels in Pregnant Women and Birth Outcomes: Results from a Birth Cohort Study in Uganda

Lynne M. Ausman, Grace Namirembe, and Julieta Mezzano for the Nutrition Innovation Lab

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UGANDA BIRTH COHORT STUDY

- Mother infant dyads (sub study of n=1244) were followed during pregnancy up to 12 months after birth
- Dyads were equally distributed in 16 subcounties in North and Southwest Uganda
- Questionnaires and anthropometric measures were taken at regular intervals in both mothers and infants.
- Blood samples for micronutrient concentrations (iron and vitamin A) and inflammatory markers were collected at birth and six months after birth for mother and infants, respectively
- This report presents the results of mother and infant characteristics at time of parturition

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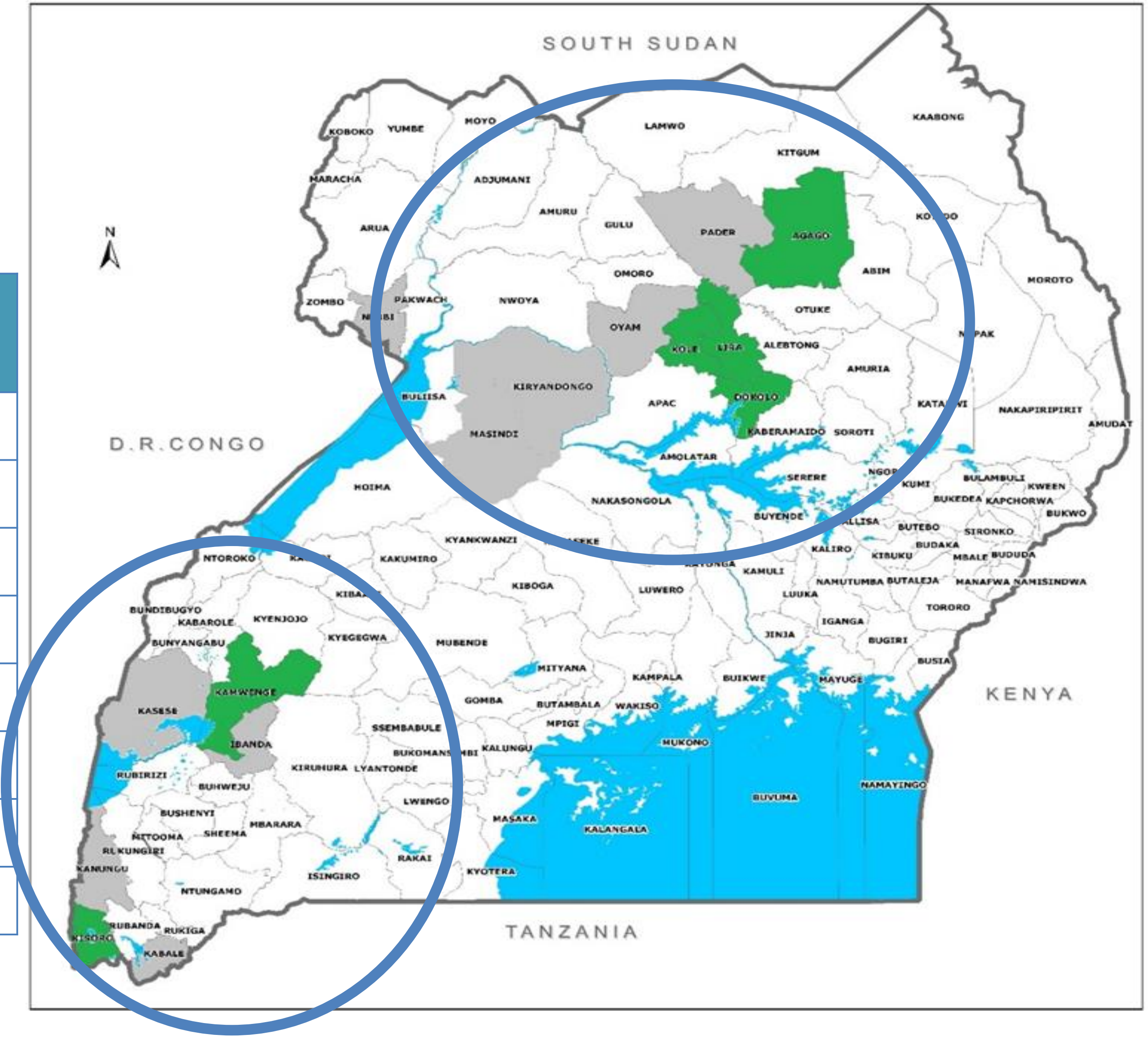
UGANDA STUDY DISTRICTS

South Western districts
Ibanda
Kabale
Kamwenge
Kanungu
Kasese
Kiryandongo
Kisoro
Masindi



Northern districts
Agago
Dokolo
Kole
Lira
Nebbi
Oyam
Pader

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IRON AND VITAMIN A SUPPLEMENTATION IN UGANDA

- Standard practices mandate from Ministry of Health:
  - Iron and folic acid supplementation to pregnant women
  - Cooking oil fortified with Vitamin A in form of retinyl palmitate
  - Commercial wheat flour and maize fortified with iron and three other nutrients

https://www.unbs.go.ug/news-highlights.php?news=104&read

BRINDA CORRECTION FOR IRON AND VITAMIN A BIOMARKERS

- Inflammatory biomarkers CRP, AGP, and malaria alter the expression of ferritin, sTfR, and RBP biomarkers.

- Utility to predict amounts of absolute deficiency can be improved with a BRINDA adjustment of these biomarkers.

$$\text{Ferritin}_{\text{adjusted}} = \text{ferritin}_{\text{unadjusted}} - \beta_1\left(\text{CRP}_{\text{obs}} - \text{CRP}_{\text{ref}}\right) - \beta_2\left(\text{AGP}_{\text{obs}} - \text{AGP}_{\text{ref}}\right) - \beta_3\text{malaria}$$

Namaste SM, Aaron GJ, Varadhan R, Peerson JM, Suchdev PS; BRINDA Working Group. Methodologic approach for the Biomarkers Reflecting Inflammation and Nutritional Determinants of Anemia (BRINDA) project. Am J Clin Nutr. 2017 Jul;106(Suppl 1):333S-347S

MATERNAL MICRONUTRIENT & INFLAMMATION BIOMARKERS AT PARTURITION

Variable	n	Mean	SD	Median	Min	Max
Ferritin (corrected) (µg/L)	1244	48.90	30.13	42.73	3.38	176.88
Ferritin (µg/L)	1244	67.14	42.64	56.95	3.59	327.34
sTfR (corrected) (mg/L)	1244	7.25	4.18	6.02	2.05	45.20
sTfR (mg/L)	1244	7.80	4.92	6.35	1.67	49.74
Hemoglobin at birth (g/dL)	1186	13.00	1.61	13.10	7.00	17.80
RBP (µmol/L)	1244	1.97	0.77	1.84	0.41	4.00
AGP (g/L)	1244	1.07	0.58	0.93	0.13	4.57
CRP (mg/L)	1244	7.73	17.87	1.90	0.01	277.11
Albumin (g/dL)	1209	3.78	0.80	3.85	1.16	6.86

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IRON DEFICIENCY AND ANEMIA IN UGANDAN MOTHERS

Parameter of deficiency	Prevalence (%) (95% CI)	
	Uncorrected	Corrected *
Iron depleted stores (FER)	7.4% (6.0, 8.9)	12.3% (10.5, 14.3)*
Iron deficient erythropoiesis (sTfR)	26.7% (24.3, 29.2)	21.6% (19.4, 24.0)*
Depleted body iron Stores (BIS)	8.0% (6.6, 9.7)	10.5% (8.8, 12.3)#
Anemia (Hgb)	11.0% (9.2, 12.9)	13.8% (11.9, 15.9)^
Iron Deficiency Anemia (IDA)	---	4.5% (3.4, 5.8)

* Correction for inflammation using BRINDA Coefficient Regression method
# BIS was calculated as the ratio of BRINDA-adjusted sTFR/FER
^ Anemia was adjusted for altitude

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VITAMIN A DEFICIENCY IN UGANDAN MOTHERS

Parameter of deficiency#	Prevalence (%) (95% CI)
	Uncorrected*
Vitamin A deficiency (RBP <0.83 µmol/L)	**3.1%** (2.2, 4.3)
Vitamin A deficiency (RBP < 1.05 µmol/L)	**8.5%** (7.2, 9.9)
Moderate vitamin A deficiency (RBP <1.17 µmol/L)	**12.2%** (10.5, 14.2)

Using three commonly used cut-offs for RBP.
* BRINDA adjustment for inflammation not recommended in mothers or women of reproductive age

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BIRTH OUTCOMES

Characteristics	n	Mean ± SD
Birth weight (kg)	1244	3.26 ± 0.49
Birth Length (cm)	1244	47.57 ± 3.33
Weight-for-age Z score	1239	-0.12 ± 1.00
Length-for-age Z score	1233	-1.00 ± 1.73
Weight-for-length Z score	1006	0.54 ± 1.74
BMI Z-score	1215	0.60 ± 1.65
Gestational age (days)	1108	274.56 ± 21.71

Prevalence Estimates	(%)
Underweight	2.4
Stunted	26.2
Wasted	7.8
Pre-term birth	19.5
Low birth weight	3.5

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MATERNAL FERRITIN (μg/L) AND BIRTH OUTCOMES

	UNADJUSTED MODEL			ADJUSTED MODEL #		
	n	β estimate (SE)	p value	n	β estimate (SE)	p value
Birth weight (kg)	1244	-0.03 (0.02)	0.153	1077	-0.03 (0.02)	0.126
Weight-for-age Z score	1240	-0.05 (0.04)	0.196	1076	-0.05 (0.04)	0.175
Length-for-age Z score	1240	-0.01 (0.07)	0.874	1072	-0.07 (0.04)	0.132
Weight-for-length Z score	1020	-0.03 (0.08)	0.722	867	0.11 (0.06)	0.081
		OR (95% CI)			**OR (95% CI)**	
Small for Gestational Age	1001	0.97 (0.76-1.24)	-	915	0.98 (0.72-1.34)	-
Preterm	1403	1.11 (0.93-1.32)	-	1018	1.24 (0.92-1.65)	-

* Log (ln) transformed and adjusted for inflammation using BRINDA
#Adjusted for maternal age, education, & height, wealth index, subcounty, infant sex, iron supplementation frequency

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MATERNAL sTFR (mg/L)* AND BIRTH OUTCOMES

	UNADJUSTED MODEL			ADJUSTED MODEL #		
	n	β estimate (SE)	p value	n	β estimate (SE)	p value
Birth weight (kg)	1244	0.03 (0.03)	0.371	1077	-0.02 (0.04)	0.662
Weight-for-age Z score	1240	0.06 (0.07)	0.375	1076	-0.02 (0.07)	0.767
Length-for-age Z score	1240	0.17 (0.11)	0.126	1072	0.10 (0.14)	0.484
Weight-for-length Z score	1020	0.07 (0.13)	0.615	867	0.03 (0.13)	0.829
	~~n~~	OR (95% CI)		~~n~~	OR (95% CI)	
Small for Gestational Age	1001	0.75 (0.49-1.15)	-	915	0.96 (0.59-1.59)	-
Preterm	1403	0.86 (0.64-1.16)	-	1018	0.67 (0.48-0.94)*	-

* Log (ln) transformed and adjusted for inflammation using BRINDA'

Adjusted for maternal age, education, & height, wealth index, subcounty, infant sex, iron supplementation frequency.

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MATERNAL RBP (μmol/l) AND BIRTH OUTCOMES

	UNADJUSTED MODEL			ADJUSTED MODEL#		
	n	β (SE)	p value	n	β (SE)	p value
Birth weight (kg)	1244	0.01 (0.02)	0.485	1077	-0.01 (0.02)	0.576
Weight-for-age Z score	1240	0.01 (0.04)	0.759	1076	-0.03 (0.05)	0.523
Length-for-age Z score	1240	0.16 (0.07)	**0.014**	1072	0.12 (0.06)	**0.030**
Weight-for-length Z score	1020	-0.06 (0.07)	0.413	867	-0.02 (0.06)	0.709
	n	**OR (95% CI)**		**n**	**OR (95% CI)**	
Small for Gestational Age (days)	1001	1.19 (0.95-1.50)	-	915	1.25 (0.90-1.74)	-
Preterm	1403	0.83 (0.70-0.98)	-	1018	0.88 (0.71-1.10)	-

* Log (ln) transformed and not adjusted for inflammation.

Adjusted for maternal age, education, & height, wealth index, subcounty, infant sex, iron supplementation frequency.

FOOD SECURITY, VITAMIN A & IRON INTAKE

Characteristics	%
HFIAS - Food Secure	36.52
Vegetable solid fats	1.51
Vegetable liquid oils	22.00
Wheat consumption	6.22
Maize consumption	33.31
Vit. A rich food intake (plant)	39.10
Vit. A rich food intake (animal)	11.59
Iron rich food intake (non-heme)	93.62
Iron rich food intake (heme)	22.04
MDD-W - Consumption of >=5 food categories	17.14
Iron suppl. during pregnancy	94.13

SUMMARY OF FINDINGS

- The BRINDA adjustment for FER shows an increase in iron deficiency from 7.4% to 12.3% in women
  - After adjustment, maternal FER levels are positively trend toward improved WLZ (p=0.08)
- The BRINDA adjustment for sTfR shows a decrease in iron-deficient erythropoiesis from 26.7% to 21.6% in women
  - After adjustment, sTfR is associated with lower odds of preterm births (OR = 0.67)
- Maternal Vitamin A deficiency as measured by RBP ranges from 3% to 8.5%.
- Maternal RBP was associated with increased LAZ of offspring (p=0.03).
- Deficiencies of both nutrients continue to exist in pregnant women in Uganda. Vitamin A intake from oils, and both animal and plant source foods appears to be low.
- Heme iron intake is low
- Only 17% of women consumed at least 5 food groups (MDD-W) suggesting the necessity for investment in programs to diversify diets.

Mezzano J. et al. Iron and vitamin A levels in pregnant women and birth outcomes: results from a birth cohort study in Uganda. Under review

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Lifecycle Connections in Our Micronutrient Related Research in Nepal

Andrew Thorne-Lyman, ScD, MHS
Associate Scientist, Johns Hopkins Bloomberg School of Public Health

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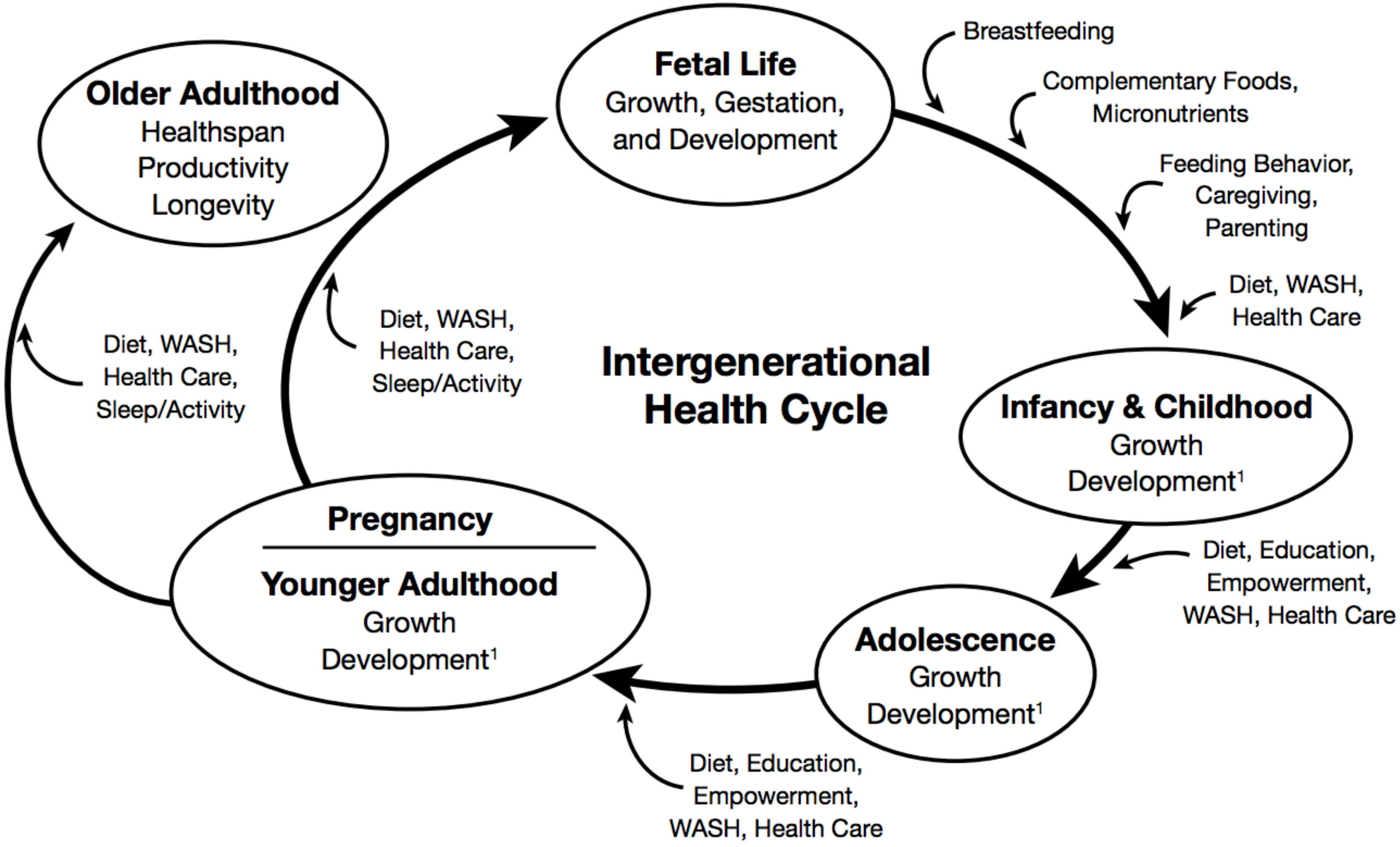
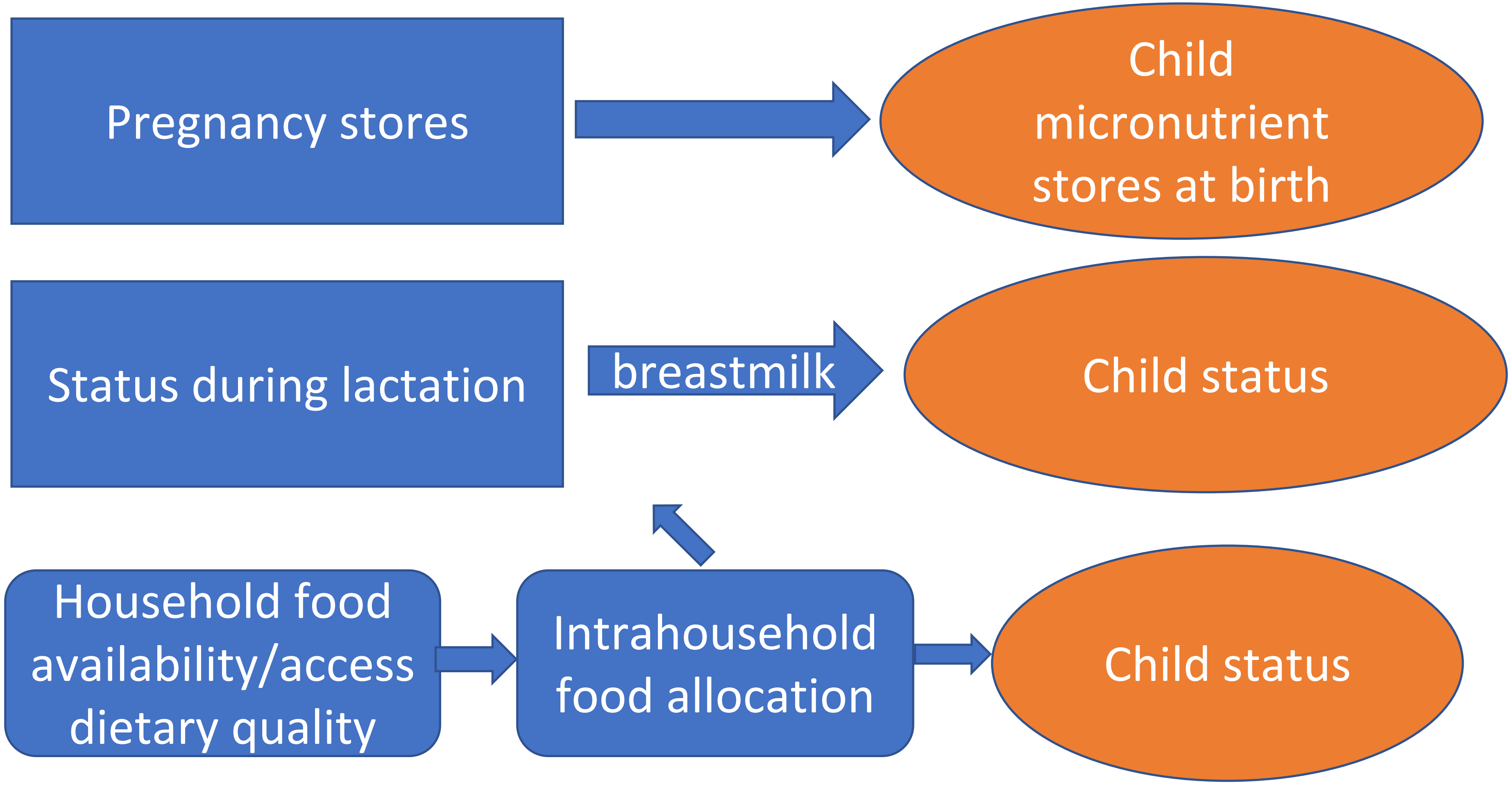


ACC/SCN (2000) Fourth Report on the World Nutrition Situation

PATHWAYS FOR MICRONUTRIENTS



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Study 1. The risk factors for anemia are consistent across three national surveys in Nepal

Monica M. Pasqualino, Andrew L. Thorne-Lyman, Swetha Manohar, Angela KC, Binod Shrestha, Ramesh Adhikari, Rolf D. Klemm, Keith P. West Jr

Current Developments in Nutrition (In Press)

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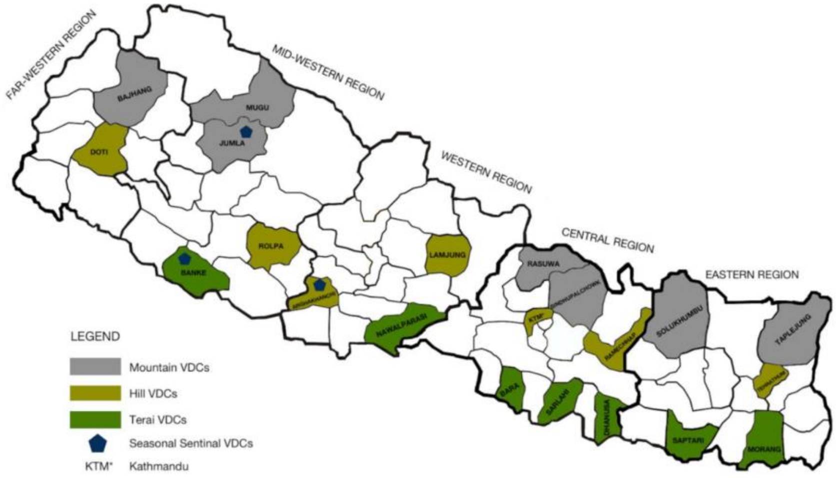
PoSHAN SURVEYS

Study design

- Nationally representative sample obtained across the Mountains, Hills, and Tarai.
- Annual same-season community-based observational surveys conducted in the same 63 wards in 2013, 2014, 2016
- Data collected on individual, household, and community-level factors.



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ANEMIA ASSESSMENT

Methods

- Random sample of children 6-59 months and mothers selected each year for anemia assessment using a Hb 201+ hemoglobinometer (HemoCue AB, Angelholm, Sweden).
- Anemia status defined based on WHO standard (hemoglobin concentration <11.0 g/dL) and adjusted for altitude.

Prevalence of anemia among children 6-59 months

	2013	2014	2016
National, n	809	796	865
% (95% CI)	63.4 (59.1, 67.5)	52.1 (47.0, 57.3)	59.5 (54.8, 64.1)
Mountains, n	148	135	133
% (95% CI)	62.3 (54.9, 69.7)	52.6 (42.9, 62.1)	58.6 (46.1, 70.2)
Hills, n	221	214	245
% (95% CI)	51.1 (43.2, 59.0)	38.8 (30.2, 48.1)	46.1 (38.1, 54.3)
Tarai, n	440	447	487
% (95% CI)	70.0 (64.3, 75.2)	58.4 (52.3, 64.2)	66.5 (60.5, 72.0)

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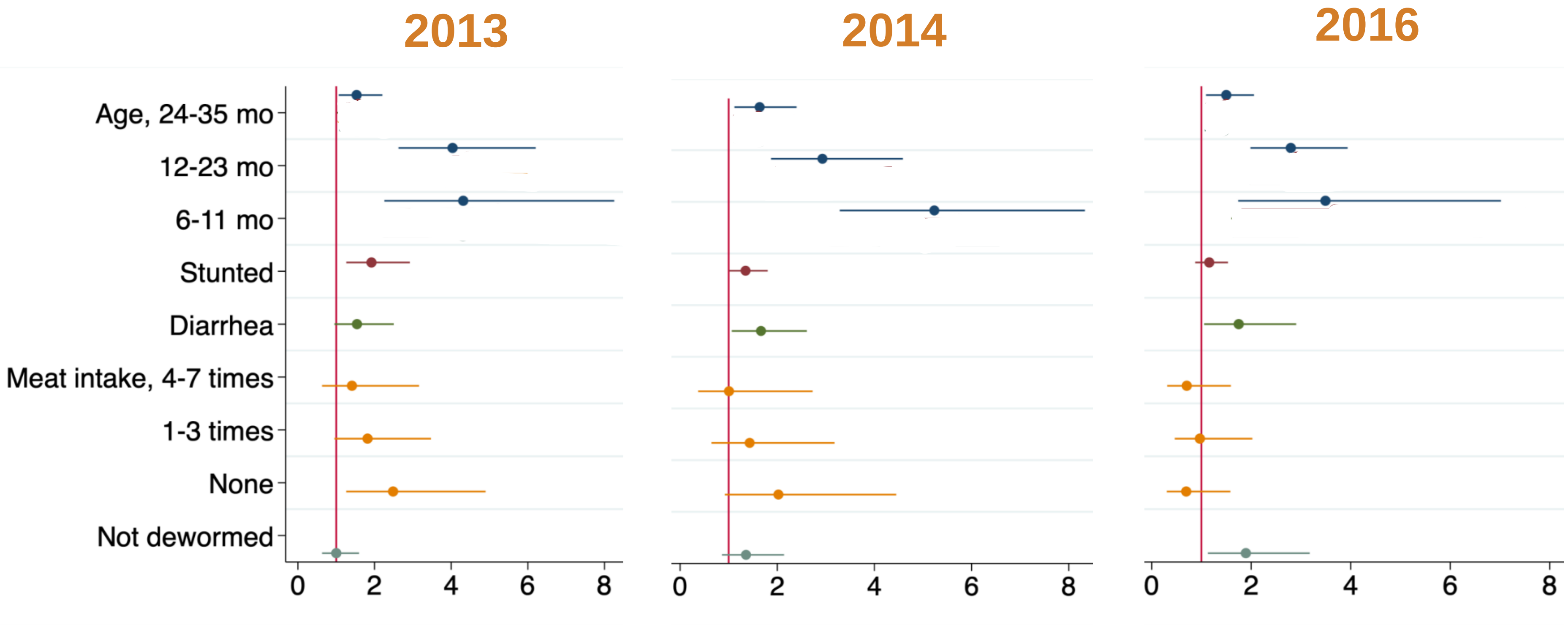
Child-level risk factors for child anemia



Age reference level: 36-59 mo
Diarrhea: any in last 7 days
Meat intake: frequency in last 7 days; reference level: 8+ times
Deworming: last 12 months

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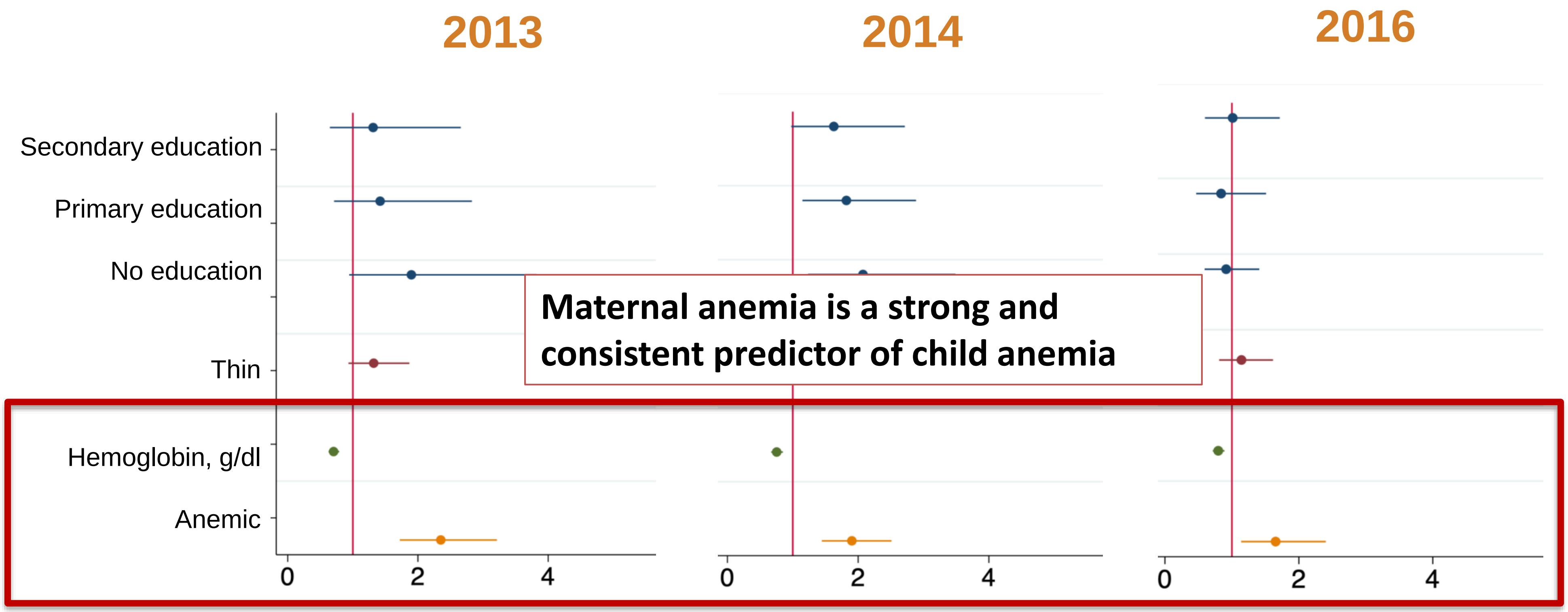
Partially adjusted odds ratios, maternal-level risk factors



Education reference level: Higher secondary or more
Thin: MUAC <22.5 cm

STUDY 2. WHAT FACTORS ARE ASSOCIATED WITH LOW DIETARY DIVERSITY IN PREGNANCY?

- Cross-sectional study, 327 pregnant women
- Baglung district, urban municipality in the western hill region of Nepal
- Minimum Dietary Diversity for Women (MDD-W), $\geq$5 of 10 food groups past 24 hours
- 45% of women had low dietary diversity

PLOS ONE

RESEARCH ARTICLE

Factors associated with dietary diversity among pregnant women in the western hill region of Nepal: A community based cross-sectional study

Vintuna Shrestha[1]*, Rajan Paudel[2], Dev Ram Sunuwar[3], Andrew L. Thorne Lyman[4], Swetha Manohar[4,5], Archana Amatya[2]

1 Department of Nursing, Dhaulagiri Prabhidhik Shikshya Pratisthan, Council for Technical Education and Vocational Training, Baglung, Nepal, 2 Central Department of Public Health, Institute of Medicine, Tribhuvan University, Kathmandu, Nepal, 3 Department of Nutrition and Dietetics, Armed Police Force Hospital, Kathmandu, Nepal, 4 Center for Human Nutrition, Department of International Health, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, United States of America, 5 International Development Program, Nitze School of Advanced of International Studies (SAIS), Johns Hopkins University, Washington DC, United States of America

* shresthavintuna@gmail.com

OPEN ACCESS

Citation: Shrestha V, Paudel R, Sunuwar DR, Lyman ALT, Manohar S, Amatya A (2021) Factors associated with dietary diversity among pregnant women in the western hill region of Nepal: A community based cross-sectional study. PLoS ONE 16(4): e0247085. https://doi.org/10.1371/journal.pone.0247085

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Abstract

Background

Dietary diversity can play an important role in providing essential nutrients for both mother and fetus during pregnancy. This study aimed to assess the factors associated with dietary diversity during pregnancy in the western hill region of Nepal.

Methods

A cross-sectional study of 327 pregnant women was conducted in an urban municipality of Baglung district in the western hill region of Nepal. A semi-structured questionnaire was used to collect information on household demographic and socioeconomic status, food taboos, household food security status, nutrition-related knowledge in pregnancy, and women's empowerment. Women consuming $\geq$5 of 10 food groups in the past 24 hours were defined as consuming a diverse diet using the Minimum Dietary Diversity Score for Women (MDD-W) tool. Bivariate and multivariate logistic regression was used to estimate crude odds ratio (cOR) and adjusted odds ratios (aOR) and 95% confidence intervals (CIs) to understand factors associated with dietary diversity.

Results

Almost 45% (95% CI: 39.6–50.4) of the participants did not consume a diverse diet and the mean dietary diversity score was 4.76 ± 1.23. Multivariable analysis revealed that women

FINDINGS

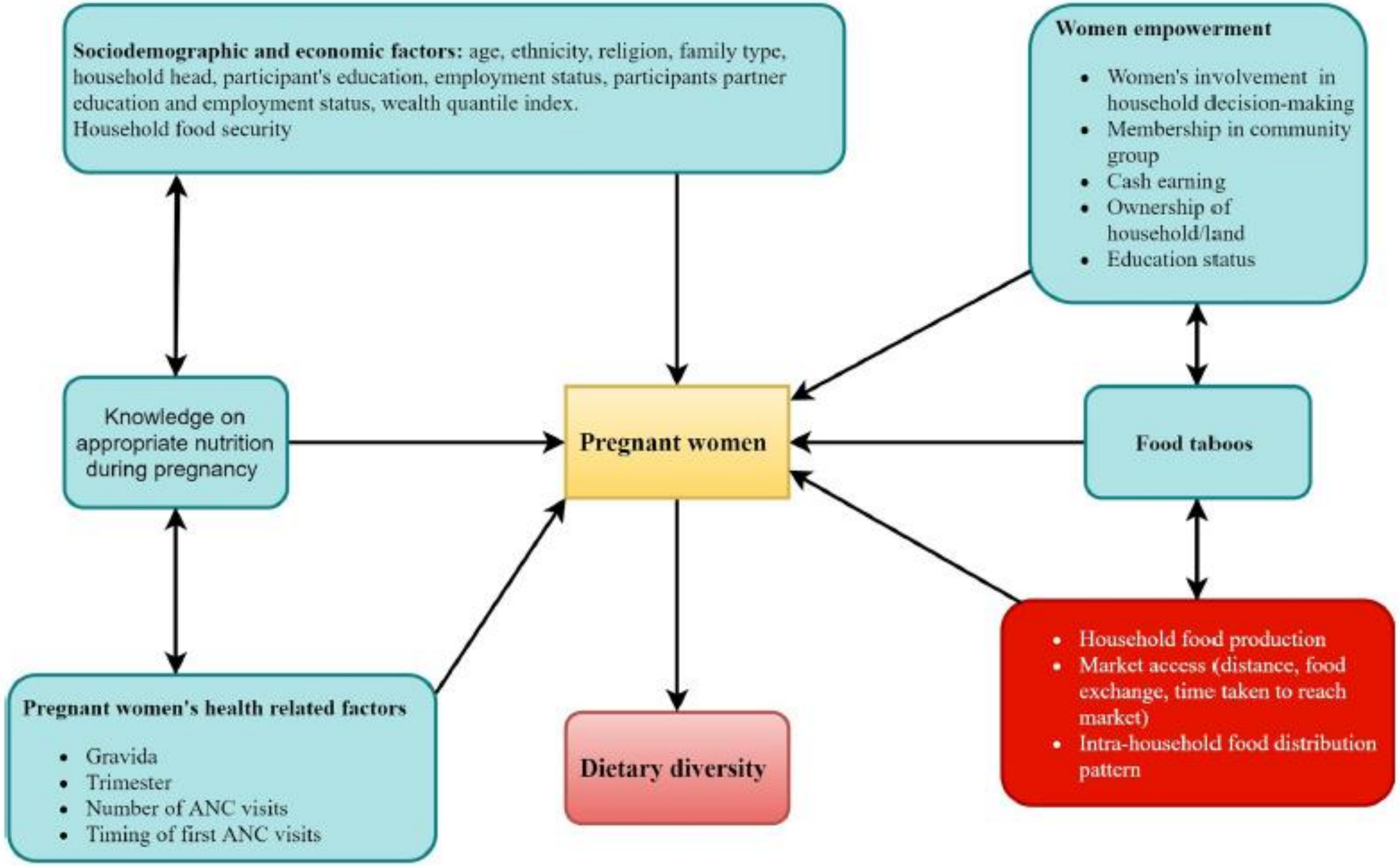

Fig 2. Conceptual framework on factors associated with dietary diversity.

https://doi.org/10.1371/journal.pone.0247085.g002

PREDICTORS OF ADEQUATE DIETARY DIVERSITY (MULTIVARIABLE LOGISTIC REGRESSION ANALYSIS)

	aOR (95% C.I.)
Greater empowerment (vs. less)	4.3 (1.9, 9.9)
Wealth (upper vs. lower tertile)	5.1 (2.7, 9.3)
Greater nutrition knowledge (vs. less)	1.9 (1.1, 3.4)
Joint families (vs. nuclear)	2.7 (1.4, 5.1)

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Study 3. Dietary diversity and nutrient adequacy among lactating women in peri-urban Nepal

- Objective: Assess the adequacy of the micronutrient intakes of lactating women in peri-urban Nepal
- N=500 randomly selected lactating women 17-44 years of age
- 3 x 24 hour recalls
- Mean probability of adequacy for 11 micronutrients was calculated

Public Health Nutrition: 18(17), 3201–3210 doi:10.1017/S136898001500067

Low dietary diversity and micronutrient adequacy among lactating women in a peri-urban area of Nepal

Sigrun Henjum[1,*], Liv Elin Torheim[1], Andrew L Thorne-Lyman[2,3], Ram Chandyo[4,5], Wafaie W Fawzi[2,6], Prakash S Shrestha[5] and Tor A Strand[4,7]
[1]Oslo and Akershus University College of Applied Sciences, PO Box 4, St. Olavs Plass, 0130 Oslo, Norway: [2]Department of Nutrition, Harvard School of Public Health, Boston, MA, USA: [3]WorldFish, Penang, Malaysia: [4]Centre for International Health, University of Bergen, Bergen, Norway: [5]Department of Child Health, Institute of Medicine, Tribhuvan University, Kathmandu, Nepal: [6]Departments of Epidemiology and Global Health and Population, Harvard School of Public Health, Boston, MA, USA: [7]Medical Services Division, Innlandet Hospital Trust Lillehammer, Norway

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Abstract
Objective: The main objectives were to assess the adequacy of the micronutrient intakes of lactating women in a peri-urban area in Nepal and to describe the relationships between micronutrient intake adequacy, dietary diversity and sociodemographic variables.
Design: A cross-sectional survey was performed during 2008–2009. We used 24 h dietary recall to assess dietary intake on three non-consecutive days and calculated the probability of adequacy (PA) of the usual intake of eleven micronutrients and the overall mean probability of adequacy (MPA). A mean dietary diversity score (MDDS) was calculated of eight food groups averaged over 3 d. Multiple linear regression was used to identify the determinants of the MPA.
Setting: Bhaktapur municipality, Nepal.
Subjects: Lactating women (*n* 500), 17–44 years old, randomly selected.
Results: The mean usual energy intake was 8464 (SD 1305) kJ/d (2023 (SD 312) kcal/d), while the percentage of energy from protein, fat and carbohydrates was 11 %, 13 % and 76 %, respectively. The mean usual micronutrient intakes were below the estimated average requirements for all micronutrients, with the exception of vitamin C and Zn. The MPA across eleven micronutrients was 0·19 (SD 0·16). The diet was found to be monotonous (MDDS was 3·9 (SD 1·0)) and rice contributed to about 60 % of the energy intake. The multiple regression analyses showed that MPA was positively associated with energy intake, dietary diversity, women's educational level and socio-economic status, and was higher in the winter.
Conclusions: The low micronutrient intakes are probably explained by low dietary diversity and a low intake of micronutrient-rich foods.

Keyword
Dietary diversit
Micronutrient adequac
Lactating wome
Peri-urban Nep

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PREVALENCE OF ADEQUACY WAS VERY LOW

Table 3 Micronutrient requirements, usual micronutrient intakes*, prevalence of adequacy and MPA in lactating women (*n* 466) aged 17–44 years, Bhaktapur municipality, Nepal, January 2008–February 2009

	Requirements†		Usual intake according to BLUP‡			Prevalence of adequacy (%)	
	EAR	SD	Mean	SD	Median	Mean	SD
Thiamin (mg/d)	1·2	0·12	0·78	0·23	0·78	5	0·8
Riboflavin (mg/d)	1·3	0·13	0·62	0·18	0·59	1	0·3
Niacin (mg/d)	13·0	1·95	11·40	3·34	11·10	31	1·6
Vitamin B_6 (mg/d)	1·7	0·17	1·45	0·37	1·44	26·7	1·6
Folate (μg/d)	450	45	163·8	70·0	147·9	0·3	0·2
Vitamin B_{12} (μg/d)	2·4	0·24	0·49	0·53	0·31	1	0·3
Vitamin C (mg/d)	55·0	5·5	60·0	27·6	46·3	36	2·0
Vitamin A (RE/d)	450	90	188·9	220·2	104·4	11	1·3
Ca (mg/d)	800	100	430·0	203·8	390·8	6·6	1·0
Fe (mg/d)§	23·4	7·02	17·4	8·6	15·2	28	1·4
Zn (mg/d)	7·0	0·88	7·80	1·60	7·63	66	1·6
MPA across 11 micronutrients‖						0·19	0·16
Median						0·15	

MPA, mean probability of adequacy; EAR, Estimated Average Requirement; RE, retinol equivalent.
*The mean is the overall mean of each individual's usual intake based on 3 d recall.
†The EAR are for lactating women; the EAR for vitamins A, C, B_6 and B_{12}, folate, thiamin, riboflavin, niacin and Fe were from WHO/FAO 2004[4]. For Ca, the Institute of Medicine EAR from 2011 was used[24]. For Zn, the International Zinc Nutrition Consultative Group EAR for a mixed or refined diet was used assuming 44 % bioavailability[25]. The SD of requirements was calculated using the CV of requirements and the EAR; the CV were 12·5 % for Zn[25], 20 % for vitamin A, 15 % for niacin, 10 % for vitamins C, B_6, B_{12}, thiamin, riboflavin, folate[28] and Ca[24], and 30 % for Fe[20].
‡Best linear unbiased predictor[21].
§Assuming 5 % bioavailability.
‖The mean probability of adequacy is the average of the probability of adequacy of the eleven micronutrients.

CONCLUSIONS

- Mean usual micronutrient intakes were below estimated average requirements for all micronutrients except vitamin C and zinc
- Mean probability of adequacy across eleven micronutrients was 0.19 (SD 0.16)
- Rice contributed to 60% of energy intake
- Low dietary diversity explains the low micronutrient intakes, even in this peri-urban population outside the Kathmandu Valley

STUDY 4. IN THE SAME POPULATION, INTAKE OF FE SUPPLEMENTS IN PREGNANCY PREDICTED HB STATUS DURING LACTATION AND BODY FE FOR SOME…

	Multiple adjusted* β	**95% C.I.**	***P***
Model 1: Hemoglobin			
Intake of supplements in pregnancy	0.29	(0.04, 0.54)	0.03
Model 2. Body Fe (mg Fe/kg body weight)			
Dietary Fe (mg)	0.03	(0.014, 0.045)	<0.01
Interaction: time since birth*Fe in pregnancy	2.69	(1.54, 3.84)	<0.01
Intake of Fe supplements in pregnancy			
Time since birth <6 months	2.72	(1.79, 3.65)	<0.01
Time since birth ≥6 months	0.02	(-0.67, 0.78)	0.93
Mother's age	0.21	(0.14, 0.28)	<0.01
Literacy	0.81	(0.25, 1.39)	<0.01
Land ownership	0.74	(0.19, 1.30)	<0.01

*Both models included mother and child age, parity, literacy
Interaction between time since birth (dichotomous, cut-off 6 months) and iron supplements in pregnancy for at least 6 months

Henjum et al, British Journal of Nutrition 2014

Study 5. Vitamin D insufficiency among Nepali infants is low despite high prevalence among their mothers

- Objective: Describe the status and predictors of vitamin D status in healthy Nepali mother and infant pairs
- N=500 randomly selected mother and infant pairs
- Plasma 25(OH)D concentrations measured by LC-MS/MS
- Mean daily solar radiation over last 3 months
- Prevalence of insufficiency 25(OH)D, <50 nmol/L
  - Infants: 3.6%
  - Mothers: 59.8%

Low Prevalence of Vitamin D Insufficiency among Nepalese Infants Despite High Prevalence of Vitamin D Insufficiency among Their Mothers

Johanne Haugen [1,2,*], Manjeswori Ulak [3], Ram K. Chandyo [3], Sigrun Henjum [4], Andrew L. Thorne-Lyman [5,6,7], Per Magne Ueland [8,9], Øivind Midtun [8,9], Prakash S. Shrestha [3] and Tor A. Strand [1,2,10]

1 Innlandet Hospital Trust, Lillehammer 2609, Norway; tors@me.com
2 Centre for International Health, University of Bergen, Bergen 5007, Norway
3 Department of Child Health, Institute of Medicine, Tribhuvan University, Kathmandu 8212, Nepal; manjeswori@gmail.com (M.U.); ram.chandyo@cih.uib.no (R.K.C.); prakashsunder@hotmail.com (P.S.S.)
4 Department of Nursing and Health Promotion, Oslo and Akershus University College of Applied Sciences, Oslo 0130, Norway; sigrun.henjum@hioa.no
5 Johns Hopkins Center for Human Nutrition, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD 21205, USA; athorne1@jhu.edu
6 WorldFish, P.O. Box 500 GPO, Penang 10670, Malaysia
7 Departments of Nutrition, Harvard T.H. Chan School of Public Health, Boston, MA 02115, USA
8 Department of Clinical Science, University of Bergen, Bergen 5007, Norway; per.ueland@ikb.uib.no (P.M.U.); oivind.midttun@bevital.no (Ø.M.)
9 Bevital AS, Bergen 5021, Norway
10 Department of Sports Science, Inland Norway University of Applied Sciences, Lillehammer 2604, Norway
* Correspondence: johanne_haugen@hotmail.com; Tel.: +47-982-67-656

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Abstract: Background: Describing vitamin D status and its predictors in various populations is important in order to target public health measures. Objectives: To describe the status and predictors of vitamin D status in healthy Nepalese mothers and infants. Methods: 500 randomly selected Nepalese mother and infant pairs were included in a cross-sectional study. Plasma 25(OH)D concentrations were measured by LC-MS/MS and multiple linear regression analyses were used to identify predictors of vitamin D status. Results: Among the infants, the prevalence of vitamin D

PREDICTORS OF MATERNAL 25(OH)D (N=499)

	Crude β	95% CI	p	**Adj. β**	**95% CI**	p
BMI (kg/m²)	0.3	(-0.1, 0.6)	0.109	**0.6**	**(0.2, 1.0)**	0.002
Global solar radiation (MJ/m²/d)	2.6	(1.8, 3.4)	<0.001	**2.6**	**(1.8, 3.4)**	<0.001
Mother's age (y)	-0.6	(-0.9, -0.2)	0.002	**-0.7**	**(-1.1, -0.4)**	<0.001

Other variables tested in crude models but not significantly associated with 25(OH)D included blood pressure, CRP, maternal average energy-intake, parity, occupational status

PREDICTORS OF INFANT 25(OH)D

	Crude β	95% CI	p	**Adj. β**	**95% CI**	p
Age of child (months)	-2.0	(-2.6, -1.3)	<0.001	**-1.5**	**(-2.1, 0.9)**	<0.001
Mothers 25(OH)D (nmol/L)	0.5	0.4, 0.6	<0.001	**0.5**	**(0.4, 0.6)**	<0.001
Mothers BMI (kg/m^2)	0.9	0.3, 1.5	0.004	**0.6**	**(0.02, 1.2)**	0.041

Other variables tested in crude models but not significantly associated with 25(OH)D included sex, anthropometric z-scores, birth weight, CRP, duration of exclusive breastfeeding, maternal average energy-intake, global solar radiation, mother's occupational status

POSSIBLE EXPLANATIONS

- Breastmilk traditionally perceived as a poor source of vitamin D..but depends on woman's status!
- Short half life of 25(OH)D…Could maternal transfer of vitamin D3 to the infant and lower production of maternal 25(OH)D be an explanation?
- Fortified foods?
  - All infants were breastfed, most also received complementary foods..
  - All 70 exclusively breastfed infants were sufficient…
- Supplement use by women was rare…
- Might it be oil massage in the sun/dermal synthesis?

Photo by Bal Krishna Thapa/THT, The Himalayan

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Work in Bhaktapur:

Dr. Tor Strand, U. Bergen

Dr. Mari Hysing, U. Bergen

Dr. Ingrid Kvested, Regional Center for Child and Youth Mental Health and Child Welfare, NORCE Norwegian Research Centre, Bergen Norway

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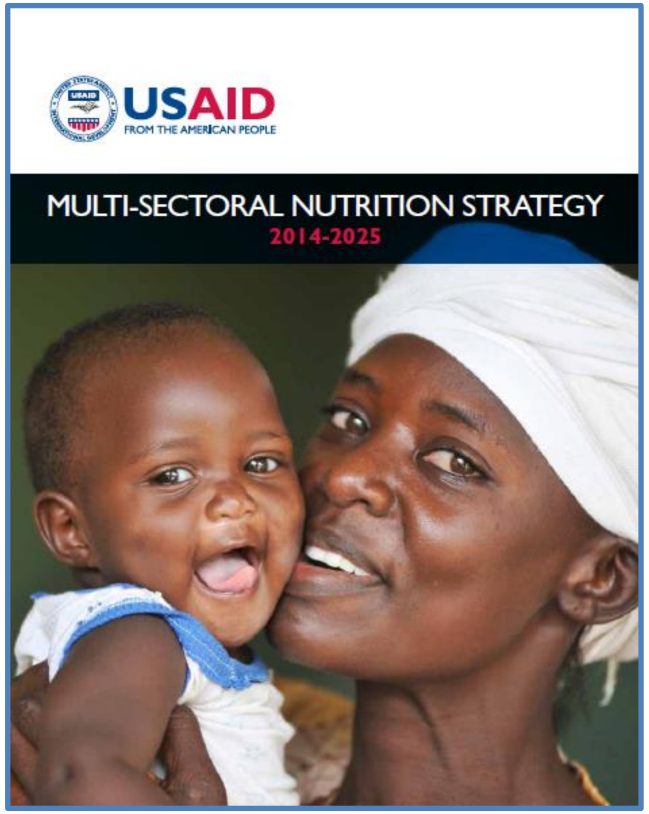
Overcoming Micronutrient Deficiencies in Women and Children



Omar Dary, USAID/Bureau for Global Health, Maternal and Child Health and Nutrition Office

May 19th, 2021

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MOTHERS TRANSFER MICRONUTRIENTS DURING PREGNANCY AND LACTATION

Breast milk as food:

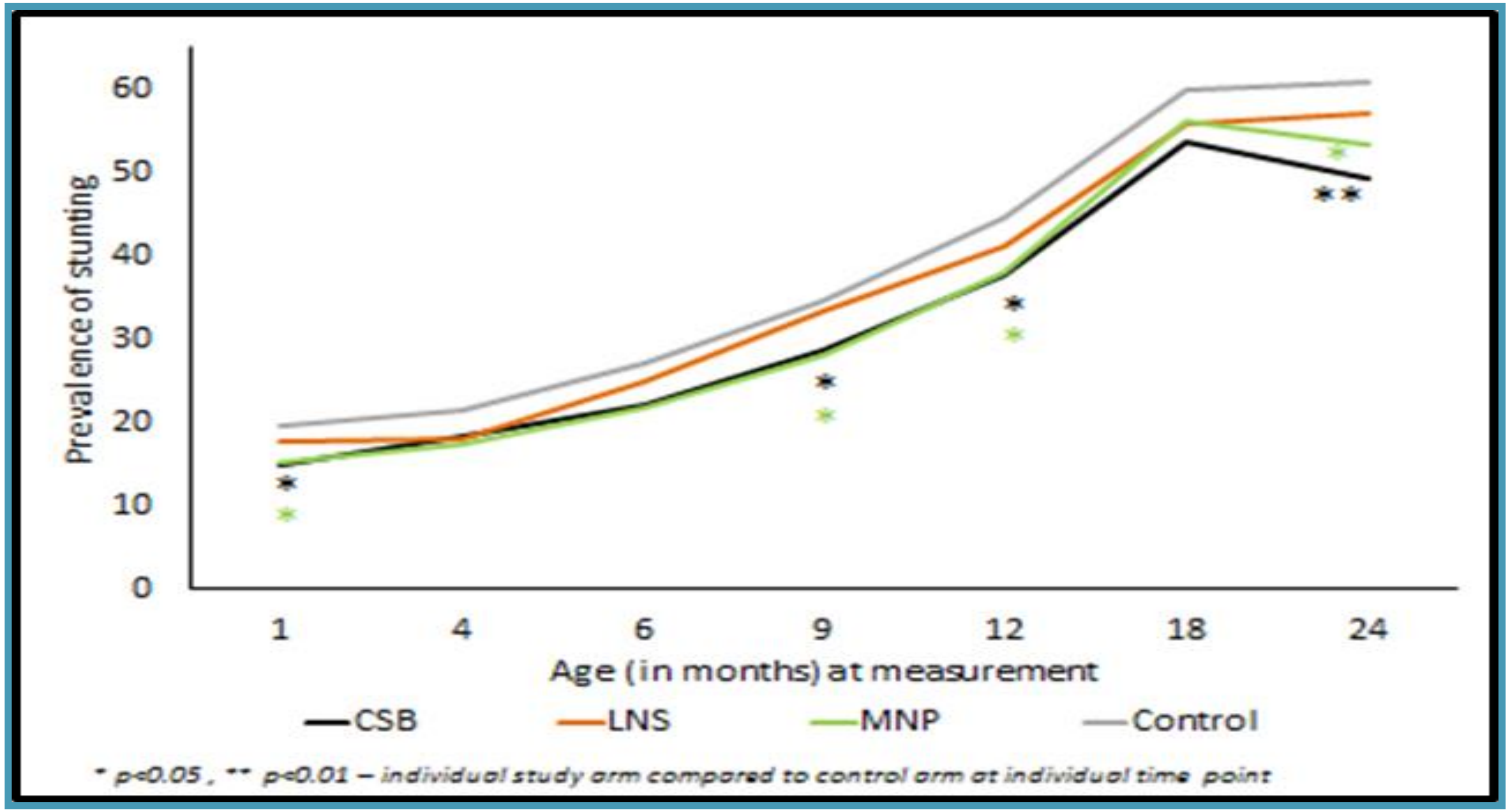
- **Macronutrients:** Protein, fat, carbohydrates (energy and building blocks)
- **Micronutrients:** vitamins and minerals (catalysis and functions)
- **Protective substances:** antibodies, non-digestible compounds that promote a healthy intestinal flora

	Nutrient	↑ in milk
Fortification vehicle		
Flour	B12	+++
Fish sauce	B1	+++
Sugar	A	+++
Salt	I	+++
Food		
Red palm oil	A	+++
B-carotene	A	+/-
Fish	DHA	+
Supplements		
LNS	Multiple	++
B12	B12	+

Content does not change with intake for: Folate
Iron, copper, zinc, and calcium

Source: Lindsay Allen, USDA and University of California at Davis

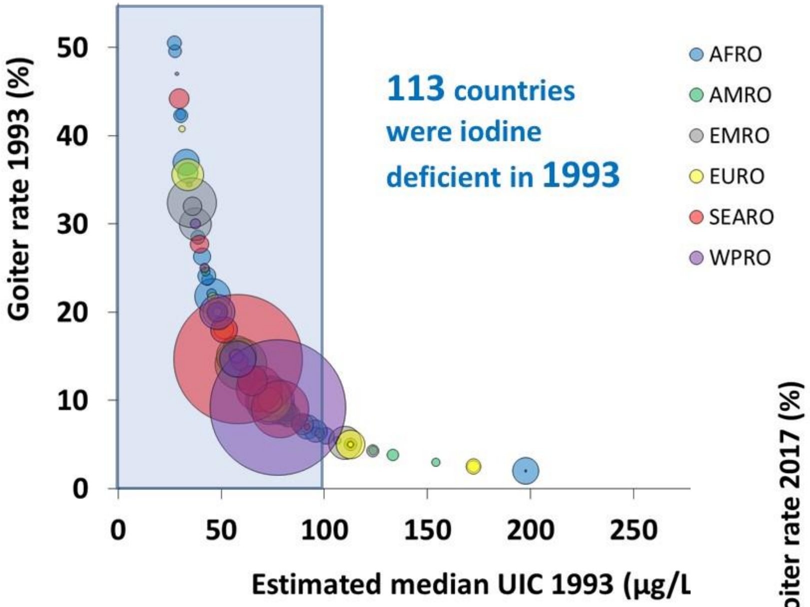
PHYSICAL GROWTH MIGHT BE DETERMINED AT THE MOMENT OF BIRTH



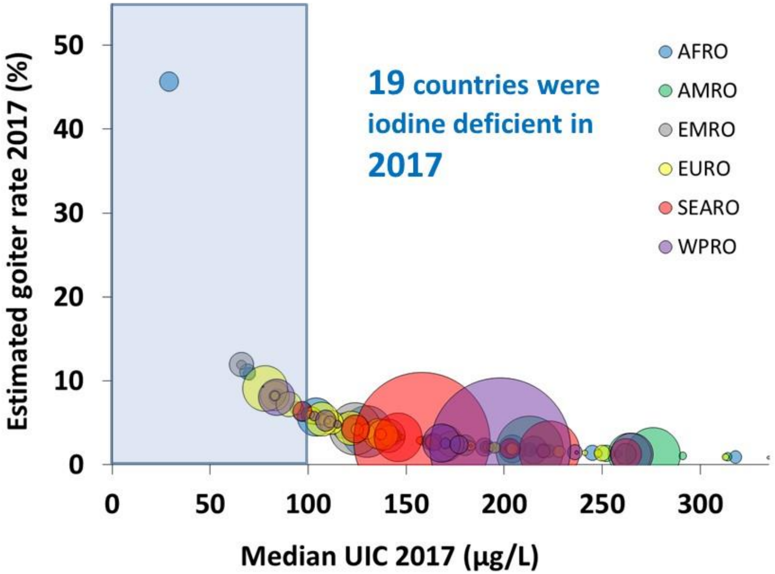
Child stunting evolution in a poor rural community of Guatemala where mothers (pregnancy) and children (starting at 6 months) received CSB, LNS, or MNP's.

Source: Olney *et al.* *J Nutr* 2018; **148**:1493.

INTELLECTUAL DISABILITY DUE TO IODINE DEFICIENCY HAS DISAPPEARED

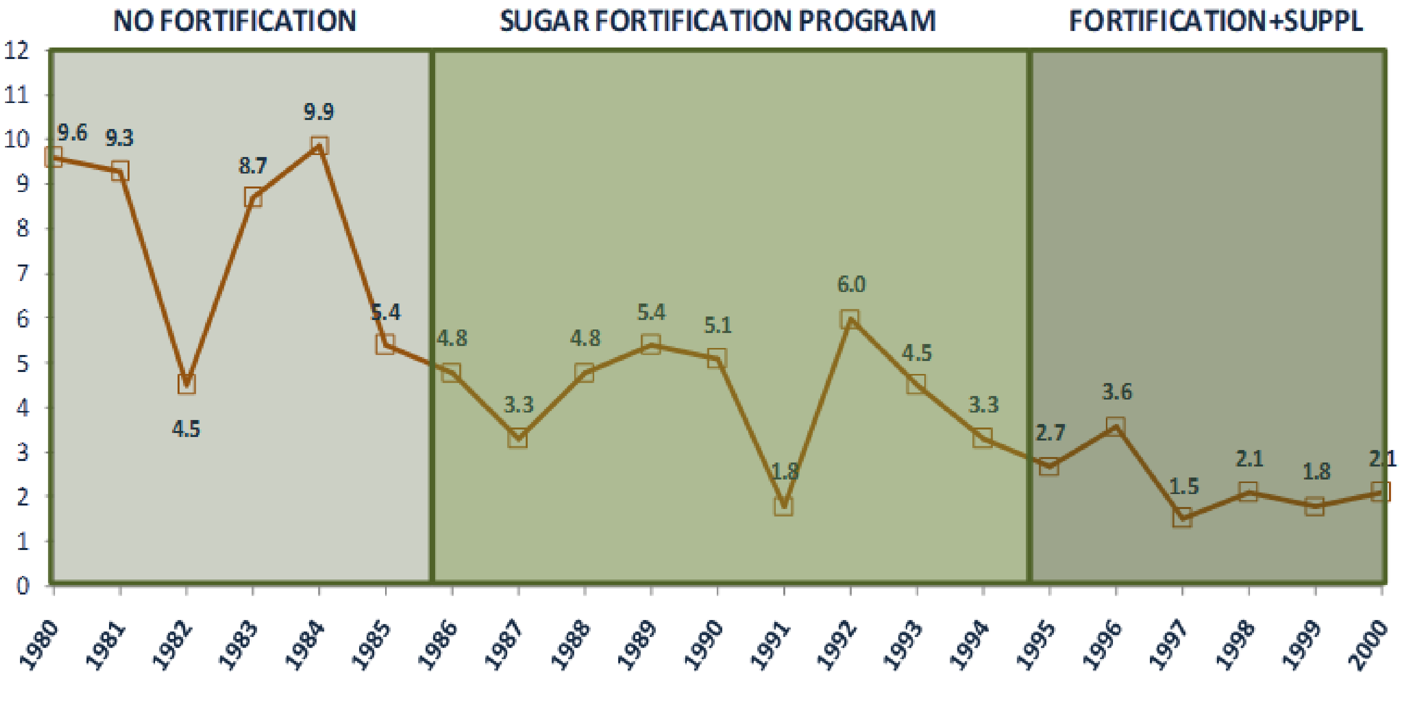


or dairy products from animals with good iodine status



Source: Jonathan Gorstein, Iodine Global Network.

REDUCTION OF XEROPHTHALMIA (VIT. A DEFICIENCY) IN GUATEMALA



From Mena I and Martínez C. **Follow-up of Nutritional Blindness in Guatemala and its association with the Sugar Fortification Program . Retrospective Case Study 1980 to 2000**. INCAP. 2004

or if no dietary sources, vitamin A supplementation

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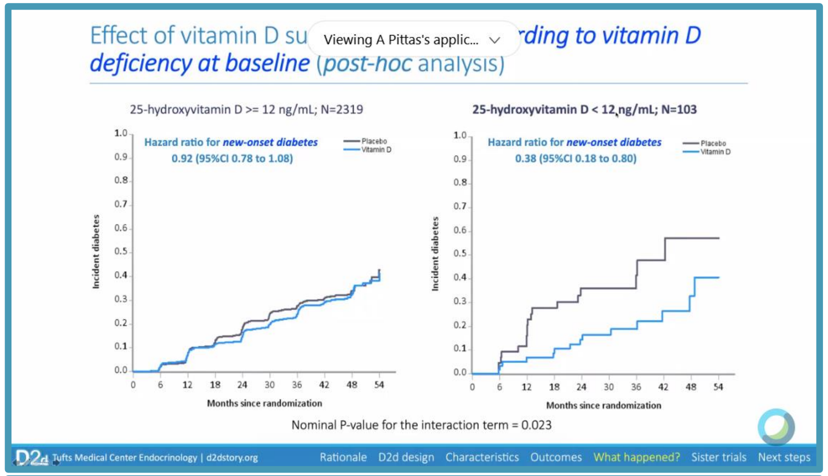
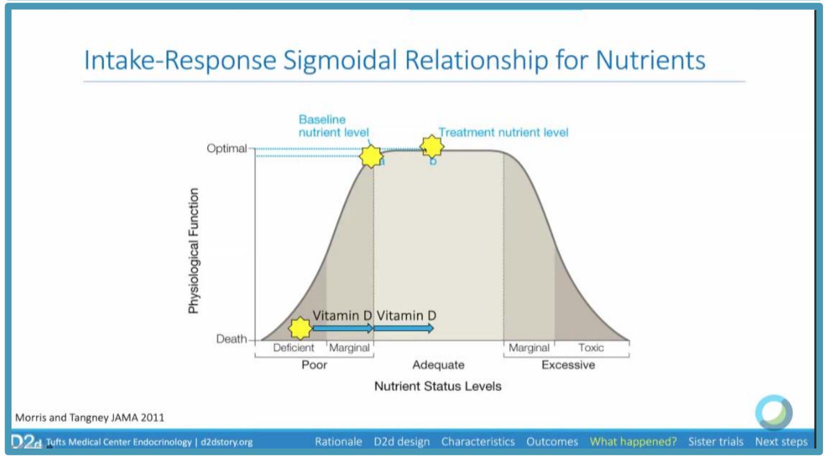
SUN LIGHT OR GOOD STATUS DURING PREGNANCY IS NEEDED FOR VIT. D

Source: Choubey *et al., Int J Dent Case Reports* 2013: **3**(2):16-19





Source: Anastassios Pittas, Tuft's University. Conference about impact of vitamin D supplementation and prevention of diabetes

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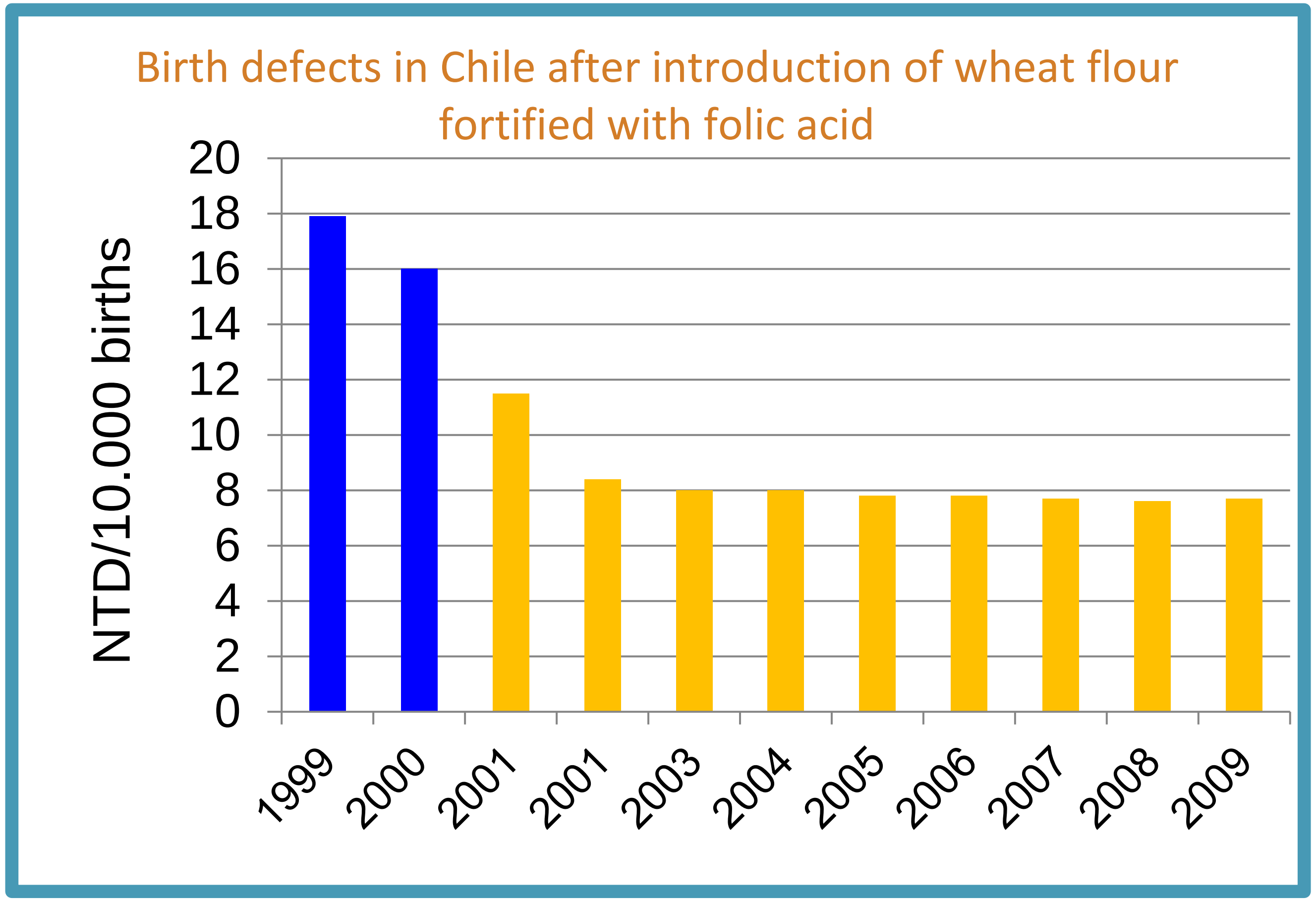
NEURAL TUBE DEFECTS ARE PREVENTED BEFORE PREGNANCY

Source: Jorge Rosenthal, CDC

Neural tube defects, the most common birth defect. It appears within 28 days after conception, consequence of genetic vulnerability, and folate and vit. B_{12} deficiencies, among others.

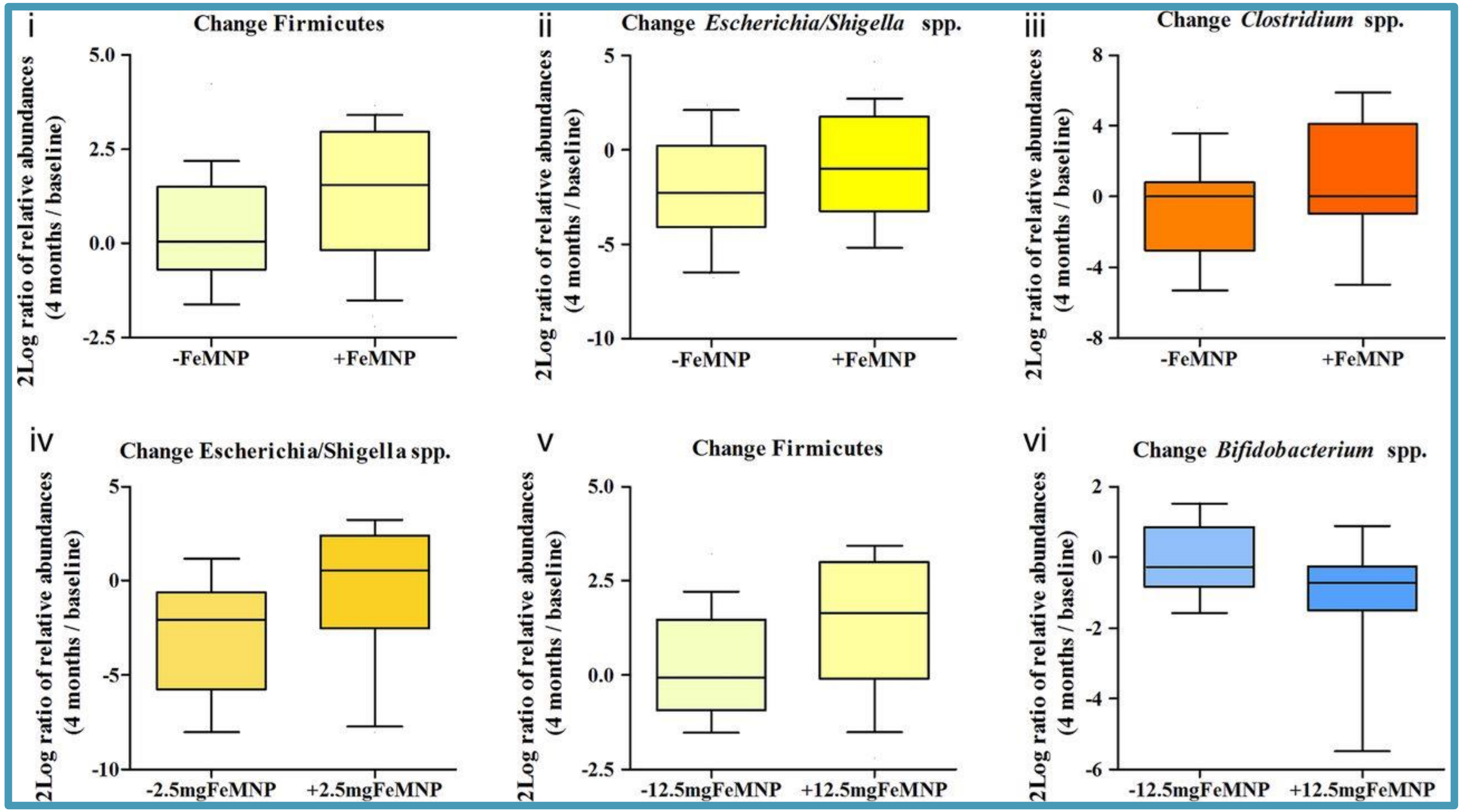
Incapacities:

- Leg paralysis
- Hydrocephaly
- Bad control of bladder and intestinal evacuations
- Learning difficulties



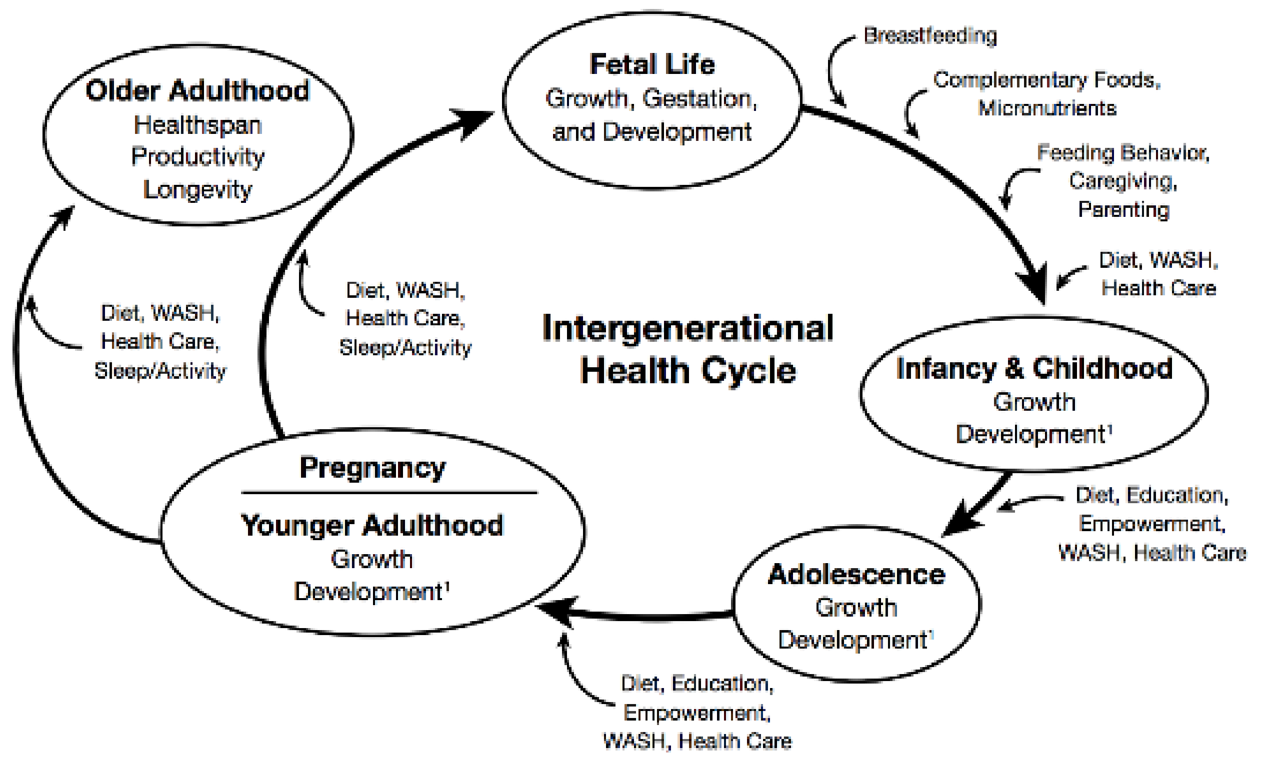
IRON SUPPLEMENTATION IN YOUNG CHILDREN

Excessive iron supply favors pathogenic intestinal bacteria in Kenyan children



Source: Jaeggi *et al.*, doi:10.1136/gutjnl-2014-307720

GOOD NUTRITION IS A GOAL ALONG THE LIFE COURSE FOR THE FAMILY



Source: USAID/BFS, adapted from ACC/SCN (2000) Fourth Report on the World Nutrition Situation. Geneva: ACC/SCN in collaboration with the International Food Policy Research Institute.

CONCLUSIONS

1. The nutritional and health status of women before and during pregnancy is needed for their well-being and survival, as well as the physical, mental, and social development of their children.

2. Micronutrients (vitamins and minerals) and other essential nutrients are transferred from mothers to children during pregnancy and through breast milk.

3. Intake of micronutrients from mothers is reflected in the breast milk content, except for calcium (this comes from the mother’s bones), folate, iron, copper, zinc, and therefore they must be transferred during pregnancy.

4. Micronutrient interventions, mostly food fortification, have been successful to improve the women’s micronutrient status, and therefore the status of the offspring.

5. Trying to improve the nutritional status during pregnancy may be late for some micronutrients, Therefore, attention to the family’s diet and habits is important.

Q&A

THANK YOU

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