



The First 1,000 Days

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Foundations of Health: Goal for Every Child

Sound, appropriate nutrition

- Health-promoting food intake, eating habits beginning with mother's pre-conception nutritional status

Stable, responsive environment of relationships

- Consistent, nurturing, protective interactions with adults that enhance learning, help develop adaptive capacities that promote well-regulated stress response systems

Safe, supportive physical, chemical and built environments

- Provide places for children that are free from toxins, allow active, safe exploration without fear, offer families opportunities to exercise, make social connections



What's important about the First 1,000 Days?

The foundations of health are built here!

Period of rapid brain growth vulnerable to nutritional deficiency

Poor nutrition establishes risk for chronic disease

- Maternal obesity, diabetes, excess gestational weight gain
- Hunger/Food Insecurity
- Childhood obesity
- High risk nutrition behaviors

Threat to the Foundations of Health

Nutrition: Double Burden

Obesity and under nutrition have been seen as separate, sometimes opposing entities

These two conditions coexist globally, nationally, locally — even within families and individuals

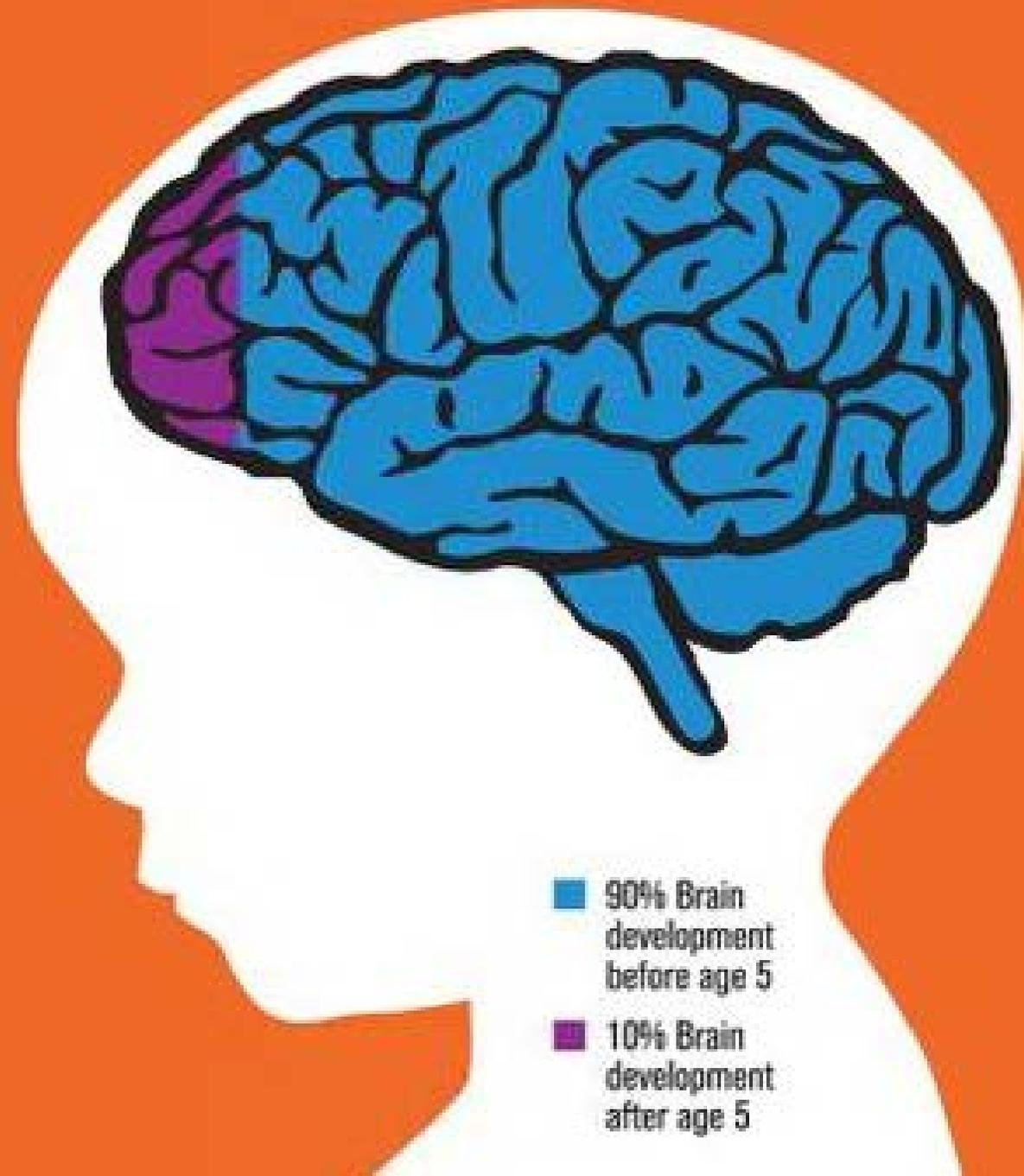
The dual burden of under and over nutrition occurring simultaneously within a population is referred to as the double burden of malnutrition

- Chopra, M. From apartheid to globalization: Health and social change in South Africa. *HygieaInternationalis*, 2004.4(1): 153–174.



90%

of a child's brain
development
happens
before age 5



- 90% Brain development before age 5
- 10% Brain development after age 5

First 1,000 Days: Brain Growth and Development

Most rapid period of brain growth and its period of highest plasticity

- Fox SE, Levitt P, Nelson CA III. How the timing and quality of early experiences influence the development of brain architecture. *Child Dev.* 2010;81(1):28–40

Each region of the brain has a unique growth pathway and specific nutrient requirements

Each time period in development has specific nutrient requirements.

- A critical nutrient at one time period may have little or no effect in another period
 - <https://www.unicef-irc.org/article/958-the-first-1000-days-of-life-the-brains-window-of-opportunity.html>

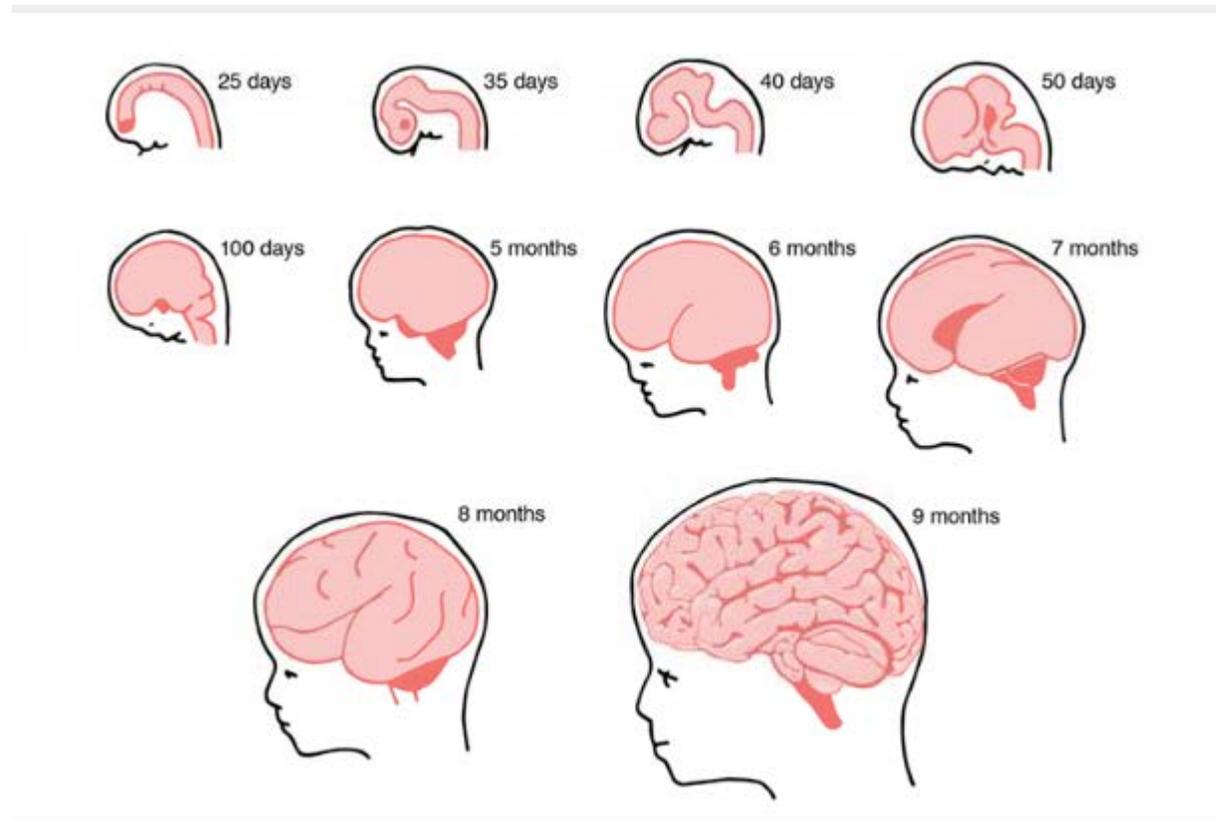
First 1,000 Days: Brain Growth

Greatest opportunity to provide optimal nutrition to ensure normal development

Greatest brain vulnerability to any nutrient deficit.

- Rapid increase in number of brain cells.
 - Rapid increase in complexity
 - Rapid increase in connectivity
-
- <https://www.unicef-irc.org/article/958-the-first-1000-days-of-life-the-brains-window-of-opportunity.html>

Rapid Brain Growth in utero



Brain Growth

Synchronized

- “Changes that are too rapid or too slow in one part of the brain may result in the failure of crucial pathway connections to other parts of the brain”

Sequential

- “ Timing is crucial; once a particular developmental sequence fails, it may not be possible to retrieve all the lost function.”

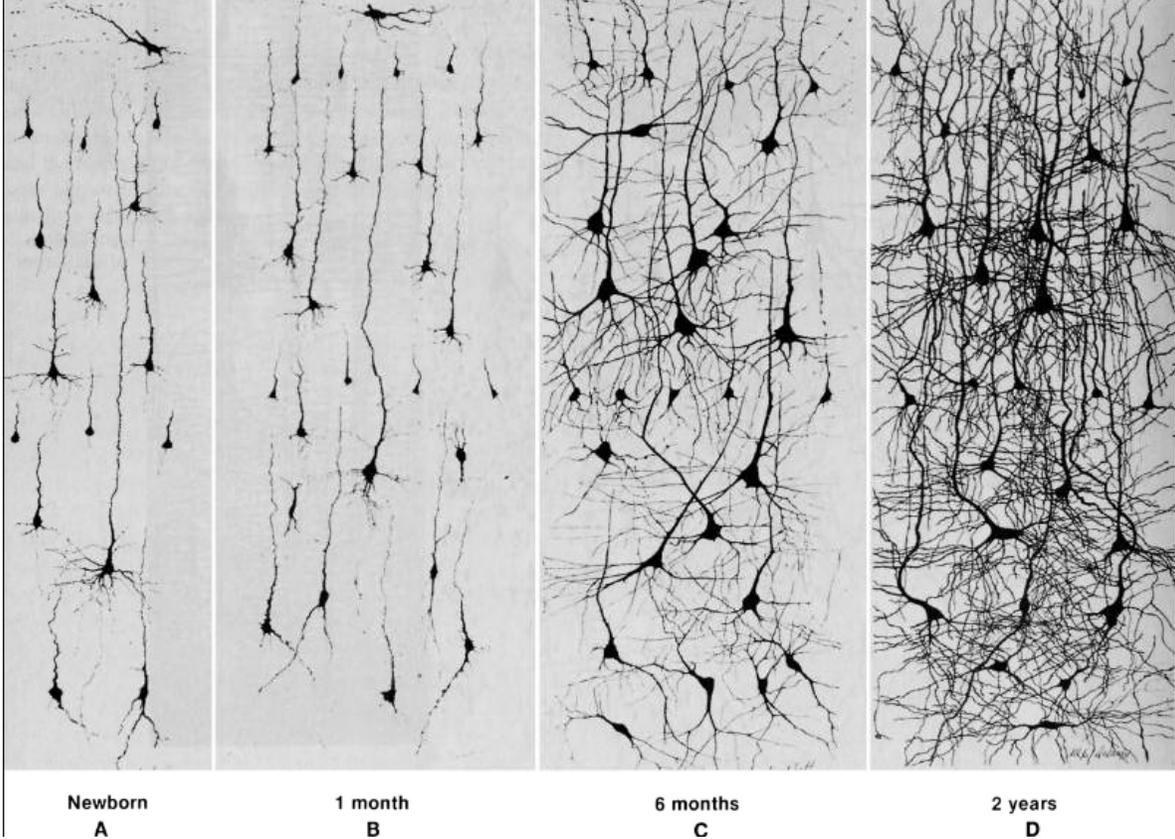
Scaffolding

- “The development of increasingly complex neural circuits (and the behaviors they support) relies on successful completion of previous stages of development. “
 - Schwarzenberg SJ, Georgieff MK, AAP COMMITTEE ON NUTRITION. Advocacy for Improving Nutrition in the First 1000 Days To Support Childhood Development and Adult Health. Pediatrics. 2018;141(2):e20173716

Increase in Complexity



Increase in Connections



Inadequate Nutrition Compromises Neurodevelopment

Macronutrient

- An essential nutrient that has a large minimal daily requirement, including proteins, fats, carbohydrates, and water.
 - Miller-Keane Encyclopedia and Dictionary of Medicine, Nursing, and Allied Health, Seventh Edition. © 2003 by Saunders, an imprint of Elsevier, Inc. All rights reserved.

Macronutrient (protein, fat, glucose) sufficiency is essential for normal brain development.

Early macronutrient undernutrition is associated with lower IQ scores, reduced school success, and more behavioral dysregulation.

- Grantham-McGregor S. A review of studies of the effect of severe malnutrition on mental development. *J Nutr.* 1995;125(suppl 8):2233S–2238S

Early supplementation of nutrients to children at risk for macronutrient deficiency improved neurodevelopmental outcomes over an extended period of life, beyond the period of supplementation.

- Pollitt E, Gorman KS, Engle PL, Rivera JA, Martorell R. Nutrition in early life and the fulfillment of intellectual potential. *J Nutr.* 1995;125(suppl 4):1111S–1118S12



TABLE 1 Nutrients That Particularly Affect Early Brain Development and Demonstrate a Critical or Sensitive Period

Macronutrients
Protein ^a
Specific fats (eg, LC-PUFAs) ^a
Glucose
Micronutrients
Zinc ^a
Copper ^a
Iodine ^a
Iron ^a
Selenium
Vitamins and cofactors
B vitamins (B ₆ , B ₁₂)
Vitamin A
Vitamin K
Folate ^a
Choline ^a

LC-PUFA, long-chain polyunsaturated fatty acid. Reprinted with permission from Georgieff MK, Brunette KE, Tran PV. Early life nutrition and neural plasticity. *Dev Psychopathol.* 2015;27(2):415.

^a Nutrients that meet the principles for demonstrating a critical or sensitive period during development.

Iron

Peak brain iron requirement/highest risk of iron deficiency-induced neurobehavioral impairment are

- Fetal/neonatal period
- Infancy/toddlerhood (6 months to 3 years)

The developing brain at these time points requires iron for proteins that regulate myelin production, neurotransmitter synthesis, and neuronal energy production.

- <https://www.unicef-irc.org/article/958-the-first-1000-days-of-life-the-brains-window-of-opportunity.html>

Iron Deficiency

Prenatal and early infancy iron deficiency

- Long term neurobehavioral damage
- Treatment may not reverse
 - Georgieff MK. Long-term brain and behavioral consequences of early iron deficiency. Nutr Rev. 2011;69(suppl1):S43–S48

Severe maternal iron deficiency

- May lead to newborn iron deficiency and associated long-term cognitive deficits
- Causes include: Limited maternal fetal iron transport (cigarette smoking or maternal hypertension), conditions that increase fetal iron demand (such as maternal diabetes)
 - Georgieff MK, Brunette KE, Tran PV. Early life nutrition and neural plasticity. Dev Psychopathol. 2015;27(2):411–423

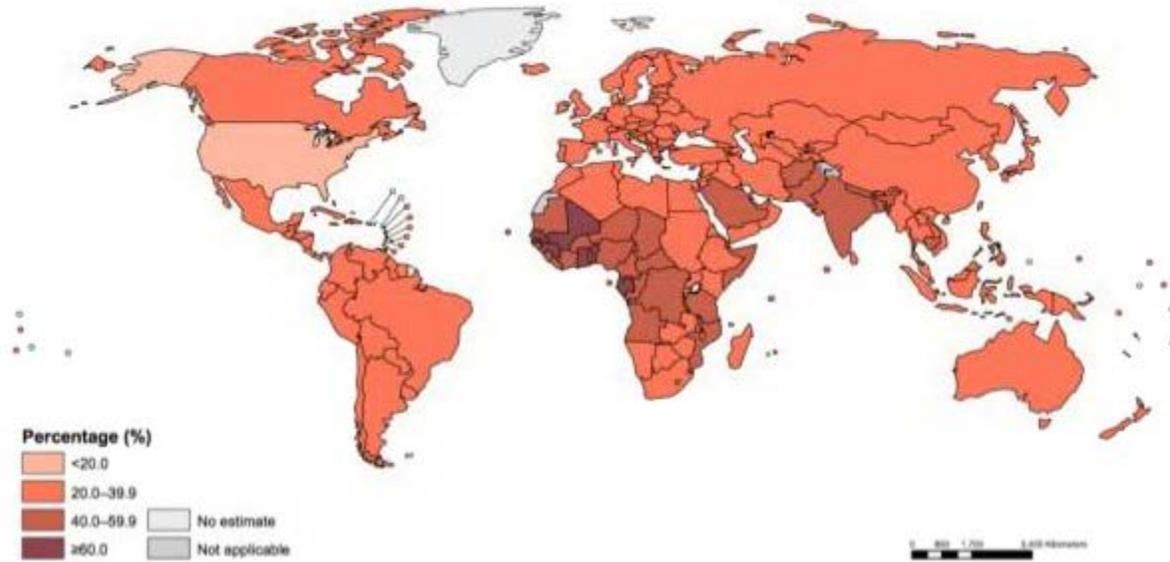
Adolescent iron deficiency

- Associated with neurocognitive impairment
- Reversible with iron treatment
 - Georgieff MK. Long-term brain and behavioral consequences of early iron deficiency. Nutr Rev. 2011;69(suppl1):S43–S48

The earlier the timing of the deficiency, the more likely long-term effects will occur

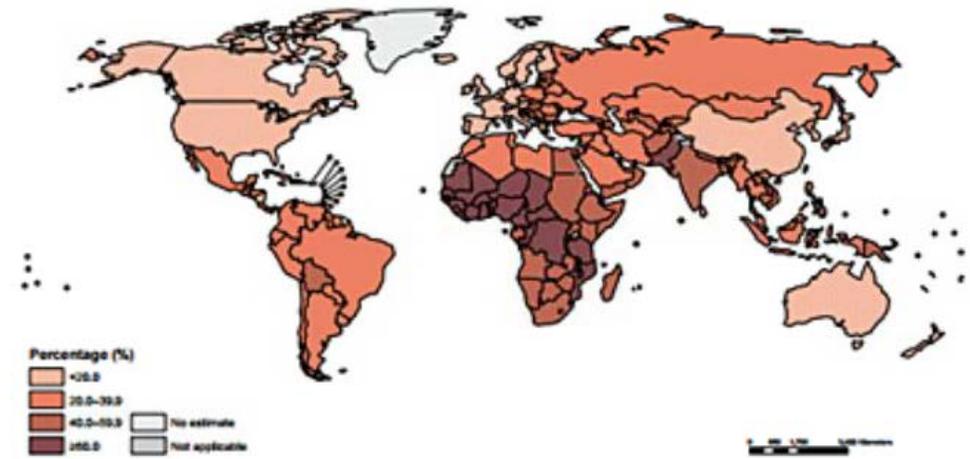
- Structure and regulation of genes involved in neural plasticity may be significantly altered.
 - Georgieff MK, Brunette KE, Tran PV. Early life nutrition and neural plasticity. Dev Psychopathol. 2015;27(2):411–423

b. Prevalence of anaemia, pregnant women aged 15-49 years, 2011



Half the anemia globally is caused by iron deficiency

Fig.1. Global estimates of the prevalence of anaemia in infants and children aged 6-59 months, 2011



The nutritional status of an infant and child depends on the nutritional status of their mother

Poor maternal micronutrient nutrition during pregnancy contributes to iron deficiency anemia in infant

- De Pee S, Bloem MW Sari M et al. The high prevalence of low hemoglobin concentration among Indonesian infants aged 3=5 months is related to maternal anemia J Nutr 2002 132;2215-21

Mothers with obesity are more likely to give birth to premature low birth weight babies at risk for depleted iron stores at birth.

- Michie C, Raffles A, Iron supplementation in the preterm or low birthweight infant Arch Dis Child 1990; 65;559

Mothers who are malnourished during lactation are more likely to have breast milk with lower than normal amounts of B vitamins (except for folate) vitamin A, selenium and iodine, placing the breastfeeding child at risk for micronutrient deficiencies.

- Allen L, Graham J, Assuring micronutrient adequacy in the diets of young infants; In: Micronutrient Deficiencies in the First Six Months of Life. Edited by Delange F, West K, Basel ; Veey/s, Karger AG 2003 55-88

Neurodevelopment and Breastfeeding

AAP Policy on Breastfeeding

Breastfeeding and the Use of Human Milk SECTION ON BREASTFEEDING Pediatrics Mar 2012, 129 (3) e827-e841;

DOI: 10.1542/peds.2011-3552

Consistent differences in neurodevelopmental outcome between breastfed and commercial infant formula-fed infants have been reported

- Outcomes are confounded by differences in parental education, intelligence, home environment, and socioeconomic status.
 - Ip S, Chung M, Raman G, et al; Tufts-New England Medical Center Evidence-based Practice Center. Breastfeeding and maternal and infant health outcomes in developed countries. Evid Rep Technol Assess (Full Rep). 2007;153(153):1–186
 - Der G, Batty GD, Deary IJ. Effect of breast feeding on intelligence in children: prospective study, sibling pairs analysis, and meta-analysis. BMJ. 2006;333(7575):945–950

In one large randomized trial, adjusted outcomes of intelligence scores and teacher's ratings are significantly greater in breastfed infants.

Higher intelligence scores are noted in infants who exclusively breastfed for 3 months or longer, and higher teacher ratings were observed if exclusive breastfeeding was practiced for 3 months or longer.

- Kramer MS, Fombonne E, Igumnov S, et al; Promotion of Breastfeeding Intervention Trial (PROBIT) Study Group. Effects of prolonged and exclusive breastfeeding on child behavior and maternal adjustment: evidence from a large, randomized trial. Pediatrics. 2008;121(3). Available at: www.pediatrics.org/cgi/content/full/121/3/e435
- Kramer MS, Aboud F, Mironova E, et al; Promotion of Breastfeeding Intervention Trial (PROBIT) Study Group. Breastfeeding and child cognitive development: new evidence from a large randomized trial Arch Gen Psychiatry. 2008;65(5):578–584
- Kramer MS, Chalmers B, Hodnett ED et al; PROBIT Study Group (Promotion of Breastfeeding Intervention Trial). Promotion of Breastfeeding Intervention Trial (PROBIT): a randomized trial in the Republic of Belarus. JAMA. 2001;285(4):413–420

Neurodevelopment and Breastfeeding

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Mar 2012, 129 (3) e827-e841; DOI:10.1542/peds.2011-3552

Significantly positive effects of human milk feeding on long-term neurodevelopment are observed in preterm infants, the population more at risk for these adverse neurodevelopmental outcomes.

- Vohr BR, Poindexter BB, Dusick AM, et al; NICHD Neonatal Research Network. Beneficial effects of breast milk in the neonatal intensive care unit on the developmental outcome of extremely low birth weight infants at 18 months of age. *Pediatrics*. 2006;118(1). Available at: www.pediatrics.org/cgi/content/full/118/1/e115
- Vohr BR, Poindexter BB, Dusick AM, et al; National Institute of Child Health and Human Development National Research Network. Persistent beneficial effects of breast milk ingested in the neonatal intensive care unit on outcomes of extremely low birth weight infants at 30 months of age. *Pediatrics*. 2007;120(4). Available at: www.pediatrics.org/cgi/content/full/120/4/e953
- Lucas A, Morley R, Cole TJ. Randomised trial of early diet in preterm babies and later intelligence quotient. *BMJ*. 1998;317 (7171):1481–1487
- Isaacs EB, Fischl BR, Quinn BT, Chong WK, Gadian DG, Lucas A. Impact of breast milk on intelligence quotient, brain size, and white matter development. *Pediatr Res* 2010;67(4):357–362

Breastfeeding mothers must be well nourished.

- Breastfeeding and the Use of Human Milk SECTION ON BREASTFEEDING Pediatrics Mar 2012, 129 (3) e827-e841; DOI: 10.1542/peds.2011-3552

Weaning and Transition

Low income countries 1/3 of families were able to prepare proper food but gave infants fewer calories than required

- micronutrient deficiencies were common.
 - Brown K, Peerson J, Kimmons J et al. Options for achieving adequate intake from home prepared complementary foods in low income countries. In; Public Health Issues in Infant and Child Nutrition ed. Black R, Michaelsen K, Philadelphia; Lippincott Williams and Wilkis 2002;239-56.

Food Insecure Households with Infants

- May stretch infant formula
 - Dilute formula
 - Feed smaller amounts
 - Increase time between feeds
 - Use juice or water as formula substitutes
 - Give cow's milk before 12 months of age
 - Introduce solid foods early
 - Bronte-Tinkew J, et.al. J Nutr. 2007; 137(9): 2160-2165.
 - Burkhardt MC, et. Al. Clinical Pediatrics (Phila). 2012;51(3):238-243.

AAP Food Security Policy released Oct 2015
www.pediatrics.org/cgi/doi/10.1542/peds.2015-3301
DOI: 10.1542/peds.2015-3301)

Know your communities resources for food, housing, literacy, early education etc.

Ask about food insecurity

- “Within the past 12 months we worried whether our food would run out before we got money to buy more”
- “Within the past 12 months the food we bought just didn’t last and we didn't have money to get more.”
 - Hager E et.al. Development and validity of a 2-item screen to identify families at risk for food Pediatrics. 2010 Jul;126(1):e26-32. doi: 10.1542/peds.2009-3146

Ensure eligible families are participating in federal nutrition programs (WIC, SNAP, summer feeding)

No baby should go hungry

The Supplemental Nutrition Assistance Program (SNAP)
is the first line of defense for babies in food-insecure homes.

Food insecurity affects kids in every American community...



13 million
children

live in food-insecure homes. That's 1 in 6 kids, and they live in every state & county.

Percent of kids under 5 in SNAP (2016)



...with devastating consequences.

Infants and toddlers from food-insecure families are:

90% more likely to be in fair or poor health

30% more likely to be hospitalized

They are also more likely to:

Suffer from low birthweight

Develop asthma & anemia

Fall behind in school

Exhibit behavioral problems



<https://www.zerotothree.org/resources/2258-hands-off-snap>

Intervention

Improve periconceptual nutrition through first 2 years of life

Improve weight and micronutrient status of mothers

Promote breastfeeding

Adjusting protein and fat content of early diets both in terms of quantity and quality

Addressing physical activity in mothers and children where appropriate.

Correcting Baseline Undernutrition

Strategies to supplement micronutrients

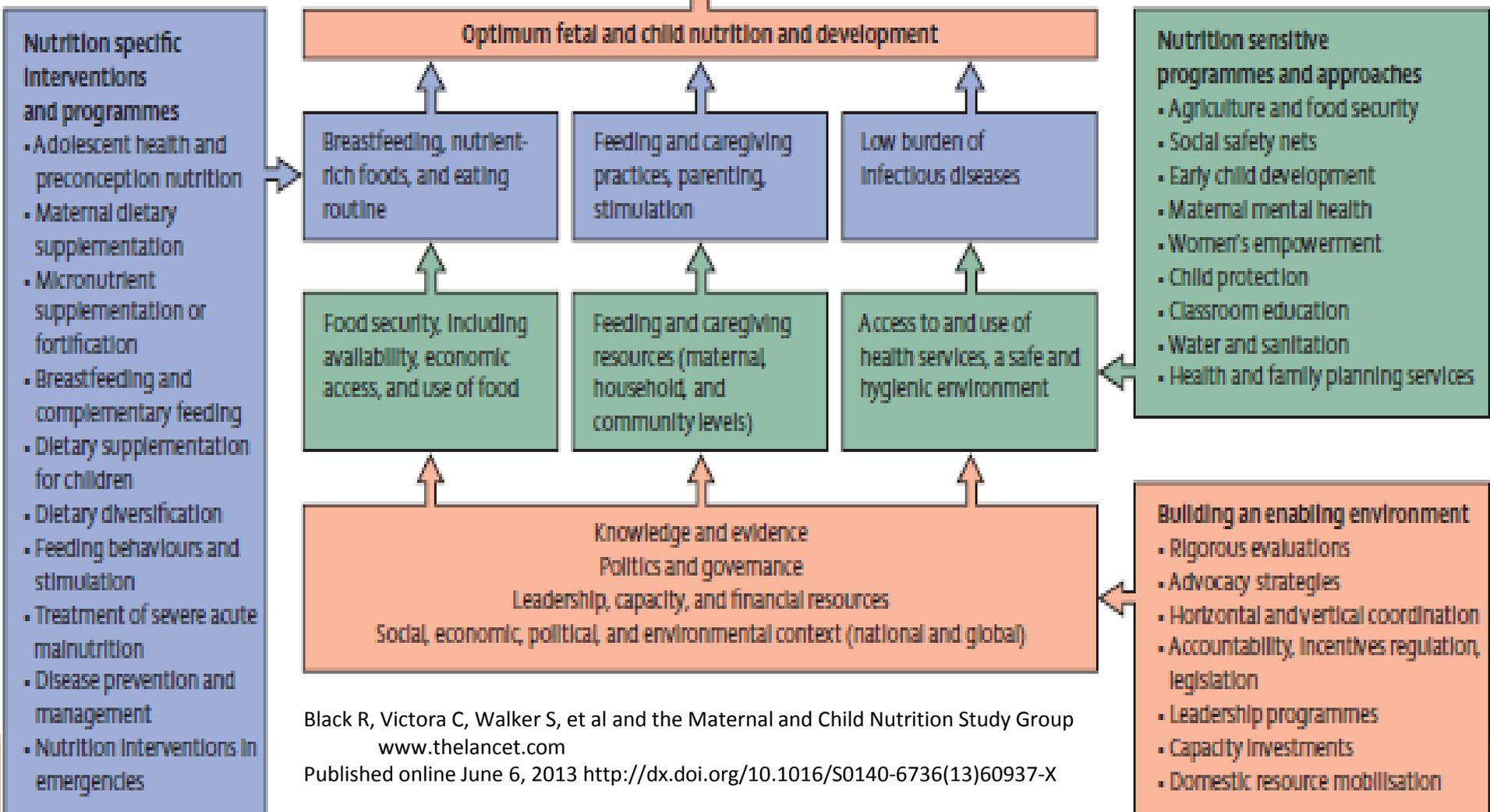
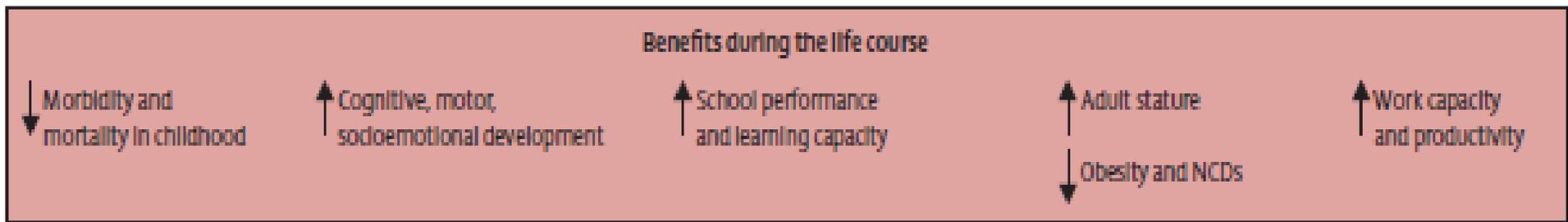
- Education
- Dietary modification
- Food provision
- Supplementation and fortification
- Universal coverage
 - Bundle of interventions: micronutrient provision, complementary foods, treatments for worms and diarrheal diseases and behavior change programs
 - Bhutta ZA, Salam RA, Das JK. Meeting the challenges of micronutrient malnutrition in the developing world. Br Med Bull. 2013;106:7-17

Correcting Basic Undernutrition

Consensus needs to be built around approaches to scale up coverage and delivery strategies to reduce disparities and provide equitable access.

Strategies to address food insecurity and poverty alleviation are key

- Complex sustainable development issues, linked to health through malnutrition, but also to sustainable economic development, environment and trade.
 - Bhutta ZA, Salam RA, Das JK. Meeting the challenges of micronutrient malnutrition in the developing world. Br Med Bull. 2013;106:7-17



Black R, Victora C, Walker S, et al and the Maternal and Child Nutrition Study Group
 www.thelancet.com
 Published online June 6, 2013 [http://dx.doi.org/10.1016/S0140-6736\(13\)60937-X](http://dx.doi.org/10.1016/S0140-6736(13)60937-X)

Childhood OBESITY



1 in 3

children are overweight or obese. Along with 65% of adults.



33%

of children ages 6-18 watch over three hours of tv each day.



1980 → 2012

Since 1980

obesity has over doubled from 5% to 10% of men and 8% to 14% of females.

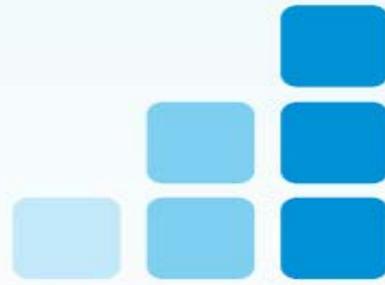
Effects of Obesity

- heart disease
- diabetes
- osteoarthritis
- cancer

Preventable with

- healthy eating
- physical activity
- less screen time
- sleeping full nights

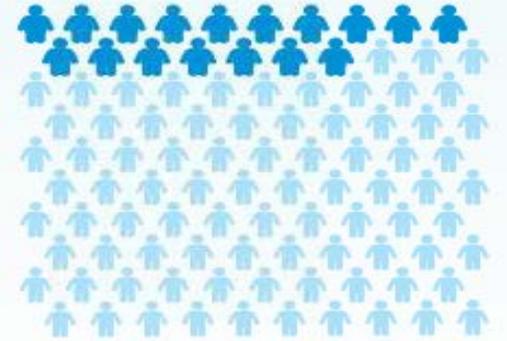
sources: <http://www.cdc.gov/healthyschools/obesity/facts.htm>
<http://www.heart.org/HEARTORG/GettingHealthy/>
<http://www.letsmove.gov/learn-facts/epidemic-childhood-obesity>
<https://publichealthonline.gwu.edu/cost-obesity-infographic-nphw/>
http://www.who.int/end_childhood_obesity/facts/en/



1980 → 2012

Since 1980, obesity prevalence among children and adolescents has almost tripled.

Adapted from <http://www.cdc.gov/obesity/childhood/data.html>



Approximately 12.5 million or 17% of children and adolescents aged 2 to 19 years are obese.

Adapted from <http://www.cdc.gov/obesity/childhood/data.html>

U.S. Childhood Obesity Trends



American Indian & Alaskan Native (2-4 years old)



Hispanic (2-4 years old)

American Indian & Alaska Native (20.7%) and Hispanic (17.9%) children aged 2 to 4 years have the highest rates of obesity.

Adapted from <http://www.cdc.gov/obesity/downloads/PedNSSFactSheet.pdf>



One out of 3 children are obese or overweight before their 5th birthday.

Adapted from <http://www.cdc.gov/obesity/downloads/PedNSSFactSheet.pdf>

Chronic Disease, Obesity and Nutrition

There is a relationship between poor food choices and chronic illness

- Cardiovascular disease
- Obesity
- Cancer
- Diabetes
- Osteoporosis/bone disease
- Dental disease

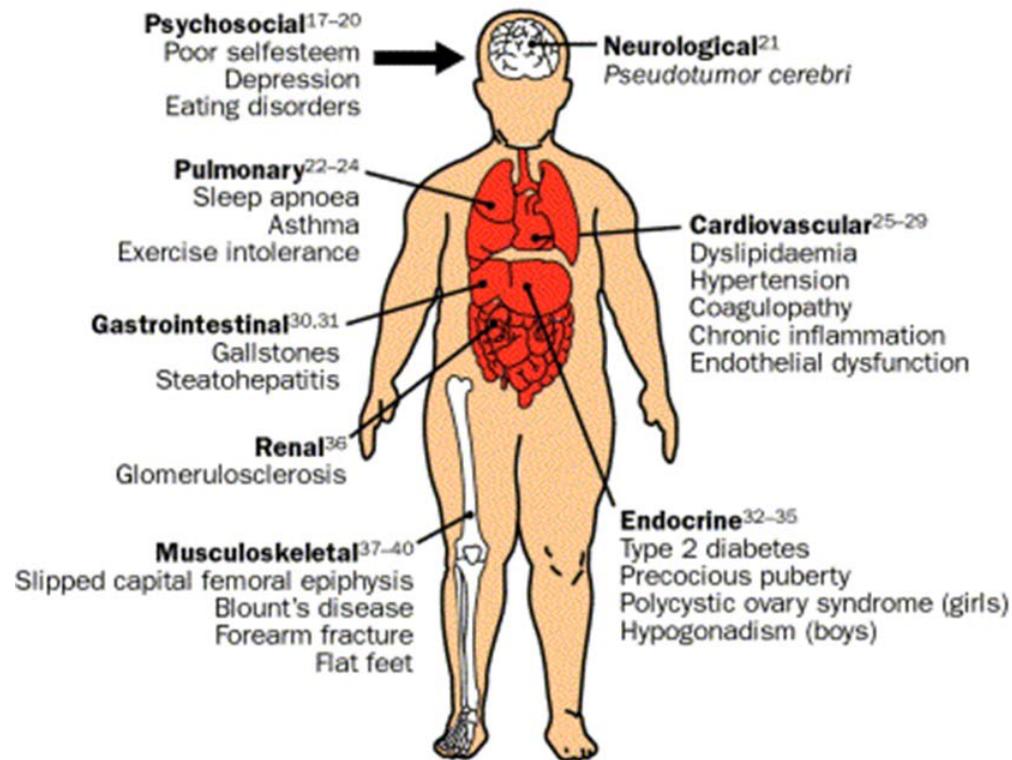
- Diet, nutrition and the prevention of chronic diseases Report of the joint WHO/FAO expert consultation WHO Technical Report Series, No. 916 (TRS 916) <http://www.who.int/dietphysicalactivity/publications/trs916/summary/en/>

Healthy People 2020 recommendations to promote health and prevent disease through diet and nutrition

- Lower salt, fat and simple sugar consumption
- Increase fruit and vegetable consumption

- US Department of Health and Human Services. Healthy people, 2020 topics and objectives: nutrition and weight status. Washington (DC): US Department of Health and Human Services; 2014. [cited 2014 Nov 18]. Available from: <http://www.healthypeople.gov/2020/topics-objectives/topic/nutrition-and-weight-status/objectives>.
- Vegetable and Fruit Acceptance during Infancy: Impact of Ontogeny, Genetics, and Early Experiences. Mennella JA, Reiter AR, Daniels LM. Adv Nutr. 2016 Jan 15;7(1):211S-219S. doi: 10.3945/an.115.008649.

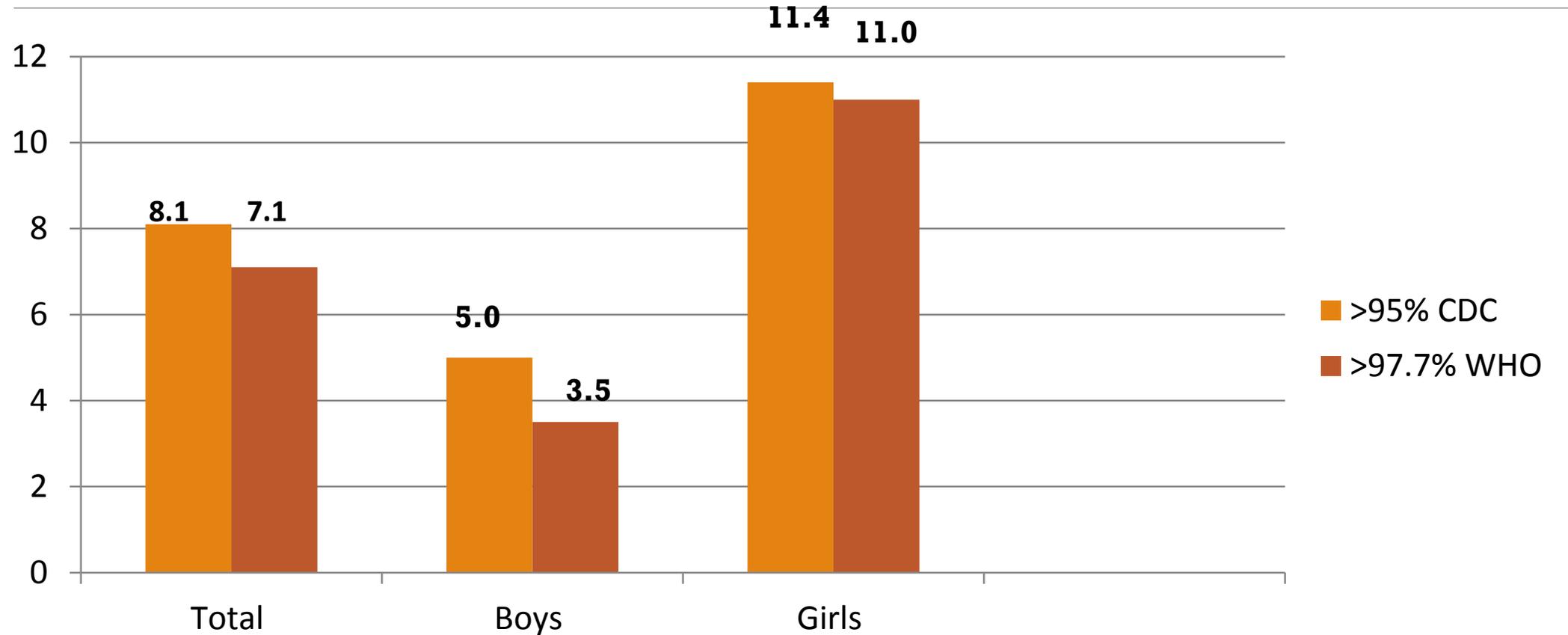
Health Consequences of Childhood Obesity



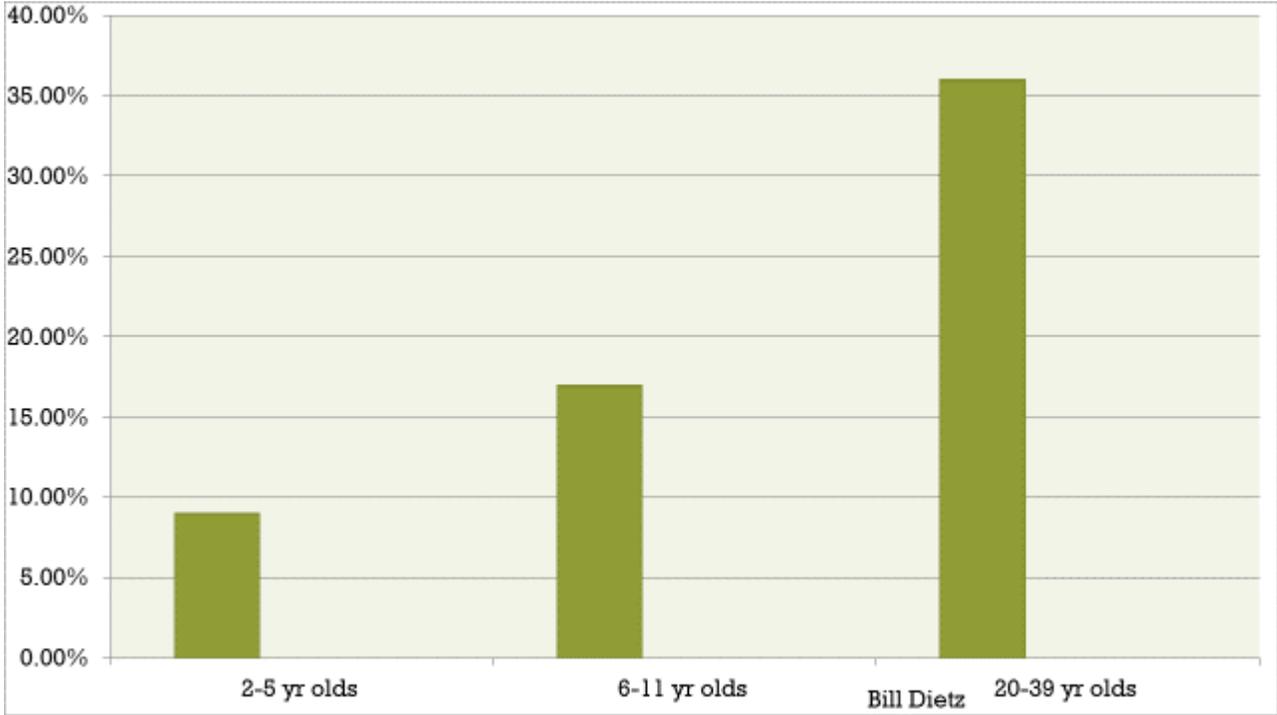
- Type 2 diabetes
- Hypertension
- Nonalcoholic fatty liver disease
- Dyslipidemia
- Upper Airway Obstruction
- Sleep Apnea Syndrome
- Blount's Disease
- Polycystic ovary syndrome
- Obesity related emergencies
- Depression/anxiety

2011-2012

U S Children 0-2 yr. Prevalence of High Weigh for Length



Obesity Prevalence by Age NHANES 2011-2014



Courtesy Bill Dietz

Maternal Health Risk

Over 1/3 of women 20-39 yrs have a BMI > 30

- Non-Hispanic white women (31.3%)
- Non-Hispanic black women (47.2%)
- Hispanic women (37.6%)

18% women 20-39 yrs have BMI > 35

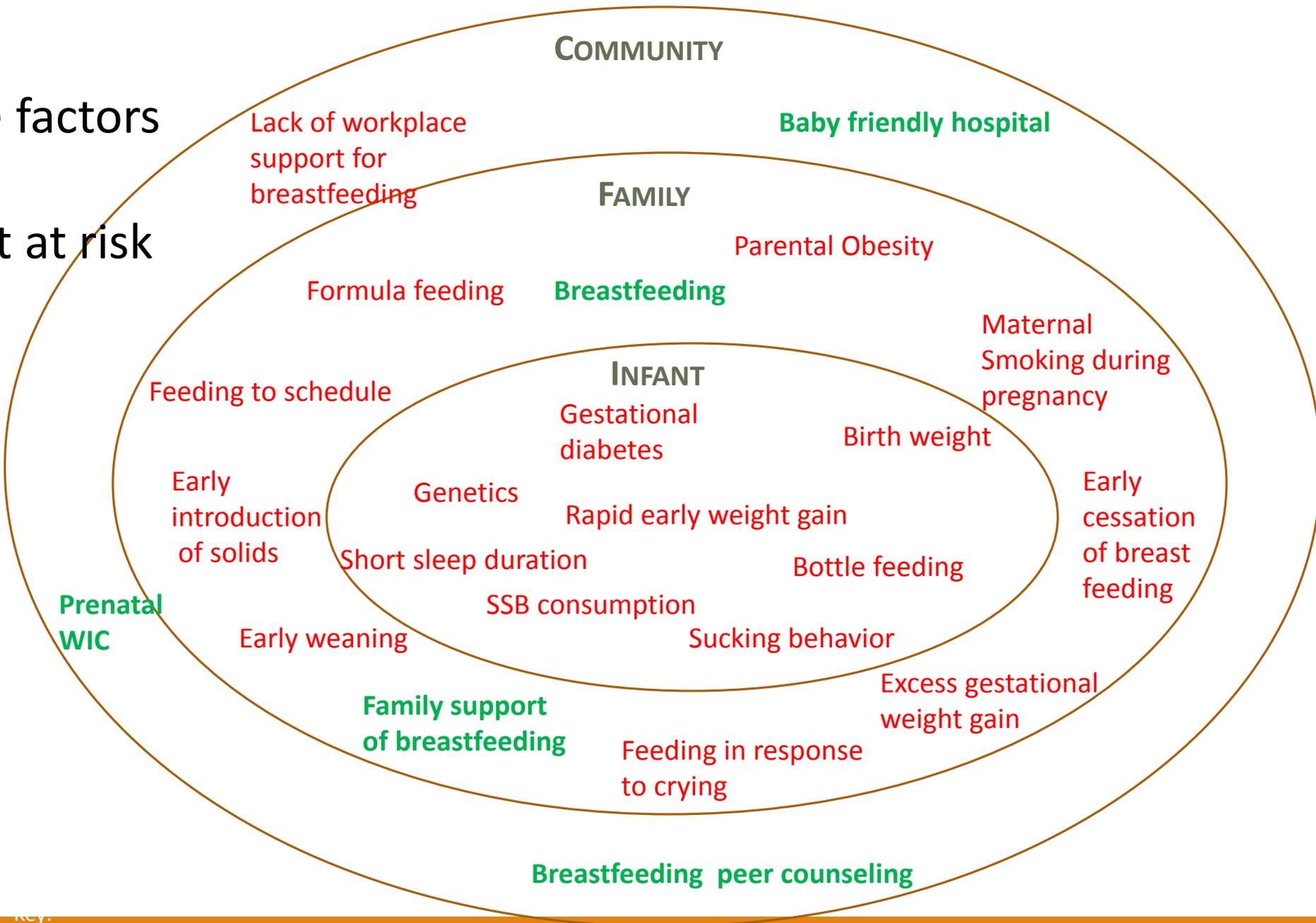
4.2% women 20-39 yrs have BMI > 40

- Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults 1999--2008. *JAMA* 2010; 303:235--41. National Health and Nutrition Examination Survey, 2007--2008.
- Nohr EA, Timpson NJ, Andersen CS, Davey Smith G, Olsen J, Sørensen TI. Severe obesity in young women and reproductive health: the Danish National birth Cohort. *PLoS One*. 2009 Dec 24; 4(12):e8444

Newborns of mothers with obesity

- Increased fat mass, body fat, ponderal index (wt/ht³), and insulin resistance
- Degree of insulin resistance in an infant correlates with maternal insulin resistance and infant adiposity
 - Sewell MF, Huston-Presley L, Super DM, Catalano P. Increased neonatal fat mass, not lean body mass is associated with maternal obesity. *Am J Obstet Gynecol*. 2006 Oct; 195(4):1100-3. Epub 2006 Jul
 - Dundar NO, Anal O, Dundar B, Ozkan H, Caliskan S, Buyukgebiz A. Longitudinal investigation of the relationship between breast milk leptin levels and growth in breast fed infants. *J Pediatr Endocrinol Metab* 2005;18:920-181-187.

Multiple factors placing an infant at risk for Obesity



Prenatal Risk Factors for Obesity: Importance of Maternal Nutrition and Nutritional behaviors

Parental obesity

Maternal diabetes/gestational diabetes

Maternal obesity

Maternal smoking and 2nd hand smoke exposure

Intrauterine growth retardation

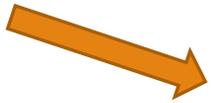
Family high risk nutrition and activity behaviors.

Maternal antibiotic exposure in 2nd-3rd trimester

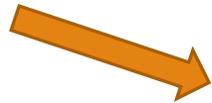
- Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. *N Engl J Med* 1997;337:869-73.
- Stettler N, Iotova V. Early growth patterns and long-term obesity risk. *Curr Opin Clin Nutr Metab Care*. Feb 22 2010.
- Oken E, Levitan EB, Gillman MW. Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. *Int J Obes (Lond)*. Feb 2008;32(2):201-210.
- Mueller N, Whyatt R, Hoepner L, et al. Prenatal exposure to antibiotics, cesarean section and risk of childhood obesity. *International journal of obesity (2005)*. 2015;39(4):665-670. doi:10.1038/ijo.2014.180.
- Wang L, Mamudu HM, Alamiyan A, Anderson JL, Brooks B. Independent and joint effects of prenatal maternal smoking and maternal exposure to second-hand smoke on the development of adolescent obesity a longitudinal study *J Paediatr Child Health*. 2014 Nov;50(11):908-15.

Maternal Mental Health

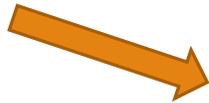
Mothers who reported more depressive symptoms in the prenatal period



Less positive parenting during infancy



Lower levels of child self regulation as a toddler



Higher child BMI at 36 months of age (controlling for birth weight and maternal BMI)

Systematic Review of Modifiable Factors Associated with Overweight and Obesity in the **first Two years of Age**

Feeding and related practices

Rate of weight gain during infancy

Breastfeeding

Introductory age to complementary food

Energy intake

Intake of sugar sweetened beverages

Fruit and vegetable consumption

Attention to hunger and satiety cues

Use of controlling, rewarding or restrictive feeding practices

TV/screen viewing time

Physical activity/play time

Sleep duration

Shared family meals

Breastfeeding and obesity

Cross sectional study: 9,206 children (4022 formula fed/5184 breast fed)

- 4.5% prevalence of obesity in formula fed children age 5-6.
- 2.3% prevalence of obesity in breast fed (from 2- 12 mos) children age 5-6.

In children breast fed for at least 6 months or more the risks of obesity reduced by 40%.

- Kries 1999 BMJ 319,147-149

Reduced incidence of obesity in breast fed infants (dose dependent)

- Owen CG et al Effect of infant feeding on the risk of obesity across the life course; a quantitative review of published evidence Pediatrics 2005;115;1367-1377.

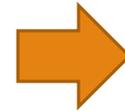
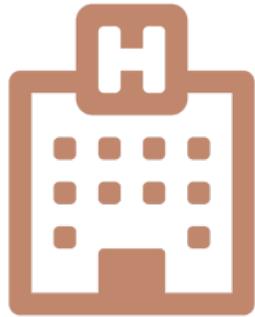
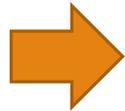
Exclusive breastfeeding for 4 months

- Smaller rate of increase of W/L percentiles during the first year in infants of normal weight mothers and mothers with obesity
 - Yeung H, Leff M, Rhee KE, Effect of Exclusive Breastfeeding Among Overweight and Obesity Mothers on Infant Weight for Length Percentile a 1 Year Breastfeed Med. 2017 Jan/Feb;12:39-47

Increased fat mass in formula fed infants

- Pieltain C et al Weight gain composition in preterm infants with dual x-ray absorptiometry Pediatr Res 2000;49:120-124.

Certain **TRANSITIONS** are critical



American Academy of Pediatrics
Institute for Healthy
Childhood Weight

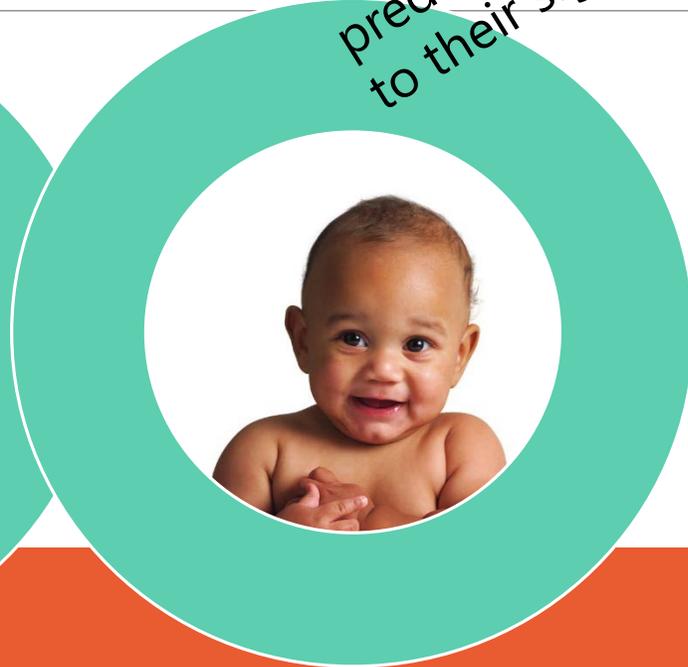
Infant signals hunger
or satiety



Caregiver recognizes
cues and responds
promptly



Child experiences a
predictable response
to their signals

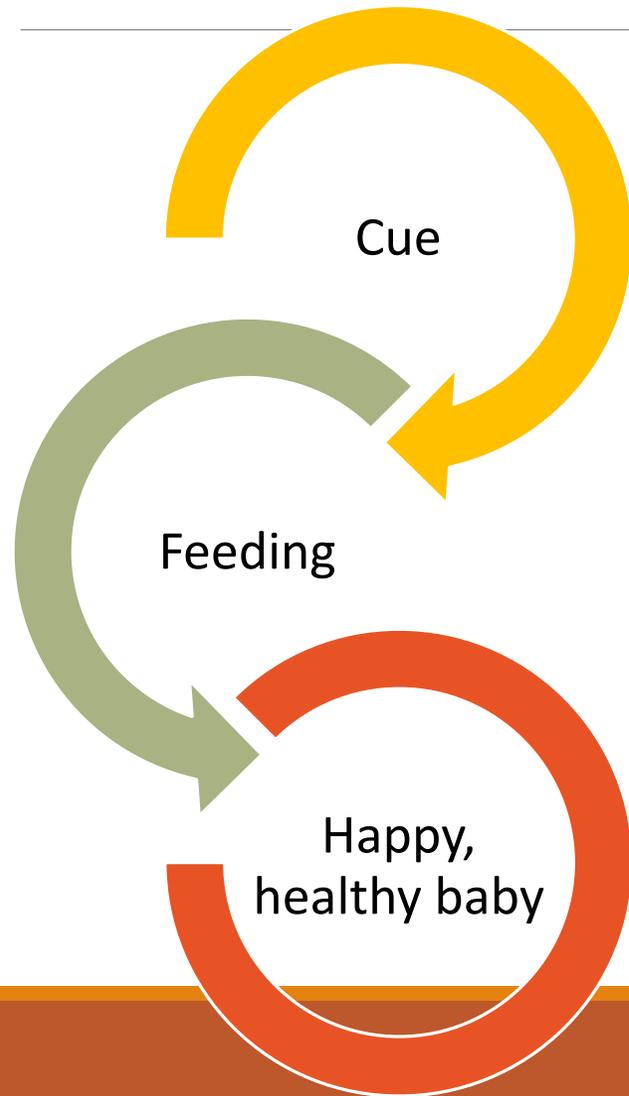


Basic components of responsive feeding



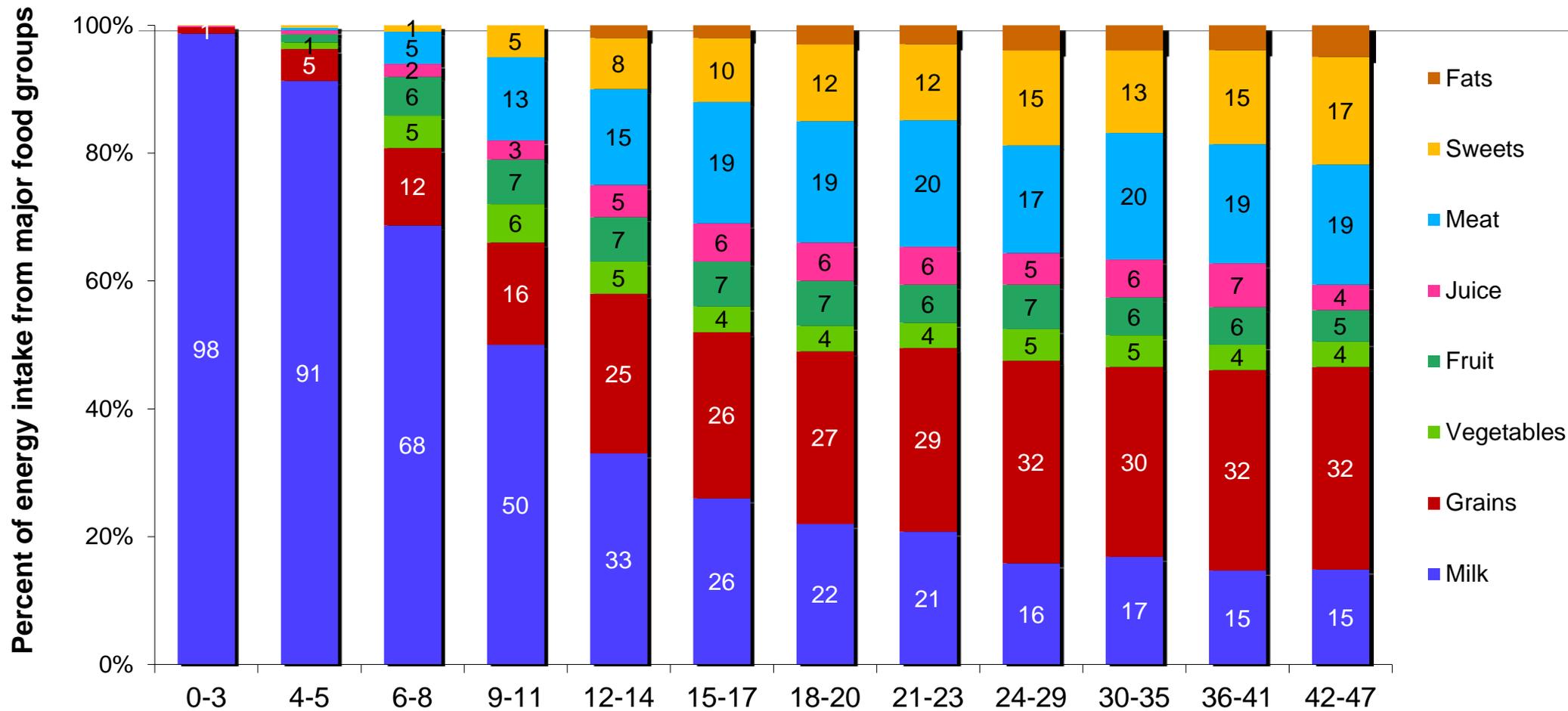
American Academy of Pediatrics
Institute for Healthy
Childhood Weight

Why? Responsive feeding



- Caregiver's and infants **interact through feeding**
 - This is a child's first and most powerful need
 - They depend on a responsive adult for this
- **Responsive feeding is associated with healthy feeding patterns**, food acceptance, and healthy food habits.
- Responsive feeding supports **self-regulation skills**
- Parents who practice responsive feeding will have children that grow up to have **healthier eating habits**

Dietary food group patterns are set very early in life



Rapid Infant Weight Gain

Risk for later obesity

The odds of the child being overweight or at-risk-for-overweight at age 4 yr. were ~40% higher for each additional 100 g/mo. weight gain between birth and 6 months of age.

- Dennison BA, Edmunds LS, Stratton HH, Pruzek RM. Rapid infant weight gain predicts childhood overweight. *Obesity* (Silver Spring). 2006 Mar;14(3):491-9.

Participation in prenatal and early infant WIC associated with reduced risk of rapid Infant weight gain (RIWG) between birth and age 1

- Edmunds LS, Sekhobo JP, Dennison BA, Chiasson MA, Stratton HH, Davison KK. Association of prenatal participation in a public health nutrition program with healthy infant weight gain *Am J Public Health*. 2014 Feb;104 Suppl 1:S35-42. doi: 10.2105/AJPH.2013.301793. Epub 2013 Dec 19

Rapid Infant Weight Gain: Feeding Patterns interactions

Feeding to schedule has also been linked to early weight gain and feeding patterns of formula fed infants tend to have higher volume/feeding and higher daily volume, lower frequency of feeds and a longer interval between feeding.

- Sievers E, Oldigs HD, Santer R, Schaub J: Feeding patterns in breast-fed and formula-fed infants. *Ann Nutr Metab* 2002, 46(6):243-248. Mathew OP, Bhatia J: Sucking and breathing patterns during breast- and bottle-feeding in term neonates. Effects of nutrient delivery and composition. *Am J Dis Child* 1989, 143(5):588-592.
- Mhrshahi S, Battistutta D, Magarey A, Daniels LA. Determinants of rapid weight gain during infancy: baseline results from the NOURISH randomised controlled trial. *BMC Pediatr*. 2011 Nov 7;11:99. doi: 10.1186/1471-2431-11-99

Interventions: Reduction of rapid weight gain in infancy

Randomized controlled trials (RCT) have reduced rapid weight gain in infancy through parenting interventions focused on responsive parenting. Participants were predominantly from non-Hispanic White, well-educated, middle-income families.

- Paul IM, Williams JS, Anzman-Frasca S, Beiler JS, Makova KD, Marini ME, Hess LB, Ruzicidlo SE, Verdiglione N, Mindell JA, Birch LL. The intervention nurses start infants growing on healthy trajectories (INSIGHT) study. *BMC Pediatr.* 2014;14:184.
- Paul IM, Savage JS, Anzman SL, Beiler JS, Marini ME, Stokes JL, Birch LL. Preventing obesity during infancy: a pilot study. *Obesity (Silver Spring)* 2011;19:353–361

Mothers were taught

- to minimize the use of feeding for non-hunger-related fussiness
- recognize and respond to infant hunger and fullness cues to allow the infant to determine how much is consumed
- to foster infant self-soothing to sleep, rather than feeding to sleep
 - Paul IM, Savage JS, Anzman-Frasca S, Marini ME, Mindell JA, Birch LL. INSIGHT Responsive Parenting Intervention and Infant Sleep. *Pediatrics.* 2016;138(1):e20160762.

Compared to a safety control, study infants grew more slowly and had lower weight status at 1 year and had longer night sleep

- Savage JS, Birch LL, Marini M, Anzman-Frasca S, Paul IM. Effect of the INSIGHT responsive parenting intervention on rapid infant weight gain and overweight status at age 1 year: a randomized clinical trial. *JAMA Pediatr.* 2016;170:742–749

Infant risk factors for later obesity: cluster of risk factors

Association in early infancy between short sleep duration and increased weight gain.

- Tikotzky L, DE Marcas G, Har-Toov J, Dollberg S, Bar-Haim Y, Sadeh A Sleep and physical growth in infants during the first 6 months. J Sleep Res. 2010 Mar;19(1 Pt 1):103-10. Epub 2009 Oct 14.PMID: 198402

The risk of overweight increases as more risk factors are added, such as maternal smoking during pregnancy, increased gestational weight gain, shortened breastfeeding duration, and decreased infant sleep duration.

- Gillman MW, Rifas-Shiman SL, Kleinman K, Oken E, Rich-Edwards JW, Taveras EM Developmental origins of childhood overweight; potential public health impact. Obesity (Silver Spring). 2008 Jul;16(7):1651-6. Epub 2008 May 1.

Infant risk factors for later obesity: sugar sweetened beverages

2X obesity prevalence at 6 years

- Children who consumed SSBs during infancy 17% vs. non-SSB consumers 8.6%

Adjusted odds of obesity at 6 years

- 71% higher for any SSB intake
- 92% higher for SSB introduction before 6 months compared with no SSB intake during infancy .

2X odds of obesity in children who consumed SSBs ≥ 3 times per week during ages 10 to 12 months vs. those who consumed no SSBs in this period.

- Pan L, Li R, Park S, Galuska DA, Sherry B, Freedman DS. A longitudinal analysis of sugar sweetened beverage intake in infancy and obesity at 6 years *Pediatrics*. 2014 Sep;134 Suppl 1:S29-35. doi: 10.1542/peds.2014-0646F.

Infant Risk Factors for Later Obesity: Feeding

Timing of solid food introduction linked to type of feeding, with early introduction of solids among formula fed infants associated with higher BMI at age 3 yr.

- Timing of solid food introduction and risk of obesity in preschool-aged children. Huh SY, Rifas-Shiman SL, Taveras EM, Oken E, Gillman MW. *Pediatrics*. 2011 Mar;127(3):e544-51. doi: 10.1542/peds.2010-0740. Epub 2011 Feb 7

Mixed breast and formula feeding is associated with higher weight and length for age Z scores at 3–6 months, 6–9 months, and 9–12 months

- Kramer MS, Guo T, Platt RW, Vanilovich I, Sevkovskaya Z, Dzikovisch, I, Michaelsen KF, Dewey K; Promotion of Breastfeeding Intervention Trials Study Group. *J Pediatr* 2004;145(5):600-605).

Weaning in first 6 mo of life

- Taveras EM, Gillman MW, Kleinman KP, Rich-Edwards JW, Rifas-Shiman SL. Reducing racial/ethnic disparities in childhood obesity: the role of early life risk factors. *JAMA Pediatr*. 2013 Aug 1;167(8):731-8. doi: 10.1001/jamapediatrics.2013.85

Goals for obesity prevention and treatment specific to First Year of Life

Breastfeeding (↑ Initiation and Duration)

Improved feeding practices for infants:

- Understanding hunger and satiety cues
- Safe and appropriate bottle feeding
- Appropriate introduction of complimentary food and drink
 - Wait until 6 months to introduce solid foods
 - Expose infants to a variety of foods and textures consistently
 - Water, breast milk or formula are preferred beverage choice

Foster self-feeding and responsive eating

- Encourage feeding self with finger and utensils
- Allow child to determine when they are “all done”

Encourage movement and activity

Early childhood (1-3 yr) risk factors for obesity

Insufficient sleep < 12 hrs from 6mo-2yr (9)

Any intake of sugar sweetened beverages (soda, flavored milk, fruit drinks) at age 2 yr

- Blum RE, Wei EK, Rockett HR et al Validation of a food frequency questionnaire in Native American and Caucasian children 1 to 5 years of age *Maternal Child Health J* 1999;3(3):167-172

Any intake of fast food at age 3 yr

- Pereira MA, Kartashov AI, Ebbeling CB et al. Fast-food habits, weight gain and insulin resistance (the CARDIA study): 15 yr prospective analysis *Lancet*. 2005;365(9453):36-42.

TV set in the room where child sleeps at age 4 yr

- Taveras EM, Gillman MW, Kleinman KP, Rich-Edwards JW, Rifas-Shiman SL. Reducing racial/ethnic disparities in childhood obesity: the role of early life risk factors. *JAMA Pediatr*. 2013 Aug 1;167(8):731-8. doi: 10.1001/jamapediatrics.2013.85

Environment

Bisphenol A (BPA) is an endocrine disruptor that is widely produced for the manufacture of polycarbonate plastic, epoxy resin, and thermal paper.

Ubiquitous presence in the environment contributes to broad and continuous human exposure

Growing evidence indicates that BPA exposure positively correlates with an increased risk of developing obesity.

- BPA exposure during all life stages correlates with increased body weight and/or body mass index.
- Developmental periods that include prenatal, infancy, and childhood appear to be critical windows with increased sensitivity to BPA effects.
- BPA promotes adipogenesis, lipid and glucose dysregulation, and adipose tissue inflammation, thus contributing to the pathophysiology of obesity.
 - Legeay S, Faure S. Is bisphenol A an environmental obesogenic? *Fundam Clin Pharmacol*. 2017 Dec;31(6):594-609. doi: 10.1111/fcp.12300. Epub 2017 Jul 7

Communities at Risk

Neighborhoods and regions where children are more likely to be overexposed to unhealthy factors and underexposed to healthy ones

In these communities, resources are minimal, infrastructure is not conducive to physical activity, income is generally low, and economic opportunities may be scarce.

The rates of obesity in communities at risk continue to rise far above those where children have access to healthy foods and places where they can engage in physical activity.

Obesogenic Environment and Norms

Goal to improve healthy eating physical activity behaviors of children

Political and commercial factors

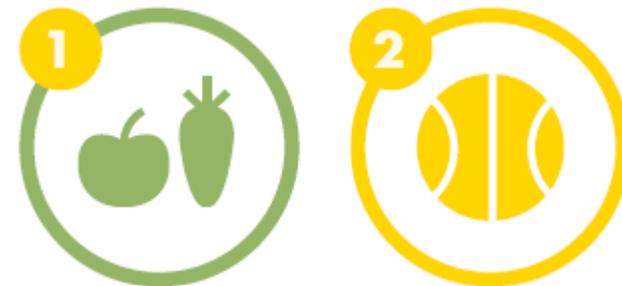
- Trade agreements
- Fiscal and agricultural policies and food systems
- Built environment
 - Availability of healthy food
 - Infrastructure and opportunities for physical activity in the neighborhood

Social norms

- Body weight and image norms
- Cultural norms regarding the feeding of children
- Status associated with higher body mass in some population groups
- Social restrictions on physical activity)

Family environment

- Parental nutrition knowledge and behaviors
- Family economics
- Family eating behaviors



Critical Elements in the Life Course

Goal: Provide guidance and support for optimal development at each stage of the life-course

Focus on **sensitive periods** of the life-course

Interventions to address **specific individual and clustered risk factors**

Integrate approach into other components of the **maternal neonatal-child health agenda**

Integrate into broader effort to tackle **noncommunicable diseases** across the whole population.



Obesity Treatment

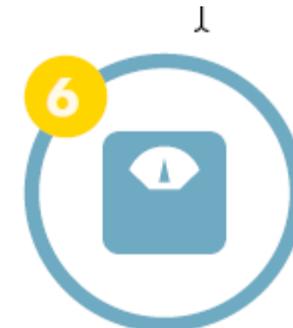
Goal: Improve current and future health of children with obesity

Reduce **overweight**

Improve obesity-related **comorbidities**

Improve risk factors for **excess weight gain**

Include management of children with overweight and obesity in effective services extended under **Universal Health Coverage**.





American Academy of Pediatrics
Institute for Healthy
Childhood Weight

WHERE LIFELONG RESULTS BEGIN

The Institute serves as a translational engine for pediatric obesity prevention, assessment, management and treatment; and moves policy and research from theory into practice in American healthcare, communities, and homes.