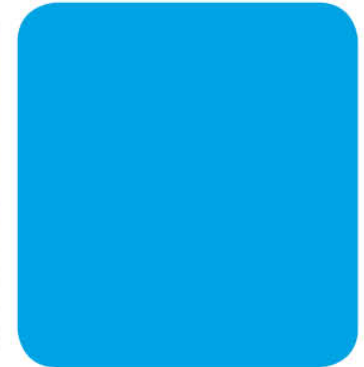
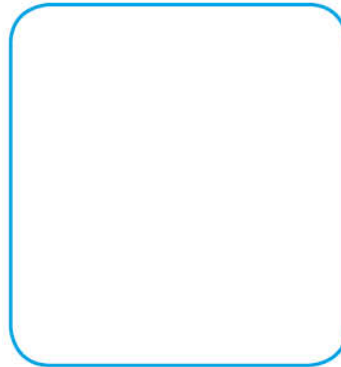
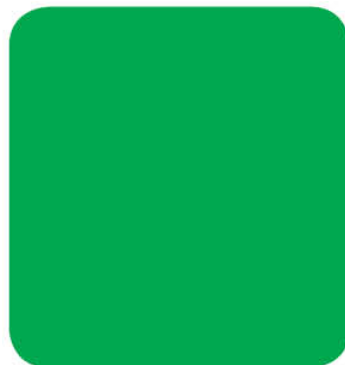


# Early Early Factors in Childhood Obesity

Katherine Kaufer  
Christoffel, MD, MPH  
CLOCC Medical/Research  
Director



Consortium to Lower Obesity  
in Chicago Children  
**clocc**



CLOCC  
Quarterly  
Meeting

Dec 9, 2009





# What I'll Be Talking About

- What we mean by 'Early Early' and why CLOCC is now looking at it
- Review: Obesity in children and the Adiposity Rebound
- Obesity rates in very young children, in the context of the obesity epidemic
- What we know about 'Early Early' factors
- First the child, then the mother
- How CLOCC can begin to address early early issues

# What We Mean By 'Early Early' And Why CLOCC Is Now Looking At It

- CLOCC aims for prevention of obesity
  - i.e., minimize how many children become obese
  - Start early because obesity, once present, often persists
- We have focused on ages 3-5
  - Pretty early!
  - There is a critical period in obesity development then
- We are ready to rethink that age focus
  - Accumulating info shows earlier factors matter
  - Too much obesity already exists by age 3-5
- So CLOCC's prevention efforts have to start earlier
  - We're calling the time before age 3 **'Early Early'**

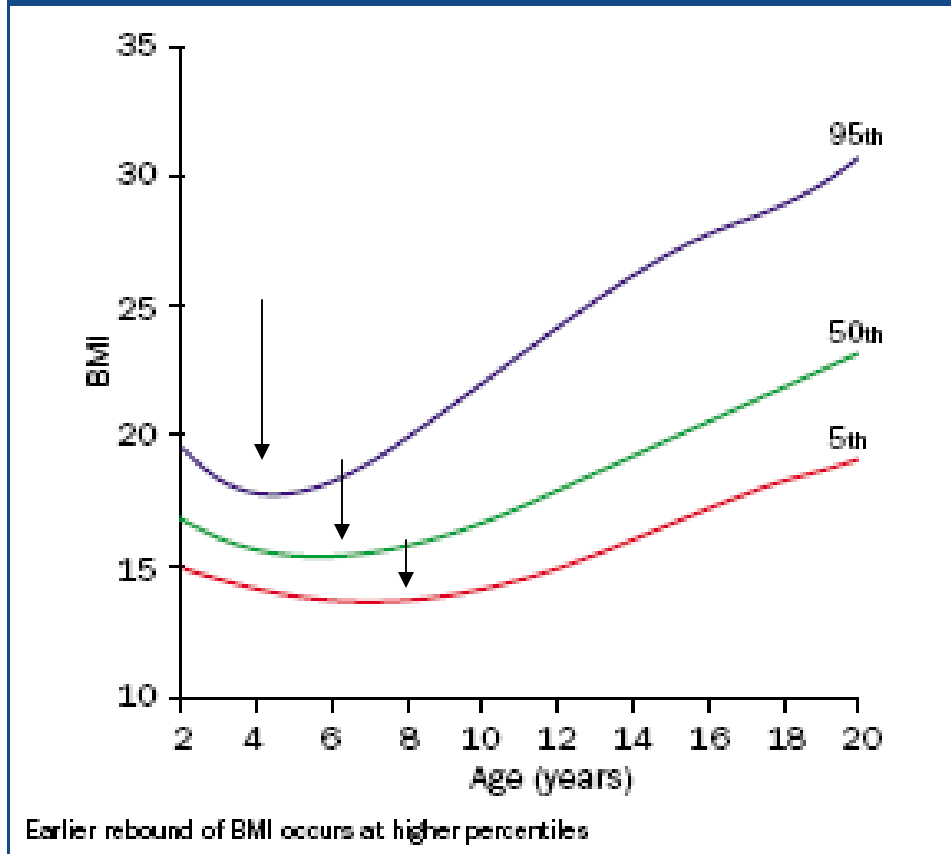


# Review: Persistence Of Early Obesity

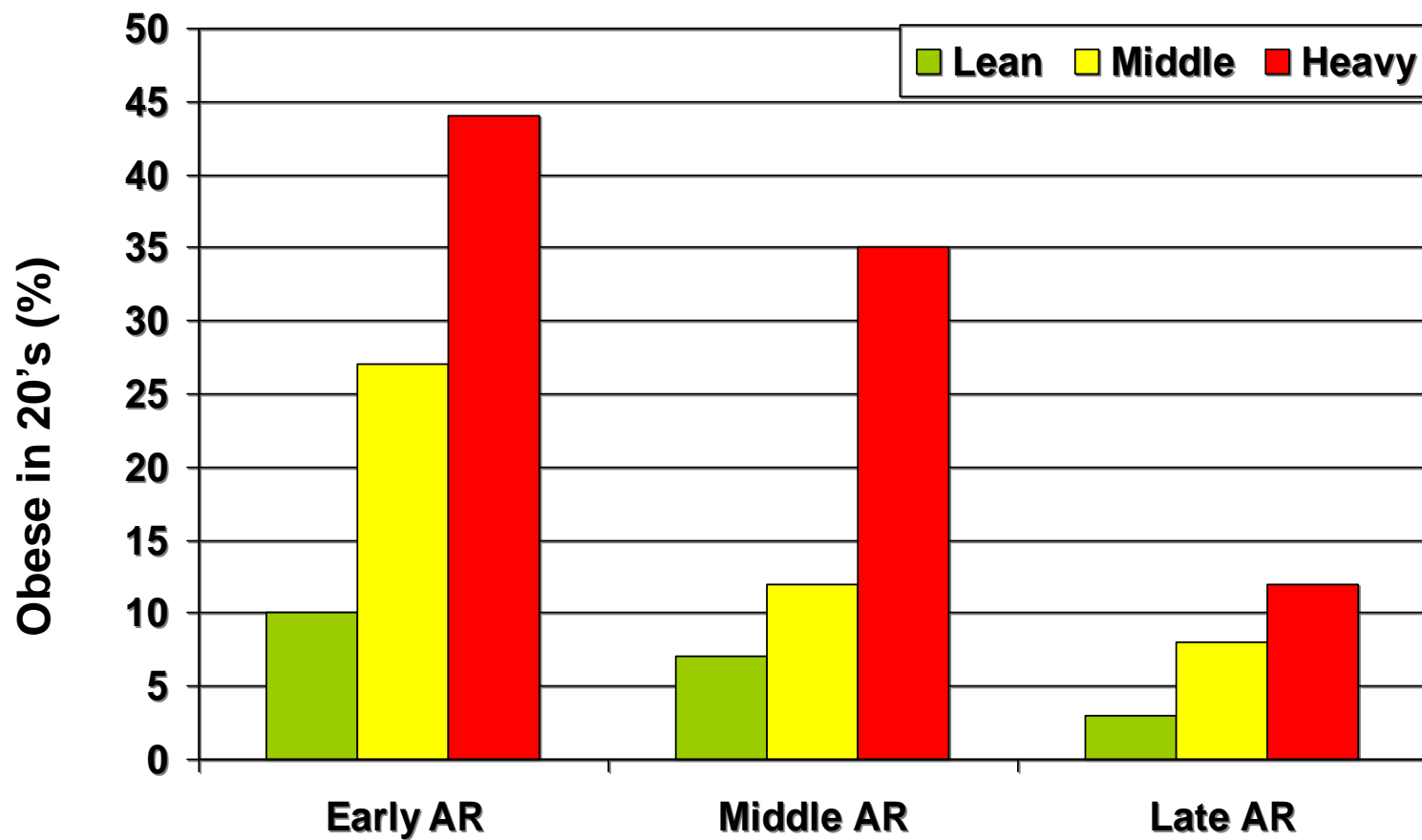
- Familiar to old CLOCC-ers

# Obesity in Children and the Adiposity (BMI) Rebound

BMI percentiles on the US Centers for Disease and Prevention growth charts



# Adiposity Rebound and Obesity





# Obesity Rates In Very Young Children

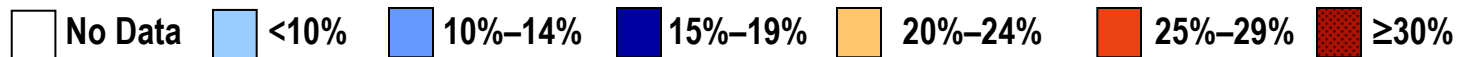
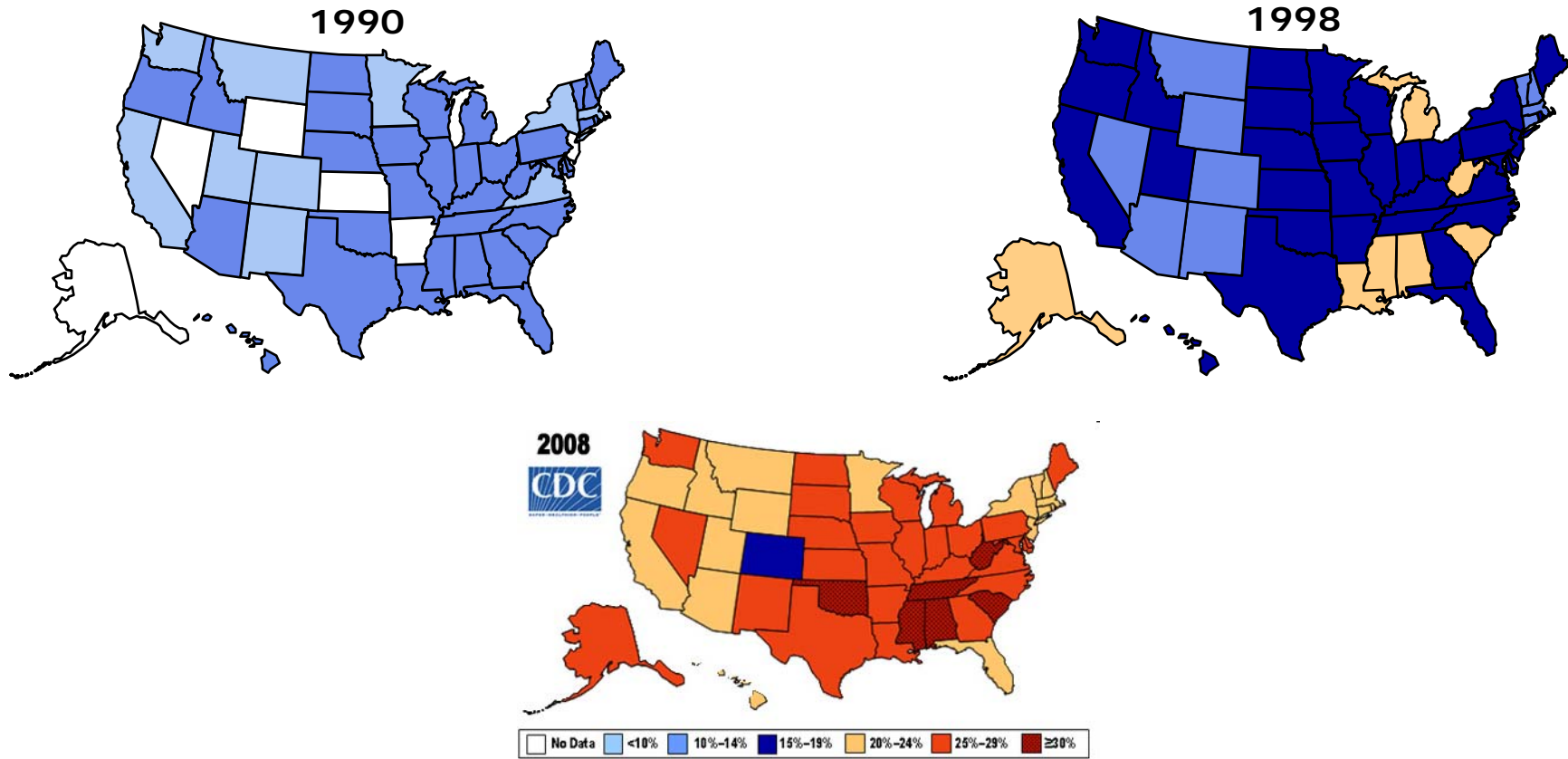
- In historical context



# Obesity Trends\* Among U.S. Adults

## BRFSS, 1990, 1998, 2008

(\*BMI  $\geq 30$ , or about 30 lbs. overweight for 5'4" person)



# Prevalence of Obesity\* Among U.S. Children and Adolescents (Aged 2–19 Years)

	Survey Periods			
	NHANES II 1976–1980	NHANES III 1988–1994	NHANES 1999–2002	NHANES 2003–2006
<b>Ages 2 through 5</b>	<b>5%</b>	<b>7.2%</b>	<b>10.3%</b>	<b>12.4%</b>
<b>Ages 6 through 11</b>	6.5%	11.3%	15.8%	17.0%
<b>Ages 12 through 19</b>	5%	10.5%	16.1%	17.6%

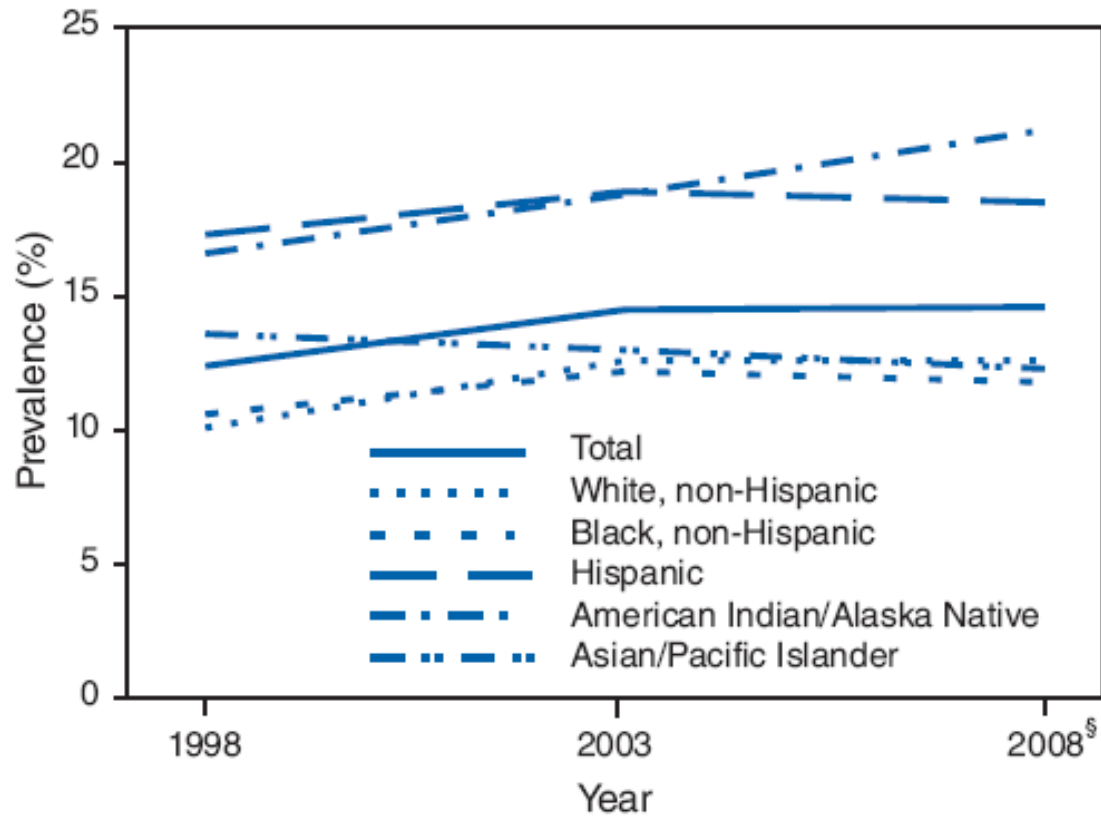
\*Sex-and age-specific BMI  $\geq$  95th percentile based on the CDC growth charts

Sources:

Ogden CL, et al *JAMA* 2002;288:1728–1732.

Hedley AA, et al *JAMA* 2008;299:2401–2405.

# Obesity prevalence, 1998-2008 2-4 year olds, by race/ethnicity (PNSS)



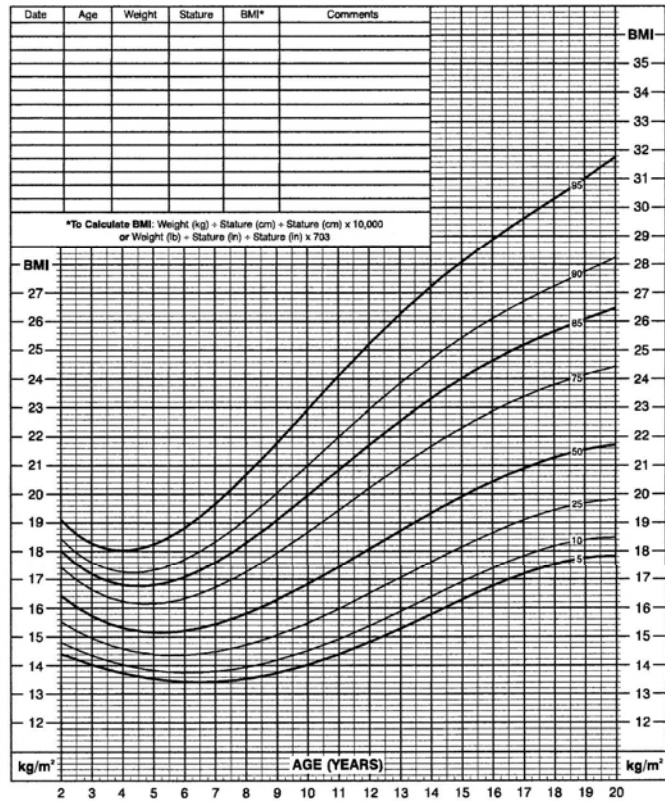
MMWR July 24, 2009 / 58(28);769-773



# A Moment On Measurement

**2 to 20 years: Girls**  
**Body mass index-for-age percentiles**

NAME \_\_\_\_\_  
RECORD # \_\_\_\_\_



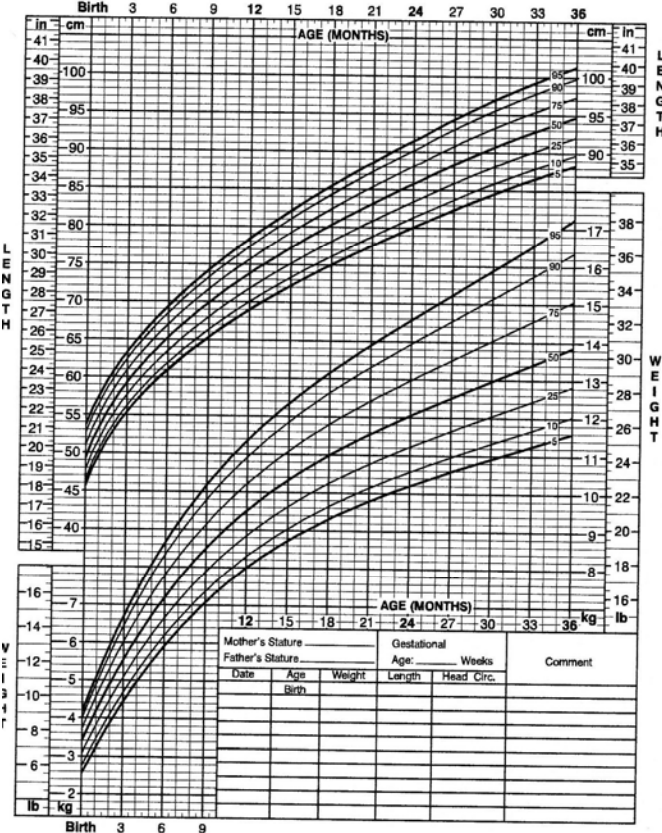
Published May 30, 2000 (modified 10/16/00).  
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).  
<http://www.cdc.gov/growthcharts>



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**Birth to 36 months: Girls**  
**Length-for-age and Weight-for-age percentiles**

NAME \_\_\_\_\_  
RECORD # \_\_\_\_\_



Published May 30, 2000 (modified 4/28/01).  
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).  
<http://www.cdc.gov/growthcharts>



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# Obesity In 1-5 Year Old New Yorkers 2004-2005

- Irigoyen et al 2008
- 1713 children in a 1<sup>o</sup> care network in NY
- Wt-for-length < age 2
- BMI for 2-5 year olds
- 74% Latino
- Finding: rapid rise in obesity ages 1-3

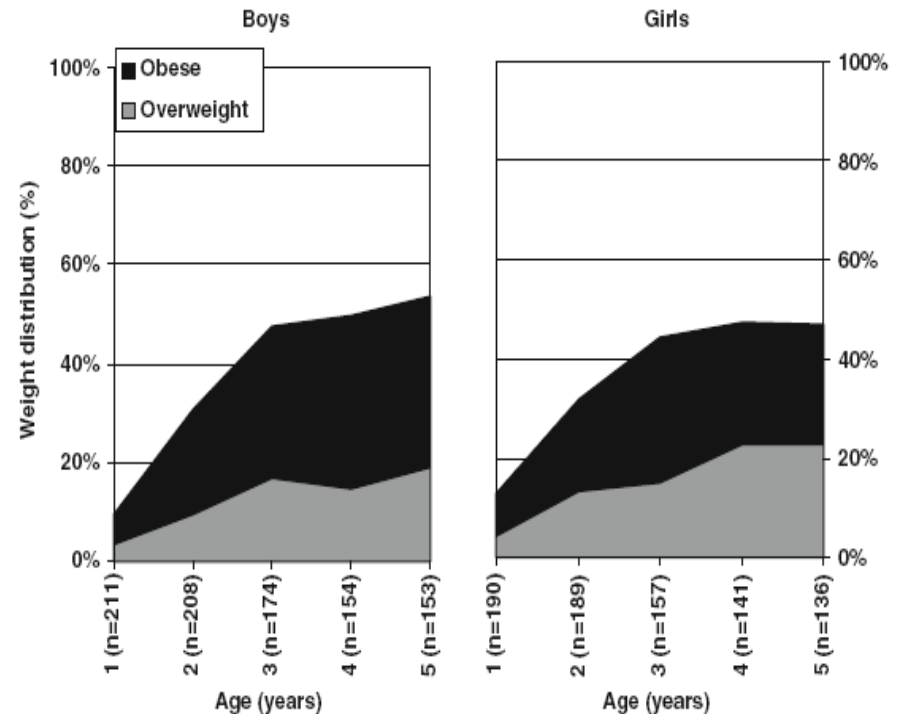


FIGURE 2. Percent of overweight vs. obesity among children ages 1 through 5 years.

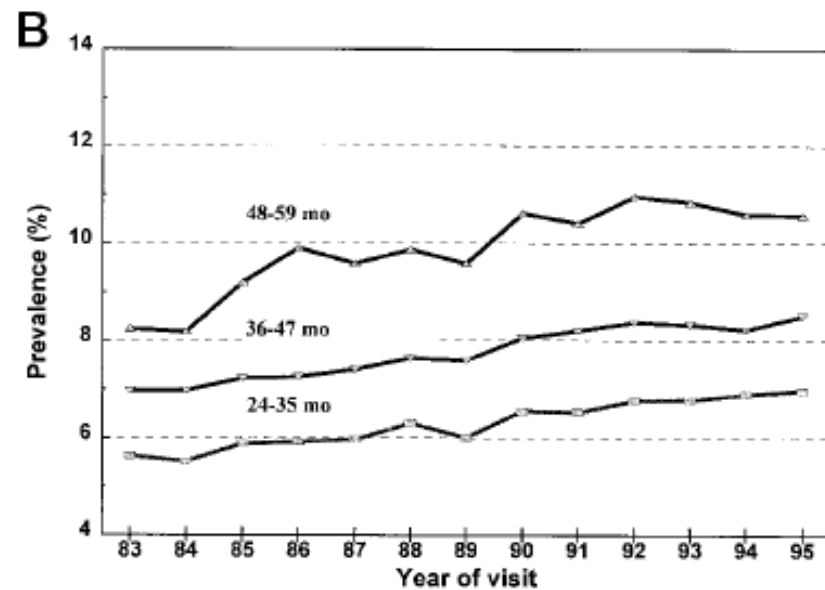
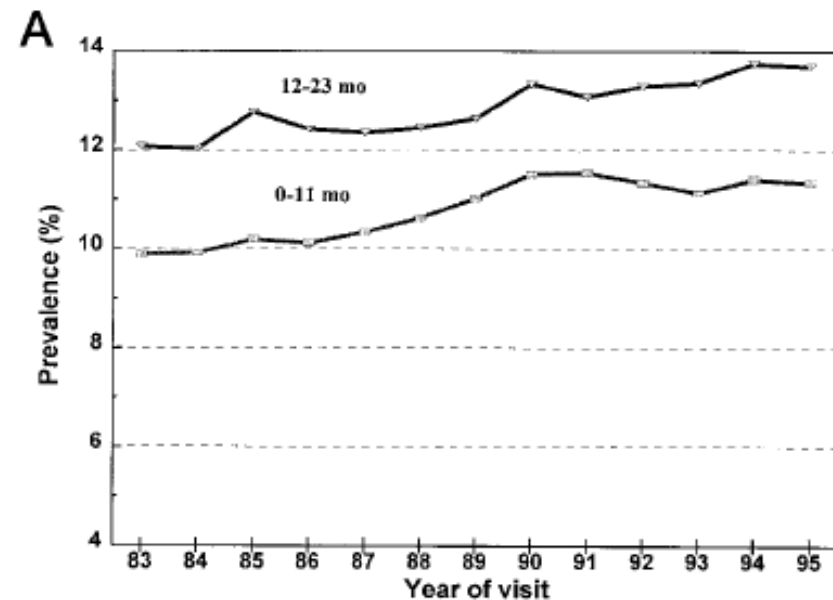
Irigoyen et al J Urban Health 2008

# Obesity rising: Infancy too

**1983-1995** Prevalence  
of obesity (wt-for-ht  
>95th %ile)

- (A) 0-23 mos of age
- (B) 24-59 mos of age

US low-income children  
adjusted by race or ethnicity, sex  
ratio, and age in month; CDC  
Pediatric Nutrition Surveillance





# What we know about Early Early factors

- NB: This section reflects a HUGE literature
  - Summaries only for this presentation
  - There are slightly more detailed slides at the end of the handouts for those interested
  - See references are on the list handed out today (those cited in slides and a few more)

# Some Early Early Factors: Mother and Child

- Mother factors
  - Pre-pregnancy maternal weight
  - Pregnancy weight gain
  - Pregnancy glucose tolerance
  - Toxic exposures in pregnancy
  - Breastfeeding initiation, maintenance
  - Feeding practices
- Child factors
  - Birth weight
  - Weight gain in the early months and years
  - Duration of breastfeeding
  - Night feedings





## Some Child Factors in Early Early Life

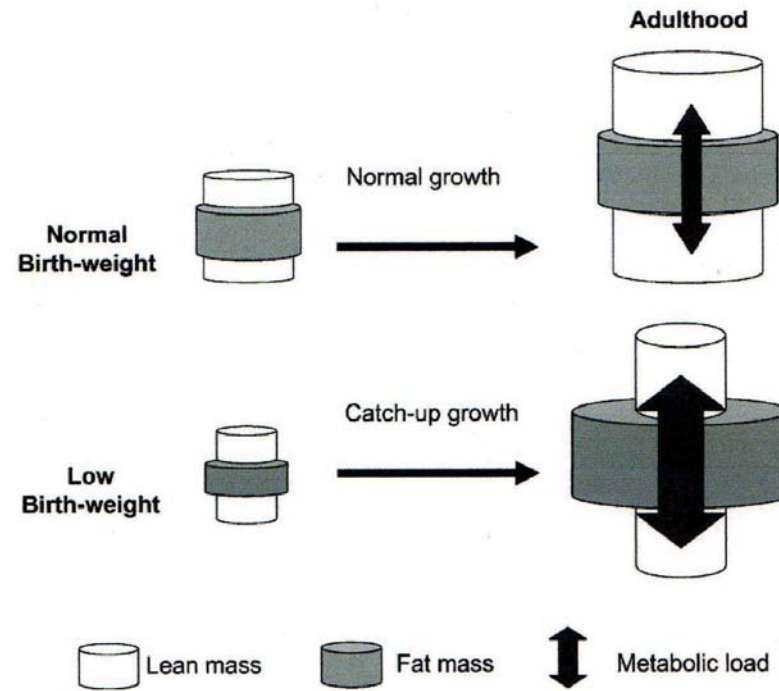
- Not an exhaustive review!
- I am not addressing feeding style issues (such as restriction)

## Birth Weight-Low

- Babies that are small for gestational age (SGA) are prone to develop obesity
  - Famous association between babies in utero during famine and obesity in adult life
- Led to the concept of prenatal developmental programming as key to later obesity

Heindel and vom Saal 2009, Ravelli et al 1999

# Postnatal Life Interacts with Prenatal Growth



**Figure 1** Schematic diagram illustrating the two complementary processes whereby early growth appears to impact on later predisposition to the metabolic syndrome and cardiovascular disease. First, normal growth promotes growth of lean mass, whereas poor fetal and infant weight gain appear permanently to constrain it. Second, catch-up growth, especially when it persists into childhood, promotes excess fat accumulation, especially in the abdomen. The relative ratio of central fat to lean mass is then represented as "metabolic load". The low-birthweight infant is at risk of high metabolic load through both routes. Further work is required to elucidate differences between populations from industrialised *versus* developing countries regarding this scenario.

# Birth weight-high

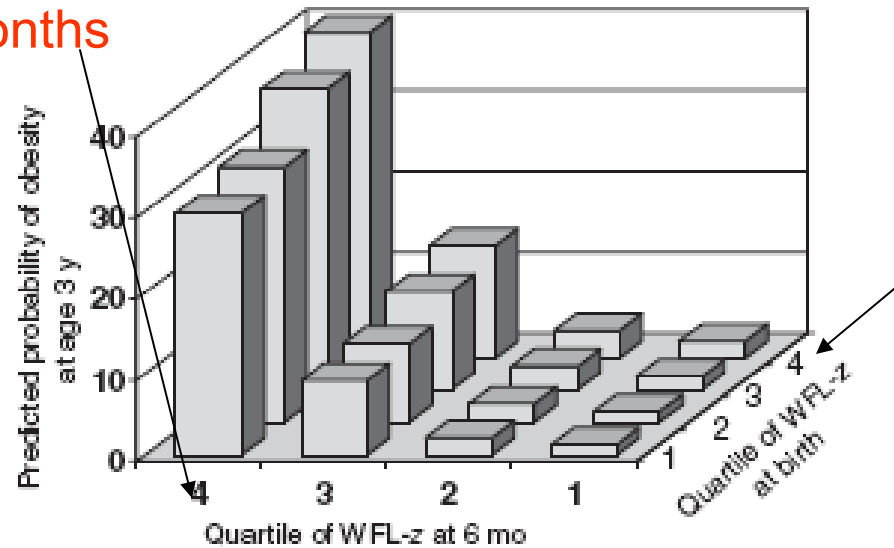
- As birth wt rises, child and young adult BMI rises
  - Mostly white young adults
- That relationship not present in middle aged adults
  - But often small studies, poor control of other factors
- Body composition matters in these analyses
  - BMI does not distinguish lean body mass (LBM)
  - In adults, high BW associated with high LBM/not adiposity
  - In child studies, similar findings, incl. LGA babies, preschool age
- Studies have mainly used skin folds to assess adiposity
  - Better studies are needed using sounder measures, e.g., DEXA

# Weight gain in the early months and years

- Multiple Studies show that no matter what the heaviness at birth, faster gain means a heavier child (controlling for other factors)
  - 1<sup>st</sup> 6 months
  - 1<sup>st</sup> year
  - 1<sup>st</sup> 2 years

# Weight gain in the early months and years

Heaviest at  
6 months



Heaviest  
at birth

FIGURE 1

Predicted probability of obesity (BMI of  $\geq 95$ th percentile) at 3 years of age according to quartile of WFL z score at birth and at 6 months of age, with adjustment for maternal smoking status, gestational weight gain, education, household income, parity, age, and prepregnancy BMI, paternal BMI, and child age, gender, and race/ethnicity.

1401 children, ~70% white/many Latino, ~75% college ed'ed mothers

Taveras et al 2009

# Duration of breastfeeding

Breast Feeding  
in 9357 German  
Children

Obese\* At  
Age 5y in 1997 (OR)  
(controlling for other factors)

---

None	5.6
< 2 months	4.8
3-5 months	2.9
6-12 months	2.1
> 12 months	1.0

# Breastfeeding

- The effect is consistent, significant, modest
  - Across multiple studies, breastfeeding reduces risk of obesity in children/adolescents by ~25%
    - Some studies find more, or don't find an association
  - Each month of breastfeeding reduces risk by 4%
- Proposed mechanisms
  - Bonding/feeding responsiveness
  - Protein content in formula is higher (may raise insulin)





## Some Mother Factors

- Not an exhaustive review!

# Pre-pregnancy maternal weight

- Maternal pre-pregnancy obesity increases risk of child obesity at 2-4 years by ~40% (controlling for other factors)
- Maternal obesity in 1<sup>st</sup> trimester raises risk of obesity in 2-4 year olds by  $\geq 2X$  (controlling for other factors)
- For mothers with 2 pregnancies in 8 years
  - Overwt & obese moms ~2x as likely to have LGA babes
  - When overwt changed from preg 1 to 2
    - More overwt in preg 2: more likely to have LGA baby
    - Less overwt in preg 2: less likely to have LGA baby

## Pregnancy weight gain

- More maternal wt gain, higher child BMI
- Mothers with adequate or excessive wt gain: 4X more likely to have overweight children at 3 years of age than those with inadequate wt gain
  - IOM guidelines for wt gain

Oken et al 2007

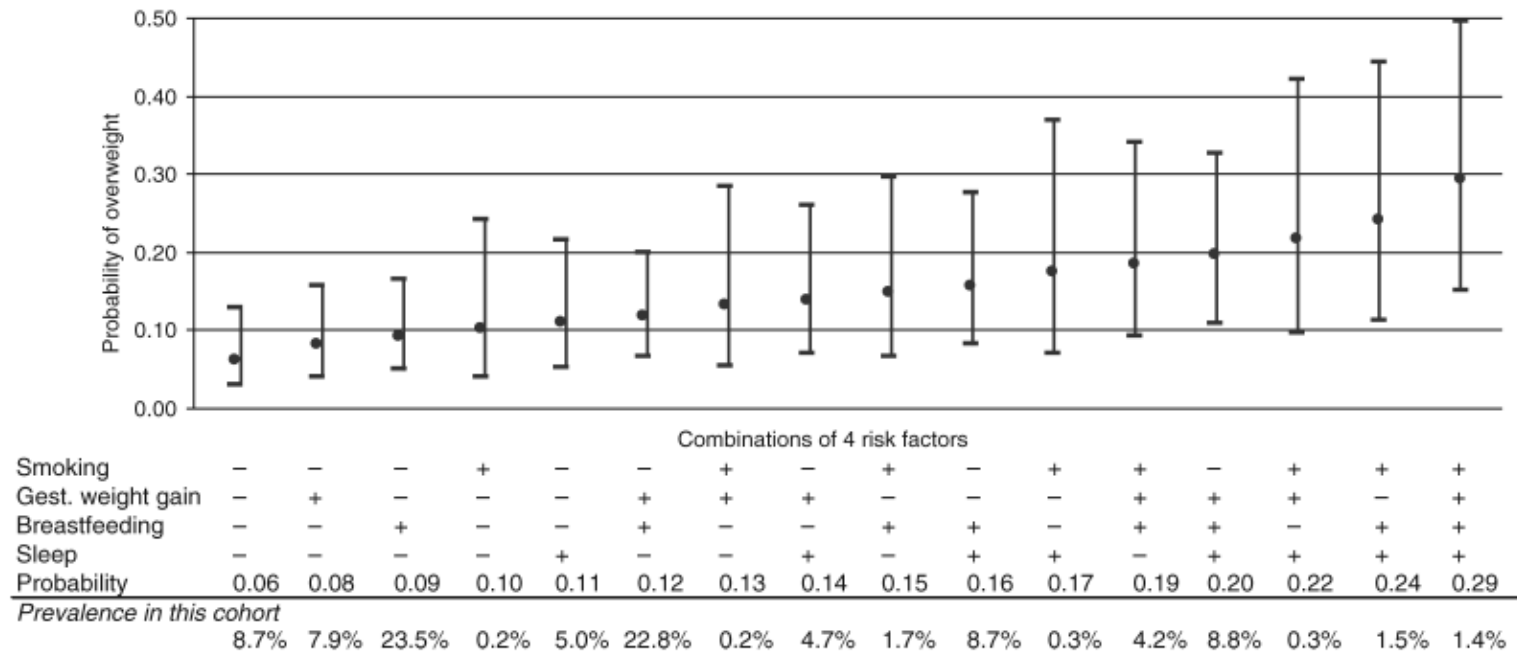
# Pregnancy glucose tolerance

- Gestational Diabetes Mellitus (GDM) raises risk for high birth weight (LGA)
  - LGA babies and babies of mother with GDM are at high risk for childhood obesity
- Maternal obesity raises the risk of GDM
  - Overweight: 2X; Obese 3.5X; Very obese 8.5X

# Toxic Exposures In Pregnancy Raise Rates Of Child Obesity

- Smoking (raises risk of child obesity ~50%)
- Endocrine disrupting chemicals (animal, human studies)
  - Glucocorticoids, other hormones, some plastics, some pesticides (many banned in US)-ongoing study
- Low protein diet
- Proposed mechanisms
  - Disruption of processes controlling eating, activity, metabolism, and fat formation
  - During critical developmental windows, e.g., formation of appetite and satiety centers in brain

# Considering Factors in Combination



**Figure 1.** Predicted probability of overweight at 3 years for 16 combinations of four modifiable risk factors during pregnancy and infancy. Bars show 95% confidence limits. Also shown is prevalence in this cohort for each depicted combination of factors. Data from 1,110 mother-child pairs participating in Project Viva. Probabilities are adjusted for maternal education and BMI, household income, and child race/ethnicity.



# I Trust You are Convinced?

- Early Early factors matter
- CLOCC has to take them on

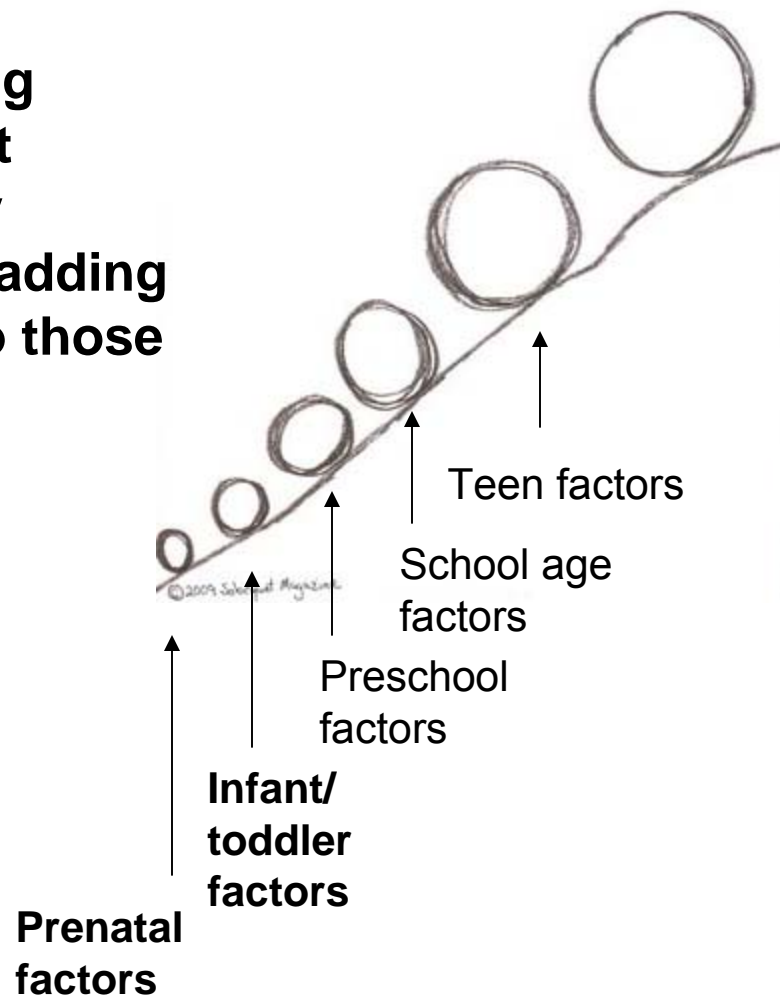


# How CLOCC Can Begin To Address Early Early Issues



# Understand the Snowball Effect At Work

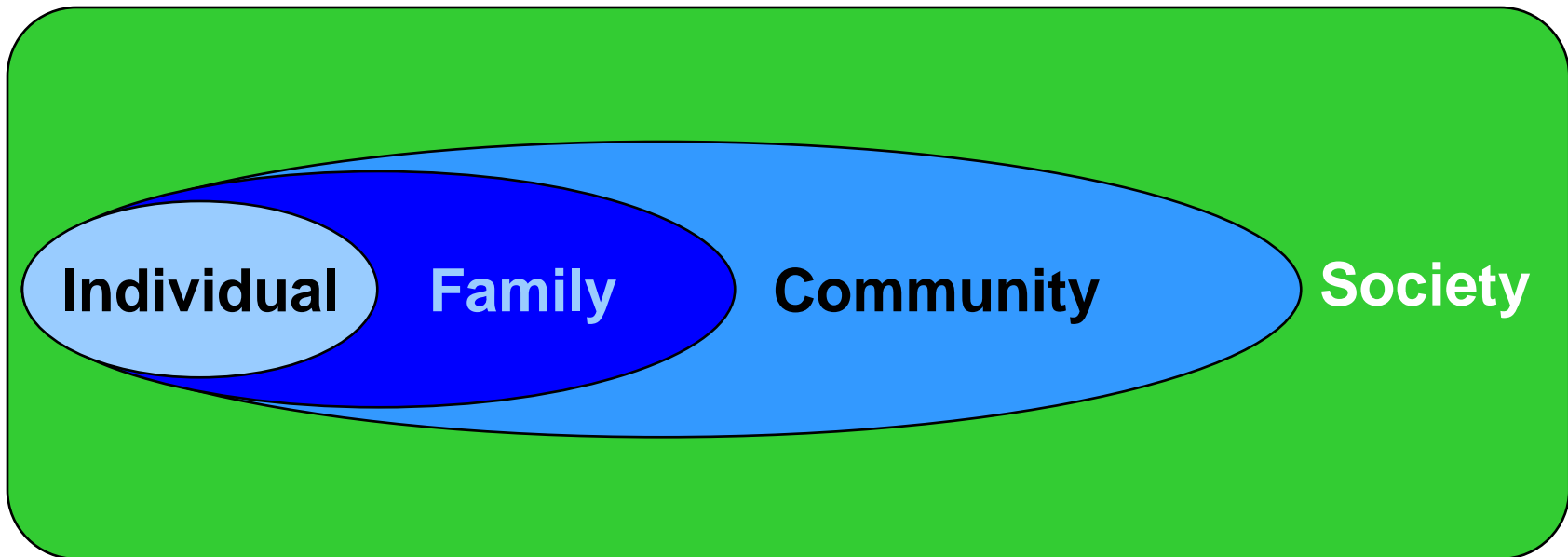
- **Accumulating factors affect child obesity**
- **We are now adding early ones to those we address**



# CLOCC Network Provides Structure

- Working Groups closest to this focus
  - Early Childhood: ECWG
  - Clinical Practices: CPWG
  - Government Policies and Programs: GPPWG
  - University Partnerships: UPWG
- COOP/Vanguard Community Partners
- Corporate Advisory Committee: CAC
- Interdepartmental Task Force: IDTF

# Using The Ecological Model



# Possible Actions (Just Examples)

CLOCC part/partner	Individual/ Clinical Level	Family Level	Community/ Institutional Level	Societal Level
ECWG	Tools/resources for providers on early child recs		Work w HC 1 on BF PR	Public Education on normal eating
CPWG	ObGyn, Ped/Adol Med, FM docs	Lactation consultants	Nutrition ed'n in child care	Focus on teens as future parents
GPPWG/ Policy		Foster BF in maternity wards	Support BF at work, in public	BF Surveillance
UPWG/students & study	X	X	X	X
Seed grants/ Evaluation	X	X	X	X
COOP/ Vanguard Areas		Parent support groups	Grocery fare WIC, BF promo	
CAC			Support BF in workplace	Corporate Inreach
IDTF			New child care regs	

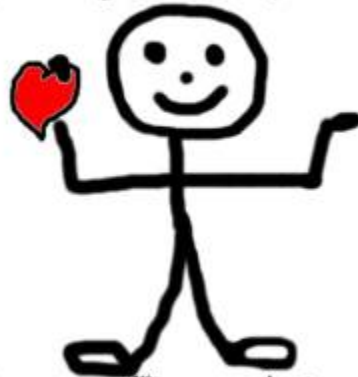
BF: Breastfeeding; FM: Family Medicine; PR: Publicity



# Our Likely Top Focuses Stick with Me Most Clearly as Pictures

# Smoking Cessation Efforts

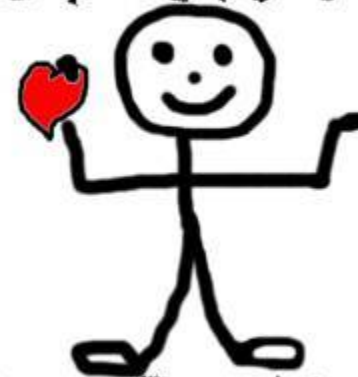
Mom I Love You!



Stop Smoking!

[www.byteland.org/cancer/](http://www.byteland.org/cancer/)

Dad I Love You!



Stop Smoking!

[www.byteland.org/cancer/](http://www.byteland.org/cancer/)

# Breastfeeding Promotion

THE ORIGINAL HAPPY MEAL



<http://www.naturesmothers.moonfruit.com/communities/2/004/006/125/212/images/4516943903.jpg>

# Clinical Providers Supporting Families



womenshealth.gov



<http://www.aboutkidshealth.ca/HealthAZ/Your-Babys-First-Medical-Visit.aspx?articleID=7648&categoryID=AZ3a>



# Child Care Settings Working with Children and Parents



nyc.gov

# City Government and Various Legislatures Making New Policies



[http://upload.wikimedia.org/wikipedia/commons/0/0a/Daley\\_Plaza\\_060716.jpg](http://upload.wikimedia.org/wikipedia/commons/0/0a/Daley_Plaza_060716.jpg)



<http://www.njbiz.com/img/photos/legislature.JPG>

## Starting with Those, CLOCC Will Step into 'Early Early'

- We look forward to working with you in this new arena for CLOCC
- Based on our shared experience, it should be a great ride!





Further Information Slides Follow

## Getahun et al 2007 Studied Mothers With Two Pregnancies During 9 Years

- What they learned
  - Overwt & obese moms ~2x as likely to have LGA babes
  - Change in overwt changed risk of LGA from preg 1 to 2
    - More overwt in preg 2: more likely to have LGA baby
    - Less overwt in preg 2: less likely to have LGA baby
- How they learned it
  - 1989-1997 MO data, 146,227 women with live births
  - Characterized wt status of mother and baby at birth
    - Mothers overwt or obese based on BMI
    - LGA babies (>90<sup>th</sup> %ile, more likely to be overwt later)
      - Large for Gestational Age

## Other Recent Studies

- Whitaker 2004
  - *What:* Maternal obesity in 1<sup>st</sup> trimester risk of obesity in 2-4 year olds by  $\geq 2X$  (controlling for other factors)
  - *How:* Ohio WIC data, 8494 low income children
- Salsberry and Reagan 2005
  - *What:* Maternal pre-pregnancy obesity increased risk of child obesity at 2-4 years by  $\sim 40\%$  (vs nl wt, controlling for other factors)
  - *How:* Nat'l Long. Survey of Youth, 3022 children

## Oken et al 2007, Boston

- *What*
  - More maternal wt gain, higher child BMI
  - Mothers with adequate or excessive wt gain were 4X more likely to have overweight children at 3 year of age (vs. inadequate weight gain; indicated by BMI and skinfolds, controlling for other factors)
- *How*
  - 1044 mother child pairs in Project Viva (11% B, 6% Hispanic, 6% unmarried)
  - 1990 IOM standards for weight gain



# Glucose Levels In Pregnancy Affect Birth Weight

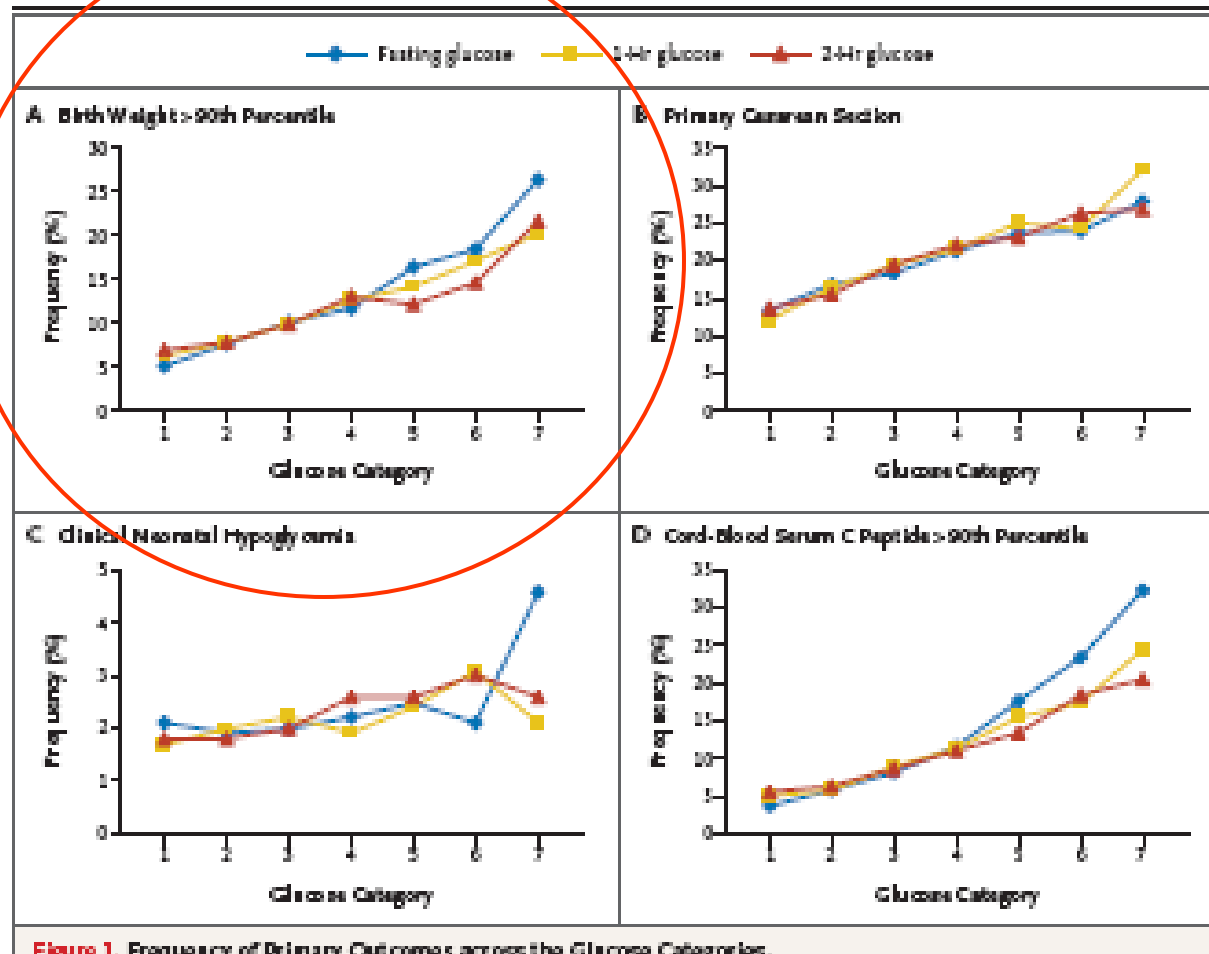


Figure 1. Frequency of Primary Outcomes across the Glucose Categories.

HAPO Study. N Engl J Med 2008;358:1991-2002.

# Cigarette smoking in pregnancy is not good for this reason too

- Olson et al-Bassett Mothers Study, rural NY
  - *What:* Smoking increased childhood overweight at 3 years by 3X (after controlling for other factors)
  - *How:* This analysis included 208 mother-child pairs
- Salsberry and Reagan-Nat'l Long. Study of Youth
  - *What:* Smoking increased child obesity (after controlling for other factors)
    - 37% at ages 2-3
    - 74% at ages 6-7
  - *How explained earlier*

# Hexachlorobenzene and childhood obesity

- Smink et al 2008
  - 482 exposed pregnancies in Menorca (an Island in Spain)
  - Measured levels of HCB, total PCBs in cord blood
  - Child ht and wt at age 6.5y
  - Overweight:  $\geq 85^{\text{th}}$  %ile BMI on WHO/NCHS curves
  - Surveys for maternal info, including smoking and weight

## Oken, Lev Itan, Gillman 2008

- Review and meta-analysis 1966-2006
  - 14 studies, 84,563 children
  - Multi-variable associations
  - Prenatal smoking and child wt age 3

# Rogers and EURO-BLCS Study Group 2003

- Review of literature on birthwt and BMI later in life, 1966-
- For children and young adults
  - Linear or U or J shaped relationship
- For middle aged subjects
  - BW associated with lean body mass but negatively associated with adiposity
    - Controlling for current wt, neg association with central adiposity
  - Many of these studies small, inadequate control for SES factors

## Gillman et al 2008

- Project Viva (Boston), 1110 mother-child pairs
- Focus on 4 risk factors: smoking in pregnancy, gestational weight gain, breastfeeding duration, daily sleep in infancy
- Obesity defined at BMI  $\geq 95^{\text{th}}$  percentile
- Survey data on maternal pre-pregnancy wt, demography, child diet/activity/screen time