Early Early Factors in Childhood Obesity

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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

Earlier rebound of BMI occurs at higher percentiles
Adiposity Rebound and Obesity

www.pediatrics.org/cgi/content/full/101/3/e5
Obesity Rates In Very Young Children

- In historical context
Obesity Trends* Among U.S. Adults
(*BMI ≥30, or about 30 lbs. overweight for 5’4” person)
## Prevalence of Obesity* Among U.S. Children and Adolescents

**(Aged 2–19 Years)**

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Ages 2 through 5</td>
<td>5%</td>
<td>7.2%</td>
<td>10.3%</td>
<td>12.4%</td>
</tr>
<tr>
<td>Ages 6 through 11</td>
<td>6.5%</td>
<td>11.3%</td>
<td>15.8%</td>
<td>17.0%</td>
</tr>
<tr>
<td>Ages 12 through 19</td>
<td>5%</td>
<td>10.5%</td>
<td>16.1%</td>
<td>17.6%</td>
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</tbody>
</table>

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

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

MMWR July 24, 2009 / 58(28);769-773
A Moment On Measurement

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

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-3</td>
<td>50</td>
<td>16</td>
</tr>
<tr>
<td>4-5</td>
<td>90</td>
<td>25</td>
</tr>
<tr>
<td>6-7</td>
<td>120</td>
<td>35</td>
</tr>
<tr>
<td>8-9</td>
<td>150</td>
<td>45</td>
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<tr>
<td>10-11</td>
<td>180</td>
<td>55</td>
</tr>
<tr>
<td>12-13</td>
<td>210</td>
<td>65</td>
</tr>
<tr>
<td>14-15</td>
<td>240</td>
<td>75</td>
</tr>
<tr>
<td>16-17</td>
<td>270</td>
<td>85</td>
</tr>
<tr>
<td>18-20</td>
<td>300</td>
<td>95</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>Height (cm)</th>
<th>Weight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>50</td>
<td>3</td>
</tr>
<tr>
<td>2-3</td>
<td>55</td>
<td>4</td>
</tr>
<tr>
<td>4-5</td>
<td>60</td>
<td>5</td>
</tr>
<tr>
<td>6-7</td>
<td>65</td>
<td>6</td>
</tr>
<tr>
<td>8-9</td>
<td>70</td>
<td>7</td>
</tr>
<tr>
<td>10-11</td>
<td>75</td>
<td>8</td>
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<td>12-13</td>
<td>80</td>
<td>9</td>
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<td>14-15</td>
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<td>10</td>
</tr>
<tr>
<td>16-17</td>
<td>90</td>
<td>11</td>
</tr>
<tr>
<td>18-20</td>
<td>95</td>
<td>12</td>
</tr>
</tbody>
</table>

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Published May 30, 2000 (modified 2/18/09).

*For Calculating BMI: Weight (kg) / Height (m) x Height (m) = BMI

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Consortium to Lower Obesity in Chicago Children (CLOCC)

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CLOCC (Consortium to Lower Obesity in Chicago Children) is a collaborative effort to reduce obesity in children through evidence-based interventions and community partnerships. For more information, visit http://www.clocc.org.
Obesity In 1-5 Year Old New Yorkers 2004-2005

- Irigoyen et al 2008
- 1713 children in a 1º 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

Mei et al 1998
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

Rogers et al 2003
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)
  - 1st 6 months
  - 1st year
  - 1st 2 years
Weight gain in the early months and years

Heaviest at birth
Heaviest at 6 months

FIGURE 1
Predicted probability of obesity (BMI of ≥95th 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
<table>
<thead>
<tr>
<th>Duration of breastfeeding</th>
<th>Obese* At Age 5y in 1997 (OR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>5.6</td>
</tr>
<tr>
<td>&lt; 2 months</td>
<td>4.8</td>
</tr>
<tr>
<td>3-5 months</td>
<td>2.9</td>
</tr>
<tr>
<td>6-12 months</td>
<td>2.1</td>
</tr>
<tr>
<td>&gt; 12 months</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Breast Feeding in 9357 German Children

* 97th %ile BMI

Von Kries et al BMJ 1999; also see Taveras et al 2006
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)

Koletzko et al 2009
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 1st trimester raises risk of obesity in 2-4 year olds by >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 overwt 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

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
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

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

Dad I Love You!
Stop Smoking!
www.byteland.org/cancer/
Breastfeeding Promotion

THE ORIGINAL HAPPY MEAL

Clinical Providers Supporting Families

womenshealth.gov

http://www.aboutkidshealth.ca/HealthAZ/Your-Babys-First-Medical-Visit.aspx?articleID=7648&categoryID=AZ3a
City Government and Various Legislatures Making New Policies

http://www.njbiz.com/img/photos/legislature.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!
That's all folks.
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 babies
  – 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 (>90th %ile, more likely to be overwt later)
      – Large for Gestational Age
Other Recent Studies

• Whitaker 2004
  – *What:* Maternal obesity in 1\textsuperscript{st} 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)
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

Cigarette smoking in pregnancy is not good for this reason too

• Olson et al-Bassett Mothers Study, rural NY
  – *What*: Smoking increased childhood overwt 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: $\geq\text{85}^{\text{th}}$ %ile BMI on WHO/NCHS curves
  – Surveys for maternal info, including smoking and weight
• Review and meta-analysis 1966-2006
  – 14 studies, 84,563 children
  – Multi-variable associations
  – Prenatal smoking and child wt age 3
• 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 \( \geq 95^{th} \) percentile
- Survey data on maternal pre-pregnancy wt, demography, child diet/activity/screen time