Childhood Overweight Increasing Globally

Figure 1: Estimates of percentage of childhood population overweight, including obese (with use of International Obesity Taskforce cutoffs) in a selection of countries

Why, What, How for Obesity Prevention During Infancy

- Why is infancy a good time to intervene?
- What can be done to prevent obesity on an *individual level*?
- How are we trying to demonstrate the efficacy of interventions?
Most recent data from 2009-2010
2-5 year olds – 12.1 Obese, 26.7% overweight or obese

Ogden CL et al. JAMA, 2012.
Can We Interrupt the Vicious Cycle of Obesity?

Overweight Mother

↑ Birth weight or Rapid infant growth

Overweight Child / Adolescent

↑ Birth weight or Rapid infant growth

Overweight / Obese Mother

Limited success with interventions

>25% of 2-5 year olds are overweight

40-50% of women aged 20-39 years

Opportunities for Prevention
Preventing Obesity – Why Infancy?

- Infancy represents an attractive period to intervene
  - period of great behavioral and metabolic plasticity
  - epigenetic changes in gene expression occur
  - numerous potential targets for preventive interventions
  - early life overweight and rapid infant weight gain are risk factors for subsequent overweight and components of metabolic syndrome
Birth Weight x Infant Weight Gain and Risk of Obesity at age 7 years

What can be targeted?

Davison KK, Birch LL. Obesity Reviews, 2001
What can be targeted?

For a better start in life
start COLA earlier!

How soon is too soon?
Not soon enough. Laboratory tests over the last few years have proven that babies who start drinking soda during that early formative period have a much higher chance of gaining acceptance and "fitting in" during those awkward pre-teen and teen years. So, do yourself a favor. Do your child a favor. Start them on a strict regimen of sodas and other sugary carbonated beverages right now, for a lifetime of guaranteed happiness.

The Soda Pop Board of America
1515 W. Halst Ave. - Chicago, I.I.L.

OWN A Motorola AND YOU KNOW YOU OWN THE BEST

HOW TELEVISION BENEFITS YOUR CHILDREN

Motorola, leader in television, shows how TV can mean better behavior at home and better marks in school!
Dietary Choices for Infant
1. Breastfeeding vs. Bottle Feeding
2. Timing of Introduction of Solids
3. Content of Diet

Maternal Biologic Features
1. Pre-pregnancy BMI
2. Gestational Weight Gain
3. Insulin sensitivity and Glucose Tolerance

Fetal & Neonatal Biologic Features
1. Birth Weight
2. Genetic Predisposition
3. Hunger/Satiety Related Hormones

Parent Behavior
1. Responsiveness to Infant Cues (e.g. Hunger, Satiety, Fatigue, Boredom, etc.)
2. Feeding Style
3. Modeling Healthy Lifestyle

Infant Behavior
1. Temperament and Self-Regulation
2. Physical Activity and Sedentary Behaviors
3. Sleep Duration

Infant Weight, Weight Gain, and Adiposity

Environmental Influences

Tobacco Use

Nocturnal Feeding
Traditional Child Feeding Practices Evolved in Response to Food Scarcity

• Food:
  – low palatability, low in energy & nutrients
  – limited &/or unpredictable availability
  – relatively expensive

• Feeding practices:
  – offer food to soothe crying
  – when available, provide large portions
  – offer palatable, liked foods if possible
  – pressure, force children to eat
Preventing Obesity during Infancy: A Pilot Study

Ian M. Paul\textsuperscript{1}, Jennifer S. Savage\textsuperscript{2}, Stephanie L. Anzman\textsuperscript{2}, Jessica S. Beiler\textsuperscript{1}, Michele E. Marini\textsuperscript{2}, Jennifer L. Stokes\textsuperscript{1} and Leann L. Birch\textsuperscript{2}

- NIH/NIDDK-funded RCT with birth cohort intending to breastfeed:
  - SLeeping and Intake Methods Taught to Infants and Mothers Early in Life (SLIMTIME) Study
- Two home nurse visits – 2-3 weeks, 4-6 months after birth plus clinical research center visit at 1 year

Paul et al. Obesity, 2011
<table>
<thead>
<tr>
<th>Introduction of Solids</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soothe/Sleep</td>
<td></td>
</tr>
<tr>
<td>N = 42</td>
<td>N = 39</td>
</tr>
<tr>
<td>2 interventions</td>
<td>1 intervention</td>
</tr>
<tr>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>N = 38</td>
<td>N = 41</td>
</tr>
<tr>
<td>1 intervention</td>
<td>0 interventions</td>
</tr>
</tbody>
</table>
**SLIMTIME Intervention 1**

- **“Soothe/Sleep” instructions** (delivered at 2-3 weeks)
  - Infant Crying ≠ Hunger
  - Parents must discriminate hunger vs. other distress
  - Soothing strategy: 5 S’s (Swaddling, Side/Stomach, Shushing, Swinging, Sucking)
  - Day/night differences

- **Key Measure**
  - Serial 96 hr diaries with 15 minute intervals recording sleeping, awake/content, awake/fussy, feeding
Short sleep duration is a risk factor for obesity in adults & children

Taveras EM et al., 2008
Infant night sleep duration increased for BF mothers taught soothing techniques

Pinilla T and Birch LL. *Pediatrics* 1993; 91: 435-44
SLIMTIME Intervention 2

- **“Introduction of Solids”**
  - delay introduction, hunger/satiety cues (2-3 wks)
  - repeated exposure to vegetables (~4-6 mos)

- **Key Outcome Measures**
  - age when solids introduced
  - quantity of food consumed with repeated exposure
  - acceptance of new food at age 1 year

- **Primary outcome** – Weight-for-length percentile at 1 yr
Repeated Exposure to Vegetables Overcomes Infant Neophobia

- To overcome neophobia for low-energy density foods, repeated exposure is often required

Sullivan SA and Birch LL, 1994
Results - Demographics

- 110/160 (69%) completed the 1 year follow-up
- Infants completing study
  - 51% female
  - Mean birth weight – 3.33 kg (45th percentile for GA)
- Mothers completing study
  - Mean age – 27.1 years
  - 91% White, 90% married
  - 65% completed college
Infant Feeding – Analysis Implications

- Study intended to study breastfeeding mother/baby pairs
- By 16 weeks only 50% still “predominantly breastfeeding”
  - Defined as ≥80%* breast milk

*As done in second Infant Feeding Practice Study (IFPS II)
“Soothe/Sleep” Improves Nocturnal Sleep for Breastfed Infants*

Breastfed infants
(n=55; \( p=.04 \))

Mixed/Formula fed infants
(n=53; \( p=.40 \))

*Interaction \( p=.06 \)
“Soothe/Sleep” Reduces Nocturnal Feeds for Breastfed Infants*

Breastfed infants (n=55; p=.003)

<table>
<thead>
<tr>
<th>Weeks</th>
<th>3</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>3.5</td>
<td>3.2</td>
<td>2.8</td>
<td>2.0</td>
</tr>
<tr>
<td>soothe/sleep</td>
<td>2.5</td>
<td>2.2</td>
<td>1.8</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Mixed/Formula fed infants (n=53; p=.94)

<table>
<thead>
<tr>
<th>Weeks</th>
<th>3</th>
<th>4</th>
<th>8</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>control</td>
<td>3.0</td>
<td>3.1</td>
<td>2.9</td>
<td>2.2</td>
</tr>
<tr>
<td>soothe/sleep</td>
<td>2.5</td>
<td>2.3</td>
<td>2.1</td>
<td>1.9</td>
</tr>
</tbody>
</table>

*Interaction p=.04
“Sleep/Soothe” Reduces Total Daily Feeds for Breastfed Infants*

Breastfed infants (n=55; \( p = .008 \))

Mixed/Formula fed infants (n=53; \( p = .61 \))

*Interaction \( p = .05 \)
“Introduction of Solids” Intervention Improves Timing of Introduction of Cereal

\[ p = 0.06 \]

**Intervention**
- 83% Cereal > 4 mos
- 17% Cereal < 4 mos

**Control**
- 66% Cereal > 4 mos
- 34% Cereal < 4 mos
"Introduction of Solids" Intervention – Repeated Exposure at 4-6 months

*p < .05
“Introduction of Solids” Improves Acceptance of Unfamiliar Foods at 1 year

Intervention
- 90% Accept
- 10% Reject

Control
- 75% Accept
- 25% Reject

p = .05
Primary Outcome:
Weight-for-Length at age 1 year (N=110)

Figure 1 Study group weight-for-length percentiles at 1 year (both interventions group vs. other three groups; P = 0.009).
Secondary Outcomes: Alternatives to feeding to soothe infant distress

• Diaries coded whether the infant was asleep, fussing/crying, feeding, alert awake

• Markov time series models assessed differences in intervention / control participant probability of infant transitioning from crying to feeding vs. awake and alert

Anzman-Frasca SL et al. In progress, 2012
The Soothe/Sleep intervention increased infants’ probability of transitioning from crying to awake/calm.
Infants’ probabilities of transitioning from fussing to feeding positively predict their weight status at ~6 months.
### What else can be targeted?

**Table 1**  
Potential interventions to prevent or address obesity during infancy

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Early infancy</strong></td>
<td></td>
</tr>
<tr>
<td>Growth monitoring</td>
<td>Educate parents about growth charts, percentiles, and their meaning</td>
</tr>
<tr>
<td>Infant feeding mode</td>
<td>- Support of breastfeeding as the preferred source of infant nutrition</td>
</tr>
<tr>
<td></td>
<td>- Plot breastfed infants on the WHO growth chart, particularly when there are weight gain concerns</td>
</tr>
<tr>
<td></td>
<td>- Educate parents on satiety cues</td>
</tr>
<tr>
<td></td>
<td>- For bottle-fed infants, emphasize to parents that the volume of formula consumed should be child, not parent driven</td>
</tr>
<tr>
<td>Sleep</td>
<td>Educate parents on methods to lengthen sleep duration and soothe at night without feeding as a first response to nocturnal crying</td>
</tr>
<tr>
<td>Parental regulation of distress</td>
<td>- Respond quickly to crying early in infancy, but use alternative methods to soothe than feeding</td>
</tr>
<tr>
<td></td>
<td>- Use nonfood items as rewards later in infancy</td>
</tr>
<tr>
<td>Introduction of solid foods</td>
<td>- Delay introduction of complementary foods until at least age 4 months</td>
</tr>
<tr>
<td></td>
<td>- Avoid placing cereal into a bottle; complementary foods should only be fed with a spoon</td>
</tr>
<tr>
<td></td>
<td>- Use repeated exposure to healthy foods as a response to normal infant neophobia</td>
</tr>
<tr>
<td><strong>Later infancy</strong></td>
<td></td>
</tr>
<tr>
<td>Parent feeding style</td>
<td>Avoid coercive or restrictive feeding styles</td>
</tr>
<tr>
<td>Transition to cow’s milk</td>
<td>Use low-fat cow’s milk</td>
</tr>
<tr>
<td>Sweet beverage consumption</td>
<td>- Do not give juice to children ≤6 months old</td>
</tr>
<tr>
<td></td>
<td>- Limit daily consumption of 100% fruit juice to ≤6 ounces (170 g) per day</td>
</tr>
<tr>
<td></td>
<td>- Give 100% juice only in a cup, never in a bottle</td>
</tr>
<tr>
<td></td>
<td>- Do not allow children to easily transport juice so that they will not steadily consume it throughout the day</td>
</tr>
<tr>
<td></td>
<td>- Completely avoid fruit drinks and soft drinks</td>
</tr>
<tr>
<td>Transitional feeding and table foods</td>
<td>- Emphasize healthy dietary choices that have high nutritional value and low energy density such as fresh fruits, cooked vegetables, cheese, yogurt, whole-grain breads and crackers, and cereals</td>
</tr>
<tr>
<td></td>
<td>- Avoid foods with added salt or sugar</td>
</tr>
<tr>
<td>Physical activity and sedentary behaviors</td>
<td>- Choose physical activities that are interactive, stimulating, easy to do, and incorporated into daily routines</td>
</tr>
<tr>
<td></td>
<td>- Avoid television watching for children younger than 2 years</td>
</tr>
<tr>
<td></td>
<td>- Keep televisions out of bedroom</td>
</tr>
</tbody>
</table>

Paul et al. Adv Pediatrics, 2009
Parents prefer higher percentiles

Figure 1. Growth chart choices for parents to rank from “healthiest” to “least healthy”

Obesity prevention is hard!

How can we put this together and show that our approach is effective?
Moving Forward with a Conceptual Framework: Responsive Parenting

• Coming from developmental literature, responsive parenting involves prompt, emotionally supportive, contingent, and developmentally appropriate responses to infant cues.

• Responsive parenting associated with:
  – Secure attachment
  – Language development
  – Cognitive development
Responsive Feeding

- Prompt, contingent, developmentally appropriate responses to infant/toddler hunger/satiety cues

- Shared feeding responsibility – “parents provide, children decide”

- Fosters development of self-control in feeding and self-regulation of eating
Discordant Feeding Responsiveness → Overweight / Obesity

- Controlling, restrictive, or coercive feeding attenuates children’s responsiveness to hunger/satiety cues
  - eating in absence of hunger
  - preferences for energy dense foods
  - increased obesity risk

The Intervention Nurses Start Infants Growing on Healthy Trajectories (INSIGHT) Study
INSIGHT Design

• Randomized, controlled trial with birth cohort (N=276):
  – "Parenting" intervention vs. Child Safety Control

• Primary outcome – BMI at age 3 years

Legend: EN – Enrollment, RZ – Randomization, HV – Home Visit, DC – Data Collection only, RC – Research Center Visit
Participants – Inclusion / Exclusion

- Singleton, term newborns $\geq$ 37 weeks gestation
- Birth weight $\geq$ 2500 grams
- Primiparous mothers $\geq$ 20 years old
- English speaking
- No major maternal/infant morbidities
- Breastfeeding or formula feeding
Early Insight: Helping parents raise healthy babies in the first 4 months

**Fussy**
- Newborns cry up to 3 1/2 hours per day, decreasing around 2 months
- Hunger is only one of many reasons why babies cry
- A crying baby may not be hungry
- Try the 5 S's to calm your baby

**Sleeping**
- 1 to 4 month olds sleep 11 to 18 hours per day
- Babies sleep for a few minutes to a few hours at a time
- White noise may help your baby sleep
- Give your baby a chance to go back to sleep on own after waking at night

**Active Social Play**
- Babies can lift their heads, look at and reach for new things
- Around 2 months of age, practice tummy time with your baby 2-3 times daily, 10-15 minutes at a time

**Your Baby is Unique!**
- Learn to read your baby's signals
- Try different soothing strategies
- Use different routines for the day and night

**Alert & Calm**

**Drowsy**
- Drowsy babies rub their eyes, yawn, or get a little fussy
- Put your baby to bed between 7 and 8 pm
- Begin to use a bedtime routine
- Put your baby to bed drowsy but still awake

**Feeding**
- Your baby only needs breastmilk and/or formula
- 1 to 2 month olds eat 2-3 oz. every 2-3 hours (6-12 feedings daily)
- 2 to 4 month olds eat 2-4 oz. every 2-4 hours (6-12 feedings daily)
- How much your baby eats may differ, meal to meal and day to day
- Learn your baby's hunger and fullness signs
Responsiveness in various domains

• **Sleep & Drowsy**
  - establish good sleep hygiene while being responsive *without* feeding as first sign of distress at night
  - avoid feeding to sleep

• **Fussy, but awake**
  - understand individual temperament differences
  - don’t assume all fussiness is due to hunger, but rather look for cues for hunger when fussy
  - provide alternatives for feeding due to fussiness
Responsiveness in various domains

• Alert, calm, and feeding
  – look for hunger/satiety cues
  – “parents provide, children decide”

• Alert, calm, and playing
  – minimize screen time
  – limit sedentary/restrictive behaviors
  – promote physical activity early in life
Additional elements

• Healthy nutrition choices
• Importance of parent modeling behaviors
• Education on normal growth and growth charts
Outcomes

- Infant and maternal weight & BMI
- Nutrition-related
- Physical activity-related
- Maternal mental health and parenting
- Feeding style and feeding behaviors
- Sleep
If this approach fails, our next attempt – tape worms!