Overweight and Obesity: Effect on Breastfeeding and the Effect of Not Breastfeeding

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Trends in obesity

Percentage of obese children by age group:
- 12-24 months
- 24-36 months
- 36-72 months

Year of visit:
- 1980
- 1985
- 1990
- 1995
- 2000

Source: 'Obesity 2006' by Juhee Kim
States with the lowest breastfeeding rates have the highest obesity rates

<table>
<thead>
<tr>
<th>BF Rank</th>
<th>State</th>
<th>% Excl BF 6mo</th>
<th>Obesity Ranking</th>
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</thead>
<tbody>
<tr>
<td>51</td>
<td>Mississippi</td>
<td>7.6%</td>
<td>1</td>
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<tr>
<td>49 (Tie)</td>
<td>Alabama</td>
<td>9.1%</td>
<td>4</td>
</tr>
<tr>
<td>49 (Tie)</td>
<td>West Virginia</td>
<td>9.1%</td>
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<tr>
<td>47 (Tie)</td>
<td>Kentucky</td>
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<td>47 (Tie)</td>
<td>Louisiana</td>
<td>9.6%</td>
<td>2</td>
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<tr>
<td>46</td>
<td>Oklahoma</td>
<td>10.4%</td>
<td>6</td>
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<td>45</td>
<td>Arkansas</td>
<td>10.6%</td>
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<td>44</td>
<td>Ohio</td>
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<td>43</td>
<td>Nevada</td>
<td>11.7%</td>
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<td>42</td>
<td>Montana</td>
<td>12.5%</td>
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True complexity of obesity is still unknown

- Could well be a combination of over 100 different disorders and involve more than 1,500 genes
- Diet, exercise, and behavior modification for people >100 lb overweight has been a failure
Massachusetts Babies (Kim et al, 2006)

- Studied 120,000 children over 22 years
- Prevalence of overweight children increased from 6.3% to 10%, a 59% jump
- Infants 0-6mo had greatest risk of becoming overweight, 59%
- Number of overweight infants increased by 74%
- Overweight greater among black and Hispanic children
Definitions

- Body mass index (BMI) – the ratio of weight (kg) to the square of height (meters)
- BMI refers to excess adiposity not excess weight
- Overweight = 26-29kg/m²
- Obesity = >29kg/m²
- >47% of women over 20 are overweight or obese
Overweight and Obesity

- ↑ risk for diabetes, osteoarthritis, cardiovascular disease, miscarriage, hypertension during pregnancy, and cesarean delivery
- Higher BMI is related to decreased initiation and duration of breastfeeding
The Very Busy Fat Cell

• Average size person has 30-35 billion fat cells
• Fat cells are not passive reservoirs of fat
• Fat cells actively sense changes in energy availability, signal the brain and other tissues to regulate feeding and cellular processes
• Fat cells make and secrete >25 signaling compounds and proteins such as:
  – Leptin
  – Resistin
  – Adiponectin (Acrp30)
Leptin

- Leptin, released from fat cells after a meal, signals the appetite control center in the brain to stop eating.
- It is also involved in wound healing, enhancing the immune & neuroendocrine systems, angiogenesis, is produced by mammary epithelial cells and secreted into breast milk.
Leptin (con’t)

• May program the brain’s circuitry for appetite control as a leptin surge occurs in humans just prior to birth
• Leptin receptors are present in the mammary gland suggesting leptin may be necessary for milk production
• Milk synthesis requires fat and leptin communicates between the fat store and the breast
Resistin

- Related to how obesity might trigger insulin resistance and type 2 diabetes
- Impairs the action of insulin on peripheral tissues and if overactive in obesity may predispose people to insulin resistance
- 80% of people with type 2 diabetes are overweight
Adiponectin

- Affects how the body processes sugars and lipids and may be involved in the metabolic programming of infants
- Involved in the metabolic syndrome
  - Insulin resistance
  - Obesity
  - Type 2 diabetes
  - Coronary artery disease
Fat Cell Signaling

- Fat tissue is the body’s largest endocrine organ.
- Exposures to these “programming” proteins during early periods of rapid growth and development could wire the brain and create the relationship between human milk components, later metabolism, and adult disease.
- Inflammation related proteins also released.
- Obesity is characterized by mild chronic inflammation.
- Plays a causal role in development of type 2 diabetes and the metabolic syndrome.
Leucine and milk signaling

- Milk proteins act as a signaling system for infant growth
- Leucine found in whey portion of breastmilk
- Leucine and insulin are activating stimuli for central cell growth regulation
- Infant formula contains unphysiologically high levels of leucine
- Results in higher levels of fat cells in formula-fed infants
- Infant formula results in excessive serum levels of leucine, insulin, & exaggerated fat programming
Association of NOT breastfeeding with obesity

• Many studies (especially before 1999) failed to account for confounding factors, leaving insufficient evidence to draw conclusions.
• Studies since then show the odds of being overweight are about 21%-34% lower in children who have been breastfed.
• Population-attributable risk of overweight due to formula-feeding is about 15%-20%.
• For each month of breastfeeding there is a 4% ↓ in the risk of developing obesity (Harder et al, 2005).
Risk Factors for Overweight and Obesity

- Genetic component - absence of particular allele may ↑ risk for excessive infant weight gain (Landmann et al, 2006)
- Parental obesity – if one parent is obese, odds ratio for obesity in the child is 3 for obesity in adulthood and increases to 10 if both parents are obese
- Extent and duration of breastfeeding is inversely associated with risk of obesity in childhood
Critical Periods of Time for Excessive Weight Gain

- **Infancy**-first 8 days
  - Each 100g increase in absolute weight gain during this period was associated with a 28%↑ in risk of adult overweight
  - Overnutrition of formula-fed babies during this time may program for overweight and obesity
- **Adolescence**
- **Pregnancy**

- Implies that breastfed babies should not be randomly supplemented with formula and that acceptable weight loss may be protective for obesity
Preterm Infant Nutrition Post Hospital Discharge

• The use of nutrient enriched formula has no advantage over term formula for growth or bone mineralization (Koo 2006)
• Excessive nutrients during this time can lead to overweight and obesity (Euser 2005)
• Fortified formula with 28% more protein ↑ blood pressure at 6-8 years of age (Singhal 2007)
Feeding Choice that Promotes Overweight

- **INGREDIENTS**
  43.2% Corn syrup solids, 14.6% soy protein isolate, 11.5% high oleic safflower oil, 10.3% sugar (sucrose), 8.4% soy oil, 8.1% coconut oil, etc

- 1 teaspoon sugar/5oz
- Europe has banned sucrose in formulas
- Why wait until children are in school to be concerned about sugar?

- Maternal BMI >27, maternal smoking, low socio-economic status, and bottle-feeding were predictive of obesity at 6 years of age
- Early bottle-feeding (little to no breast milk) brings forward the obesity rebound up to 6 years of age
Bergmann et al (con’t)

- Tracked the changing prevalence of adipose values between breastfed and formula-fed infants
  - Differences in BMI between the two groups were not present at birth
  - At 1 month BF babies were somewhat fatter than FF babies
  - At 2-3 mo FF babies developed ↑ BMI
  - At 18 mo BMI of BF babies increases slowly but FF infants show steep increase in BMI
Breastfeeding, Weight Gain in Infancy, and Overweight at Seven Years of Age
Scholtens et al. Am J Epidemiol 2007; 165:

- Non-breastfed children have higher BMI at 1 year of age compared with children breastfed >16 weeks
- High BMI at 1 year was strongly associated with high BMI between 1-7 years
- The lower BMI and lower risk of overweight among breastfed children later in life are already achieved at 1 year of age
89 children who were born to mothers who had diabetes
379 children whose mothers did not have diabetes
Children in the study were between 6 and 13 years old
If the babies had been breastfed for six months or more, children born to diabetic moms looked nearly the same as the children of non-diabetic moms.
They were no more likely to be obese
Children who were breastfed for less than six months and who had been exposed to diabetes in the womb — had significantly higher BMIs, thicker waists and stored more fat around their midsections
Childhood obesity and in utero exposure to maternal diabetes have both been associated with later development of type 2 diabetes, it follows that breastfeeding these children may also help reduce their future risk for developing type 2.
Contribution of feeding mode to obesogenic growth trajectories in Samoan infants
Hawley et al. Pediatr Obes 2013

• Samoans are recognized for high BMI and prevalent obesity

• 795 infants
  – At 15 mo 23.3% of boys and 16.7% of girls were obese

• Formula-fed boys (38.6%) were significantly more likely to be obese than breastfed boys (23.4%)
Claims that breastfeeding does not lower the risk of obesity

• Martin et al. JAMA 2013; 309:1005-1013
  – Concluded that breastfeeding does not prevent obesity at age 11

• However…
  – Did not include a fully formula-fed group, so study did not compare fully breastfed to fully formula-fed infants
  – Because it is a population based study with very low breastfeeding rates, PROBIT does not have the sample size to show the level of protection that has been shown in other studies.
  – Authors picked one statistic that support their conclusions and ignored other data
  – Authors declared conflict of interest with support from Mead Johnson, dairy associations, Jenny Craig, McDonalds,
Bifidobacteria to the Rescue
Kalliomaki et al, Am J Clin Nutr 2008; 87:534-538

• Overweight babies/children had lower levels of bifidobacteria
• Bifidobacteria typify the gut microbiota of healthy breastfed infants
• Bifidobacteria constitute an internal link between breastfeeding and weight development
• Aberrant composition of formula-fed gut may predispose to overweight
Mechanisms of Protection

• Breast milk components that wire the brain and program the neurohormonal system to control food intake
  – Greater body fatness during infancy may program the brain to be less sensitive to leptin later in life, leading to leptin resistance
  – Animal studies show overfeeding before weaning leads to overweight and leptin resistance later in life

• Programs responses of gut endocrine systems to a meal
Fetal Origins of Obesity: Programming

• Association of birth weight and later adiposity

• Fetal hyperinsulinemia
  – Maternal glucose freely transferred to the fetus but maternal insulin is not
  – Fetal pancreas responds to glucose load by producing insulin which acts as a fetal growth hormone, increasing the birth weight of infants of diabetic mothers and increasing their risk for later overweight and obesity
Intrauterine Exposures Have Lasting Effects

- Determine body composition-fat cell size and number
- Sustained hyperinsulinemia from other sources, including infant formula
- Permanent change in the structure and function of the appetite regulation centers of the brain
Trouble at Both Ends of Infant Birth Weight Spectrum

• Small size at birth is associated with central or truncal obesity and the metabolic syndrome
• May occur independent of a predisposition or genetic component and not associated with maternal hyperinsulinism
• Fetal undernutrition may cause permanent changes in pancreatic function, alterations in hormones, or in the regulation of later body proportions
More mechanisms of protection

• Prevents overfeeding and excessive growth rate during the first 4 months
  – Overfeeding ↑ number and fat content of fat cells in animals
  – 20% of childhood overweight attributable to being in top quintile for weight gain from 0-4 months

• As breast milk energy density increases, milk intake decreases showing self-regulation of breastfed babies to match their energy needs

• Prolonged bottle use (24 mo) increases risk for obesity
More and More Protective Mechanisms

• Plasma insulin levels are affected by mode of feeding
  – FF babies have ↑ insulin levels and prolonged insulin response at 6 days
  – Higher insulin levels stimulate greater adipose tissue deposition and are associated with increased weight gain and obesity

• Receiving no infant formula ↓ overweight by 11% (Taveras et al 2006)
Still More Protective Mechanisms

- FF babies consume 66%-70% more protein than BF infants at 3-6 months
- By 12 months their protein intake may be 5-6 times what is actually needed
- Higher protein intake stimulates higher insulin secretion
- Higher insulin secretion stimulates more fat deposition
Inflammation

- Obesity is associated with chronic low grade inflammation
- Macrophages in adipose tissue express high levels of inflammatory factors & are associated with total body fat
- Breastmilk is full of anti-inflammatory components
Additive Effects of Maternal BMI and Breastfeeding

- Children whose mothers were obese before pregnancy and who were never breastfed were at a 6 fold greater risk of becoming overweight during childhood compared with children whose mother had normal BMI before pregnancy and who were breastfed for at least 4 months.

Maternal BMI, Length of Exclusive Breastfeeding, Complementary Foods  
(Baker et al, 2004)

- Infant of an obese woman (pre-pregnant BMI=30) who breastfed for >40 weeks and introduced complementary foods at >16 weeks would gain 1.6% more weight than reference infant

- If this obese woman ↓ breastfeeding to <20 weeks and introduced complementary foods at <16 weeks, baby would gain 11.2% more than reference infant

• Hispanic children twice as likely to be overweight or obese
• More prevalent in low income populations
• Breastfeeding reduced risk by 40%
• Bottle-to-bed babies twice as likely to be overweight or obese
Effect of Overweight and Obesity on Lactation

• Could the reduced breastfeeding success of overweight and obese mothers be an important causal factor for the increased risk of their offspring becoming obese?

• Overweight and obese mothers are 2-3x more likely to stop breastfeeding by hospital discharge (Hilson et al, 1997)

• They initiate breastfeeding less frequently and breastfeed for shorter durations
Rate of Metabolic Syndrome is Lower with Increasing Duration of Lactation

• Lactation
  – Increases HDL
  – Decreases triglyceride levels
  – Improves insulin sensitivity
  – Decreases blood pressure
  – Decreases abdominal obesity
  – Improves fasting glucose
Postpartum weight retention

- If women exclusively breastfed for 6 mo, postpartum weight retention could be eliminated by that time in women with gestational weight gain of 26 lb

• 16-20 years after last pregnancy, women who breastfed <6mo had higher total body fat mass, higher fasting serum glucose concentration and insulin resistance, higher total and LDL cholesterol, and higher systolic and diastolic blood pressure
Overweight/obese mothers experience a delayed onset of lactogenesis II and reduced milk transfer at 60 hours postpartum.

• For each 1-unit (1 kg/m$^2$) increase in pre-pregnant BMI, a 0.5-hour delay in the onset of lactogenesis II has been calculated.

• Difference in onset of copious milk production can be up to 10 hours later in a mother with a BMI of 40 compared to a mother with a BMI of 20.
Delayed Lactogenesis II

• This delay occurs at a time when the mother has been discharged from the hospital and is concerned about the delay in the onset of copious milk production

• Could lead the mother to supplement if the baby is fussy, has few diapers, or continues to lose weight
Effects of maternal obesity

• The rate of cesarean delivery increases with increasing BMI (Shepard et al, 1998)
• Rate of gestational diabetes increases with overweight and obesity
• Increases risk of infant hypoglycemia and macrosomic infants
Overweight/obesity and Lactation

- Mothers with delayed lactogenesis II (>72 hours post birth) are more likely to have high BMI
- Breastfeeding durations decrease as maternal BMI increases
- Obesity alters the 24 hour spontaneous release of prolactin
- Prolactin response to sucking is blunted in obese mothers, decreasing by ~45ng/mL at 48 hours postpartum and 100ng/mL at 7 days, during the time period important for optimal milk production

• Mouse model showed that obesity impairs mammary gland development
  – Obese mice exhibited marked abnormalities in alveolar development within the mammary gland

• Obesity also impaired lactogenesis; seen as lipid accumulation in the secretory epithelial cells, showing an absence of copious milk secretion
Excessive weight gain during pregnancy is associated with earlier termination of breastfeeding among white women. Hilson et al. J Nutr 2006; 136:140-146

- Overweight and obese women who exceeded the IOM gestational weight gain recommendations and obese women who gained the recommended amount had ↑ risk of early breastfeeding termination

- Low (BMI <19.8) 27-39 lb
- Normal (BMI 19.8-26) 25-35 lb
- High (BMI >26-29) 15-25 lb
- BMI >29 = 13 lb
• Until menopause, mothers who did not breastfeed all of their children for >3mo exhibited significantly greater amounts of metabolically active visceral fat than mothers who had breastfed all of their children for >3mo
Lack of Specialized Interventions (Rasmussen et al, 2006)

• Many health care providers do not believe that there is a difference in the success rates between obese and non-obese breastfeeding mothers

• Given the excess risk for early abandonment of breastfeeding and lactation failure, providers need to exercise extra care and vigilance
Breaking the Cycle of Overweight/Obesity

• Breaking the cycle of overweight and obesity begins at the beginning
  – Overweight/obese mothers should breastfeed VERY frequently during the first 7-10 days
    ↪↑ number of feedings critical in the first 12 hours for stimulating lactogenesis II in mothers with IDDM
    (Ferris, 1993)
  – Infants need to be monitored more closely
  – All of these mothers need a feeding plan before hospital discharge and close follow-up thereafter

• May have decreased perceptions of breast fullness and milk production
Breastfeeding Management

• Frequent feeds 10-12 times each 24 hours should continue until lactogenesis II has been confirmed and the baby is gaining weight well

• Large breasts should be supported with a rolled up towel or receiving blanket

• Flat nipples can be everted prior to each feeding with a modified syringe

• Nipples may flatten out due to excess adipose tissue that stretches the areola & flattens the nipple
Latch on
Poor Flange Fit

- If the nipple at rest is as wide as a US nickel (22 mm) or larger, may need a larger size
- Nipples swell during pumping
- Pumpin’Pal angled flange for 22-30mm nipples

www.pumpinpal.com
Power Pumping

• Power pumping to elicit multiple “first” let-downs (double pump for 10 minutes, 5-15 minute break, then double pump another 10 minutes)

• First milk ejection releases up to 45% of total volume expressed

• Tricks the breast into performing several “first” milk ejections
Intertrigo

- irritation of touching skin surfaces in body fold regions
- can be worsened by any conditions causing increased heat, wetness, and friction.
- intertrigo may be complicated by superficial skin infection with yeast or bacteria
- Skin folds should be cleaned and dried thoroughly
Lactation after Bariatric Surgery

- Risk of vitamin B12 deficiency in maternal milk and infant
- Prolonged B12 deficiency in infants can result in developmental delays, failure to thrive, apathy, hypotonia, hyperreflexive, and slow head growth
Laparoscopic adjustable gastric band

- Skin-to-skin
- Frequent breastfeedings
- Lab work to assess status of B12, vitamin D, folate, and iron
- Weight checks on infant
- Check of developmental milestones
Positioning

• With loss of adipose tissue in breast, may see pillowly feel to breast, hard to find glandular tissue, positioning difficulties

• Breast ptosis
  – Ask about mastopexy (breast lift)
  – Ask about augmentation surgery