Prenatal and Early Life Risk Factors for Obesity

Ann Bullock, MD
Division of Diabetes Treatment and Prevention
Indian Health Service
Today’s Webinar

- Overview of *in utero* and early life risk factors for obesity
- Evidence for intervention during these periods
- Family Spirit home visiting intervention
  - Description
  - Recently published outcomes and how they relate to reducing obesity risk factors
“The exquisite system for regulation of energy balance is established just once in each individual’s life. In addition to the instructions laid down in the genetic blueprint, environmental influences during critical ontogenic periods determine the outcome of this process, with permanent consequences for body weight regulation.”

Annu Rev Nutr 2014;34:337-355, pg. 350
FIG. 7. The physiological mechanisms underlying the programming of the separate and combined elements of the metabolic syndrome

- **Substrate Restriction**
  - Decreased O2, glucose, amino acids etc
  - Amino acid balance: homocysteine/glycine

- **Maternal and/or fetal neuroendocrine adaptations**
  - Decreased anabolic hormones (Insulin, IGFs, thyroid hormones, GH/PRL)
  - Increased stress hormones (Glucocorticoids, catecholamines)

- **Changes in Organ Development and Growth**
  - Decreases in cell number, organ growth, fetal growth
  - Decreased vasculogenesis, angiogenesis
  - Premature differentiation of functional capacity

- **Programmed Set points in Physiological Systems**
  - Cardiovascular, renal, metabolic, HPA, etc
  - Altered neuroendocrine regulation of energy balance
  - Homeostasis, growth etc

- **Insulin synthetic/secretory capacity**
- **Hepatic glucose production**
- **Skeletal muscle mass**
- **Cardiac and renal functional capacity**
- **Altered vascular reactivity**
- **HPA activity**
  - Altered set points for GH / IGF, appetite regulatory axes

- **Increased insulin sensitivity – muscle, adipocyte**
- **Increased appetite**
- **Catch up growth**
- **Visceral obesity, increased circulating FFAs**
- **Hepatic glucose intolerance**

- **Obesity**
  - Insulin resistance – hepatocyte, muscle
  - Decreased insulin synthetic/secretory capacity

- **Decreased GFR**
- **Increased intravascular volume**
- **Increased vascular reactivity**
- **Hypertension**
- **Cardiac Hypertrophy**

- **Type 2 Diabetes**
- **Obesity**
- **CVS Disease**
Maternal Stress and Nutrition in Pregnancy Increase Offspring Obesity Risk

*J Nutr Metab* 2012; 2012: 632548

- Fetuses of obese mothers develop insulin resistance in utero
  *Diabetes Care* 2009;32:1076-1080
- Maternal diet during pregnancy:
  - Epigenetically affects child’s adiposity at age 9 yrs
  *Diabetes* 2011;60:1528-1534
  “Our findings suggest a substantial component of metabolic disease risk has a prenatal developmental basis.”
- Maternal stressful life events during 1st trimester increase the risk of preterm birth (OR 2.4) and SGA
  *Am J Obstet Gynecol* 2010;203:34.e1-8
- Inverse association between gest age and insulin levels at birth and early childhood
  *JAMA* 2014;311:587-596
- Both SGA and preterm birth are strongly associated with later risk for chronic disease
  *Diabetes* 2009;58:523-526
## Adverse Childhood Experiences (ACE)

- Physical, emotional, sexual abuse; mentally ill, substance abusing, incarcerated family member; seeing mother beaten; parents divorced/separated

  --Overall Exposure: 86% (among 7 tribes)

<table>
<thead>
<tr>
<th></th>
<th>Non-Native</th>
<th>Native</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Abuse-M</td>
<td>30%</td>
<td>40%</td>
</tr>
<tr>
<td>Physical Abuse-F</td>
<td>27</td>
<td>42</td>
</tr>
<tr>
<td>Sexual Abuse-M</td>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>Sexual Abuse-F</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td>Emotional Abuse</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td>Household alcohol</td>
<td>27</td>
<td>65</td>
</tr>
<tr>
<td>Four or More ACEs</td>
<td>6</td>
<td>33</td>
</tr>
</tbody>
</table>

*Am J Prev Med 2003;25:238-244*
ACEs and Adult Health

• ACE Score ≥4
  • 4-12 x risk for alcoholism, drug abuse, depression and suicide attempt
  • 2-4 x risk for smoking, teen pregnancy, STDs, multiple sexual partners
  • 1.4-1.6 x risk for severe obesity
  • Strong graded relationship at all levels of ACEs for almost all outcomes, including heart disease


• Across 10 countries, adults who experienced ≥3 childhood adversities
  • Hazard ratios 1.59 for diabetes, 2.19 for heart disease
  • Risk similar to the association between cholesterol and heart disease
    • Both in magnitude as well as population prevalence

  *Arch Gen Psychiatry 2011;68:838-844*
90-100% Chance of Developmental Delays When Children Experience 6-7 Risk Factors

Center on the Developing Child at Harvard website
Stress in Children

- **Positive**
  - Normal/necessary part of healthy development
    - First day with new caregiver; immunization
  - Brief increases in heart rate and stress hormones

- **Tolerable**
  - More severe, longer lasting stressor
    - Loss of a loved one, natural disaster, injury
  - If buffered by relationship with supportive adult(s), brain and body can recover

- **Toxic**
  - Strong, frequent, prolonged adversity
    - Abuse, neglect, caregiver mental illness, poverty
  - If no adult support, can disrupt brain and organ development long-term

Center on the Developing Child at Harvard Univ.
### Domains of Impairment in Children Exposed to Complex Trauma

<table>
<thead>
<tr>
<th>I. Attachment</th>
<th>IV. Dissociation</th>
<th>VI. Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems with boundaries</td>
<td>Distinct alterations in states of</td>
<td>Difficulties in attention regulation</td>
</tr>
<tr>
<td>Distrust and suspiciousness</td>
<td>consciousness</td>
<td>and executive functioning</td>
</tr>
<tr>
<td>Social isolation</td>
<td>Amnesia</td>
<td>Lack of sustained curiosity</td>
</tr>
<tr>
<td>Interpersonal difficulties</td>
<td>Depersonalization and derealization</td>
<td>Problems with processing novel</td>
</tr>
<tr>
<td>Difficulty attuning to other</td>
<td>Two or more distinct states of</td>
<td>information</td>
</tr>
<tr>
<td>people's emotional states</td>
<td>consciousness</td>
<td>Problems focusing on and completing</td>
</tr>
<tr>
<td>Difficulty with perspective</td>
<td>Impaired memory for state-based events</td>
<td>tasks</td>
</tr>
<tr>
<td>taking</td>
<td></td>
<td>Problems with object constancy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Difficulty planning and anticipating</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problems understanding responsibility</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Learning difficulties</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problems with language development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Problems with orientation in time and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>space</td>
</tr>
<tr>
<td>II. Biology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensorimotor developmental</td>
<td>V. Behavioral control</td>
<td></td>
</tr>
<tr>
<td>problems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analgesia</td>
<td>Poor modulation of impulses</td>
<td></td>
</tr>
<tr>
<td>Problems with coordination,</td>
<td>Self-destructive behavior</td>
<td></td>
</tr>
<tr>
<td>balance, body tone</td>
<td>Aggression toward others</td>
<td></td>
</tr>
<tr>
<td>Somatization</td>
<td>Pathological self-soothing behaviors</td>
<td></td>
</tr>
<tr>
<td>Increased medical problems</td>
<td>Sleep disturbances</td>
<td></td>
</tr>
<tr>
<td>across a wide span (e.g.,</td>
<td>Eating disorders</td>
<td></td>
</tr>
<tr>
<td>pelvic pain, asthma, skin</td>
<td>Substance abuse</td>
<td></td>
</tr>
<tr>
<td>problems, autoimmune disorders,</td>
<td>Excessive compliance</td>
<td></td>
</tr>
<tr>
<td>pseudoseizures)</td>
<td>Oppositional behavior</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difficulty understanding and complying</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with rules</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reenactment of trauma in behavior or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>play (e.g., sexual, aggressive)</td>
<td></td>
</tr>
<tr>
<td>III. Affect regulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficulty with emotional</td>
<td>VII. Self-concept</td>
<td></td>
</tr>
<tr>
<td>self-regulation</td>
<td>Lack of a continuous, predictable sense</td>
<td></td>
</tr>
<tr>
<td>Difficulty labeling and</td>
<td>of self</td>
<td></td>
</tr>
<tr>
<td>expressing feelings</td>
<td>Poor sense of separateness</td>
<td></td>
</tr>
<tr>
<td>Problems knowing and</td>
<td>Disturbances of body image</td>
<td></td>
</tr>
<tr>
<td>describing internal states</td>
<td>Low self-esteem</td>
<td></td>
</tr>
<tr>
<td>Difficulty communicating</td>
<td>Shame and guilt</td>
<td></td>
</tr>
<tr>
<td>wishes and needs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Stress in Children and Obesity Risk

• Chronic exposure to Intimate Partner Violence almost doubles (OR 1.8) risk of obesity at age 5 years
  \(Arch \ Pediatr \ Adolesc \ Med\ 2010;164:540-546\)

• Young children who had objectively-measured poor quality maternal-child relationships had 2 \(\frac{1}{2}\) x increased prevalence of adolescent obesity c/w those who did not
  \(Pediatrics \ 2012;129:132-40\)

• Children who experienced multiple negative life events are at higher risk of being overweight by age 15 years
  \(Pediatrics \ 2013;132(6):e1506-12\)
“We ...know that sound maternal and fetal nutrition, combined with positive social-emotional support of children through their family and community environments, will reduce the likelihood of negative epigenetic modifications that increase the risk of later physical and mental health impairments.”
Reducing Poverty and its Effects

• Opening or expanding tribal casinos was associated with increased economic resources and decreased child obesity and overweight
  
  *JAMA* 2014;311:929-936

• “Growing up in a family that is struggling economically in a neighborhood that is plagued with failed schools, crime, disorder, and violence creates cumulative health risks and functional deficits that contribute to higher rates of many health conditions, including asthma, attention-deficit/hyperactivity disorder, and obesity. Without a coherent and functional system of high-quality services such as child care, early education, family support, health care, and mental health services, risks go unaddressed, preventable health problems develop, and disabling conditions compound over time, becoming more pronounced as sick and impaired teens become chronically ill and disabled adults.”
  
  Neal Halfon, *JAMA* 2014;311:915-917
Prenatal/Early Life Home Visiting

• One of the key evidence-based interventions proven to improve the life trajectories of low income women and children
• Positive effects now shown up to age 19 years


• Tribal Maternal, Infant & Early Childhood Home Visiting Program (MIECHV)
• 25 tribes/T.O.’s now funded to provide home visiting
Academic Achievement and Preschool Language Scale

Academic Achievement
Grades 1–3, Age 9—Memphis
(Born to low-resource mothers)

Preschool Language Scale
Age 4—Denver
(Born to low-resource mothers)

Source: Reproduced with permission from Pediatrics, Vol. 120, e838, Copyright © 2007 by the AAP.

Source: Reproduced with permission from Pediatrics, Vol. 114, 1565, Copyright © 2004 by the AAP.
Days Hospitalized for Injuries and Months Between Births

Source: JAMA, 1997, Vol. 278, 650, Copyright © 1997, American Medical Association. All rights reserved.

Source: JAMA, 2000, Vol. 283, 1987, Copyright © 2000, American Medical Association. All rights reserved.
Months Receiving Welfare Assistance and Months receiving Food Stamps

Source: JAMA, 2000, Vol. 283, 1987, Copyright © 2000, American Medical Association. All rights reserved.
Monetary Benefits

- **Lower-risk families**: $7,271
- **Higher-risk families**: $7,271

Net present value dollars per child 2003

- Increased participant income (net of welfare loss)
- Reduction in tangible crime losses
- Savings to government
- Cost

Source: 2005 RAND Corporation Study
$4-$9 in Returns for Every Dollar Invested in Early Childhood Programs

Center on the Developing Child at Harvard website
Sources: Masse, L. and Barnett, W.S., A Benefit Cost Analysis of the Abecedarian Early Childhood Intervention (2002); Karoly et al., Early Childhood Interventions: Proven Results, Future Promise (2005); Heckman et al., The Effect of the Perry Preschool Program on the Cognitive and Non-Cognitive Skills of its Participants (2009)
“Early Life Investments Substantially Boost Adult Health”

• Carolina Abecedarian Project
  • 4 cohorts of disadvantaged children born 1972-77
    • Intervention provided from birth to age 5 years
  • Intervention:
    • Devel of language, emotional regulation, cognitive skills
    • Caregiving/supervised play
    • Nutrition: 2 meals and a snack at childcare center
    • Primary pediatric care

• In their mid-30s: lower prevalence of CVD and metabolic disease risk factors including BP, A1C, obesity, HDL

Science 2014;343:1478-1485
“...reducing toxic stress can target the common physiologic pathway implicated in an enormous array of health outcomes from asthma to cardiovascular disease.”

Pediatrics 2013;131:319-327
Going Forward—What Works?

• Exposures in the *in utero* and early life periods have significant impact on later obesity risk
  • Risk factors and associations are being defined
  • Mechanisms are starting to be understood
• Intervention research is in its infancy, but part of the picture is emerging.
  • Early, intensive interventions can reduce some of the risk factors for later obesity
    • Do they reduce obesity itself?
  • Family Spirit
Advancements in Diabetes: Reducing Risk Factors for Obesity Early in Life

Allison Barlow, MA, MPH, PhD and Jennifer Richards, MPH
John Hopkins Center for American Indian Health

For more than three decades we have partnered with American Indian Communities to co-design program to achieve optimal health and well-being across the lifespan.

MOU with IHS since 1991.
Our Center’s 3 decade partnership with Southwestern tribal communities
Our Center’s present scope
John Hopkins Center for American Indian Health

- Training & Scholarship
- Behavioral
- Infectious Disease Research

- Family Spirit – Parenting/Family Strengthening
- Substance abuse prevention
- Suicide and depression prevention
- HIV prevention
- Nutrition promotion
- Diabetes Prevention
- Youth Development
A changing landscape...

- Major shift from high infectious disease mortality to
- Behavior and mental health inequalities
- Low education, employment, modern trauma, fractured families
How do we break this cycle?

Diagram:

1. Unprepared parenthood
2. Early child neglect
3. Poor school readiness
4. Obesity and Diabetes
5. Suicide and substance use
6. Drop-out
7. Unemployment
An indigenous solution: 
Family Spirit home visiting program
Family Spirit Program History

**SOS Project:**
* Service
* teen Moms, babies
* prenatal-6 months postpartum
  (160 Moms served)

**Family Strengthening:**
* Teen Moms/Dads
* Prenatal to baby’s 6 month postpartum
* RCT evaluation Moms/Dads
  (48 Dads/68 Moms served)

**Cradling Our Future:**
* Teen Moms
* 28 weeks gestation-36 most postpartum
* RCT evaluation Moms
  (322 Moms/kids enrolled)

---

1995

1998-1999

1999-2001

2002-2005

2006-Present

---

**Fathers Project:**
* Service
* Curriculum to address needs of young Dads
  (55 Dads/62 Moms served)

**Family Spirit:**
* Teen Moms/Dads
* Prenatal to 12 months postpartum
* RCT evaluation Moms/Dads
  (75 Dads/166 Moms served)

**Return to Service: Program Replication**
* Replication with Tribal communities (39+)
  across US
* Trainings scheduled throughout the year
Family Spirit Intervention

Home-Based Outreach

Family Involvement

Structured, home-based curriculum taught by AI Home Visitors to young mothers from pregnancy – 36 mos post-partum

Community Referrals
Curriculum Overview
Lesson Presentation

What participant sees:

What Health Educator sees:
Family Spirit: Key Content

• Goal-Setting
• Parenting and Well-Child Care
• Reproductive Health
• Nutrition/Responsive Feeding
• Establishing Meal Time/Sleep Routines
• Oral Health
• Family Planning
• Substance Abuse & Depression Prevention/Referral
• Conflict and problem Solving
• School/Career Planning
• Budgeting for One’s Family
• Preparing Young Children for School
Tapping Cultural Assets

- Children are sacred
- Matrilineal societies

- Changing woman
- Sunrise Ceremony, Kinaalda
Culturally Grounded Content and Format

• “Familiar” stories create dialogue between Family Health Educator and mom to solve problems

• Illustrations by Apache-Navajo artist

• Out-takes for local cultural activities and additional resources
Cultural Community Components for Adaptation

• Traditional parenting/nurturing practices
• Cultural teachings/worldviews
• Family structure – elder caregivers, extended family
• American Indian life skills development
• Lesson Modules – illustrative designs, scenarios, activities
• Community resources - tribal programs, IHS
• Native American population vs. general population
How Well Has Family Spirit Worked?
Family Spirit Impact: Pregnancy to Age 3

Parenting
- Increased maternal knowledge $^{1,2,3,4}$
- Increased parent self-efficacy $^{3,4}$
- Reduced parent stress $^{2,4}$
- Improved home safety attitudes $^3$

Mothers’ Outcomes
- Decreased depression. $^{1,2,4}$
- Decreased substance use $^4$
- Fewer risky behaviors $^{3,4}$

Child Outcomes
- Fewer social, emotional and behavior problems through age 3. – Decreased Externalizing, Internalizing and Dysregulation. $^{2, 3, 4}$
- Lower clinical risk of behavior problems over life course $^4$

ITSEA Problem Domains and Subscales within Domains

**Externalizing**
- Aggression/Defiance
- Peer Aggression
- Activity/Impulsivity

**Internalizing**
- General Anxiety
- Depression/Withdrawal
- Separation Distress
- Inhibition to Novelty

**Dysregulation**
- Negative Emotionality
- Eating
- Sleep
- Sensory Sensitivities
Parenting and Early Childhood Behavior Problems Associated with Obesity

• Negative parenting (inconsistent discipline; restrictive, coercive parenting) associated with increased obesity risk in children.
  • *Trends Endocrinol Metab.* 2013 Apr 19 E-pub

• Externalizing behaviors at 24 mos associated with higher BMI at 24 months and thru age 12
  • *BMC Pediatr.* 2010 Jul 14;10:49

• Obese children have higher rates of externalizing and internalizing disorders.
  • *Acad Pediatr.* 2013 Jan-Feb;13(1):6-13
Family Spirit: Ready to Scale

Highest participant retention: 91% to 1 year postpartum; 83% to 3 years postpartum

4.0/4.0 on “Readiness for Dissemination”

Highest federal rating for HomeVEE: effectiveness of home visiting program models targeting families with children 0 to 5
Current National Reach
Replication Phases

PLANNING
- Introductory Webinar
- Readiness/Evaluation Tools
- Distribution of Curriculum to Trainees
- Online Knowledge Assessments
- Pre-Training Calls

TRAINING
- Rigorous Week-Long Training
- Focus on Curriculum Content/Delivery
- Evaluation Training
- FS Certification

IMPLEMENTATION
- Post-Training / Implementation Calls
- Quarterly Check-Ins
- FS Connect Opportunities
  * Option to help with evaluation.
What’s Next for Family Spirit?
Current IHS Partnership

• Contract between Indian Health Service Community Health Representative Program (HQ) and Johns Hopkins Center for American Indian Health (Oct 2013 – Sept 2015)
  • Train 6 Indian Health Service Community Health Representative Programs to implement Family Spirit Program

• Recent interest from SDPI tribal program to implement Family Spirit to address risk factors, including those for obesity
Email: familyspirit@jhu.edu

Johns Hopkins Center for American Indian Health

415 N. Washington St.
4th Floor
Baltimore, MD 21231
410-955-6931

8205 Spain Rd NE
Suite 210
Albuquerque, NM 87109
505-797-3305