Weight Gain in Pregnancy: How Much is Too Much—or Too Little?

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Disclosures

• I have no financial disclosures to report.
Objectives

• Review effects of BMI and gestational weight gain (GWG) on maternal and infant outcomes in OW/OB and GDM women
• Explore data supporting less GWG for higher BMI groups than IOM recommendations
• Review Diet/Exercise RCT interventions to lower GWG and improve pregnancy outcomes
  – OW and Obese women
  – GDM women
• Attempt to offer practical advice that might be useful
Up to 75% of Women of Childbearing Age are Overweight or Obese

***Obesity prevalence was 9.3% in 1960...32% in 2010
WHO OW and Obesity 5th greatest RF for global deaths

Increasing Prevalence of Obesity in Children and Adolescents

Figure 1. Trends in obesity among children and adolescents: United States, 1963–2008

2007-2008: 16.9% were obese
Ages 2-19 years

NOTE: Obesity is defined as body mass index (BMI) greater than or equal to sex- and age-specific 95th percentile from the 2000 CDC Growth Charts.
Obese Children worldwide Increased to 44 Million 2012
Expected to Increase to 70 Million by 2015
Role of Genetics & Environment in Body Composition at Birth

Neonatal fat mass = 46% of variability of birth weight

Intrauterine Environment

- Fat Mass
  - 12-15%
  - Humans born with highest % fat mass of any species
  - Studies in human pregnancies necessary

- Fat Free Mass
  - 85-88%

Genetics

Catalano, AJOG 1995
Increased Neonatal Adiposity Offspring of GDM and Obese Infants

B.W. = 2893 gms;
Body Fat = 16.8%
by DXA

Catalano PM; 2003; Am J Obstet Gynecol; 189:1698

Catalano PM 2007;109:419
Newborn Intrahepatic Fat Increased in GDM/Obese Offspring

Brumbaugh, Pediatrics 2013

- Visceral fat associated with severe insulin resistance
- Hepatic fat is associated with NAFLD
- N=13 infants of obese GDM and 12 NW mothers
- Infants of Obese GDM moms had 68% more intrahepatic fat
- Genesis of NAFLD?
How Much Should We Worry About Baby Fat???
Developmental Origins
BW and Risk of Childhood Metabolic Syndrome

"Thrifty" Phenotype: Hales & Barker (1992)

- Poor Nutrition in Early Life
- Organ Development Changes Gene Expression
- Catch Up Growth
- Metabolic Syndrome

- Low Birth Weight = 7.6% of all births
- Followed by rapid catch up growth

BIRTHWEIGHT

Updated Hypothesis:

- Overnutrition in Utero
- Changes in Gene Expression
- Environmental Stimuli, Continued Postnatal Growth
- Metabolic Syndrome

Epigenetic Stimuli

The Hungry Gene: The Science of Fat and the Future of Thin
Ellen Ruppel Shell
Heavier Baby Girls at Higher Risk for Diabetes, Heart Woes as Adults

Study found that as teens, they have larger waist size, higher blood levels of insulin, fat

High birth weight and increased adiposity at age 12 months increases risk of metabolic syndrome at age 17 yrs old in girls

Obese infants are 2-9 times as likely to be obese as adults 

_Baird J, BMJ 2005;331:929_

Predictors of 4 yr old OW/Obesity: OW/Obesity at 2 yrs (4.1)

_Kitsantas P Earl Hum Dev 2010;86:563_
Risk Factors Associated with Childhood Obesity

• Factors Associated with high BMI at 2-3 yr:
  – *Maternal BMI, GWG, LGA, Glucose, Lipids, Dietary fat*
  – *Rate of Infant Weight Gain 0-6 mo infants triple their fat mass; Rapid wt gain birth-2 yrs; Catch up-growth in IUGR*
  – *Feeding mode* BF protective in most studies

Poston L. Curr Opin Clin Nutr Metab Care 2012
Predictive Value of BW, Obesity and GDM on Metabolic Syndrome Age 6-11  

**TABLE 4. Hazard Ratio for the Risk of MS (n = 175)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Hazard Ratio</th>
<th>P Value</th>
<th>95% CI for Hazard Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>LGA versus AGA</td>
<td>2.19</td>
<td>.006</td>
<td>1.25–3.82</td>
</tr>
<tr>
<td>Maternal obesity* versus nonobese</td>
<td>1.81</td>
<td>.039</td>
<td>1.03–3.19</td>
</tr>
<tr>
<td>GDM versus control</td>
<td>1.44</td>
<td>.191</td>
<td>0.83–2.50</td>
</tr>
<tr>
<td>Male versus female</td>
<td>1.52</td>
<td>.133</td>
<td>0.88–2.61</td>
</tr>
</tbody>
</table>

* Prepregnancy BMI of >27.3 mg/m²
GWG Also Linked to Infant Adiposity, Especially in Overweight Mothers *Hull, H* *AJOG* 2011

**TABLE 7**

<table>
<thead>
<tr>
<th>Prepregnancy BMI</th>
<th>GWG</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Appropriate</td>
<td>Excessive</td>
</tr>
<tr>
<td>Normal</td>
<td></td>
<td>355.5 ± 20.1</td>
<td>388.9 ± 21.9</td>
</tr>
<tr>
<td>Overweight</td>
<td></td>
<td>303.6 ± 46.1</td>
<td>484.4 ± 28.8</td>
</tr>
<tr>
<td>Obese</td>
<td></td>
<td>472.9 ± 56.0</td>
<td>486.4 ± 33.5</td>
</tr>
</tbody>
</table>

Adjusted for infant sex, gestational age, infant age, maternal race/ethnicity, and maternal age. BMI, body mass index; GWG, gestational weight gain.


GWG according to IOM and 306 infants measured by Pea Pod
40% NW and 70% OW and Obese mothers gained excessive GWG
OW mothers who gained excessive wt had greatest difference in infant FM
Obese mothers had highest infant FM regardless of wt gain
Association of maternal body mass index, excessive weight gain, and gestational diabetes mellitus with large-for-gestational-age births.

BC data Florida 2004-2008 in Florida to assess influence of BMI vs GWG vs GDM on LGA

Excessive GWG contributed the most to LGA

However, Pre-pregnancy Wt obtained by BC (underestimate of BMI and Pre-pregnancy Wt). Wt at delivery measured. May have underestimated BMI and overestimated GWG.

Target GWG more than Pre-Pregnancy BMI
Excess GWG is Associated with Increased Adiposity at Birth and at 6 Yrs
Southampton’s Women’s Study Group, UK  
*Crozier SR Am J Nutr* 2010

**FIGURE 1.** Mean (and 95% CI) fat mass at birth, 4 y, and 6 y by 2009 Institute of Medicine pregnancy weight-gain categories. ¹Adjusted for sex, gestation, age at measurement, age squared, length, maternal smoking in pregnancy, age, height, parity, and educational attainment. ²Adjusted for sex, age at measurement, childhood height, maternal smoking in pregnancy, age, height, parity, educational attainment, and breastfeeding duration.

Prospective; GWG measured Prepreg (within 1 yr) and 34 wks gestation; ~50% excessive GWG DXAs on 564 at birth; 543 at 4 yrs; 402 at 6 yrs
No Relationship Between Maternal Weight Gain and BW in Obese Women


In most studies, SGA is linked to inadequate GWG only in UW or NW mothers; NOT TO OW OR OBESE MOTHERS unless assoc with maternal morbidities→ placental insufficiency
Prepregnancy BMI and GWG Predict Postpartum Weight Retention

- >60% of previous NW gravidas become OW with subsequent pregnancy Villamoor E 2006; Catalano PM, 2003; Artal R 2010
- Women retain 7-8 lb of their GWG; OW/Obese women retain more
- Postpartum retained fat is deposited centrally
- Strongest predictor of 1 yr PP Wt retention is GWG Phelan S Am J Obstet Gynecol 2010;202:135
  - Excessive GWG ↑ Obesity by 4-5 fold at 21 yrs after pregnancy Mamum AA A J Clin Nutr 2010;91:1336
- PP Wt retention at 6 mos predicts long-term excess Wt Gain, T2DM, CVD and next pre-preg BMI Gunderson EP 2004;
Interpregnancy wt gain carries a 3-fold risk for GDM or recurrent GDM

Whiteman VE 2011

Interpreg Wt loss by 12 lbs ↓ risk GDM in OW and obese women by ~75% Ehtlich SF 2011

Interpreg Wt Loss also ↓ risk of LGA, PE, and GDM (↓40% LGA) Jain A AJOG 2013
## 2009 Weight Gain Recs 2009

<table>
<thead>
<tr>
<th>Pre-preg category</th>
<th>BMI *</th>
<th>Total wt. Gain</th>
<th>Rates wt gain (lbs/wk)</th>
<th>Kcal/kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>28-40</td>
<td>1 (1-1.3)</td>
<td>36-40</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
<td>25-35</td>
<td>1 (0.8 – 1)</td>
<td>30</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>15-25</td>
<td>0.6 (0.5 - 0.7)</td>
<td>24</td>
</tr>
<tr>
<td>Obese</td>
<td>≥ Or 30.0</td>
<td>11-20</td>
<td>0.5 (0.4 –0.6)</td>
<td>12-18</td>
</tr>
</tbody>
</table>

* No distinction on grades of obesity

Twins: NW 37-54 lbs; OW 31-50; Obese 25-42 lbs  
[Fox NS Obstet Gynecol 2010;116:100](#)
How Much Weight is Necessary to Gain??

19 lbs 2oz
Baby Boy; 9/2009
Mother age 41 DM
Medan, North
Sumatra Indonesia
Where Wt Gain Goes

- Fetus 3400 g (7.5 lbs)
- Placenta 650 g (1.4)
- Uterus 970 (2.1 lbs)
- Mammary 405 g (0.9 lbs)
- Amniotic fluid 800g (1.8 lbs)
- Blood volume inc 1450 (3.2 lbs)
- Inc extravasc water 1480 (3.3 lbs)
- Maternal fat 3345 g (7.4 lbs)

**Obligate ~ 7800 g = 17lbs = 60,000 kcal or 225 kcal/day**

**Obligate + Mat fat + water = 28 lbs = 100,000 kcal or 375 kcal/day**
Energy Costs for Conceptus, Fat deposition, and Maintenance (BMR) in Affluent and Poor Countries

King JC
Ann Rev Nutr 2006;26:271

>75,000 kcal for fat = 21 lbs

~36,000 kcal for fat

~12,000 kcal for fat

-2,400

Energy cost, MJ

Swedish

41 lbs
144,000
540/day

England

22 lbs
77,000
288/day

Thailand

12 lbs
42,000
160/day

Gambia-S

-2,400

Gambia-NS

Maintenance
Fat
Conceptus
Why So Little Change in Guidelines?

- Balance risk of low vs high GWG but “first, do no harm”

Maternal BMI most important for infant adiposity; focus on that

- Focus on getting women to gain weight within guidelines

- SGA may be more important than LGA

Did not include studies with preeclampsia and GDM as outcomes due to “confounders”

- Inadequate data on BMI >35 so obese range primarily based on BMI data of 30-34.9
Oppositions to 2009 IOM guidelines

Current Commentary

Weight Gain Recommendations in Pregnancy and the Obesity Epidemic
Raul Artal, MD, Charles J. Lockwood, MD, and Haywood L. Brown, MD

Rebuttal

Current Commentary

Recommendations for weight gain during pregnancy in the context of the obesity epidemic

Rasmussen KM, Abrams B, Bodnar LM, Butte NF, Catalano PM, Maria Siega-Riz A.
“Adequate” GWG Increases Childhood Adiposity at 3 Yrs  *Oken E* *AJOG* 2007;196:322

1044 mother-child pairs; Harvard Project Viva; 1/3 BMI >26

IOM guidelines; 51% *excessive*; 14% inadequate

Indep of BMI, gluc toler, and LGA; SGA not ↑ in inadequate vs adequate
Gestational Weight Gain and Pregnancy Outcomes in Obese Women  *Kiel DW Obstet Gynecol 2007;110:752*

Missouri Birth Certificate 120,251 (1990-2001)

**Class I BMI 30-34.9:**

![Graph showing gestational weight change and pregnancy outcomes](image)

**Fig. 1.** Absolute risk of pregnancy outcomes by gestational weight gain category for class I obese women (body mass index 30–34.99). SGA, small for gestational age; LGA, large for gestational age.

Gestational Weight Gain and Pregnancy Outcomes in Obese Women  

**BMI 35-39.9:** 0-9 lbs optimal; SGA risk minimal without wt gain

---

**Fig. 2.** Absolute risk of pregnancy outcomes by gestational weight gain category for class II obese women (body mass index 35–39.99). SGA, small for gestational age; LGA, large for gestational age.

Gestational Weight Gain and Pregnancy Outcomes in Obese Women  

Kiel DW Obstet Gynecol 2007;110:752

BMI > 40: Wt **LOSS** 0-9 lbs optimal; SGA risk minimal

---

**Fig. 3.** Absolute risk of pregnancy outcomes by gestational weight gain category for class III obese women (body mass index greater than or equal to 40). SGA, small for gestational age; LGA, large for gestational age.

Optimal gestational weight gain ranges for the avoidance of adverse birth weight outcomes: a novel approach\textsuperscript{1–3}

Andreas Beyerlein, Barbara Schiessl, Nicholas Lack, and Rüdiger von Kries

\textit{AJ Clin Nutri} 2009;90:1152

\textbf{FIGURE 1.} Predicted risk of small-for-gestational-age (SGA) and large-for-gestational-age (LGA) births (separate as well as joint) by gestational weight gain (GWG) as calculated by logistic regression models (\(n = 177,079\)) and stratified by maternal BMI. The horizontal lines represent the joint predicted risk (JPR) limit of 20%. The vertical gray (dashed) lines represent the GWG associated with a JPR of \(\leq 20\%\).

177,079 term deliveries in Bavaria 2004-2006; Joint Predicted Risk of \(< 20\%\) LGA or SGA
Optimal Gestation Weight Gains with Avoidance of SGA/LGA

<table>
<thead>
<tr>
<th></th>
<th>Underweight</th>
<th>Normal weight</th>
<th>Overweight</th>
<th>Obese</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Institute of Medicine</strong></td>
<td>12.5 to 18.0</td>
<td>11.5 to 16.0</td>
<td>7.0 to 11.5</td>
<td>5.0 to 9.0</td>
</tr>
<tr>
<td><strong>Original analysis</strong></td>
<td></td>
<td></td>
<td>15-25 lbs</td>
<td>11-20</td>
</tr>
<tr>
<td>JPR ≤20%</td>
<td>8 to 25</td>
<td>2 to 18</td>
<td>-7 to 12</td>
<td>-15 to 2</td>
</tr>
<tr>
<td><strong>Current analysis</strong></td>
<td></td>
<td></td>
<td>-15-+26</td>
<td>-33++4</td>
</tr>
<tr>
<td>JPR ≤20% and SGA ≤10%</td>
<td>14 to 25</td>
<td>8 to 18</td>
<td>0 to 12</td>
<td>-7 to 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0-26</td>
<td>-15+4</td>
</tr>
</tbody>
</table>

1 These analyses pertain to term infants only.

Large effect modification by Smoking and Parity
A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: birthweight, fetal growth, and postpartum weight retention

Anna Maria Siega-Riz, PhD; Meera Viswanathan, PhD; Merry-K Moos, BSN, MPH; Andrea Deierlein, MS, MPH; Sunni Mumford, SM; Julie Knaack, MPH; Patricia Thieda, MS; Linda J. Lux, MPA; Kathleen N. Lohr, PhD

- Systematic review of 35 highest quality studies drawn from report conducted for the Agency for Healthcare Research and Quality (AHRQ)
- Strong support between excessive GWG and LGA
- Strong support between inadequate wt gain and SGA ONLY IN normal or underweight women
- Moderate support between GWG and postpartum wt retention
- **Overweight and obese women who gain below IOM recs do NOT have higher risk for SGA**
- AHRQ report will be used by IOM committee to reexamine guidelines
Association of Maternal GWG with Short- and Long-term Maternal and Child Health Outcomes
Zilko CE AJOG 2010;202:574

4496 children ages 14-22 in National Longitudinal Survey of Youth 1979

SGA, LGA, PP Wt Retention, Child Obesity, C-section according to 2009 IOM Guidelines

GWG increased PP Wt Retention, Child OW, LGA

SGA only decreases with GWG in UW and NW moms

Optimal GWG for OW; 5kg (11 lbs) (<10% SGA/LGA)

Optimal GWG for Obese < 5 kg (0-11 lbs)
**Gestational Weight Gain and Risk of Infant Death in the United States**

Davis RR. Am J Pub Health 2014; 104:S90

Regina R. Davis, PhD, MPH, Sandra L. Hofferth, PhD, and Edmond D. Shenassa, ScD

**TABLE 3—Association Between Gestational Weight Gain and Infant Death by Prepregnancy BMI: Pregnancy Risk Assessment Monitoring System, Phase 5; United States; 2004–2008**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1, OR (95% CI)</th>
<th>Model 2, OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Underweight (BMI &lt; 18.5)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate</td>
<td>6.56*** (2.61, 16.48)</td>
<td>6.18*** (2.45, 15.56)</td>
</tr>
<tr>
<td>Normal (Ref)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Excessive</td>
<td>1.19 (0.48, 2.98)</td>
<td>1.34 (0.51, 3.54)</td>
</tr>
<tr>
<td><strong>Normal weight (BMI = 18.5-24.9)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate</td>
<td>1.75* (1.30, 2.37)</td>
<td>1.47* (1.08, 2.01)</td>
</tr>
<tr>
<td>Normal (Ref)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Excessive</td>
<td>0.62 (0.39, 0.98)</td>
<td>0.64 (0.40, 1.02)</td>
</tr>
<tr>
<td><strong>Overweight (BMI = 25-30)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate</td>
<td>2.32*** (1.45, 3.69)</td>
<td>2.11*** (1.30, 3.42)</td>
</tr>
<tr>
<td>Normal (Ref)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Excessive</td>
<td>1.06 (0.71, 1.60)</td>
<td>1.21 (0.80, 1.85)</td>
</tr>
<tr>
<td><strong>Obese (BMI ≥ 30.0)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inadequate</td>
<td>1.12 (0.71, 1.78)</td>
<td>1.01 (0.63, 1.64)</td>
</tr>
<tr>
<td>Normal (Ref)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Excessive</td>
<td>0.48** (0.30, 0.77)</td>
<td>0.51** (0.31, 0.84)</td>
</tr>
</tbody>
</table>

PRAMS survey conducted at mean of 4 mos after delivery (61-450 days)

Infant death up to >1 yr, not Perinatal Deaths

Did not exclude Preterm Births (lower GWG and ↑ death rate but “controlled”)

No Severity of Obesity Class (↓GWG, ↑ deaths)

Macrosomia, age >40 not controlled

Recall bias of GWG, DM (only 4%, seriously??)
What About GWG in GDM?

- Retrospective review; n=652  *Gibson KS 2012*
  - Weight gain prior to 24 weeks is a significant risk factor for GDM in OW and Obese women
- GDM women have a 3 fold higher risk of delivering an LGA infant than without GDM
- Majority of GDM women are OW or Obese
- No specific guidelines for GDM women
Low GWG in GDM
_Eun Park J 2011_

- Retrospective study of 215 OW and Obese Korean women with GDM (BMI ~30); diet and/or insulin
- Inadequate: 2.4 kg; Adequate 7.2; Excess 13.8; BMI not different
- Insulin Req: 26% Inad vs 44% Ad vs 48% Ex; Macrosomia 2.4 vs 8.3 vs 18%

Best Infant Outcomes and lower Need for Insulin in Inadequate GWG group; No rise in SGA
GWG and GDM  *Cheng YW 2008*

- Retrospective analysis of Sweet Success CA Program; n=31,074; Used old IOM guidelines (BMI >29 at least 15 lbs)

GWG less than IOM leads to or raises PTD, macrosomia, C-section, need for insulin

GWG less than IOM → improves above but slightly raises risk of SGA (CI 1.01-1.9)

~50% of women with GWG < IOM guidelines were underweight!!

No indication of control of glycemia or chronic htn (assoc with SGA)

Speculate that women with GDM may not need to gain as much weight
802 Observational Cohort of Irish Women screened using IADPSG criteria for GDM

65% GDM; 23% T1DM; 12% T2DM

57% GDM gained excessive amount; 64% PDM

Those who gained Excessive GWG needed more Insulin which was associated with LGA
Weight Loss after Dx of GDM in OW and Obese Women Katon J 2013

- Retrospective; n=322, Charlotte, NC
- 19% lost wt (1.4 kg) between GDM dx and delivery
- After adjustment for age, parity, race, A1C, wt gain prior to GDM, Rx, and GA delivery, Wt Loss → BW 283 gms lighter in OW women (as long as they did not exceed IOM recs before GDM dx) Trend in Obese women
- No difference in SGA
What Interventions are Effective to Minimize Excessive Weight Gain?

**ACOG 2002:** Mod exercise (3-5 METS), ≥30 mins or more per day on most, if not all days of the week, recommended for women with low risk pregnancies. Women at risk for preeclampsia or GDM should be even more active.
13 Diet
18 Physical Activity
13 Mixed + behavioral counseling
Diet is Superior to Increased Physical Activity in Pregnancy to Decrease GWG

Thangaratinam S BMJ 2012;344

Overall reduction in Mat Wt Gain ~1.4 kg (~3 lbs)

**Diet studies alone:** Reduction 3.8 kg (~8.5 lbs)

No difference in adherence to IOM Recs
Physical Activity is Superior to Diet in Decreasing BW and Does not Increase SGA  *Thangaratinam S BMJ 2012;344*

Physical Activity lowers BW by 60g

N.S. SGA

Trend to lower LGA Physical Activity

Mixed Approach N.S.
Diet but not Physical Activity Decreases Adverse Pregnancy Outcomes, especially GDM

Diet but not PA
Lower Preeclampsia, GDM, Gest Htn, and PTD

Mixed Approach N.S.
Interventions to Reduce and Prevent Obesity in Pre-Conceptual and Pregnant Women: A Systematic Review and Meta-Analysis

Maliha Agha¹, Riaz A. Agha²*, Jane Sandell³

14 RCTs or CTs in OW
Obese And Morbid Obesity (2734); Only 1 Pre-concep
Lower GWG with intervention (-1.6 kg)
No effect in Class 3 Obesity
No effect on BW, GA Del,
or PP Wt Retention

-9 kg in study used diet and
PA counseling in obese
women

-7 kg Intense Diet
Counseling 10X for 1hr

Intense and early better
Does Exercise Improve Outcomes in GDM Women??

- Adding exercise to diet alone; no clear benefit in preventing GDM; Only 3/8 studies positive

- In women WITH GDM 5/7 (~70%) activity-based interventions showed improvement in glycemic control or limiting insulin use
  
  In most successful studies (3 times/wk), insulin requirement ↓ 2-3 fold

- OW or obese women benefit the most with longer delay from dx to initiation of insulin Rx

- Only one significantly ↓ GWG but not glycemic control (Artal R 2007)

- Compliance was major issue in all studies but better in women with GDM
  
  GDM women are more highly motivated to minimize insulin use
  GDM women are more concerned about risks to baby
  GDM women receive regular appointments
  GDM women may understand the significance of GDM on future disease risk
RCT 425 obese preg women by 14 wks to PA+D, PA, Con

Advice: GWG <5 kg!!

Raises Pedometer steps by 50% (11,000); assessed on 7 consec days q4 wks

Diet: Hypocaloric (1200-1675) Mediterranean diet q 2 wks

389 completed:
PA+D 8.6kg (-9.6-34); PA 9.4 (-3.4-28); Con 10.9 (-4.4-28)

Overall, PA lowers GWG by ~ 1.5 kg vs 2.3 with PA +D

No diff in BW between groups but risk of having macrosomic infant was lower with <5 kg GWG (14% vs 29%) but no diff in SGA
One of largest RCTs (Denmark) enrolling at 10-14 wks in obese women (~150 per group)
4 diet sessions, weekly aerobic classes, motivating initiatives, free fitness membership
Modest ↓ in GWG (7.4 vs 8.6 kg) and HOMA IR; N.S. PIH, GDM, LGA, C-sec, gluc, TGs
Compliance poor with only 56% attending aerobic classes for at least half the sessions
GDM Danish criteria: 6% vs 5.2% but IADPSG criteria 39% vs 44%!!!
No ↑ in SGA in women who gained <5kg
Babies of women who eat junk food while pregnant 'more likely to be obese'

Babies of women who eat junk food while pregnant will be more likely to be obese as an adult and will be born with an addiction to fatty foods, Australian scientists have concluded.
Nutritional Strategies in the Management of GDM
Hernandez T, Chartier-Logan C, Anderson M, Friedman J, Barbour LA
Clin Obstet Gynecol, Dec 2013, in press

-ADA abandoned recs on macronutrient content of GDM diet

-In only 6 randomized controlled trials (RCTs) in 250 women, data suggest that a diet higher in complex carbohydrate and fiber, low in simple sugar, and lower in saturated fat may be effective in blunting postprandial hyperglycemia, preventing worsened insulin resistance and excess fetal growth. The use of diet in GDM remains an area in grave need for high-quality RCTs.

High fat diet can worsen maternal insulin resistance and ↑ FFAs, and preliminary RCT data suggests it may cause increased infant adiposity

Emphasize avoidance of simple carbs and high fat and increase fiber
A Higher-Complex Carbohydrate Diet in Gestational Diabetes Achieves Glucose Targets and Lowers Postprandial Lipids: A Randomized Crossover Study

Teri L. Hernandez,1,2,3 Rachael E. Van Pelt,4 Molly A. Anderson,4 Linda J. Daniels,5 Nancy A. West,6 William T. Donahoo,1,5 Jacob E. Friedman,7 and Linda A. Barbour1,8

May 2014, Diabetes Care 37:1254
### Higher Infant Adiposity with LC/CONV Exposure

<table>
<thead>
<tr>
<th></th>
<th>LC/CONV</th>
<th>HCC/LF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td><strong>C-section</strong></td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td><strong>Sex (M/F)</strong></td>
<td>2/4</td>
<td>3/2</td>
</tr>
<tr>
<td><strong>Gest Age, weeks</strong></td>
<td>39.1±0.4</td>
<td>39.9±0.3</td>
</tr>
<tr>
<td><strong>Birth Weight, g</strong></td>
<td>3449±175</td>
<td>3118.5±87</td>
</tr>
<tr>
<td><strong>Adiposity, PeaPod, 2wks</strong></td>
<td>14.1±1.4</td>
<td>10.7±2.2</td>
</tr>
</tbody>
</table>

Mean±SEM

CHOICE™ = HCC/LF

Hernandez, TL (2013), Preliminary data, R21DK 088324
Conclusions for OW, Obese and GDM Women

- Excess GWG ↑ LGA, PE, GDM, C-sec, PP wt retention, pre-Preg BMI
- B.W. and SGA related to Wt gain in UW and NW; not OW/Obese
- Obese women, with BMI >35, do not appear to need to gain wt
- Diet superior to prevent excess GWG and adverse outcomes and to promote Wt Loss PP. Exercise may ↓ LGA if compliance improved
- IOM should re-examine recs for OW and Obese women and stratify
- Presenter Recs: Target lower range; consider no GWG for BMI >35
  - BMI <20; No change in IOM guidelines (28-40 lbs)
  - BMI 20-25.9: 25 lbs
  - BMI 26-29.9: 15 lbs
  - BMI 30-35: No more than ~10-11 lbs
  - BMI > 35: No wt gain needed; avoid wt loss for now
- Women with GDM are likely to need even less GWG and benefit more
- Stress importance of PP wt loss for subsequent pregnancy risks to both mother and offspring as well as future CVD and Diabetes risk
Healthy Weight Gain During Pregnancy

Are you having a baby?

If you're pregnant or thinking about having a baby, follow this link to get expert advice about gaining the right amount of weight during your pregnancy so that both you and your baby will have a healthy start together.

Let's Go!

Launch the interactive web experience

To learn more about how you can maintain a healthy weight gain during pregnancy, explore the resources below. Follow the conversation on Twitter using the hashtag #WhatToGain.

Para obtener algunos de estos recursos en Español, visita www.iom.edu/embarazosaludable.

Recommended Pregnancy Weight Gain by BMI

BMI is a measure of body fat that is based on height and weight. To calculate your BMI, go to www.nhlbisupport.com/bmi.

Download the PDF

Pregnancy Weight Tracker

Use this tool to track your weight gain during pregnancy and compare it to the recommended ranges.

Download the PDF or request a hard copy

WHAT CAN BE DONE??

Healthy Weight During Pregnancy
Practical Approaches: Stakes in GDM Women Even Higher than in Obesity

- **Brisk walking after meals**/physical activity may improve glucose disposal into skeletal muscle, ↓ need for meds, ↓GWG

- **Ready availability of healthy snacks** (washed veggies, string cheese, nuts); Avoid buying high carb/high fat snacks to reduce impulsive eating (don’t go to grocery store hungry)

- ↓ Cals best to minimize GWG, ↓ need for insulin/meds

- Avoiding excess GWG may ↓ LGA, GDM, PIH, C-sec, PP weight retention, and long term obesity risk

- Favorable intrauterine environment may also ↓ risk of childhood obesity and metabolic syndrome

- OW/Obese GDM women may benefit even more

- Potential for healthy behaviors to be adopted by entire family and for mother to prevent T2DM
Diabesity Begets Diabesity: Halting the Cycle

- **INSULIN RESISTANCE**
  - Genetics
  - Obesity
  - Hyperlipidemia
  - Glucose Intolerance
  - Inflammation/Ox Stress

- **Environment**
  - GWG, Diet, PA

- **Epigenetics**

- **Fetal Metabolic Programming**

- **Metabolic Syndrome**
  - > 50%

- **Type 2 Diabetes**
  - Childhood Obesity, IGT

- **Catch-up Growth**
132 lbs at Age 3

Aged three and already 60kg

THIS three-year-old tips the scales at 60kg (9st 6lb), making him at least four times the size of a normal child his age. When Lu Hao was born, he weighed just 2.5kg (5lb 8oz) but piled on the pounds from when he was three months old. ‘His appetite is so good that for a meal he can eat three big bowls of rice, even larger than I and his mother,’ said Hao’s father Lu Yuncheng in China.

Picture: Rex