Objective 2

Current recommendations for optimal weight gain during pregnancy
Pregnancy weight gain over the years...

Up to the 1920’s – focus on physical beauty, clothing, cosmetics and slenderness

“The pregnant woman should exercise some care of her diet. … She should eat rather less during early pregnancy than other times; ….”
Connelius Clifford Venderbeck, M.D.
Pancoast Ladies’ New Medical Guide, 1890, pp585

“Pregnancy is essentially a problem in nutrition”
J. Morris Slemons, 1919
Post 1920, obstetrical texts began to focus on weight gain, acknowledging that middle class women had easy access to food and drink.

Patient to Federal Children’s Bureau, 1926
“According to one doctor, I am allowed to eat everything ‘on earth’ while another doctor tells me to eat nothing but milk, potatoes, butter, no eggs, vegetables or meat. I am in a great predicament as which is which.”

AMA Vice President, William J. Carrington
“...excessive calories do not go into the baby’s sinews but are stored as fat in odd and embarrassing places about the body of the mother” 1944

AMA Vice President, William J. Carrington
“...It is a mistake to overeat, although many bridge table experts give the gratuitous advice that a mother expecting must eat for two” 1944
# Pregnancy weight gain recommendations

**Source:** ACOG Committee Opinion 548, Jan 2013

<table>
<thead>
<tr>
<th>Prepregnancy BMI</th>
<th>Total Weight Gain</th>
<th>Rates of Weight Gain* 2nd and 3rd Trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range in kg</td>
<td>Mean (range) in kg/week</td>
</tr>
<tr>
<td>Underweight (&lt; 18.5 kg/m²)</td>
<td>12.5-18</td>
<td>0.51 (0.44-0.58)</td>
</tr>
<tr>
<td>Normal weight (18.5-24.9 kg/m²)</td>
<td>11.5-16</td>
<td>0.42 (0.35-0.50)</td>
</tr>
<tr>
<td>Overweight (25.0-29.9 kg/m²)</td>
<td>7-11.5</td>
<td>0.28 (0.23-0.33)</td>
</tr>
<tr>
<td>Obese (≥ 30.0 kg/m²)</td>
<td>5-9</td>
<td>0.22 (0.17-0.27)</td>
</tr>
</tbody>
</table>

*Calculations assume a 0.5-2 kg (1.1-4.4 lbs) weight gain in the first trimester (based on Siega-Riz et al., 1994; Abrams et al., 1995; Carmichael et al., 1997).
IOM recommended tracking weight at doctor visits.
Prevalence of gestational weight gain in US women - 2015

Gestational weight gain was within the recommended range for 32% of women giving birth to full-term, singleton infants in 2015. 48% gained more weight, 21% less weight than recommended.
Excess gestational weight gain is more prevalent in women with overweight/obesity.

39% of women who were normal weight gained within, compared to only 26% women who were overweight, and 24% women with obesity before pregnancy.

Excess gestational weight gain is more prevalent in women with overweight/obesity.

Weight gain above the recommendations was highest among women who were overweight (61%) or obesity (55%) before pregnancy.

Prevalence of excess gestational weight gain in US women - 2015

Where does pregnancy weight gain go?

For a woman with BMI 20-24.9 kg/m² at conception

EARLY GESTATION (0 TO < 24 WEEKS)

Composition of Maternal Unit = +3.6 kg

Blood = 1.7 kg
Uterus & Breast = 1.1 kg
Extracellular Fluid = 0.2 kg
Other Tissues (Fat) = 0.6 kg

Composition of Fetal Unit = +1.7 kg

Placenta = 0.3 kg
Fetus = 1.1 kg
Amniotic Fluid = 0.3 kg

TOTAL GESTATION (0 TO 40 WEEKS)

Composition of Maternal Unit = +7.0 kg

Blood = 2.0 kg
Uterus & Breast = 1.7 kg
Extracellular Fluid = 1.7 kg
Other Tissues (Fat) = 1.5 kg

Composition of Fetal Unit = +5.3 kg

Placenta = 0.9 kg
Fetus = 3.2 kg
Amniotic Fluid = 1.2 kg

Broskey, Marlatt et al 2017 In Press
More pregnancy weight gain = more fat gained!

<table>
<thead>
<tr>
<th>BMI category</th>
<th>Weight gain category (n)*</th>
<th>Body weight gain (kg)**</th>
<th>Fat gain (kg)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight (BMI &lt; 19.8 kg/m²)</td>
<td>Less than recommended (6)</td>
<td>7.9 ± 1.6</td>
<td>0.6 ± 1.9</td>
</tr>
<tr>
<td></td>
<td>Recommended (7)</td>
<td>12.6 ± 2.4</td>
<td>6.0 ± 2.6</td>
</tr>
<tr>
<td></td>
<td>More than recommended (8)</td>
<td>16.1 ± 3.9</td>
<td>6.9 ± 3.5</td>
</tr>
<tr>
<td></td>
<td>All underweight women (21)</td>
<td>12.6 ± 4.4</td>
<td>4.8 ± 3.8</td>
</tr>
<tr>
<td>Normal weight (BMI = 19.8–26)</td>
<td>Less than recommended (31)</td>
<td>8.6 ± 1.9</td>
<td>1.3 ± 3.0</td>
</tr>
<tr>
<td></td>
<td>Recommended (46)</td>
<td>12.1 ± 3.4</td>
<td>3.8 ± 3.5</td>
</tr>
<tr>
<td></td>
<td>More than recommended (41)</td>
<td>15.2 ± 3.4</td>
<td>6.0 ± 3.1</td>
</tr>
<tr>
<td></td>
<td>All normal weight women (118)</td>
<td>12.2 ± 4.0</td>
<td>3.9 ± 3.7</td>
</tr>
<tr>
<td>Overweight (BMI &gt;26–29)</td>
<td>Less than recommended (7)</td>
<td>8.5 ± 3.2</td>
<td>0.3 ± 2.5</td>
</tr>
<tr>
<td></td>
<td>Recommended (9)</td>
<td>9.1 ± 3.1</td>
<td>2.8 ± 4.1</td>
</tr>
<tr>
<td></td>
<td>More than recommended (13)</td>
<td>13.6 ± 5.1</td>
<td>4.2 ± 6.9</td>
</tr>
<tr>
<td></td>
<td>All overweight women (29)</td>
<td>11.0 ± 4.6</td>
<td>2.8 ± 5.4</td>
</tr>
<tr>
<td>Obese (BMI &gt;29)</td>
<td>Less than recommended (7)</td>
<td>3.2 ± 2.7</td>
<td>-5.2 ± 1.5</td>
</tr>
<tr>
<td></td>
<td>Recommended (6)</td>
<td>6.9 ± 4.4</td>
<td>-0.6 ± 4.6</td>
</tr>
<tr>
<td></td>
<td>More than recommended (15)</td>
<td>12.0 ± 4.6</td>
<td>3.1 ± 3.9</td>
</tr>
<tr>
<td></td>
<td>All obese women (28)</td>
<td>8.7 ± 5.6</td>
<td>0.2 ± 5.0</td>
</tr>
</tbody>
</table>

Lederman et al 1997 Obstet Gynecol 90(4); 483-88
GWG and Incidence of Gestational Diabetes

N = 652, retrospective chart review (2006-2009)
Weight gain until 24w
GDM Dx (50g > 200mg/dl or 100g), N = 163
GWG and Type 2 Diabetes 21 years later

N=3,386, prospective cohort study
Births 1981-1984 – 21y follow-up
Owt – 12%, Obese – 4%
Self-report DM!

Table 4. Odds ratio (OR) of diabetes at 21 years post-partum by the IOM categories of gestational weight gain (N = 3386).

<table>
<thead>
<tr>
<th>Model</th>
<th>Odds Ratio (95% confidence interval) of diabetics at 21 years by IOM categories</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inadequate</td>
</tr>
<tr>
<td>Model 1</td>
<td>1.02(0.73,1.42)</td>
</tr>
<tr>
<td>Model 2</td>
<td>1.00(0.72,1.40)</td>
</tr>
<tr>
<td>Model 3</td>
<td>0.99(0.71,1.39)</td>
</tr>
<tr>
<td>Model 4</td>
<td>1.05(0.75,1.48)</td>
</tr>
<tr>
<td>Model 5</td>
<td></td>
</tr>
<tr>
<td>Pre-pregnancy BMI&lt;25 kg/m² (n = 2870)</td>
<td>1.00(0.69,1.45)</td>
</tr>
<tr>
<td>Pre-pregnancy BMI≥25 kg/m² (n = 516)</td>
<td>1.12(0.50,2.52)</td>
</tr>
<tr>
<td>Model 6</td>
<td></td>
</tr>
<tr>
<td>Pre-pregnancy BMI&lt;25 kg/m² (n = 2870)</td>
<td>1.05(0.72,1.54)</td>
</tr>
<tr>
<td>Pre-pregnancy BMI≥25 kg/m² (n = 516)</td>
<td>1.16(0.51,2.64)</td>
</tr>
</tbody>
</table>

Model 1- adjusted for IOM categories and maternal age at first clinic visit.
Model 2- adjusted for model 1 plus maternal smoking during pregnancy, parity, maternal educational attainment, race, TV watching and exercise before pregnancy.
Model 3- adjusted for model 2 plus breastfeeding duration.
Model 4- adjusted for model 3 plus BMI at 21 years.
Model 5- model 3 results are repeated stratifying by the maternal pre-pregnancy BMI≥25 kg/m² and BMI<25 kg/m².
Model 6- model 3 is repeated further adjusting for maternal BMI at 21 years.
GWG and hypertensive disorders

N=12,552, Avon longitudinal study

IOM categories of gestational weight gain

Odds ratio (95% CI)

Gestational hypertension

Preeclampsia

Meta-analysis: 11 studies
Postpartum follow-up: 0-1y, 1-9y and ≥15y

>68,000 women
Ideal vs Excess gain

2.98 kg

4.96 kg

Excess weight gain during pregnancy is associated with increased body fat in childhood. 948 children who had DXA at birth, 4y and 6y. 40% of infants were born to women with excess GWG.
last effects on GWG and offspring adiposity in adulthood

Maternal BMI, Parity, and Pregnancy Weight Gain: Influences on Offspring Adiposity in Young Adulthood


N=276 men and women, characterization of mothers pregnancy
Timing of GWG may also be important for neonate adiposity

N=172 singleton gestation

Pregravid BMI associated with:
- GWG
- neonatal FM

52% women exceeded IOM

Macrosomia
Normal wt - 5%
Overweight - 12%
Obese - 28%

The ‘double burden’ of maternal BMI and pregnancy weight gain - it’s a vicious cycle...

Int. J. Environ. Res. Public Health 2012, 9, 1263-1307