A Dynamic Model Predicting Gestational Weight Gain

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Overview

- Purpose
- Clinical Utility
- Methods
- Validation
How much weight should I gain?

Eating and nutrition

- It’s important to eat a healthy diet during pregnancy.
- You also need plenty of vitamins and minerals in your diet.
- Most pregnant women need around 300 extra calories per day.

Hytten FE, Chamberlain G. (1980) *Clinical physiology in obstetrics*
Institute of Medicine (IOM) recommends weight gain by pre-pregnancy BMI

**Purpose**

### TABLE 7-3 New Recommendations for Total and Rate of Weight Gain during Pregnancy, by Prepregnancy BMI

<table>
<thead>
<tr>
<th>Prepregnancy BMI</th>
<th>Total Weight Gain</th>
<th>Rates of Weight Gain* 2(^{nd}) and 3(^{rd}) Trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range in kg</td>
<td>Range in lbs</td>
</tr>
<tr>
<td>Underweight (&lt; 18.5 kg/m(^2))</td>
<td>12.5–18</td>
<td>28–40</td>
</tr>
<tr>
<td>Normal weight (18.5–24.9 kg/m(^2))</td>
<td>11.5–16</td>
<td>25–35</td>
</tr>
<tr>
<td>Overweight (25.0–29.9 kg/m(^2))</td>
<td>7–11.5</td>
<td>15–25</td>
</tr>
<tr>
<td>Obese (&gt; 30.0 kg/m(^2))</td>
<td>5–9</td>
<td>11–20</td>
</tr>
</tbody>
</table>

Why manage gestational weight gain (GWG)?

**Purpose**

- **Short term:**
  - (High BMI) Increased Risk for GDM, Preeclampsia (High GWG) C-section.

- **Long term:**
  - (High BMI and GWG) Postpartum weight retention, Increased maternal body fatness and risk factors for cardiovascular disease

- **Large for gestational age infants**
How does a mathematical model help?

Purpose

1. Enables setting precise goals with a health care provider.

2. Provides Continuous Feedback

3. Generates Opportunities to Intervene and Manage Weight Gain

Overview

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Java Based System to Manage GWG

Clinical Utility

User enters baseline data:
- Age
- Height
- Pre-gravid Weight
- Weight

Adjusts EI by trimester

Initial BMI is 24.5 (Normal). Init. calories is 2385. Weight gain is 8.2 kgs. 1st tri. cal. increase is 300, 2nd tri. cal. increase is 300, 3rd tri. cal increase is 300.

Weight

Gestational Week

Diana M. Thomas, Ph.D.
Java Based System to Manage GWG

Clinical Utility

Green Zone
IOM recommended range

Initial BMI is 24.5 (Normal). Init. calories is 2385. Weight gain is 8.2 kgs. 1st tri. cal. increase is 300. 2nd tri. cal. increase is 300. 3rd tri. cal increase is 300.
Java Based System to Manage GWG

Clinical Utility

Blue Curve
Model predicted weight
Outside Recommendations
Java Based System to Manage GWG

Clinical Utility

Blue Curve
Model predicted weight
Inside Recommendations

Adjust EI
Model can be applied to determine additional EI by trimester

### Clinical Utility

<table>
<thead>
<tr>
<th>Classification</th>
<th>Pre-gravid weight (kg)</th>
<th>Pre-gravid BMI (kg/m²)</th>
<th>Target GWG (kg) Trimester</th>
<th>Model predicted ΔEI (kcal/d) Trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Underweight</td>
<td>45</td>
<td>16.9</td>
<td>0.5-2.0</td>
<td>11.4-15.8</td>
</tr>
<tr>
<td>Normal</td>
<td>55</td>
<td>20.7</td>
<td>0.5-2.0</td>
<td>9.1-13.0</td>
</tr>
<tr>
<td>Overweight</td>
<td>72</td>
<td>27.1</td>
<td>0.5-2.0</td>
<td>6.0-8.6</td>
</tr>
<tr>
<td>Obese</td>
<td>97</td>
<td>36.5</td>
<td>0.5-2.0</td>
<td>4.4-7.0</td>
</tr>
</tbody>
</table>
Model can be used to compare different recommendations

Clinical Utility

GWG resulting from FAO/WHO/UNU

IOM Weight Range

GWG (kg)

Gestational Day


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Overview

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- **Methods**
- Validation
There are pregnancy specific challenges for model development…

**Methods**

- Pre-Gravid Weight
- Body Composition Measurements
- Components of Energy Expenditure (RMR, TEF, SPA, PA)
The Butte study contains the necessary measurements for model development...

**Methods**

Simultaneous measurements at weeks 0, 9, 22, 36

- Body composition (body weight, TBW, body volume, bone mineral content)
- Energy expenditures (DLW)
- RMR (respiration calorimetry)

The first mathematical model that predicts weight gain during pregnancy

**Methods**

\[
\frac{dFFM}{dt}_{ES} + \frac{9500}{dt} \frac{dFM}{EI} = \left(1 - g\right)\left(EI_0 + \Delta EI\right) - \frac{15FFM + 1903}{EE}
\]

\[
FFM = 1.8 FFM(0) - 1.8TBW(0) - 1.8TBP(0) + 0.8FM + 23.5
\]

\[
TBW = 0.5W + 3.9
\]

\[
TBP = \begin{cases} 
0.1W + 1.3 & \text{if } 52 < W \leq 57.7 \text{ kg} \\
0.08W + 3.1 & \text{if } W > 57.7 \text{ kg}
\end{cases}
\]
Overview

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The model agrees with observed data from the Kopp-Hoolihan Study.

Model predictions agree with observed data from the Goldberg study

Thank you to my Collaborators…

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Questions?