THE GROWING CHALLENGES OF MATERNAL OBESITY

Dr C.P. Noel McCarthy Memorial Lecture 2019
New England Obstetrical and Gynecological Society
90th Annual Spring Meeting, April 10th 2019

1936-2009
Maternal obesity

- Common
- Complicated
- Costly
- Consequences
- Challenging

Adult obesity has increased in all OECD countries

Data are based on measurements rather than self-reported height and weight.

Source: OECD Health Statistics 2018, OECD

Figure 5: Projected rates of obesity

Note: Obesity is defined as a body mass index (BMI) of 30 kg/m². OECD projections assume that BMI will continue to rise in a linear fashion. To OECD, OECD average of national health survey data.
Prepregnancy obesity USA

Overall 25.6% (2015) birth certificates
NYC 17.8% to Mississippi 33.5%

2011 – 2015: 8% increase
  Mild: +6%
  Moderate: +10%
  Severe: +14%

(CDC NVSS, 2018)
Maternal complications of obesity

OR
Venous thromboembolism 9.7
Gestational Diabetes Mellitus 2.4 - 3.6
Hypertension 2.1 - 3.3
Postpartum haemorrhage 1.4 - 2.3

(Denison et al, 2018)

Fetal complications of obesity

OR
Macrosomia 2.4 - 3.1
Neonatal death 2.6
Stillbirth 2.1
Birth defects 1.6
Prematurity 1.2

(Denison et al, 2018)

Costs of maternal obesity

- Increase in investigations eg laboratory, imaging
- Increase in drug usage eg ↑BP, GDM, antibiotics
- Increase in interventions eg induction, CS
- Increase in hospital stay
Risk of Type 2 DM

Challenges of maternal obesity

- Intravenous access e.g. postpartum haemorrhage
- Ultrasound for growth, anomalies
- Long needles for regional anaesthesia
- Customised medical equipment
I. Diagnosis of maternal obesity

Body Mass Index categories

- Underweight: <18.5 kg/m²
- Normal: 18.5-24.9 kg/m²
- Overweight: 25.0-29.9 kg/m²
- Obese Class 1: 30.0-34.9 kg/m²
- Obese Class 2: 35.0-39.9 kg/m²
- Obese Class 3: >40.0 kg/m²

(World Health Organization)

Adolphe Quetelet
Belgian Astronomer Mathematician Statistician Sociologist

Lambert Adolphe Jacques Quetelet (22.02.1796 – 17.02.1874)

BMI initially devised by Adolphe Quetelet & he called it as “Social Physics” (1830-1850).
Body Mass Index

- 1832: Definition of “a normal man” in Belgium
  - No reference to adiposity
- 1972: Index revived by Keys et al
  - Predictor of “fatness”
  - 7400 healthy men in 5 countries

Belgian Man Index (BMI)

Calculation of BMI

- Usually based on self reporting of weight and height
- Inexpensive
- Can be done remotely e.g. telephone, form
- Facilitates epidemiological analysis of Big Data
BMI and pregnancy

- Based on self reporting or measurement?
- Timing of measurement? During pregnancy or not?
- Gestation at measurement? Sonographic dating?
- WHO categorisation?
- Cut-off points for increased risk? Ethnicity?

Maternal BMI calculation

- Underreporting of weight by 59% of women (mean 1.5kg)
- Underreporting inversely related to measured weight
- Wrong BMI category in 21% of women
- Incidence of obesity increased from 16% to 20% with measurement

(Fattah et al., 2009)
Maternal obesity rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Maternal obesity rates (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>16.0</td>
</tr>
<tr>
<td>2011</td>
<td>18.9</td>
</tr>
<tr>
<td>2012</td>
<td>14.5</td>
</tr>
<tr>
<td>2013</td>
<td>15.0</td>
</tr>
<tr>
<td>2014</td>
<td>15.5</td>
</tr>
<tr>
<td>2015</td>
<td>16.0</td>
</tr>
<tr>
<td>2016</td>
<td>16.5</td>
</tr>
<tr>
<td>2017</td>
<td>17.0</td>
</tr>
</tbody>
</table>

Source: Reynolds et al. 2019

RR of diabetes in obese women: 1.73 (Chiolero et al., 2007)

Obesity rates

<table>
<thead>
<tr>
<th>Year</th>
<th>% of total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>5</td>
</tr>
<tr>
<td>2011</td>
<td>10</td>
</tr>
<tr>
<td>2012</td>
<td>15</td>
</tr>
<tr>
<td>2013</td>
<td>20</td>
</tr>
<tr>
<td>2014</td>
<td>25</td>
</tr>
<tr>
<td>2015</td>
<td>30</td>
</tr>
<tr>
<td>2016</td>
<td>35</td>
</tr>
<tr>
<td>2017</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: OECD Health Data

Measurement of weight

RR of diabetes in obese women: 1.73 (Chiolero et al., 2007)
**Risk of Type 2 Diabetes Mellitus**

<table>
<thead>
<tr>
<th></th>
<th>Self-reporting</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overweight</td>
<td>2.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Obese Class 1</td>
<td>3.2</td>
<td>2.2</td>
</tr>
<tr>
<td>Obese Class 2-3</td>
<td>11.8</td>
<td>7.0</td>
</tr>
</tbody>
</table>

(Shields et al. 2008)
Bioelectrical Impedance Analysis (BIA)

- Fat more resistant to current
- Multifrequency, 8-electrode
- Direct measurement
- Safe in pregnancy

### Mean BIA first trimester

<table>
<thead>
<tr>
<th>Metric</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (kg/m²)</td>
<td>25.7</td>
</tr>
<tr>
<td>Fat mass (kg)</td>
<td>22.7</td>
</tr>
<tr>
<td>Fat-free mass (kg)</td>
<td>46.3</td>
</tr>
<tr>
<td>Fat (%)</td>
<td>31.7</td>
</tr>
<tr>
<td>TBW (%)</td>
<td>33.4</td>
</tr>
<tr>
<td>Visceral fat (1-59)</td>
<td>4.0</td>
</tr>
<tr>
<td>Arm fat (kg)</td>
<td>1.3</td>
</tr>
<tr>
<td>Leg fat (kg)</td>
<td>4.8</td>
</tr>
</tbody>
</table>

(Fattah et al. 2010)
Learning points

- Maternal BMI should be calculated based on measurement of height and weight in early pregnancy.
- Maternal weight and body composition does not change until 18-20 weeks gestation.
Guidelines for Perinatal Care (2012)

- Maternal weight should be evaluated at each scheduled prenatal visit
- Progress towards GWG goals should be monitored
- Counselling should be provided if there are significant deviations from goals

Monitoring maternal weight

- 66 countries surveyed
- 90% recommended assessment at first visit
- 62% guidelines on GWG with wide variations
- 8/66 IOM recommendations for obese women

(Scott et al., 2014)

<table>
<thead>
<tr>
<th>Pre-pregnancy weight class</th>
<th>Pre-pregnancy BMI (kg/m²)</th>
<th>Total weight gain range (kg)</th>
<th>Mean (range) rate of weight gain in second and third trimesters (lb/week)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>&lt;18.5</td>
<td>12.7-18.1 (28-40)</td>
<td>1.0 (0.8-1.3)</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-24.9</td>
<td>11.3-15.9 (25-35)</td>
<td>1.0 (0.8-1.0)</td>
</tr>
<tr>
<td>Overweight</td>
<td>25.0-29.9</td>
<td>6.8-11.3 (15-25)</td>
<td>0.5 (0.3-0.7)</td>
</tr>
<tr>
<td>Obese (all classes)</td>
<td>≥30.0</td>
<td>5.0-9.1 (11-19)</td>
<td>0.5 (0.4-0.6)</td>
</tr>
</tbody>
</table>

*Assumes a first trimester weight gain of 0.5-2.0 kg (1-4 lb)
GWG metanalysis

- 1.3 million, 23 studies
- 1999 – 2017
- "Excessive" GWG associated with
  - Large for Gestational Age (LGA) OR 1.85 (n=13)
  - Macrosomia OR 1.95 (n=11)
  - Caesarean Section (CS) OR 1.30 (n=8)
  
  [Goldstein et al, JAMA, 2017]

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**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*</th>
<th>2nd and 3rd Trimester</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range in kg</td>
<td>Range in lbs</td>
<td>Mean (range) in kg/week</td>
</tr>
<tr>
<td>Underweight (&lt; 18.5 kg/m²)</td>
<td>12.5-18</td>
<td>28-60</td>
<td>0.31 (0.44-0.58)</td>
</tr>
<tr>
<td>Normal weight (18.5-24.9 kg/m²)</td>
<td>11.5-16</td>
<td>25-35</td>
<td>0.42 (0.35-0.50)</td>
</tr>
<tr>
<td>Overweight (25.0-29.9 kg/m²)</td>
<td>7.11-15</td>
<td>15-25</td>
<td>0.28 (0.23-0.33)</td>
</tr>
<tr>
<td>Obese (≥ 30.0 kg/m²)</td>
<td>5.9-11</td>
<td>11-20</td>
<td>0.22 (0.17-0.27)</td>
</tr>
</tbody>
</table>

*Calculations based on 0.5-2 kg (1.1-4.4 lbs) weight gain in the first trimester (based on Siege-Ritz et al., 1994; Abrams et al., 1995; Carmichael et al., 1997).

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Gestational Weight Gain

- Californian university hospital 1980-90
- 14,092 singleton deliveries
- "Good outcomes": 7002
- 60% (n=4218) complete data
- Obese: 4% (n=173)

[Carmichael et al., 1997]
Gestational Weight Gain

- Self-reported prepregnancy weight
- Last measured weight 1 week before delivery
- GWG per trimester estimated (linear regression)
- First trimester
  - Normal BMI: mean 2.19 kgs
  - Obese BMI: mean 1.65 kgs (NS)
  - (Carmichael et al, 1997)

Measurement of GWG

- Baseline measurement variable
- Final measurement variable
- Weight changes not linear
- Fluid retention third trimester

- (O’Higgins et al, 2014)

64% of obese women exceeded IOM guidelines for GWG

- (Caughey, JAMA Editorial, 2017)
### BMI and GWG (kg)

<table>
<thead>
<tr>
<th></th>
<th>&lt;28 weeks</th>
<th>&gt;28 weeks</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal (n=65)</td>
<td>7.6</td>
<td>4.2</td>
<td>11.8</td>
</tr>
<tr>
<td>Overweight (n=55)</td>
<td>7.2</td>
<td>3.9</td>
<td>11.1</td>
</tr>
<tr>
<td>Obese (n=64)</td>
<td>5.5</td>
<td>4.1</td>
<td>9.6</td>
</tr>
</tbody>
</table>

Farah et al, 2012

### GWG and BMI category

<table>
<thead>
<tr>
<th>BM</th>
<th>GWG (kgs)</th>
<th>GWG (%)</th>
<th>Excessive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>14.6 kg</td>
<td>31%</td>
<td>0%</td>
</tr>
<tr>
<td>Normal</td>
<td>12.6 kg</td>
<td>21%</td>
<td>3%</td>
</tr>
<tr>
<td>Overweight</td>
<td>16.3 kg</td>
<td>12%</td>
<td>18%</td>
</tr>
<tr>
<td>Obese</td>
<td>10.4 kg</td>
<td>9%</td>
<td>46%</td>
</tr>
</tbody>
</table>

O’Dwyer et al, 2013
Median GWG globally (n=33)

Overall: 14.0 kgs (IQR 11.0 – 17.9)
Underweight: 14.2 kgs
Normal: 14.5 kgs
Overweight: 13.9 kgs
Obese:  
  Mild 11.2 kgs
  Moderate 8.7 kgs
  Severe 6.3 kgs

(Santos et al, 2018)

GWG globally

- Minimal until 15 – 20 weeks
- Rate greater 22 – 25 weeks especially if overweight
- Trajectories not linear
- Not associated with pregnancy complications
- Similar in different populations internationally

(Santos et al, 2018)
Multivariate regression analysis of predictors of birth weight (n=2618)

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>REGRESSION COEFFICIENT</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gestation</td>
<td>143.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Smoking</td>
<td>-219.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Parity</td>
<td>124.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age</td>
<td>3.3</td>
<td>0.032</td>
</tr>
<tr>
<td>Fat-free Mass</td>
<td>17.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fat Mass</td>
<td>0.7</td>
<td>0.821</td>
</tr>
</tbody>
</table>

(Kent et al, 2013)

aOR of birth weight >4 kg by fat mass quartile

(Kent et al, 2013)

aOR of birth weight > 4 kg by fat free mass quartile

(Kent et al, 2013)
GWG and birth weight

- Observational study (n=522)
- Weight measured at each visit
- Gross GWG calculated at term
- Net GWG: total GWG minus birth weight

(O’Higgins et al. 2018)
Birth weight by net GWG

Mean GWG (kgs)

Net GWG

Gross GWG

Birth weight by net GWG

(O’Higgins et al. 2018)