Nutrition in Pregnancy

• Nutritional requirements increase
• Opportunity to improve health
  – Motivated ‘a teachable moment’ (O’Brien O.A. et al., 2017)
  – Regular contact with HCPs (Jackson et al., 2011)
• Lifelong value for offspring (Barker, 1997)
• Nutrition impacts on maternal outcomes
  – Gestational weight gain (Walsh et al., 2012)
  – Delivery and caesarean section (i-WIP Collaborative Group, 2017)
  – Blood glucose concentrations (Zhang et al., 2016)
Maternal diet and body composition
- Glucose, energy substrates
- Micronutrients – folate, B12, B6, etc
- Macronutrient balance
- Metabolic status

Potential oocyte/embryo responses
- Epigenetic modifications & gene expression changes
- Altered intracellular signaling
- Metabolic stress
- Apoptosis
- Altered cell differentiation & proliferation

Potential fetal consequences
- Epigenetic modifications & gene expression changes
- Altered fetal growth rate
- Altered setting of neuroendocrine axis
- Abnormal birth weight

Potential long-term consequences
- Stunting
- Impaired neurodevelopment
- Obesity
- Cardiovascular & metabolic disorders

Effects on next generation

Hanson et al FIGO nutrition committee IJOG 2016
Figure 1: Obesity among adults, 2015 or nearest year
Figure 1: Obesity among adults, 2015 or nearest year
The westernised diet rich in carbohydrates is thought to contribute to the rates of obesity
Not all carbohydrate foods are created equal

- **Low GI**
  - [Vegetables, rice, fruits]

- **Medium GI**
  - [Whole grains, legumes, starchy vegetables]

- **High GI**
  - [Refined grains, sugary foods, pastries]
• Pregnancy is a condition in which the glycaemic index may be of particular relevance

• Maternal glucose is the main energy substrate for intrauterine growth
RCT Of LOw glycaemic index diet vs usual diet to prevent macrosomia

Walsh, McGowan, McAuliffe et al BMJ 2012
ROLO

• **P**: Secundigravid with previous birthweight >4000g (n=759)
• **I**: Healthy low GI diet from early pregnancy
• **C**: Routine care
• **O**: Birthweight
• Gestational weight gain, glucose intolerance, gestational diabetes

• Excluded previous gestational diabetes

*Walsh, McGowan, Mahony, Foley, McAuliffe* BMJ 2012
ROLO-Intervention

• Focused on the Glycemic Index
• Exchange high GI carbohydrates for low GI alternatives
• Recipes
• Small groups of 2 – 6 people
• Gestation 15.7+/-3.0 weeks

Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012
ROLO main findings

• Low GI diet in pregnancy
• No difference in birthweight
  • Less infant adiposity (thigh circumference)

• Maternal benefits
  i. Less gestational weight gain of 1.3Kg
  ii. Improved glucose homeostasis
  iii. Improved nutrient and food intakes

Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012
# Results – Glycaemic Load

<table>
<thead>
<tr>
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<th>Intervention Group Low GI diet</th>
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<tbody>
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<td>Early pregnancy</td>
<td>132 ± 33</td>
<td>136 ± 38</td>
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<td>Second trimester</td>
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<td>140 ± 32*</td>
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<tr>
<td>Third trimester</td>
<td>127 ± 30</td>
<td>140 ± 37 *</td>
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*Walsh, McGowan, Mahony, Foley, McAuliffe BMJ 2012*
# Maternal Nutrient Intakes

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P value – independent samples t test
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P value – independent samples t test
Other Dietary Changes

- **Fruit** consumption was significantly higher at T3 among the intervention group (91% vs. 85%; p<0.05)

- **Vegetable** consumption was significantly higher at T3 among the intervention group (98% vs. 94%; p<0.05)

- **Oily fish** consumption was significantly higher at T2 among the intervention group (21% vs. 13%; p<0.05)

*McGowan, McAuliffe 2013*
Conclusion

• A low glycemic index diet in pregnancy has no effect on infant birthweight in a group at risk of fetal macrosomia

• Maternal benefits
  – Less gestational weight gain
  – Improved glucose homeostasis
  – Improved nutrient and food intakes
ROLO Study – Irish Birth Cohort

2007 – 2011
ROLO Study

2008 – 2016
ROLO Kids

2017 – Present
ROLO PreTeens

Birth
3 Months
6 Months
5 Years
9 – 11 Years
2 Years

Pregnancy
ROLO Study – Irish Birth Cohort

2007 – 2011

- ROLO Study

Pregnancy – 3 Months
- Maternal anthropometry
- Food Diaries in each trimester
- Lifestyle information
- Fetal ultrasound measurements
- Maternal blood & urine samples
- Cord blood samples
- Infant anthropometry

6 months – 5 Years
- Maternal & child anthropometry
- Feeding & development
- FFQ
- Physical activity
- Blood Pressure
- Step test (child)
- Blood sample
- Body composition (BIA)
- Bone mineral density (DXA)

2017 – Present

- ROLO PreTeens

9 – 11 Years
- Maternal & child anthropometry
- FFQ
- Eating Behaviours
- Lifestyle information
- Physical activity and fitness
- Blood Pressure
- Blood and saliva samples
- Shuttle run (child)
- Bone mineral density (DXA)
Pregnancy - Window to Future Health

• Pregnancy itself as a determinant of future health
• Physiological demands of pregnancy have lasting effect on a woman’s future health
  – Glucose tolerance
  – Gestational weight gain → weight retention
• Influence of diet or environmental factors
• Longitudinal studies lacking
<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>P</th>
<th>95% CI</th>
<th>Model P</th>
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<td>Fasting glucose, Early pregnancy, (mmol/L)</td>
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O’Brien, McAuliffe BJOG 2018
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<td>1.04</td>
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<td>(0.09, 1.99)</td>
<td>0.035</td>
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<td>1.70</td>
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<td>(0.36, 3.04)</td>
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<td>Glucose intolerant, 28 weeks' gestation</td>
<td>1.06</td>
<td>0.050</td>
<td>(0.00, 2.12)</td>
<td>0.039</td>
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O’Brien, McAuliffe BJOG 2018
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<tr>
<th>Well-being percentage score, change pregnancy to 5-year follow-up</th>
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<td>Gestational weight gain, (kg)</td>
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<td>Glycaemic Index, 5-year follow-up</td>
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O’Brien, McAuliffe BJOG 2018
### Weight Retention (kg) - 5-Year Follow-Up

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<tr>
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<th>B (%Δ)</th>
<th>P</th>
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<tr>
<td>Well-being percentage score, change pregnancy to 5-year follow-up</td>
<td>-0.06</td>
<td>0.011</td>
<td>(-0.11, -0.02)</td>
<td>0.002</td>
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<tr>
<td>Gestational weight gain, (kg)</td>
<td>0.19</td>
<td>0.049</td>
<td>(0.00, 0.38)</td>
<td>0.001</td>
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<tr>
<td>Glycaemic Index, 5-year follow-up</td>
<td>0.26</td>
<td>0.012</td>
<td>(0.06, 0.46)</td>
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<tr>
<td>Glycaemic Load, 5-year follow-up</td>
<td>0.04</td>
<td>0.017</td>
<td>(0.01, 0.07)</td>
<td>0.002</td>
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O’Brien, McAuliffe BJOG 2018
Clinical Implications

Pregnancy factors are determinants of future health

• Highlights pregnancy as opportunity to intervene
• Weight gain
• Glycaemic control – fasting early pregnancy

Postpartum

Weight retention postpartum

• Diet
  – Low GI: wholegrains, limit refined carbohydrate foods
  – Protein sources
• Well-being
The association between maternal nutrition and lifestyle during pregnancy and 2-year-old offspring adiposity: analysis from the ROLO study

Mary K. Horan¹ · Jean M. Donnelly¹ · Ciara A. McGowan¹ · Eileen R. Gibney² · Fionnuala M. McAuliffe¹

Horan et al, 2016 Journal of Public Health
### 2 Year Infant Results

#### Weight-for-age z-score

<table>
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<tr>
<th></th>
<th>B</th>
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<th>p</th>
<th>R²adj</th>
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<td>Mother MUA circumference baseline (cm)</td>
<td>0.065</td>
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</tr>
<tr>
<td>Trimester 3 saturated fat (%TE)</td>
<td>0.048</td>
<td>0.024</td>
<td>0.046</td>
<td>0.205</td>
<td>5.316</td>
<td>&lt;0.001</td>
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<tr>
<td>2 year mother weight (kg)</td>
<td>0.030</td>
<td>0.014</td>
<td>0.035</td>
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</tr>
<tr>
<td>2 year mother BMI (kg/m²)</td>
<td>-1110.7</td>
<td>421.127</td>
<td>0.009</td>
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</tr>
<tr>
<td>Age given drinks other than breastmilk (weeks)</td>
<td>-0.010</td>
<td>0.005</td>
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#### Waist:length ratio

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<tr>
<td>Baseline maternal minutes sitting per weekday</td>
<td>4.71E-05</td>
<td>0.000</td>
<td>0.019</td>
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<tr>
<td>Mother height (cm)</td>
<td>0.000</td>
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#### Subscapular:triceps skinfold thickness ratio

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*Controlled for maternal BMI, birthweight, education, gender, breastfeeding group

Horan et al, 2016 *Journal of Public Health*
## 2 Year Infant Results

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Horan et al, 2016 *Journal of Public Health*
## 2 Year Infant Results

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<td>0.005</td>
<td>0.057</td>
<td></td>
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</table>

### Waist:length ratio

<table>
<thead>
<tr>
<th></th>
<th>B</th>
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<th>p</th>
<th>R²adj</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline maternal minutes sitting per weekday</td>
<td>4.71E-05</td>
<td>0.000</td>
<td>0.019</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother height (cm)</td>
<td>0.000</td>
<td>0.000</td>
<td>0.054</td>
<td>0.142</td>
<td>3.807</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Trimester 2 Polyunsaturated fat (%TE)</td>
<td>-0.005</td>
<td>0.002</td>
<td>0.017</td>
<td></td>
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</tr>
<tr>
<td>Trimester 3 Polyunsaturated fat (%TE)</td>
<td>-0.004</td>
<td>0.002</td>
<td>0.070</td>
<td></td>
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### Subscapular:triceps skinfold thickness ratio

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Trimester 1 Glycaemic Index</td>
<td>0.009</td>
<td>0.004</td>
<td>0.029</td>
<td>0.088</td>
<td>2.782</td>
<td>0.007</td>
</tr>
<tr>
<td>Trimester 2 Saturated Fat (%TE)</td>
<td>0.018</td>
<td>0.005</td>
<td>0.001</td>
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*Controlled for maternal BMI, birthweight, education, gender, breastfeeding, group

Horan et al, 2016 *Journal of Public Health*
## 2 Year Infant Results

### Weight-for-age z-score

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<th>R^2 adj</th>
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<th>P</th>
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<tbody>
<tr>
<td>Mother MUA circumference baseline (cm)</td>
<td>0.065</td>
<td>0.035</td>
<td>0.065</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trimester 3 saturated fat (%TE)</td>
<td>0.048</td>
<td>0.024</td>
<td>0.046</td>
<td>0.205</td>
<td>5.316</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>2 year mother weight (kg)</td>
<td>0.030</td>
<td>0.014</td>
<td>0.035</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 year mother BMI (kg/m^2)</td>
<td>-1110.7</td>
<td>421.127</td>
<td>0.009</td>
<td></td>
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*Controlled for maternal BMI, birthweight, education, gender, breastfeeding group

Horan et al, 2016 *Journal of Public Health*
Maternal lipids and childhood adiposity

- Dietary saturated fat, mono and poly unsaturated fat intake associated with total cholesterol levels in early pregnancy (p=0.02)

Geraghty et al, 2016 Plos One
### Blood Lipids and Birthweight

*Controlled for mother’s BMI, education level, smoking, gestational age, gender, leptin cord blood*

<table>
<thead>
<tr>
<th>Model</th>
<th>B</th>
<th>P</th>
<th>$r^2$ adj</th>
<th>F</th>
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<tbody>
<tr>
<td>TG (late)</td>
<td>111.17</td>
<td>0.034</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TG (cord)</td>
<td>-453.75</td>
<td>0.013</td>
<td>0.318</td>
<td>6.54</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LDL-C (cord)</td>
<td>88.55</td>
<td>0.426</td>
<td></td>
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Geraghty et al, 2016 *Plos One*
Fig 1. Scatter plot displaying the association between birth weight and late pregnancy triglyceride concentrations stratified by BMI category.
Dietary Protein in Pregnancy

Geraghty, McAuliffe et al, BJN 2018
Dietary Protein in Pregnancy

- 570 ROLO mother and child dyads
- Food Diaries in each trimester
  - Protein intake per kg of maternal weight (gr/day/kg)
- Child body composition
  - Birth, 6 months, 5 Years
- Weight, BMI, Waist:length ratio, Skinfolds

Geraghty, McAuliffe et al, BJN 2018
Dietary Protein in Pregnancy

Geraghty, McAuliffe et al, BJN 2018
• Diet in pregnancy associated with infant BMI and adiposity
  – Maternal Glycaemic index
  – Maternal Lipids
  – Maternal Protein intake
Effect of diet and physical activity based interventions in pregnancy on gestational weight gain and pregnancy outcomes: meta-analysis of individual participant data from randomised trials

The International Weight Management in Pregnancy (i-WIP) Collaborative Group

- 36 RCT, N=12,526 women
- \(-0.70\text{kg} \ (95\% \text{ CI } -0.92 \text{ to } -0.48\text{kg})\) Gestational Weight Gain
- Lowed the odds of caesarean section by \(0.91\) (95% CI 0.83 to 0.99)
Lifecourse model of chronic disease
Developmental trajectories developed in early life influenced by maternal diet and body composition affect the risk of disease across the lifecourse
International Federation of Gynaecology and Obstetrics FIGO

• 2014 set up a maternal nutrition working committee
• Obstetricians/nutritionists/scientists
• Guidelines for nutrition from adolescence, pregnancy and postpregnancy
The International Federation of Gynecology and Obstetrics (FIGO) recommendations on adolescent, preconception, and maternal nutrition: “Think Nutrition First”*

Mark A. Hanson, Anne Bardsley, Luz Maria De-Regil, Sophie E. Moore, Emily Oken, Lucilla Poston, Ronald C. Ma, Fionnuala M. McAuliffe, Ken Maleta, Chittaranjan N. Purandare, Chittaranjan S. Yajnik, Hamid Rushwan, Jessica L. Morris,*
Balanced diet

Pre-conception: Iron, B12, vit D, folate, iodine
1st trimester: Iron, B12, folate, vit D, protein, fats
2nd and 3rd trimesters: Protein, fats, carbohydrates, iron, calcium, vitamins
Breastfeeding: Protein, fats, calcium, iron, vit D

Pregnancy

Critical periods for development of embryo, fetal organs and tissues

Infant

Appropriate gestational weight gain

Mother

Postdelivery weight loss

Interpregnancy interval ≥ 2 years

General issues: Age at conception, energy balance, obesity, chronic disease, and infectious disease risk management
FIGO Initiative on Adolescent, Preconception and Maternal Nutrition

Good Nutrition Matters

UNDERNUTRITION causes approximately 3.5 million DEATHS of women and children

OVERNUTRITION is producing an increase in chronic NON-COMMUNICABLE DISEASES such as DIABETES AND HYPERTENSION

MICRONUTRIENT DEFICIENCIES affect 2 billion people worldwide and are caused by an INADEQUATE DIET which lacks VITAMINS AND MINERALS

Think Nutrition First

Good nutrition → Good health
IMPROVING NUTRITION and establishing healthy dietary habits in adolescent girls and in the preconceptual period of women paves the way for healthy pregnancies and healthy babies

Building a prosperous future today
A woman’s FITNESS AND HEALTH is the foundation for her future health and that of generations to come

Think of the children
BENEFITS for the next generation include reduced risk of stunting, obesity, and chronic non-communicable diseases and improved cognitive and behavioral development

FIGO Recommends

Greater ATTENTION to the links between poor maternal nutrition and increased risk of later non-communicable diseases in the mother and offspring

ACTION to improve nutrition among adolescent girls and women of reproductive age

Public health MEASURES to improve nutritional education, particularly of adolescents, girls and young women

Increased AWARENESS of the impact of women’s nutrition on themselves and on future generations

To view the original content of this infographic, please visit the FIGO website: [FIGO's website](https://www.figo.org)

Infographic produced by the Micronutrient Initiative


The FIGO Initiative on Adolescent, Preconception and Maternal Nutrition (Phase 1) was supported by an unrestricted educational grant from Abbott.
Conclusions and Recommendations

• Maternal nutrition important and requires input from all Healthcare Professionals

• Maternal dietary interventions reduce excessive gestational weight gain & improve glucose homeostasis

• Maternal saturated fat and protein intake also important
Prof. Fionnuala McAuliffe, Director
Consultant & Head of Women & Children's Health

Prof. Mary Higgins, Obstetrician

Cecily Mulcahy, Research Midwife

Dr. Rebecca Moo, MD student

Dr. Maria Kennelly, PhD

Prof. Colm O’Donnell
Neonatology

Prof. Mary Wingfield, Reproductive Medicine

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