Dietary pattern, gestational weight gain and risk of gestational diabetes mellitus

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Presentation Outline

• Gestational weight gain (GWG)
• Gestational diabetes mellitus (GDM)
• Dietary patterns (DP) in pregnancy
  – Gestational weight gain
  – Gestational diabetes mellitus
STUNTING
• TARGET: 40% reduction in the number of children under-5 who are stunted

ANAEMIA
• TARGET: 50% reduction of anaemia in women of reproductive age

LOW BIRTH WEIGHT
• TARGET: 30% reduction in low birth weight

CHILDHOOD OVERWEIGHT
• TARGET: No increase in childhood overweight

BREASTFEEDING
• TARGET: Increase the rate of exclusive breastfeeding in the first 6 months up to at least 50%

WASTING
• TARGET: Reduce and maintain childhood wasting to less than 5%
Role of gestational programming in population shifts towards obesity and metabolic syndrome

(Desai et al., 2015)
The stunting syndrome

Maternal factors in pregnancy:
- Inadequate diet
- Intrauterine infection
- Systemic infection and/or inflammation
- EED
- Ambient air pollution

Conceptus

Pre-conception dietary interventions now being tested

Neonate

Low birthweight
Small for gestational age
Prematurity
Short for gestational age
Small head circumference
Hyperinsulinaemic

2 Years

HAZ < -2
Increased morbidity and mortality from infections
Poor complementary feeding practices
Poor WASH resulting in diarrhoea and EED
Recurrent infections
Exposure to mycotoxins, arsenic, biomass fuels
Poor infant stimulation and nurturing
Maternal depression

Diet adequate in nutrients with excess calories

Adult

Stunted
Overweight
Central adiposity
Hypertension
Diabetes
CVD

Short stature
Low physical stamina
Low IQ
Lower lifetime earnings and fewer assets

School Age

Overweight, increased WAZ relative to HAZ

HAZ < -2
Fewer years of schooling
Poor school performance

School Age

HAZ < -2
Increased morbidity and mortality from infections
Poor complementary feeding practices
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Overweight, increased WAZ relative to HAZ

HAZ < -2
Fewer years of schooling
Poor school performance

(Prendergast & Humphrey, 2014)
National Plan of Action for Nutrition of Malaysia (NPANM) 2016 - 2025

1. Promoting maternal, infant and young child nutrition
2. Promoting healthy eating and active living
3. Preventing and controlling nutritional deficiencies
4. Preventing and controlling obesity and other diet-related NCDs
5. Sustaining food systems to promote healthy diets
6. Supporting efforts to promote food safety and quality

% with anemia
% with recommended GWG
% with GDM
More women are entering pregnancy with higher body weights .......

**Overweight and Obesity**

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>MANS 2003</th>
<th>MANS 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-19</td>
<td>20.2</td>
<td>17.7</td>
</tr>
<tr>
<td>20-29</td>
<td>28.8</td>
<td>40.3</td>
</tr>
<tr>
<td>30-39</td>
<td>38.6</td>
<td>55.7</td>
</tr>
<tr>
<td>40-49</td>
<td>53.4</td>
<td>60.8</td>
</tr>
<tr>
<td>50-59</td>
<td>58.4</td>
<td>67.2</td>
</tr>
</tbody>
</table>
**Gestational Weight Gain Recommendation (IOM, 2009)**

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

**0.5 – 2.2 kg weight gain in 1st trimester

- ✓ Development of placenta, uterus and breasts
- ✓ Increase in blood supply and fluid volume
- ✓ A healthy ~ 3 kg infant
High income setting – 20-50% of pregnant women gain more than the recommended GWG

Mean= 13.08 ± 6.08kg
Mean= 17.39 ± 7.22kg

- Brazil (N=1052) (Godoy et al., 2014)* Obese women
- China (N=6341) (Yang et al. 2015)
- Thailand (N=378) (Pongcharoen et al., 2016)
- India (N=1279) (Bhavadharini et al., 2017) *Obese women
- Indonesia (N=29) (Soltani et al., 2017) *Obese women

Inadequate  Adequate  Excessive
Women tend to retain some weight (2-5 kg) with each successive pregnancy.

Excess GWG --- higher postpartum weight retention --- increased risk of OW/OB & metabolic risk profile in long run

(Gilmore et al., 2015)
Association between gestational weight gain according to prepregnancy body mass index and short postpartum weight retention in postpartum women

Mean GWG : 15.9 kg
Mean PPWR : 5.1 kg
% with excessive GWG : 43.2%
% with PPWR ≥ 5kg : 53.3%
✓ Excessive – 70.2%
✓ Adequate – 49.1%
✓ Inadequate – 29.3%

(Ma et al., 2014)
Hyperglycemia in pregnancy (20 – 49 years) by IDF region, 2017

Estimated 21.3 million of live births to women had some form of hyperglycemia in pregnancy

• 86.4% GDM
• 7.4% other types of diabetes (type 1 or type 2) first detected in pregnancy
• 6.2% due to diabetes detected before pregnancy
GDM in various settings ……

Singapore (N=1136) (Chong et al. 2014)
Japan (N=5424) (Shimodaira et al. 2016)
Ireland (N=6105) (Atlantic DIP study)
UK (N=1375) (Ali et al., 2014)
Germany (N=567191) (Melchior et al., 2017)

China (N=2987) Zhu et al., 2017
Taiwan (n=3641) (Hung et al. 2015)
Thailand (N=25255) (Srichumchit et al. 2015)
Vietnam (N=2772) (Tran et al., 2013)
Korea (N=5212) (Heo et al. 2015)
GDM in Malaysia ….
Excessive gestational weight gain prior to glucose screening and the risk of gestational diabetes: a meta-analysis

Stefanie Brunner¹ · Lynne Stecher¹ · Stephanie Ziebarth² · Ina Nehring² · Sheryl L. Rifas-Shiman³ · Christine Sommer⁴,⁵ · Hans Hauner¹ · Rüdiger von Kries²

Fig. 2 Forest plot of the random effects (RE) model showing the pooled estimate of the association between excessive vs non-excessive weight gain and GDM

Fig. 3 Forest plot of the random effects (RE) model showing the pooled estimate of the association between excessive vs recommended weight gain and GDM
Gestational weight gain and risk of GDM - SECOST

Note. The reference category is non GDM.
Adjusted for clinic and gestational week at OGTT, maternal age, pre-pregnancy BMI and parity

Excessive vs Non-excessive
AOR=2.13 [95% CI 0.87 – 5.18], p= 0.10

Inadequate vs Adequate
AOR=1.08 [95% CI 0.57 – 2.06], p= 0.82

Excessive vs Adequate
AOR=2.94 [95% CI 1.26 – 6.87], p< 0.05
- Energy & Nutrients
- Non-nutrients
- Foods / food groups
- Diet quality index
- Glycemic index / load
- Dietary patterns
### Dietary pattern in pregnancy (non-Asian countries)

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Pattern 1</th>
<th>Pattern 2</th>
<th>Pattern 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schoenaker et al. (2015)</td>
<td>Australia</td>
<td>Meats, snacks and sweets</td>
<td>Mediterranean</td>
<td>Fruit and low-fat dairy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>red and processed meat, cakes, sweet biscuits, fruit juice, chocolate and pizza</td>
<td>vegetables, legumes, nuts, tofu, rice, pasta, rye bread, red wine and fish</td>
<td>fruits and low-fat dairy including yoghurt, low-fat cheese and skimmed milk</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Cooked vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>carrots, peas, cooked potatoes, cauliflower and pumpkin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shin et al. (2015)</td>
<td>US</td>
<td>1. High refined grains, fats, oils and fruit juice</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. High nuts, seeds, fat and soybean; low milk and cheese</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freitas-Vilela et al. (2017)</td>
<td>UK</td>
<td>1. Fruit and vegetables</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>non-white bread, bran- and oat-based breakfast cereals, crispbreads/crackers, poultry, fish, eggs, cheese, meat substitutes, pulses, nuts, potatoes (not fried), pasta, rice, vegetables, fruit, fruit juice, herbal tea, low-fat milk and alcohol</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Meat and potatoes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>fried potatoes, roast potatoes (not fried), poultry, red meat, meat pies and sausages/burgers, in addition to white bread, other breakfast cereal, biscuits, puddings, cakes/buns, fried foods, pizza, eggs, baked beans, peas, cola, tea, sweets, chocolates, snacks and full-fat milk</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. White bread and coffee</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>white bread, coffee, cola and full-fat milk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carvalho et al. (2017)</td>
<td>Brazil</td>
<td>1. Brazilian pattern</td>
<td>2. Energy rich pattern</td>
<td>3. Healthy</td>
</tr>
<tr>
<td></td>
<td></td>
<td>beans, rice, processed meat, fats, refined grains, rice, pasta &amp; pastries, soft drinks, sugar and sweets, cookies &amp; crackers</td>
<td>salty deep-fried snacks, popcorn, packaged snacks, instant noodles, tubers and chicken</td>
<td>fruits and fruit juices, vegetables, whole grains, seafood, dairy products)</td>
</tr>
</tbody>
</table>
Dietary pattern in pregnancy (Asian countries)

<table>
<thead>
<tr>
<th>Study</th>
<th>Healthy</th>
<th>Less Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loy &amp; Jan Mohamed (2013) - Malaysia</td>
<td>fish &amp; other seafood, fruit, dairy products, vegetables, nuts &amp; legumes</td>
<td>confectioneries, condiments, oils and fats, tea and coffee, cereals, meat and offal</td>
</tr>
<tr>
<td>Shin et al (2015) - Korea</td>
<td>fruits, rice &amp; cereals, salted vegetables, noodles, meat</td>
<td>poultry &amp; eggs, processed meat &amp; seafood, snack &amp; dessert, fast food, deep fried food, coffee &amp; beverages, seaweeds</td>
</tr>
<tr>
<td>Deseymour et al. (2016) - Singapore</td>
<td>vegetables, fruit, white rice, bread, low-fat meat and fish, and low in fried potatoes, burgers, carbonated and sugar-sweetened beverages</td>
<td>soup, fish and seafood products, noodles, low-fat meat, seafood, and low in ethnic bread, legumes and pulses, white rice, and curry-based gravies</td>
</tr>
<tr>
<td>Du et al. (2016) - China</td>
<td>dairy, baked/fried food and white meat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>light-colored vegetables, fine grain, red meat and tubers</td>
<td></td>
</tr>
<tr>
<td></td>
<td>edible fungi, shrimp/shellfish and red meat</td>
<td></td>
</tr>
<tr>
<td></td>
<td>dark-colored vegetables and deep-sea fish</td>
<td></td>
</tr>
<tr>
<td>Sedaghat et al. (2017) - Iran</td>
<td>sweets, jams, mayonnaise, soft drinks, salty snacks, solid fat, high-fat dairy products, potatoes, organ meat, eggs, red meat, processed foods, tea, and coffee</td>
<td>liquid oils, legumes, nuts and seeds, fruits and dried fruits, fish and poultry whole, and refined grains</td>
</tr>
</tbody>
</table>
### Dietary pattern and excessive GWG

<table>
<thead>
<tr>
<th>Study</th>
<th>Population/Setting</th>
<th>Dietary Patterns</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tielemans et al. (2015)</td>
<td>Population-based cohort in the Netherlands</td>
<td>Vegetable, oil &amp; fish, Nuts, high-fiber cereals &amp; soy, Margarine, sugar &amp; snacks</td>
<td>Adherence to the “Margarine, sugar and snacks” pattern was associated with a higher prevalence of excessive GWG (OR 1.45 (95% CI 1.06; 1.99))</td>
</tr>
<tr>
<td>Shin et al. (2016)</td>
<td>The National Health and Nutrition Examination Survey (NHANES)</td>
<td>Mixed pattern, Healthy, Western pattern</td>
<td>The ‘Mixed’ pattern characterized by a intake of meat, dairy products, fruits, vegetables, potatoes, nuts and seeds was significantly associated with lower risk of excessive GWG (AOR 0.39, 95% CI 0.15-0.99)</td>
</tr>
<tr>
<td>Wrottesley et al. (2017)</td>
<td>Urban Black South African women</td>
<td>Western, Traditional, Mixed</td>
<td>Traditional dietary pattern was associated with lower risk of excessive GWG (OR 0.81, p=0.006). Western and Mixed patterns were associated with higher weekly GWG in normal weight and obese women</td>
</tr>
</tbody>
</table>
Dietary pattern and GDM (Asia)

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Country</th>
<th>Dietary Pattern</th>
<th>Increased Risk of GDM</th>
<th>Lower Risk of GDM</th>
</tr>
</thead>
<tbody>
<tr>
<td>He et al. (2015)</td>
<td>China</td>
<td>Vegetable pattern, Protein-rich pattern, Prudent pattern, Sweets and seafood pattern</td>
<td>Vegetable pattern was associated with a decreased risk of GDM (RR 0.79, 95% CI 0.64-0.97)</td>
<td>Sweets and seafood pattern was associated with an increased risk of GDM (RR 1.23, 95% CI 1.02-1.49)</td>
</tr>
<tr>
<td>DeSeymour et al. (2016)</td>
<td>Singapore</td>
<td>A vegetable-fruit-rice based diet, Seafood-noodle based diet, Pasta cheese processed meat diet</td>
<td>Seafood-noodle-based-diet was associated with a lower risk of GDM (OR = 0.74, 95% CI =0.59-0.93)</td>
<td></td>
</tr>
<tr>
<td>Du et al. (2017)</td>
<td>Northern China</td>
<td>Western pattern, Traditional pattern, Mixed pattern, Prudent pattern</td>
<td>Western pattern and the traditional pattern (fine grain, red meat, tubers) were associated with an increased risk of GDM (OR = 4.40, 95% CI: 1.58-12.22; OR = 4.88, 95% CI: 1.79-13.32)</td>
<td></td>
</tr>
<tr>
<td>Sedaghat et al. (2017)</td>
<td>Iran</td>
<td>Western pattern, Prudent pattern</td>
<td>Western pattern was associated with increased risk of GDM before and after adjustment for confounders (OR = 1.97, 95% CI: 1.27–3.04, OR = 1.68, 95% CI: 1.04–2.27)</td>
<td></td>
</tr>
</tbody>
</table>
Maternal dietary patterns and gestational diabetes mellitus: a large prospective cohort study in China

Jian-Rong He1, Ming-Yang Yuan1, Nian-Nian Chen1, Jin-Hua Lu1, Cui-Yue Hu1, Wei-Bi Mai2, Rui-Fang Zhang2, Yong-Hong Pan2, Lan Qiu1, Ying-Fang Wu1, Wan-Qing Xiao1, Yu Liu1, Hui-Min Xia1 and Xi Qiu1

1Division of Birth Cohort Study, Guangzhou Women and Children’s Medical Center, Guangzhou Medical University, 9 Jiansu Road, Tianhe District, Guangzhou 510623, People’s Republic of China
2Department of Obstetrics and Gynecology, Guangzhou Women and Children’s Medical Center, Guangzhou Medical University, Guangzhou, People’s Republic of China

(Submitted 1 November 2014 – Final revision received 20 January 2015 – Accepted 13 February 2015 – First published online 30 March 2015)

Abstract

Few studies have explored the relationship between dietary patterns and the risk of gestational diabetes mellitus (GDM). Evidence from non-Western areas is particularly lacking. In the present study, we aimed to examine the associations between dietary patterns and the risk of GDM in a Chinese population. A total of 5635 pregnant Chinese women from an ongoing prospective cohort study were included. Data on dietary intake were collected using a FFQ at 24–27 weeks of gestation. GDM was diagnosed using a 75 g, 2-h oral glucose tolerance test. Dietary patterns were determined by principal components factor analysis. A log-binomial regression model was used to examine the associations between dietary patterns and the risk of GDM. The analysis identified four dietary patterns: vegetable pattern; protein-rich pattern; prudent pattern; sweets and seafood pattern. Multivariate analysis showed that the highest tertile of the vegetable pattern was associated with a decreased risk of GDM (relative risk 0.63, 95% CI 0.49, 0.80), compared with the lowest tertile, whereas the highest tertile of the sweets and seafood pattern was associated with an increased risk of GDM (relative risk 1.77, 95% CI 1.30, 2.41). No significant association was observed among women with a similar pattern score. In addition, a vegetable pattern score was more evident in women with a higher BMI, but this finding was not consistently observed with an increased risk of GDM. These findings suggest that the vegetable pattern was associated with a lower risk of GDM, whereas the sweets and seafood pattern was associated with a higher risk of GDM. The present study provides new evidence on the associations between dietary patterns and the risk of GDM in a Chinese population.
Dietary patterns and GDM - (Systematic review)

Increased risk

- Western pattern
- Meats, snacks and sweets
- Low-carbohydrate dietary pattern

Lower risk

- Mediterranean pattern
- Prudent pattern
- Vegetable pattern
- DASH / HEI
## Dietary pattern and GWG - SECOST

<table>
<thead>
<tr>
<th></th>
<th>Pattern 1</th>
<th>Pattern 2</th>
<th>Pattern 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-pregnancy</strong></td>
<td>Other vegetables, green leafy vegetables, nuts, seeds &amp; legumes, fruits, eggs, milk &amp; dairy products</td>
<td>Condiments &amp; spices, sugar, spread &amp; creamer</td>
<td>Rice, noodles &amp; pasta, oils &amp; fats, high energy beverages, fish &amp; seafood, sweet foods, poultry &amp; meat</td>
</tr>
<tr>
<td><strong>First trimester</strong></td>
<td>Other vegetables, green leafy vegetables, nuts, seeds &amp; legumes, fruits</td>
<td>Condiments &amp; spices, sugar, spread &amp; creamer, oils &amp; fats</td>
<td>Eggs, milk &amp; dairy products, rice, noodles &amp; pasta, high energy beverages, fish &amp; seafood, sweet foods, poultry &amp; meat, bread, cereal &amp; cereal products</td>
</tr>
<tr>
<td><strong>Second trimester</strong></td>
<td>Other vegetables, green leafy vegetables, nuts, seeds &amp; legumes, rice, noodles &amp; pasta</td>
<td>Condiments &amp; spices, sugar, spread &amp; creamer</td>
<td>Fruits, eggs, milk &amp; dairy products, high energy beverages, fish &amp; seafood, sweet foods, poultry &amp; meat, bread, cereal &amp; cereal products, processed meat</td>
</tr>
<tr>
<td><strong>Third trimester</strong></td>
<td>Other vegetables, green leafy vegetables, nuts, seeds &amp; legumes, rice, noodles &amp; pasta, poultry &amp; meat</td>
<td>Condiments &amp; spices, sugar, spread &amp; creamer, tea &amp; coffee</td>
<td>Fruits, eggs, milk &amp; dairy products, high energy beverages, fish &amp; seafood, sweet foods, poultry &amp; meat, bread, cereal &amp; cereal products, processed meat</td>
</tr>
</tbody>
</table>

**Pattern 1 – Plant based**

**Pattern 2 – Commonly added food pattern**

**Pattern 3 – Mixed food pattern**
Dietary pattern and excessive GWG - SECOST

- **3 DP:**
  - DP 1 – mainly plant-based
  - DP 2 – commonly added food
  - DP 3 – mixed pattern

- **No significant associations were observed between dietary patterns and excessive GWG.**

Normal GWG as reference group
Dietary patterns were classified in tertiles of adherence (1st tertile= low adherence (LA); 2nd tertile= medium adherence (MA) & 3rd tertile= high adherence (HA)). Adjusted for maternal age, pre-pregnancy BMI, and gestational age at which total GWG is considered. Additional adjusted for energy intake at that particular trimester.
Dietary patterns and GDM - SECOST

- **Pattern 2** – commonly added-food pattern
  (Condiments & spices, sugar, spread & creamer)

- **DP 2 at pre-pregnancy and 1st trimester** were associated with risk of GDM

The reference category is non GDM.
Dietary patterns were classified in tertiles of adherence (1st tertile= low adherence (LA); 2nd tertile= medium adherence (MA) & 3rd tertile= high adherence (HA)).
Adjusted for clinic and gestational week, maternal age and monthly household income.

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Odd Ratio (CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-pregnancy DP2 (MA vs LA)</td>
<td>2.38 [1.12 – 5.08], p= 0.03*</td>
<td></td>
</tr>
<tr>
<td>Pre-pregnancy DP2 (HA vs LA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st trimester DP2 (MA vs LA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st trimester DP2 (HA vs LA)</td>
<td>3.06 [1.35 – 6.91], p= 0.01*</td>
<td></td>
</tr>
</tbody>
</table>

Odd ratio scale: 0 to 8
• Dietary pattern and GWG / GDM (SECOST)
  – 3 identified patterns – mainly plant-based food, commonly added food, mixed food
  – DP and GDM – commonly added food pattern (pre-pregnancy and 1st trimester) was associated with risk of GDM
  – DP and GWG – no significant association but warrant further investigation
Conclusion

• Pregnancy as a window of opportunity to impact not only maternal and foetal health but also health in later life
  – Gestational weight gain
  – Gestational Diabetes Mellitus

• Opportunities for interventions to address GWG and GDM – preconception, pregnancy, postpartum
• Diets before and during pregnancy play an important role in achieving recommended GWG and preventing GDM
  – Setting-specific dietary behaviours and patterns can inform intervention studies and practical dietary advice / guideline
  – Relationship between dietary factors and pregnancy outcomes may be complex and require further elucidation
High-quality evidence indicates that diet or exercise, or both, during pregnancy can reduce the risk of excessive GWG. Other benefits may include a lower risk of caesarean delivery, macrosomia, and neonatal respiratory morbidity, particularly for high-risk women receiving combined diet and exercise interventions. Maternal hypertension may also be reduced. Exercise appears to be an important part of controlling weight gain in pregnancy and more research is needed to establish safe guidelines. Most included studies were carried out in developed countries and it is not clear whether these results are widely applicable to lower income settings.

**Weight management interventions led to a reduction in the risk of women gaining excess weight by 20% (13 – 27%) over the course of pregnancy**

- 65 RCTs (49 trials – meta analysis of 11,444 women)
- Diets – low glycemic load, diabetic, low calorie or low-fat
- Exercise – moderate intensity of regular walking, dance and aerobic classes
- Comparison / control – received standard care

(Muktabhant et al., 2015)
Seremban Cohort Study (SECOST)

RESEARCH TEAM
Zalilah Mohd Shariff
Yong Heng Yaw
Barakatun Nisak Mohd Yusof
Zulida Rejali
Gan Wan Ying
Mohd Nasir Moh Taib
Farah Yasmin
Wan NoorFatehah Wan Zakaria
Liyana Abdul Razak
Lalitha Palaniveloo

SECOST) is funded by Danone Dumex
Thank You