Definition of

Gestational Diabetes Mellitus (GDM)

“Any degree of glucose intolerance that is first detected during pregnancy”

Rani & Begum, 2016; Magon, 2011; Mumtaz, 2000; Schmidt et al., 2001; Avi & Amon, 2010
Commonly used guidelines for GDM diagnosis

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Fasting Plasma glucose</th>
<th>Glucose Challenge</th>
<th>1-h plasma glucose</th>
<th>2-h plasma glucose</th>
<th>3-h plasma glucose</th>
</tr>
</thead>
<tbody>
<tr>
<td>WHO 1999**</td>
<td>≥7.0</td>
<td>75g OGTT</td>
<td>Not required</td>
<td>≥7.8</td>
<td>Not required</td>
</tr>
<tr>
<td>American Congress of Obstetricians</td>
<td>≥5.3</td>
<td>100g OGTT</td>
<td>≥10.0</td>
<td>≥8.6</td>
<td>≥7.8</td>
</tr>
<tr>
<td>and Gynecologists**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian Diabetes Association**</td>
<td>≥5.3</td>
<td>75g OGTT</td>
<td>≥10.6</td>
<td>≥8.9</td>
<td>Not required</td>
</tr>
<tr>
<td>IADPSG**</td>
<td>≥5.1</td>
<td>75g OGTT</td>
<td>≥10.0</td>
<td>≥8.5</td>
<td>Not required</td>
</tr>
</tbody>
</table>

* one value is sufficient for diagnosis
** two or more values are required for diagnosis
*** two or more values required for diagnosis
**** one value is sufficient for diagnosis

Country-specific prevalence of GDM

Country-specific prevalence of GDM according to different diagnostic criteria. C&C Carpenter and Coustan criteria, IADPSG International Association of Diabetes and Pregnancy Study Groups, NDDG National Diabetes Data Group, WHO World Health Organization, other included International Classification of Diseases codes and local guidelines or criteria. (Yeyi& Cuiin 2016)

GDM in Singapore

Up to...

1 in 4 pregnant women gets affected by GDM every year.

- > 1,200 women are diagnosed with GDM at KK Women’s and Children Hospital (KKH) each year.
- About 800 women are diagnosed with GDM at National University Hospital (NUH) each year - 4 fold increase in the last decade.
- Figures are expected to rise further.

Risk Factors for GDM

- Age
- Ethnicity
- Family History of GDM
- Overweight/Obese/BMI
- Lifestyle factors
- Previous delivery of baby over 4kg

Findings from the GUSTO Study

Risk Factors for GDM

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Ethnic Differences in the percentage of Gestational Diabetes Mellitus cases attributable to overweight and obesity, 2004-2007. (Kim et al, 2012)

1200 mothers
3 major ethnic groups
Deep phenotyping

IN UTERO ➔ BIRTH ➔ INFANCY & CHILDHOOD

20th-28th gestation ➔ Birth ➔ 3 mth ➔ 6 mth ➔ 9 mth ➔ 12 mth ➔ 24 mth
3 yr ➔ 4 yr ➔ 5 yr ➔ 6 yr ➔ 7 yr ➔ 8 yr ➔ 9 yr
Selective screening (high-risk) failed to detect nearly half the women with GDM.

YS Chong et al., 2014. Ethnic differences translate to inadequacy of high-risk screening for gestational diabetes mellitus in an Asian population: a cohort study.

Maternal dietary patterns associated with risk of GDM

<table>
<thead>
<tr>
<th>Ethnic Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>translates to inadequacy of high-risk screening for GDM in an Asian population</td>
</tr>
</tbody>
</table>

Proportion of detected GDM in GUSTO cohort using universal vs. high-risk screening

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Universal</th>
<th>High-risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Cohort</td>
<td>25%</td>
<td>20%</td>
</tr>
<tr>
<td>Chinese</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>Malay</td>
<td>20%</td>
<td>15%</td>
</tr>
<tr>
<td>Indian</td>
<td>15%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Maternal dietary patterns associated with risk of GDM

<table>
<thead>
<tr>
<th>Vegetables, Fruit and Rice-Based (VFR)</th>
<th>SEAFOOD AND NOODLE-BASED (SNF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables</td>
<td>Soup</td>
</tr>
<tr>
<td>Fruits</td>
<td>Fish &amp; seafood products</td>
</tr>
<tr>
<td>Wholegrain bread</td>
<td>Flavoured noodles</td>
</tr>
<tr>
<td>White rice</td>
<td>Noodles in soup</td>
</tr>
<tr>
<td>Fried potatoes</td>
<td>Red meat (healthy prep)</td>
</tr>
<tr>
<td>Burger</td>
<td>Seafood</td>
</tr>
<tr>
<td>Carbonated Drinks</td>
<td>Soya sauce based gravy</td>
</tr>
<tr>
<td>Flavoured rice</td>
<td>Legumes and pulses</td>
</tr>
<tr>
<td>Sweetened Drinks</td>
<td>Ethnic Bread</td>
</tr>
<tr>
<td>Fried Meat / Meat in curry</td>
<td>Rice</td>
</tr>
<tr>
<td></td>
<td>Curry gravy</td>
</tr>
<tr>
<td></td>
<td>Other Grains</td>
</tr>
</tbody>
</table>

Table. Associations of maternal dietary patterns with GDM (n=3822)

<table>
<thead>
<tr>
<th></th>
<th>OR (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VFR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted</td>
<td>1.356 (1.132, 1.624)</td>
<td>0.001</td>
</tr>
<tr>
<td>Multivariable model 1</td>
<td>1.093 (0.885, 1.350)</td>
<td>0.401</td>
</tr>
<tr>
<td>SNF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted</td>
<td>0.893 (0.677, 0.952)</td>
<td>0.012</td>
</tr>
<tr>
<td>Multivariable model 1</td>
<td>0.767 (0.617, 0.933)</td>
<td>0.007</td>
</tr>
<tr>
<td>PCF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unadjusted</td>
<td>1.005 (0.829, 1.443)</td>
<td>0.939</td>
</tr>
<tr>
<td>Multivariable model 1</td>
<td>0.992 (0.810, 1.216)</td>
<td>0.941</td>
</tr>
</tbody>
</table>

1 Adjusted for Ethnic (Indo, Caucasian, Both Other), Smoking, Alcohol consumption, Age, Education, and Household monthly income.

J de Seymour et al., 2016. Maternal Dietary Patterns and Gestational Diabetes Mellitus in a Multi-ethnic Asian Cohort: the GUSTO study.
Imbalance Folate and B12 associated with higher risk of GDM

B12-insufficient (<221pmol/L)

B12-sufficient (≥ 221pmol/L)

OR and 95% CI for GDM

<table>
<thead>
<tr>
<th>T1</th>
<th>OR (95% CI)</th>
<th>Median (IQR) of plasma folate (nmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>18.2(11.6,24.4)</td>
<td>34.5(33.3,37.1) 49.7(44.5,58.5)</td>
</tr>
</tbody>
</table>

P = 0.036 (T2 vs T1)

P = 0.034 (T3 vs T1)

High folate and low vitamin B12 status during pregnancy is associated with gestational diabetes mellitus.

Implications of GDM on child

A continuous relationship between maternal glycemia and excessive neonatal adiposity extends across the range of maternal glycemia.

Cai S et al., 2017. Sleep Quality and Nocturnal Sleep Duration in Pregnancy and Risk of Gestational Diabetes Mellitus.

Maternal Circadian Eating Time and Frequency Are Associated with Blood Glucose Concentrations during Pregnancy

Effect of Maternal Glyceremia on Neonatal Adiposity in a Multiethnic Asian Birth Cohort

Regional Symposium on Diabetes - Current Science and Multi-Stakeholder Approaches to Prevention & Management, October 4-5, 2017, Singapore
The reduced weight gain in early years of life conferred by greater breastmilk intake was observed in non-GDM children, but not GDM children.

Long term implications of GDM on child

Child of mother who suffered from GDM has

- **Two times** the risk of overweight during adulthood
- **Eight times** the risk of developing prediabetes/diabetes

Damm, et al., 2016. Gestational diabetes mellitus and long-term consequences for mother and offspring: a view from Denmark.
Incidence of T2DM amongst GDM women in different countries

- Singapore: 45.40% (N= 304, Ziegler, 2012, Follow up: 19 years)
- Germany: 48.30% (N= 102, Lee et al, 2007, Follow up: 15 years)
- Australia: 25% (N= 71, Lin, 2016, Follow up: 9 years)
- Taiwan: 40.80% (N= 170, Herath, 2017, Follow up: 10.9 years)
- Sri Lanka: 61.30%

Risk Factors for Transition to Type 2 Diabetes

- Ethnicity
- Family History of Diabetes
- Insulin use during pregnancy
- Postpartum BMI
- Lifestyle factors
- Breast-feeding
- Gestational age at the diagnosis of GDM

Protective Factors - Lifestyle changes

- Physical Activity
- Bao, 2014. Physical Activity and Sedentary Behaviours Associated with Risk of Progression From Gestational Diabetes Mellitus to Type 2 Diabetes Mellitus.

Healthful eating patterns (DASH, aMED, aHEI) is associated with lower risks of progression from GDM to T2DM. (Tobias, 2012)
Intensive lifestyle vs pharmacological treatments to prevent transition to T2DM

Women without prior GDM

Women with prior GDM


Protective Factors - Breastfeeding

Potential protective effect of lactation against incidence of type 2 diabetes mellitus in women with previous gestational diabetes mellitus: A systematic review and meta-analysis

Longer lactation postpartum 2-5 years significantly reduced risk of type 2 diabetes mellitus compared to lactation for 4-12 week postpartum.

Lactation Intensity and Postpartum Maternal Glucose tolerance in Women with GDM

The SWIFT cohort

The higher the intensity of lactation, the lower the incidence rate of T2DM.

Gunderson, 2015. “Lactation and Progression to Type 2 Diabetes Mellitus After Gestational Diabetes Mellitus”
Social, behavioral factors and perception of developing T2DM in mothers with GDM – a Qualitative study

S. S. Hewage et al

- Most mothers perceived their risk of getting T2DM to be low.
- Women with abnormal OGTT results had limited understanding of their health condition AND failed to seek immediate health advice

“I don’t understand how come I have that. Impaired glucose tolerance means what? Cannot tolerate glucose?”

“…waiting for the signal (before seeing a doctor) ”

- Unless screening offered at work, no regular check-ups or proactively seeking help/treatment.

New Model of Care for women with GDM

Temasek Foundation Cares has committed $1.09 million to the GDM Care programme to be piloted over a 3 year period.1

Objectives

1. Establish an effective system for early diagnosis of GDM, optimal care and follow-up during pregnancy.
2. Pilot a structured follow-up after delivery to diagnose T2DM yearly and allow good care for disease.

Key takeaways

- GDM and progression to T2DM has long term implications on health of women and their offspring, the next generation at risk of diabetes.

- Age, ethnicity and family history of diabetes are unmodifiable risk factors of GDM and progression to T2DM.

- Adopting a healthy lifestyle including diet, physical activity and sleep contributes to the maintenance of a healthy weight, which mitigates the risk of GDM and progression to T2DM. It is important for women to maintain body weight within normal range before conception and after delivery.

- Breastfeeding promotion is a practical, low-cost intervention to prevent diabetes.

- Pregnancy is an important point in the life of a woman when she has regular contact with the healthcare system- GDM presents a window of opportunity for early prevention of T2DM.
Thank you for your kind attention!

Acknowledgments

- **GUSTO team** led by A/Prof Chong Yap Seng
- **SICS team**
- **Epigen team** led by Keith Godfrey
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- **Students and interns**
  - Hazel, Sumali, Kenneth, Darren, Yi Chieh
- **GUSTO mothers and children**