Screening and Diagnosis of Diabetes Mellitus in Taiwan

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Conflict of interest disclosure

- None
DAROC Clinical Practice Guidelines for Diabetes Care- 2015

- In Chinese
- 21 chapters, 192 pages, 459 references
- Chapter 1 is the executive summary, both in Chinese and in English.
- A website, with interactive tools
Screening for diabetes in asymptomatic adults

1. Using a service by the government based on age

2. Using a risk assessment calculator to estimate the risk for undiagnosed diabetes

3. Based on risk factors for diabetes
1. Using a service by the government based on age

- In adults aged 40-64 years, screening for diabetes every 3 years should be considered. For adults aged 65 or over, annual screening for diabetes is recommended.*
- Based on the service provided by Health Promotion Administration, Ministry of Health and Welfare in Taiwan
- The service includes a blood test for fasting plasma glucose.
2. Using a risk assessment calculator

- Using risk assessment calculator, the Taiwan Diabetes Risk Score, to estimate the risk for undiagnosed diabetes.
  - Based on the recommendations of IDF, to use risk assessment tools to define the high risk group of diabetes.
  - Taiwan Diabetes Risk Score uses age, gender, waist circumference, use of anti-hypertensive drugs, and family history of diabetes to define the risk of undiagnosed diabetes.
  - Compared with other diabetes risk score, it is easier to implement, and has better performance in Taiwanese.

Taiwan Diabetes Risk Score

<table>
<thead>
<tr>
<th>Male</th>
<th>X = −8.3805 + age (years) × 0.0325 + waist circumference (cm) × 0.0423 + 0.5866 if using anti-hypertensive drugs + 0.2429 in the presence of family history of diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>X = −9.523 + age (years) × 0.0446 + waist circumference (cm) × 0.0468 + 0.4264 if using anti-hypertensive drugs + 0.5060 in the presence of family history of diabetes</td>
</tr>
</tbody>
</table>

Risk of undiagnosed DM (%) \( \frac{1}{1 + e^{-X}} \).

Family history of diabetes includes diabetes in parents, grand parents, or siblings.

<table>
<thead>
<tr>
<th>Risk category</th>
<th>Risk of undiagnosed diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very high</td>
<td>&gt; 20 %</td>
</tr>
<tr>
<td>High</td>
<td>10 ~ 20%</td>
</tr>
<tr>
<td>Medium</td>
<td>5 ~ 10 %</td>
</tr>
<tr>
<td>Low</td>
<td>&lt; 5 %</td>
</tr>
</tbody>
</table>

2. Using a risk assessment calculator

- For subjects with very high risk for undiagnosed diabetes, annual screening is recommended. For subjects with high or moderate risk for diabetes, screening every 3 years is recommended.

Interactive tools

Screening of DM
Step 1

**gender**

- Male
- Female

**age**

- 50 years

**WC**

- 90 cm

**FH of DM**

- Family history of diabetes

**Use of anti-hypertensives**

- Yes
- No
Risk category

Related materials

Screening of DM

計算結果
風險等級：中【潛藏有糖尿病的機率為6.2%】

成人糖尿病篩檢建議

一、40歲以上民衆，每3年篩檢1次；65歲以上民衆，每年篩檢1次。
二、台灣糖尿病風險評估公式顯示為極高風險者，每年篩檢1次或中高風險者，至少每三年一次。
三、符合下列A或B情況者，也建議篩檢。
   A. 空腹血糖偏高或A1c≥5.7%者，建議篩檢。篩檢正常者，建議每年再檢測1次。
   B. 符合下列兩個或以上危險因子者，建議篩檢。篩檢正常者，建議至少每三年再檢測一次。

1. 身體質量指數≥24kg/m²或腰圍男≥90/80cm
2. 一等親人罹患糖尿病
3. 高血壓（≥140/90mmHg）或已接受高血壓治療
4. 臨床表現胰島素抵抗（例如：重度肥胖，黑色棘皮症）
5. 高密度脂蛋白膽固醇<35mg/dl或三酸甘油酯≥250mg/dl
6. 多發性囊泡卵巢症候群的婦女
7. 生產4kg以上嬰兒，或曾診斷為妊娠性糖尿病
8. 曾罹患心血管疾病，缺乏運動

連結

- 第七章
- 第八章
Taiwan Diabetes Risk Score

<table>
<thead>
<tr>
<th>性别</th>
<th>糖尿病風險評估公式</th>
</tr>
</thead>
<tbody>
<tr>
<td>男性</td>
<td>X = -8.3805 + 年齡(歲) × 0.0325 + 臁圍(cm) × 0.0423 + (如果有使用抗高血壓藥物加 0.5866 + 如果有糖尿病家族史加 0.2429)</td>
</tr>
<tr>
<td>女性</td>
<td>X = -9.5235 + 年齡(歲) × 0.0446 + 臁圍(cm) × 0.0468 + (如果有使用抗高血壓藥物加 0.4264 + 如果有糖尿病家族史加 0.5060)</td>
</tr>
<tr>
<td>罹患糖尿病的風險(%)</td>
<td>1/(1+e^-X)</td>
</tr>
</tbody>
</table>

糖尿病家族史指的是父母、祖父母或是兄弟姊妹罹患糖尿病。

e為自然對數底數，約等於 2.718，e^-X 在 Excel 檔案指令為 exp(-X)，計算罹患糖尿病風險的公式為 1/(1+exp(-X))。
## Indications of medical intervention to prevent diabetes


### 連結
- 第七章
- 第八章
Lifestyle intervention to prevent diabetes

3. Based on risk factors for diabetes

- Screening should be considered in the following conditions (A and B):
  - Modified from the “2015 ADA Standards of Medical Care in Diabetes”
  - Risk factors were classified into two category according by expert opinion.

- A. Subjects who have impaired fasting glucose, impaired glucose tolerance, or HbA1c 5.7-6.4%.
  - For those with normal results, screening is recommended annually
3. Based on risk factors for diabetes

B. Screening is recommended if one has two or more of the following risk factors. For those with normal results, screening at least in 3 years is recommended.

- BMI ≥24 kg/m² or WC ≥90 cm in men or ≥80 cm in women
- first-degree relative with diabetes
- hypertension
- clinical conditions associated with insulin resistance (e.g., severe obesity, acanthosis nigricans)
- Plasma HDL-C <35 mg/dL or plasma TG ≥250 mg/dL
- women with polycystic ovary syndrome
- women who delivered a baby weighing >4 kg or were diagnosed with GDM
- history of cardiovascular disease
- physical inactivity
Screening for diabetes in asymptomatic adults

1. Using a service by the government based on age

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Procedure for Diabetes Screening

• ADA : fasting plasma glucose (FPG), HbA1c, or an oral glucose tolerance test (OGTT)

• IDF : Screen with FPG first. OGTT is used in subjects with FPG 100-125 mg/dl (5.6-6.9 mmol/L)
  – Good specificity, but sensitivity is not good enough.

• EASD & ESC : evaluate risk by risk scores first. OGTT is used for high risk groups.
The Recommended Screening Algorithm

Modified from Li HY, J Diabetes Investigation 2012; 3(3): 259-265

Sensitivity 91.9%
Specificity 100%
OGTT: 14.7%

Abbreviation: FPG, fasting plasma glucose; HbA1c, Hemoglobin A1c; OGTT, oral glucose tolerance test; PG, plasma glucose
Interactive tools

Diagnosis of DM
糖尿病的診斷

使用方法
請正確填寫FPG值及HbA1c值，勿輸入數字及小數點以外字元。填寫完成後，會由下方算出是否需要繼續。填寫口服葡萄糖耐受試驗結果，選擇確認送出後，會立即顯示出診斷結果。

Step.1

FPG【空腹血糖】： 105 mg/dL
HbA1c【糖化血色素】： 6.2 %

確認送出

延伸閱讀資料

糖尿病的診斷標準

- 糖化血色素≥6.5%
- 空腹血醣葡萄糖≥126 mg/dL (7.0 mmol/L) 空腹的定義：至少8小時未攝取熱量
糖尿病的診斷

使用方法
請正確填寫FPG值及HbA1c值，勿輸入數字及小數點以外字元。填寫完成後，會由下方算出是否需要繼續進行口服葡萄糖耐受試驗結果。選擇確認送出後，會立即顯示診斷結果。

Step.1
FPG【空腹血糖】： 105 mg/dL
HbA1c【糖化血色素】： 6.2 %

Step.2
OGTT 2hr： 180 mg/dL

確認送出
Results

Prediabetes

Related materials

Hyperlinks to related chapters

糖尿病的診斷標準

糖尿病高風險群(糖尿病前期)的分類

建議篩檢流程

糖尿病高風險群(糖尿病前期)的定義：

- 空腹血漿葡萄糖≥126 mg/dL (7.0 mmol/L)
- 口服葡萄糖耐量試驗第2小時血漿葡萄糖≥200 mg/dL
- 高血糖症狀（包括多尿、口渴、體重減輕）且隨機血漿葡萄糖≥200 mg/dL (11.1 mmol/L)

Diagnosis of Diabetes Mellitus

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin A1c</td>
<td>$\geq 6.5%$</td>
</tr>
<tr>
<td>Fasting plasma glucose</td>
<td>$\geq 126$ mg/dL (7.0 mmol/L)</td>
</tr>
<tr>
<td>Fasting: no energy intake for at least 8 hours</td>
<td></td>
</tr>
<tr>
<td>Oral glucose tolerance test</td>
<td></td>
</tr>
<tr>
<td>Plasma glucose at 2 hours</td>
<td>$\geq 200$ mg/dL</td>
</tr>
<tr>
<td>Symptoms of hyperglycemia (polyuria, polydipsia, body weight loss) and random plasma glucose</td>
<td>$\geq 200$ mg/dL (11.1 mmol/L)</td>
</tr>
</tbody>
</table>

Categories of increased risk for diabetes (pre-diabetes)

<table>
<thead>
<tr>
<th>Category</th>
<th>Definition</th>
<th>Reference</th>
</tr>
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<tbody>
<tr>
<td>1. Impaired glucose tolerance (IGT)</td>
<td>OGTT 2-hour plasma glucose 140-199 mg/dL (7.8-11.0 mmol/L) or</td>
<td>American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2014; 37 Suppl 1: S81-90.</td>
</tr>
<tr>
<td>2. Impaired fasting glucose (IFG)</td>
<td>Fasting plasma glucose 100-125 mg/dL (5.6-6.9 mmol/L) or</td>
<td></td>
</tr>
<tr>
<td>3. Hemoglobin A1c</td>
<td>5.7-6.4%</td>
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IGT: Impaired glucose tolerance
IFG: Impaired fasting glucose
Comparison of the Two Criteria

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<tr>
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<th>75g OGTT* “one-step”</th>
<th>100g OGTT† “two-step”</th>
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<td><strong>Goal</strong></td>
<td>To predict perinatal adverse outcomes</td>
<td>To predict maternal DM after delivery</td>
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<tr>
<td><strong>50g GCT</strong></td>
<td>No</td>
<td>Yes (cutoff at 140 mg/dl)</td>
</tr>
<tr>
<td><strong>Adopted by</strong></td>
<td>ADA (in 2011)</td>
<td>ACOG, NIH, and ADA</td>
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<td><strong>Fasting</strong></td>
<td>≥92</td>
<td>≥95</td>
</tr>
<tr>
<td><strong>1h</strong></td>
<td>≥180</td>
<td>≥180</td>
</tr>
<tr>
<td><strong>2h</strong></td>
<td>≥153</td>
<td>≥155</td>
</tr>
<tr>
<td><strong>3h</strong></td>
<td></td>
<td>≥140</td>
</tr>
<tr>
<td><strong>GDM</strong></td>
<td>Meet 1 of the 3 criteria</td>
<td>Meet 2 of the 4 criteria</td>
</tr>
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IADPSG criteria, Diabetes Care 2010, 33: 676-682
Carpenter MW et al., Am J Obstest Gynecol 1982, 144: 768-773
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</tr>
<tr>
<td>3h</td>
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IADPSG criteria, Diabetes Care 2010, 33: 676-682
Carpenter MW et al., Am J Obstet Gynecol 1982, 144: 768-773
## Two Studies Compares Pregnancy Outcomes by the 2 Criteria

### SPAIN
- Prospective cohort study
  - Apr 2012 – Mar 2013: IADPSG, N=1526
- Median age: 32 years-old

### TAIWAN
- Retrospective cohort study
- Jan 2011 – Dec 2011
- C&C N=888, IADPSG N=952
- Mean age 33.6 years-old

- GDM diagnosis:
  - 50g GCT + 100g OGTT by C&C criteria
  - 75g OGTT by IADPSG criteria
- Both C&C and IADPSG groups received the same treatment and follow-up regimens.

Duran A et al., Diabetes Care 2014
Li HY et al., J Diabetes Invest 2016
Higher Prevalence of GDM by the IADPSG Criteria

More women with mild hyperglycemia are diagnosed to have GDM by the IADPSG criteria and are treated.

Duran A et al., Diabetes Care 2014
Li HY et al., J Diabetes Invest 2016
Better Maternal Outcome by Adopting the IADPSG Criteria- Taiwan Study

<table>
<thead>
<tr>
<th></th>
<th>50g GCT + 100g OGTT N(%)</th>
<th>75g OGTT N(%)</th>
<th>Adjusted ORs (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary CS</td>
<td>225 (25%)</td>
<td>211 (21%)</td>
<td>0.79 (0.63-0.99)*</td>
</tr>
<tr>
<td>CS</td>
<td>337 (37%)</td>
<td>351 (36%)</td>
<td>0.89 (0.72-1.09)</td>
</tr>
<tr>
<td>PIH</td>
<td>19 (2.1%)</td>
<td>15 (1.5%)</td>
<td>0.58 (0.26-1.3)</td>
</tr>
<tr>
<td>Preeclampsia</td>
<td>10 (1.1%)</td>
<td>13 (1.4%)</td>
<td>0.92 (0.39-2.18)</td>
</tr>
</tbody>
</table>

N=1840, * p<0.05, CS, Cesarean section; ORs were adjusted for parity, maternal age, gestational weight gain, maternal weight at delivery, gestational week (not adjusted for preterm delivery), history of preterm delivery (adjusted for preterm delivery), history of macrosomia (adjusted for LGA and macrosomia), and history of PIH and preeclampsia (adjusted for pre-eclampsia and PIH).

Li HY et al., J Diabetes Invest 2016
Better Fetal Outcome by Adopting the IADPSG Criteria - Taiwan Study

<table>
<thead>
<tr>
<th></th>
<th>50g GCT + 100g OGTT</th>
<th>75g OGTT</th>
<th>Adjusted ORs (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth weight &gt;90(^{th}) percentile</td>
<td>93 (10.4%)</td>
<td>88 (9.2%)</td>
<td>0.87 (0.62-1.21)</td>
</tr>
<tr>
<td>Jaundice</td>
<td>209 (24%)</td>
<td>216 (23%)</td>
<td>0.86 (0.68-1.07)</td>
</tr>
<tr>
<td>Admission to neonatal ICU</td>
<td>5 (0.5%)</td>
<td>3 (0.3%)</td>
<td>0.29 (0.06-1.4)</td>
</tr>
<tr>
<td>Birth trauma</td>
<td>7 (0.8%)</td>
<td>7 (0.7%)</td>
<td>0.78 (0.27-2.25)</td>
</tr>
<tr>
<td>Neonatal hypoglycemia</td>
<td>4 (0.4%)</td>
<td>5 (0.5%)</td>
<td>0.94 (0.2-4.31)</td>
</tr>
<tr>
<td>Fetal death</td>
<td>0 (0%)</td>
<td>1 (0.1%)</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Any one of above adverse outcome</strong></td>
<td><strong>289 (32.6%)</strong></td>
<td><strong>281 (29.5%)</strong></td>
<td><strong>0.79 (0.64-0.98)</strong></td>
</tr>
</tbody>
</table>

N=1840, * p<0.05, ORs were adjusted for parity, maternal age, gestational weight gain, maternal weight at delivery, gestational week, history of macrosomia (adjusted for LGA and macrosomia), and history of PIH and preeclampsia (adjusted for pre-eclampsia and PIH).

Li HY et al., J Diabetes Invest 2016
Shifting to “One-step” Method:
More GDM, Improved perinatal Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Spain Study</th>
<th>Taiwan Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence of GDM</td>
<td>Increased</td>
<td></td>
</tr>
<tr>
<td>Weight gain &amp; birth weight</td>
<td>Neutral</td>
<td>Reduced</td>
</tr>
<tr>
<td>Maternal outcome</td>
<td>Improved</td>
<td></td>
</tr>
<tr>
<td>Fetal outcomes</td>
<td>Improved</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Cost-saving</td>
<td>Cost-effective</td>
</tr>
<tr>
<td>No screening by 50g GCT</td>
<td>More OGTT, No missed GDM</td>
<td>Earlier diagnosis &amp; intervention</td>
</tr>
<tr>
<td>Manpower</td>
<td>Increased need for manpower</td>
<td></td>
</tr>
</tbody>
</table>

Duran A et al., Diabetes Care 2014
Li HY et al., J Diabetes Invest 2015
## Diagnosis of Gestational Diabetes Mellitus

<table>
<thead>
<tr>
<th></th>
<th>Plasma glucose, mg/dl (mmol/L)</th>
<th>75g OGTT* &quot;one-step&quot;</th>
<th>100g OGTT† &quot;two-step&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fasting</td>
<td>≥ 92 (5.1)</td>
<td></td>
<td>≥95 (5.3)</td>
</tr>
<tr>
<td>at 1 hour during OGTT</td>
<td>≥ 180 (10.0)</td>
<td></td>
<td>≥180 (10.0)</td>
</tr>
<tr>
<td>at 2 hour during OGTT</td>
<td>≥ 153 (8.5)</td>
<td></td>
<td>≥155 (8.6)</td>
</tr>
<tr>
<td>at 3 hour during OGTT</td>
<td></td>
<td></td>
<td>≥140 (7.8)</td>
</tr>
</tbody>
</table>

* Based on the recommendations of the IADPSG. All pregnant women are advised to receive FPG or HbA1c test in the first prenatal visit. If FPG ≥126 mg/dL or HbA1c ≥6.5%, the patient is diagnosed with overt diabetes. If FPG level is ≥92 mg/dL but <126 mg/dL, the patient is diagnosed with GDM. Women with FPG<92 mg/dl are advised to receive OGTT at 24-28 gestational week. If one of the data is higher than the cutoffs, GDM is diagnosed.

† These criteria were proposed by the National Diabetes Data Group and was modified by Dr. Carpenter and Dr. Coustan. It is often preceded by an 50-g glucose challenge test (GCT, non-fasting). If plasma glucose at 1 hour after GCT is ≥140 mg/dL (sensitivity 80%) or ≥130 mg/dL (sensitivity 90%), an 100g OGTT is advised. If two of the data are higher than the cutoffs, GDM is diagnosed.

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Welcome to Taipei