Screening for people at risk of type 2 diabetes: Current situation and future challenges

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I. Introduction
Diabetes: A global emergency

Number of people with diabetes worldwide and per region in 2017 and 2045 (20-79 years)
The development of type 2 diabetes

- **Fasting Glucose, mmol / l**
  - **NG**: <7.8 mmol / l
  - **IFG**: 7.8 - 11.0 mmol / l
  - **IGT**: 7.8 - 11.0 mmol / l
  - **IGT+IFG**: >11.0 mmol / l

- **2-h glucose, mmol / l**
  - **Type 2 diabetes**: >12.0 mmol / l

- **4.0% / year**
  - NG to IFG

- **4.3% / year**
  - IGT to IGT+IFG

- **7.0% / year**
  - IFG to Type 2 diabetes

- **7.8% / year**
  - IGT+IFG to Type 2 diabetes
Modifiable type 2 diabetes risk factors

- Obesity / weight gain
- Central obesity
- Physical inactivity
- Sitting time
- Smoking
- Gestational Diabetes
- Pre-eclampsia
- Very low birth weight
- Fatty liver
- Depression
- Anti-psychotic drugs
- Poor sleep
- Hypertension
- Statins

- Dietary Factors (risk increase or decrease)
  - Carbohydrate quality
  - Fat quality
  - Glycemic index
  - Whole grain / cereal fibers
  - Low-fat dairy products
  - Alcohol
  - Coffee
  - Fast food intake
  - Sweet beverages
  - Magnesium
II. Why screen for people at a high risk for T2D?
Diabetes Prevention Study

Log-rank test: p=0.0001
Hazard ratio=0.57 (95% CI 0.43–0.76)

Number at risk, intervention/control:
265 257 261 250 250 238 228 214 191 174 118
257 251 231 209 192 176 157 140 91

Follow up time (years)
Diabetes Prevention Program

Cumulative incidence of type 2 diabetes with placebo, metformin, and lifestyle intervention.
### Summary of intervention trials in people with prediabetes

<table>
<thead>
<tr>
<th>Study</th>
<th>Intervention</th>
<th>Patients (n)</th>
<th>Follow-up (years)</th>
<th>RRR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Da-Qing Study China(^{25})</td>
<td>Diet</td>
<td>130</td>
<td>6</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Exercise</td>
<td>141</td>
<td></td>
<td>46</td>
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<tr>
<td></td>
<td>Diet + exercise</td>
<td>126</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>133</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes Prevention Study Finland(^{27})</td>
<td>Diet + physical activity</td>
<td>265</td>
<td>3.2</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>257</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Diabetes Prevention Program</td>
<td>Diet + physical activity</td>
<td>1079</td>
<td>2.8</td>
<td>58</td>
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<tr>
<td>Outcomes Study USA(^{28})</td>
<td>Metformin</td>
<td>1073</td>
<td></td>
<td>31</td>
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<tr>
<td></td>
<td>Placebo</td>
<td>1082</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indian Diabetes Prevention Program, India(^{29})</td>
<td>Lifestyle</td>
<td>133</td>
<td>2.5</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Metformin</td>
<td>133</td>
<td></td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Lifestyle + metformin</td>
<td>129</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japanese trial in men with IGT Japan(^{30})</td>
<td>Diet + exercise</td>
<td>102 356</td>
<td>4</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study on lifestyle-intervention and IGT Maastricht study, The Netherlands(^{25})</td>
<td>Diet + physical activity</td>
<td>74</td>
<td>3</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>European Diabetos Prevention Study, Newcastle, UK(^{31})</td>
<td>Diet + physical activity</td>
<td>51</td>
<td>3.1</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zenharen(^{2}) Study Japan(^{31})</td>
<td>Diet + physical activity</td>
<td>330</td>
<td>3</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>311</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CDC Diabetes Prevention Recognition Program

• 1557 CDC-recognized programs across 50 states/territories.
• >10,300 coaches (lay people; health professionals) trained.
• Serving 156,935 eligible participants.
• 65 commercial health plans providing some coverage for 3M in 11 states
Diabetes Prevention in the Real World

Dunkley et al. Diabetes Care 2014
III. How to screen for people with type 2 diabetes?
Identify and treat those beyond a threshold for risk factor

Shift the whole population distribution of risk factor lower

Disease prevention approaches
High risk strategy

• Identification of people at high risk of type 2 diabetes (screening)
• Intervention targeting people at high risk of type 2 diabetes
Strategies for detecting DT2 and hyperglycemia

Measurement of blood glucose

- OGTT
- Fasting glucose
- HbA1C
- Capillary glucose

IDENTIFY PEOPLE AT HIGH-RISK OF DT2 LATE

Questionnaires (risk scales) of lifestyle and risk factors for diabetes

IDENTIFY PEOPLE AT HIGH-RISK OF DT2 EARLY
Objectives of screening

• What is the probability that people with a positive test have diabetes?

• Is the test is a good predictor for future diabetes?

• Can the test identify people at low risk?
Screening vs diagnosis

- A screening test is not diagnostic

- Screening tests are cheaper than diagnostic tests

- A positive screening test needs confirmation through a diagnostic test
The concept is developing a screening tool that ...

... is simple, economical and reliable to identify people at high risk for type 2 diabetes.

... can be applied easily in the general population.

... does not require blood extractions or other measures that require special equipment or trained personnel.
FINnish Diabetes RIsk SCore

Score range 0-26 p

- No laboratory tests
- No specially trained personnel needed
- No special equipments
- Inexpensive, easy, fast
- Accurate

Lindström & Tuomilehto
Diabetes Care 2003; 26: 725-731
The ROC curve of the FINDRISC

Cut off point:  >10

Sensitivity = 0.73
Specificity = 0.83
Positive predictive value= 0.16
Negative predictive value= 0.99
AUC = 0.85
DIABETES
Know the Score

You can do this risk score yourself and it only takes a few minutes. You may feel fine but Type 2 Diabetes can develop over a number of years without you feeling unwell. By the time the problem is found, the condition can be quite advanced. Diabetes can cause heart attacks, strokes and major problems with your eyes, feet and kidneys if it is not managed early enough.

People with diabetes have high levels of sugar in their blood right now. However at least 1 in 7 middle aged adults have a higher than normal blood sugar. This means they are at greater risk of diabetes in the future.

The good news is that few small changes can prevent or delay diabetes. This test could be the first step.

Do you want to find out how likely you are of having undiagnosed Type 2 Diabetes now or in the future?

STOP WORKS
Healthy Life

DIABETES
Know the Score

HIGH RISK - 25 or more points
Your risk of having diabetes now is 7% but your risk of developing diabetes in the next 10 years is 32%.

You are at high risk of having undiagnosed diabetes now & developing diabetes in the future. You need to see your GP. For a blood test as soon as possible. This blood test is very important to confirm or rule out diabetes. Either way your GP will support you and Diabetes UK is there to help as well. However it is important for you to follow a healthy lifestyle regardless of whether you have diabetes or not.

MIXED RISK - 16 to 24 points
Your risk of having diabetes now is 4% but your risk of developing diabetes in the next 10 years is 19%.

If your lifestyle does not improve through regular physical activity and a healthy well balanced diet your risk score may have identified specific areas of your lifestyle that you could improve to reduce your risk. These may be your weight, your diet and/or the amount of physical activity that you do.

INCREASED RISK - 7 to 15 points
Your risk of having diabetes now is 2% but your risk of developing diabetes in the next 10 years is 10%.

Even if you do not have diabetes now, you may have elevated blood sugars levels which may increase your risk of developing the diabetes in the future. However you can make a difference through regular physical activity and a healthy well balanced diet.

LOW RISK - 0 to 6 points
You are at low risk of diabetes - keep up the good work with leading a healthy lifestyle! However as you get older your risk score will increase, so it is important for everyone to follow a healthy lifestyle in order to reduce their risk of diabetes and other problems such as heart disease and high blood pressure.

For each question, tick one box. The number in the blue box next to the box you have ticked is your score for that question. When you have answered all the questions, add up your total score.

1. How old are you?
   - 49 and younger
   - 50 – 59
   - 60 – 69
   - 70 and older

2. Are you male or female?
   - Male
   - Female

3. How would you describe your ethnicity?
   - White European
   - Other Ethnic Group

4. Do you have a father, mother, brother, sister and/or own child with Type 1 or Type 2 diabetes?
   - Yes
   - No

5. What is your waist circumference? (See instructions)
   - Less than 90 cm
   - 90 – 100 cm
   - 100 – 109 cm
   - 110 – 119 cm
   - 120 cm & above

6. What is your Body Mass Index (BMI)? (See instructions)
   - Less than 25
   - 25 – 29
   - 30 – 34
   - 35 – 39
   - 40 & above

7. Has a doctor given you medicine for high blood pressure OR told you that you have high blood pressure?
   - Yes
   - No

Add up your score here:
### 1. Edad

<table>
<thead>
<tr>
<th>Edad</th>
<th>Puntaje</th>
</tr>
</thead>
<tbody>
<tr>
<td>Menos de 45 años</td>
<td>0</td>
</tr>
<tr>
<td>45 a 54 años</td>
<td>1</td>
</tr>
<tr>
<td>55 a 64 años</td>
<td>2</td>
</tr>
<tr>
<td>Más de 64 años</td>
<td>3</td>
</tr>
</tbody>
</table>

### 2. Tiene antecedente de padres o hermanos con diagnóstico de diabetes mellitus

<table>
<thead>
<tr>
<th>Condición</th>
<th>Puntaje</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Sí</td>
<td>2</td>
</tr>
</tbody>
</table>

### 3. Toma medicamentos para el tratamiento de la hipertensión arterial

<table>
<thead>
<tr>
<th>Condición</th>
<th>Puntaje</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Sí</td>
<td>2</td>
</tr>
</tbody>
</table>

### 4. Perímetro abdominal*

<table>
<thead>
<tr>
<th>Sexo</th>
<th>Puntaje</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hombres Menos de 94 cm.</td>
<td>0</td>
</tr>
<tr>
<td>Menos de 90 cm.</td>
<td></td>
</tr>
<tr>
<td>94 cm. o más</td>
<td>2</td>
</tr>
</tbody>
</table>

*SVer instrucciones de medición en cara 2*

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Sume los puntos de cada pregunta. Si el **puntaje total es mayor o igual a 4**, indique una **prueba de tolerancia a la glucosa** dado que, la persona tiene 5 veces más posibilidades de tener diabetes mellitus en comparación con aquellos sujetos con menos de 4 puntos.
Receiver operating characteristics (ROC) curves for the prevalence of abnormal glucose tolerance for the SADRISC (Saudi Arabian Diabetes Risk Score) and the original FINDRISC.

ROC for original FINDRISC
Area under the curve: 0.71; 95% CI 0.68-0.74

ROC for SADRISC
Area under the curve: 0.76; 95% CI 0.73-0.79
Are there differences in risk factors for type 2 diabetes among different populations?

NO!
But the relative contribution (weight) may vary between populations.
FINDRISC distributed (n=14,193)

FINDRISC ≥ 13 (n=4,915)
- No OGTT (n=2,611)
  - Normoglycemic 59% (n=1,347)
  - IFG 11% (n=263)
  - IGT 9% (n=204)
  - IFG and IGT combined 8% (n=184)
- OGTT (n=2,304)
  - Screen detected T2D 13% (n=306)

FINDRISC < 13 (n=9,278)

Barengo et al Diabetes Metab Res Rev. 2013
IV. Unsolved questions and challenges
Which diagnostic test to use?

Which invasive diagnostic test to use after screening (fasting glucose, HbA1C, 2-hour glucose, 1-hour glucose, capillary glucose)?
Optimal time interval

What is the optimal time interval between screening activities?
Changing lifestyle

Are people diagnosed as being at a high risk of T2D more likely to change their lifestyle than people who are unaware of their risk or whether a negative test may have an adverse shift in health behaviors?

“What fits your busy schedule better, exercising one hour a day or being dead 24 hours a day?”
Long term benefits

Information on long-term benefits of T2D screening programs?
Impact

Short or long-term impact of T2D screening programs?
Attendance

Attendance for diagnostic tests after positive screening test?
FINDRISC distributed (n=14,193)

FINDRISC ≥ 13 (n=4,915)
- No OGTT (n=2,611)
  - Normoglycemic 59% (n=1,347)
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FINDRISC < 13 (n=9,278)

Barengo et al Diabetes Metab Res Rev. 2013
V. Conclusions and recommendations
Conclusions (II)

• Validated screening tests exist
• Screening tests have been successfully implemented in various countries and institutions
• Main challenges include among others monitoring attendance, short- and long term benefits, implementation of guidelines and time interval of screening tests.
Knowledge integration process

1. Discovered from multiple disciplines
2. Tests of promising interventions (drugs, behavioral, organizational, policies)
3. Evidence-based recommendations, policies, and guidelines on effectiveness
4. Organizational and community systems and quality improvement programs
5. Population health outcomes (surveillance effectiveness and cost-effectiveness)

- Stakeholder engagement
- Mixing methods, modeling, and multilevel designs

Source. Modified from Khoury et al. 31
Thank you

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