PATHWAYS TO TYPE 2 DIABETES

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Overview

- Diabetes 101
  - How does diabetes work
  - Types of diabetes
  - Diabetes in numbers
  - Complications
- Risk and protective factors
- Role of psychological factors in diabetes
- Take home messages
What is Diabetes?

A disease in which the body is unable to convert food to energy appropriately.
• Food is converted to glucose (sugar) in the bloodstream.

• Insulin is produced in response and allows glucose to pass from the bloodstream into the cells to produce energy.
DIABETES
- Fasting blood sugar: 7.0 mmol/L or greater
- OGTT: 11 mmol/L or greater
- HbA1c: 6.5% or higher

PRE-DIABETES
- Fasting blood sugar: between 5.5 and 7.0 mmol/L
- OGTT: 7.7 to 11 mmol/L
- HbA1c: 5.7 to 6.5%

NORMAL
- Fasting blood sugar: 5.5 mmol/L or less
- OGTT: less than 7.7 mmol/L
- HbA1c: 5.7% or less
Why is Diabetes Important?
Major diabetic complications

- Stroke
- Skin infections
- Hardening of arteries
- Blindness
- Heart disease
- Kidney failure
- Sexual dysfunction
- Lower Limb Amputations
- Sensory impairment
A SNAPSHOT
DIABETES
IN THE UNITED STATES

DIABETES

29.1 million people have diabetes
That's about 1 out of every 11 people

1 out of 4 do not know they have diabetes
A SNAPSHOT

DIABETES IN THE UNITED STATES

Prediabetes is when your blood sugar level is higher than normal but not high enough yet to be diagnosed as type 2 diabetes.

86 MILLION

86 million people — more than 1 out of 3 adults — have prediabetes.

9 OUT OF 10 do not know they have prediabetes.
A SNAPSHOT

DIABETES
IN THE UNITED STATES

Without weight loss and moderate physical activity, 15-30% of people with prediabetes will develop type 2 diabetes within 5 years.

If you have prediabetes, losing weight by eating healthy and being more active can cut your risk of getting type 2 diabetes in half.
What Are The Risk Factors?
DIABETES RISK FACTORS

- Family history
- Lack of exercise
- Unhealthy eating
- Overweight
Obesity and Diabetes
Obesity 2013

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

1994

Obesity (BMI ≥30 kg/m²)

Diabetes

Obesity (BMI $\geq 30$ kg/m$^2$)

- 18.0%–21.9%
- 22.0%–25.9%
- 14.0%–17.9%
- Missing Data

Diabetes

- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- 9.0%–10.9%
- ≥9.0%
- <4.5%
- Missing data

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

1995

Obesity (BMI≥30 kg/m²)

- <14.0%
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- <4.5%
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

1996

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

**1997**

**Obesity (BMI≥30 kg/m²)**
- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

**Diabetes**
- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%


Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

1998

Obesity (BMI ≥30 kg/m²)

Diabetes

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

1999

**Obesity (BMI ≥ 30 kg/m²)**

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

**Diabetes**

- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2000

Obesity (BMI≥30 kg/m^2)

Diabetes

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2001

Obesity (BMI≥30 kg/m²)

- Missing Data
- <14.0%
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- <4.5%
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2002

Obesity (BMI ≥30 kg/m²)

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing Data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults 2003

Obesity (BMI≥30 kg/m²)

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2004

Obesity (BMI≥30 kg/m²)

Diabetes

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2005

Obesity (BMI≥30 kg/m²)

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2006

Obesity (BMI≥30 kg/m²)

Missing Data
14.0%–17.9%
22.0%–25.9%

<14.0%
18.0%–21.9%

Diabetes

Missing data
4.5%–5.9%
6.0%–7.4%

<4.5%
7.5%–8.9%

≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2007

Obesity (BMI ≥ 30 kg/m²)

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2008

Obesity (BMI≥30 kg/m²)

Diabetes

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2009

Obesity (BMI≥30 kg/m²)

Missing Data
14.0%–17.9%
22.0%–25.9%
26.0%

Diabetes

Missing data
4.5%–5.9%
6.0%–7.4%
7.5%–8.9%
≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2010

Obesity (BMI≥30 kg/m²)

- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes

- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%

Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults

2012

Obesity (BMI≥30 kg/m²)
- Missing Data
- 14.0%–17.9%
- 18.0%–21.9%
- 22.0%–25.9%
- ≥26.0%

Diabetes
- Missing data
- 4.5%–5.9%
- 6.0%–7.4%
- 7.5%–8.9%
- ≥9.0%
Age-Adjusted Prevalence of Obesity and Diagnosed Diabetes Among US Adults 2013

Obesity (BMI≥30 kg/m²)

Diabetes

Type 2 Diabetes is Preventable!
Diabetes Prevention Program (DPP)

Big Question:
Can type 2 diabetes be prevented or delayed in adults at risk?

- DPP overview
  - A randomized, controlled trial (RCT)
    - Considered the “gold standard” for clinical trials
    - Most reliable form of scientific evidence
  - 3,234 participants
    - All overweight and had prediabetes
Participants were randomly assigned to 1 of 3 groups:

Group 1: Lifestyle Modification Group
- Intensive training in diet, physical activity, and behavior modification.
- Participants were asked to exercise at least 150 minutes a week and eat less calories.

Group 2: Metformin
- Standard information on diet and exercise

Group 3: Placebo
- Standard information on diet and exercise
DPP Goal: Compare rates of diabetes
## DPP Findings

<table>
<thead>
<tr>
<th>Group</th>
<th>Developed Diabetes</th>
<th>Risk Reduction</th>
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<tbody>
<tr>
<td></td>
<td>29%</td>
<td>58%</td>
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<td></td>
<td>22%</td>
<td>31%</td>
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<tr>
<td></td>
<td>14%</td>
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</table>
DPP Findings: Older Adults

- Lifestyle modification worked **even better** for adults 60 and older:
  - Diabetes risk reduced by 71%
  - Reduced risk explained by more physical activity and greater weight loss.
  - Metformin **least** effective in adults aged 45+
Balance your act.

Diet

Exercise
DIABETES RISK FACTORS

- Family history
- Lack of exercise
- Unhealthy eating
- Overweight
## Signs and Symptoms of Depression

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<thead>
<tr>
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<tr>
<td>![Smiley Face]</td>
<td>![Fish]</td>
<td>![Massage]</td>
<td>![Bed]</td>
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<tr>
<td><strong>Feelings of</strong></td>
<td><strong>Feelings of</strong></td>
<td><strong>Loss of</strong></td>
<td><strong>Decreased</strong></td>
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<td><strong>unhappiness,</strong></td>
<td><strong>low self-esteem,</strong></td>
<td><strong>interest</strong></td>
<td><strong>energy, fatigue,</strong></td>
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<tr>
<td><strong>hopelessness,</strong></td>
<td><strong>worthlessness,</strong></td>
<td><strong>or pleasure</strong></td>
<td><strong>feeling “slowed</strong></td>
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<td><strong>pessimism</strong></td>
<td><strong>guilt</strong></td>
<td><strong>in hobbies,</strong></td>
<td><strong>down”</strong></td>
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<td><strong>work,</strong></td>
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<td><strong>activities,</strong></td>
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<td><strong>sex.</strong></td>
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<tr>
<td>![Person]</td>
<td>![Question Mark]</td>
<td>![Cake]</td>
<td>![Brain]</td>
</tr>
<tr>
<td><strong>Insomnia,</strong></td>
<td><strong>Difficulty</strong></td>
<td><strong>Appetite</strong></td>
<td><strong>Irritability,</strong></td>
</tr>
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<td><strong>early-morning</strong></td>
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<td><strong>changes</strong></td>
<td><strong>restlessness,</strong></td>
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<td><strong>awakening,</strong></td>
<td><strong>remembering,</strong></td>
<td><strong>eating</strong></td>
<td><strong>hostility</strong></td>
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<tr>
<td><strong>or oversleeping</strong></td>
<td><strong>decision making</strong></td>
<td><strong>significantly</strong></td>
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<td></td>
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<td><strong>less or more</strong></td>
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<td>![Downward Arrow]</td>
<td>![Heartbeat]</td>
<td>![Brain]</td>
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<td><strong>Feeling</strong></td>
<td><strong>Recurrent</strong></td>
<td><strong>headaches or</strong></td>
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<td><strong>anxious; low</strong></td>
<td><strong>thoughts of</strong></td>
<td><strong>chronic</strong></td>
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<td><strong>tolerance for</strong></td>
<td><strong>death or suicide</strong></td>
<td><strong>indigestion</strong></td>
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<td><strong>stress</strong></td>
<td><strong>attempts</strong></td>
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<td><strong>respond</strong></td>
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<td><strong>to treatment</strong></td>
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</table>
Diabetes

Increased appetite
Low energy
Higher cortisol levels
Anxiety

Depression

Stress of diabetes management
Stress Eating

- Eating in response to emotional cues
  - Comfort foods are high in fat, sugar, and salt
  - Reduces anxiety
    - Leads to weight gain and higher risk for diabetes
- Common (40%)
Positive Affect

- Positive affect—the feeling that reflects pleasurable engagement with the environment
  - Lower diabetes risk
  - Better diabetic glycemic control
  - Lower mortality among people with diabetes

- How?
  - Healthier lifestyles
  - Better functioning of body systems
Humans are complex beings!

• So far we talked about obesity, or exercise, or familial risk, or depression…
• But we all have a varying degree of each!
Combinations Matter!

- Now that the main influences are described, scientists have started looking at combinations of protective and risk factors.
  - Can the presence of one factor affect whether another one influences diabetes risk?
  - In the DPP, participants had prediabetes but exercise lowered their risk.
A lot less is known about mental health

Are stress and anger additional risk factors?

- Obesity
- Genetic predisposition
- Sedentary lifestyle
Examples from our lab using a national study of adults (1)

Tsenkova, Ryff, et al., 2010

% HbA1c

6.5

6

5.5

5

Low Central Obesity

High

Experienced weight discrimination

Did not experience weight discrimination
Examples from our lab using a national study of adults (2)

Tsenkova, Ryff, et al., 2014

![Graph showing the relationship between high anger and low anger on the BMI scale with increasing insulin resistance.]

- High anger
- Low Anger
Positive psychology

Could good mental health be protective?

- Obesity
- Genetic predisposition
- Sedentary lifestyle
Examples from our lab (3)  

Tsenkova, Ryff, et al., under review

![Graph showing probability of diabetes with low positive affect vs. high positive affect in individuals with and without a parental history of diabetes.](image)
Take Home Messages
Take Home Message #1

• Exercise and healthy diet are IMPORTANT!
• Current Physical Activity Guidelines for Americans
  • 150 min a week of moderate exercise
  • Yes, even older adults
Take Home Message #2

- Mental and physical health are closely linked
- Many roads lead to diabetes

- Assess your route
  - Your risk and protective factors could be biological, psychological, or social
  - Make changes where needed!
Thank you!

- **Funding Sources**
  - National Institutes of Health
  - Robert Wood Johnson Foundation

- **Collaborators**
  - Carol Ryff, PhD
  - Arun Karlamangla, MD
  - Chris Coe, PhD
  - And many others!