# Prediabetes

## Screening and Monitoring

# Rationale for Prediabetes Screening

- Epidemiologic evidence suggests the complications of diabetes begin early in the progression from normal glucose tolerance to frank type 2 diabetes
- Prediabetes and diabetes are conditions in which early detection is appropriate, because:
  - Duration of hyperglycemia is a predictor of adverse outcomes
  - There are effective interventions to prevent disease progression and to reduce complications

Garber AJ, et al. *Endocr Pract*. 2008;14:933-946.

# Risk Factors for Prediabetes and Type 2 Diabetes

- Age ≥45 years
- Family history of T2D or cardiovascular disease
- Overweight or obese
- Sedentary lifestyle
- Non-Caucasian ancestry
- Previously identified IGT, IFG, and/or metabolic syndrome
- PCOS, acanthosis nigricans, or NAFLD
- Hypertension (BP >140/90 mmHg)
- Dyslipidemia (HDL-C <35 mg/dL and/or triglycerides >250 mg/dL)
- History of gestational diabetes
- Delivery of baby weighing >4 kg (>9 lb)
- Antipsychotic therapy for schizophrenia or severe bipolar disease
- Chronic glucocorticoid exposure
- Sleep disorders
  - Obstructive sleep apnea
  - Chronic sleep deprivation
  - Night shift work

BP, blood pressure; HCL-C, high density lipoprotein cholesterol; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; NAFLD, nonalcoholic fatty liver disease; PCOS, polycystic ovary syndrome; T2D, type 2 diabetes.

Handelsman YH, et al. *Endocr Pract*. 2015;21(suppl 1):1-87.

# Normal FPG and Risk of T2D

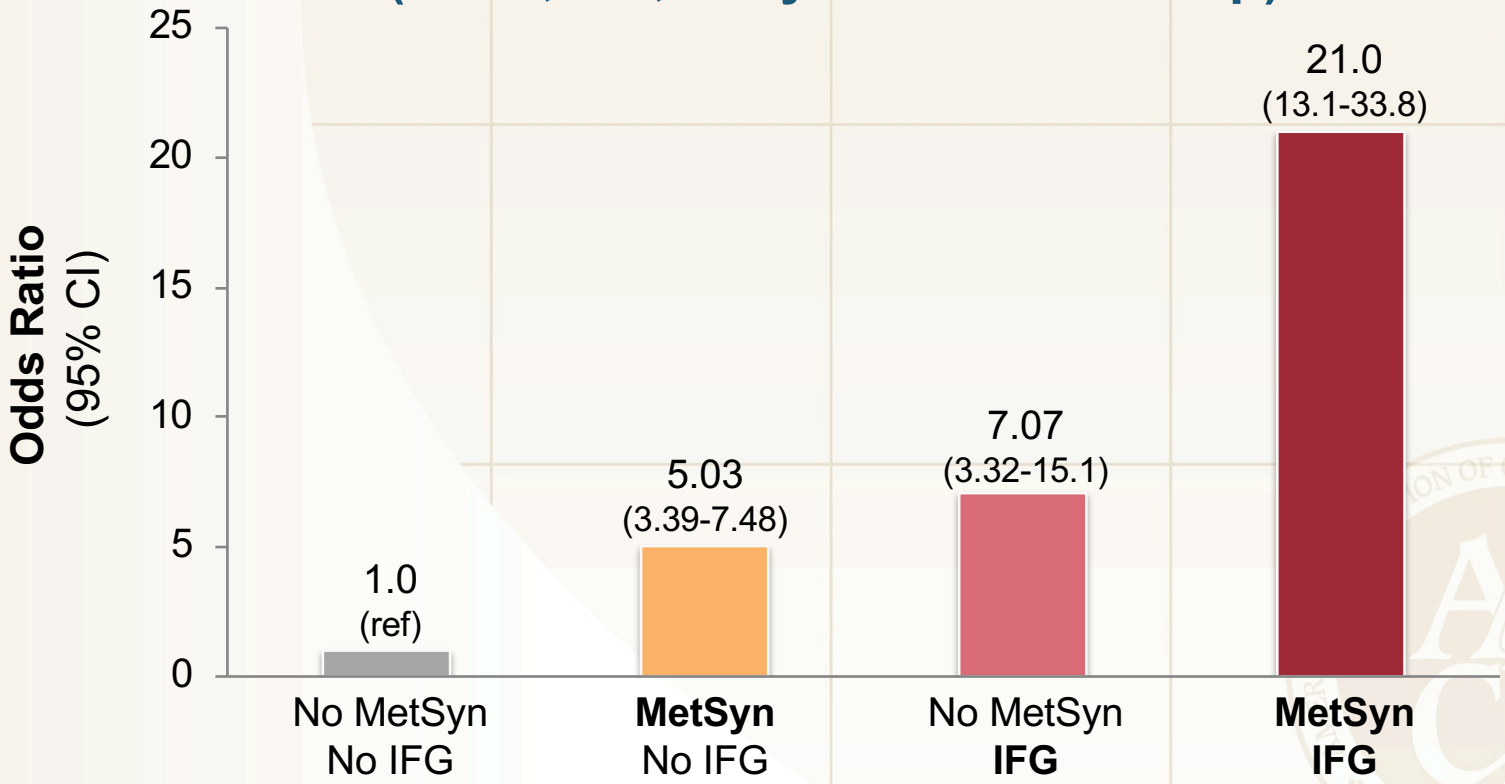
- Patients with normal FPG and any of the following comorbidities are at increased risk of developing T2D:
  - Obesity
  - Hypertension
  - Low HDL-C
  - High triglycerides
  - Smoking
- Closer surveillance for diabetes development might be warranted in these patients

FPG, fasting plasma glucose; HCL-C, high density lipoprotein cholesterol; T2D, type 2 diabetes.

Nichols GA, et al. *Am J Med* 2008;121:519-524.

# Effect of Metabolic Syndrome and IFG on Risk of T2D

**San Antonio Heart Study**
**Men and Women Age 25-64 Years**
**(N = 2,559; 7.4 years of follow-up)**

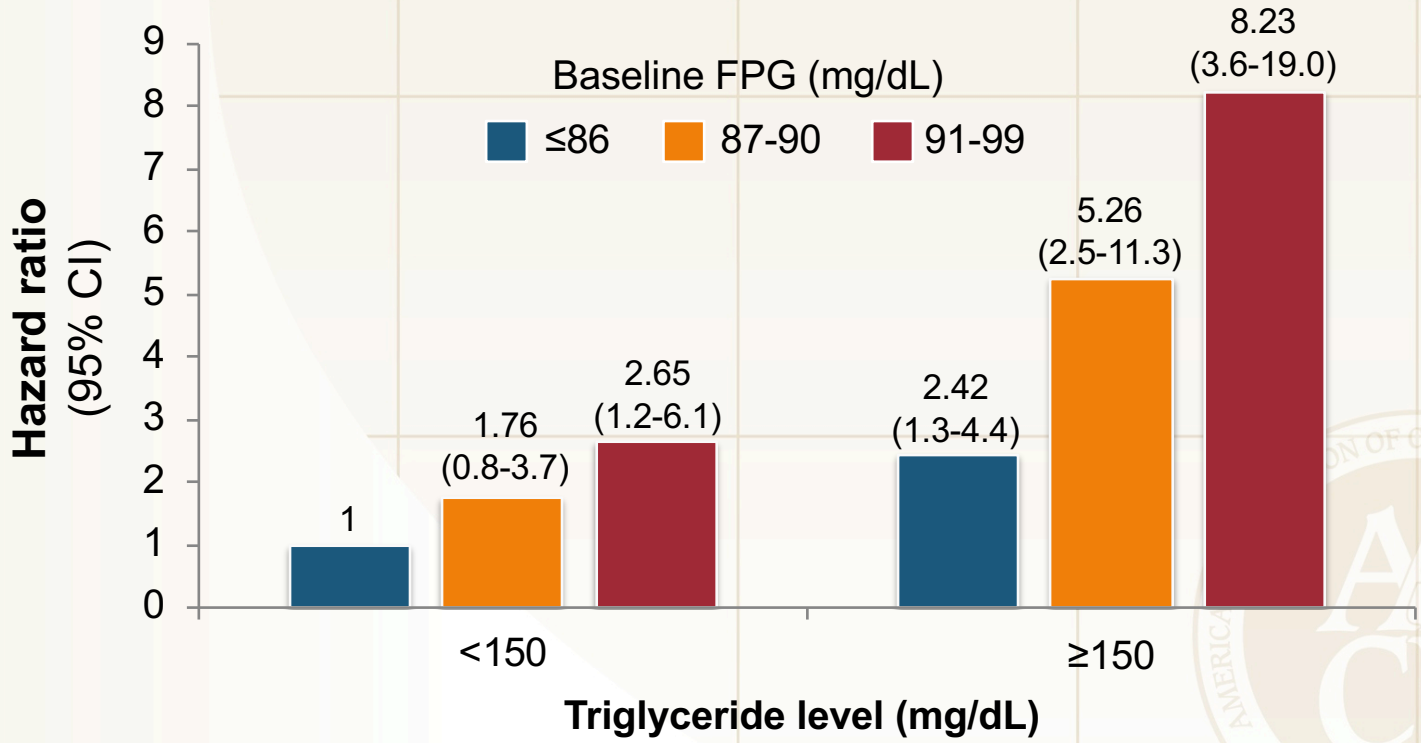



CI, confidence interval; IFG, impaired fasting glucose; MetSyn, metabolic syndrome; T2D, type 2 diabetes.

Lorenzo C, et al. *Diabetes Care*. 2007;30:8-13.

# Effect of Triglyceride Level on Risk of T2D

## Men Age 26-45 Years (74,309 person-years of follow-up)

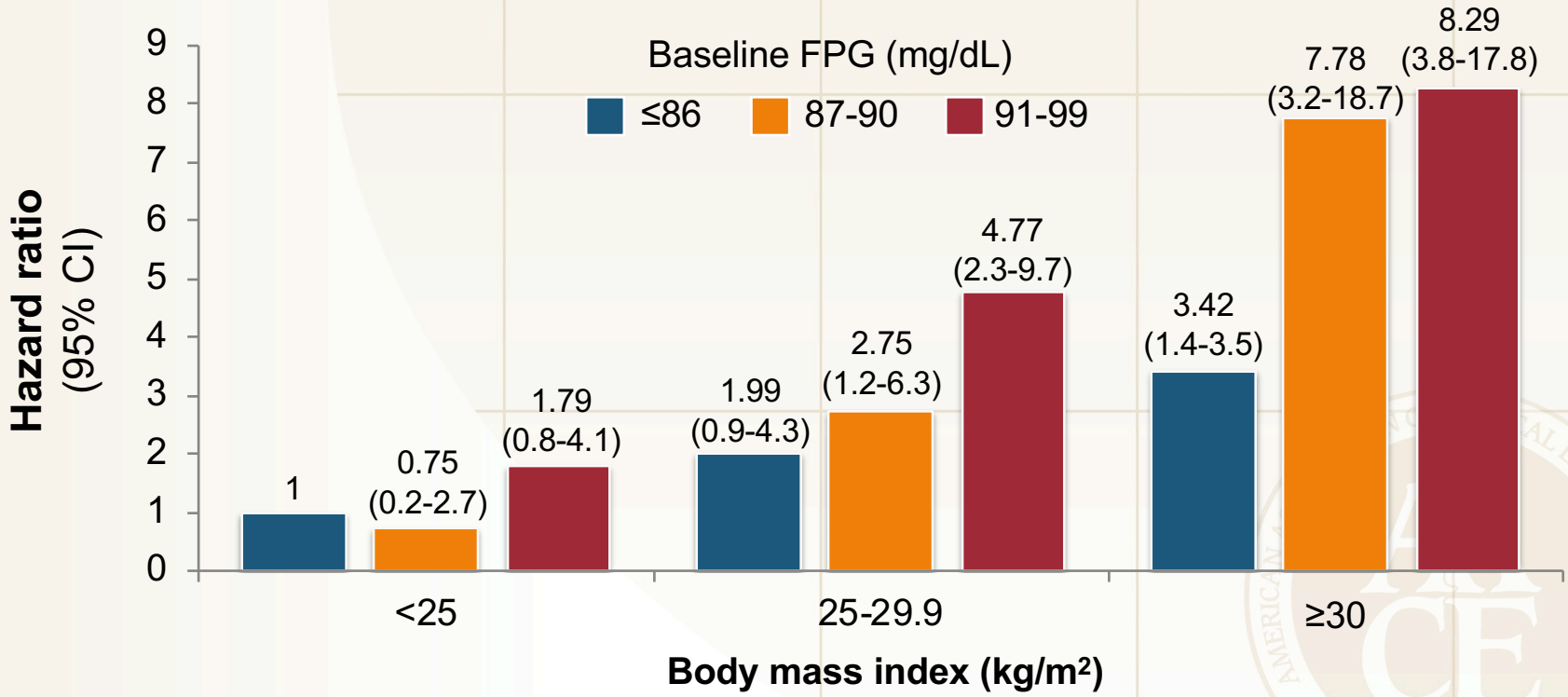



CI, confidence interval; FPG, fasting plasma glucose, T2D, type 2 diabetes.

Tirosh A, et al. *N Engl J Med.* 2005;353:1454-1462.

# Effect of Body Mass Index on Risk of T2D

## Men Age 26-45 Years (74,309 person-years of follow-up)




CI, confidence interval; FPG, fasting plasma glucose; T2D, type 2 diabetes.

Tirosh A, et al. *N Engl J Med.* 2005;353:1454-1462.

# Interventional Criteria for Prediabetes

- IFG: FPG 100-125 mg/dL
- IGT: 2-hour PPG 140-199 mg/dL
  - In patients with IFG, a 2-hour OGTT may further clarify the level of risk while also detecting undiagnosed diabetes
  - Patients with impaired glucose metabolism identified by 2-hour OGTT were greater in number than patients discovered by routine FPG
- Metabolic syndrome diagnosed by the NCEP criteria should be considered a prediabetes equivalent
  - 3 of 5 metabolic syndrome criteria are sufficient; recent evidence suggests even 2 of 5 metabolic syndrome criteria may be adequate

FPG, fasting plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; NCEP, national cholesterol estrogen program.

Handelsman YH, et al. *Endocr Pract*. 2015;21(suppl 1):1-87; Garber AJ, et al. *Endocr Pract*. 2008;14:933-946.

# Screening and Diagnosis of Prediabetes and Diabetes

| Test | Normal | High risk for diabetes | Diabetes* |
|---|---|---|---|
| FPG, mg/dL | <100 | ≥100 – 125 (IFG) | ≥126 |
| 2-h PG†, mg/dL | <140 | ≥140 – 199 (IGT) | ≥200 |
| Random PG, mg/dL | | | ≥200 + symptoms of diabetes |
| Hemoglobin A1C, % | <5.5 | 5.5 – 6.4 (screening only) | ≥6.5‡ |

*Confirm diagnosis on a separate day by repeating the glucose or A1C testing.

†Measured with an OGTT performed 2 hours after 75-g oral glucose load.

‡AACE prefers use of glucose criteria for diagnosis of diabetes. When A1C is used for diagnosis, follow-up glucose testing should be done when possible to help manage diabetes.

FPG, fasting plasma glucose; IFG, impaired fasting glucose; IGT, impaired glucose tolerance; OGTT, oral glucose tolerance test; PG, plasma glucose.

Handelsman YH, et al. *Endocr Pract*. 2015;21(suppl 1):1-87.

# Clinical Identification of Metabolic Syndrome

| Risk Factor | Definition |
|---|---|
| Abdominal obesity<br>Men<br>Women | Waist circumference†<br>>102 cm (>40 in)<br>>88 cm (>35 in) |
| Triglycerides | ≥150 mg/dL |
| HDL cholesterol<br>Men<br>Women | <br><40 mg/dL<br><50 mg/dL |
| Blood pressure | ≥130/85 mmHg |
| Fasting glucose | ≥110 mg/dL |

Note: The ATP III panel did not find adequate evidence to recommend routine measurement of insulin resistance (eg, plasma insulin), proinflammatory state (eg, high-sensitivity C-reactive protein), or prothrombotic state (eg, fibrinogen or PAI-1) in the diagnosis of the metabolic syndrome.

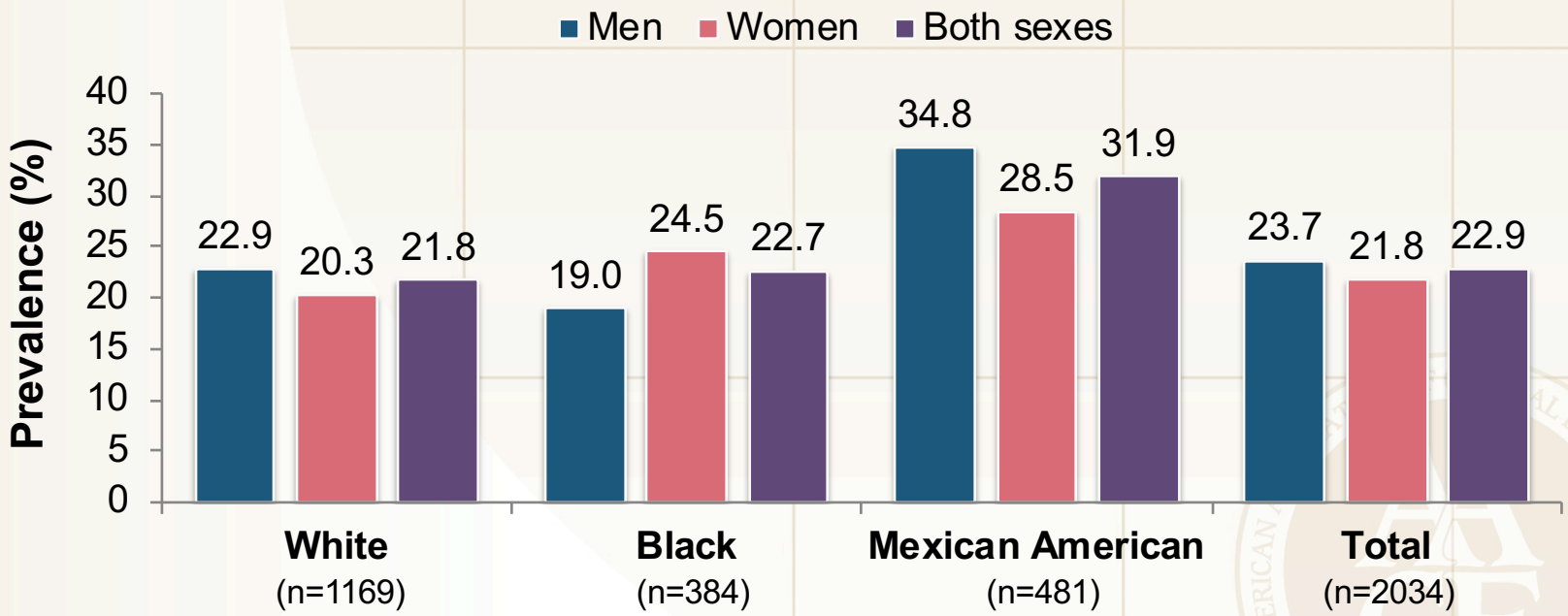
† Some male persons can develop multiple metabolic risk factors when the waist circumference is only marginally increased, eg, 94-102 cm (37-39 in). Such persons may have a strong genetic contribution to insulin resistance. They should benefit from changes in life habits, similarly to men with categorical increases in waist circumference.

ATP III, Adult Treatment Panel III; NCEP, National Cholesterol Education Panel; PAI-1, plasminogen activator inhibitor-1.

NCEP ATP III Final Report. NIH, NHLBI. 2002. Publication No. 02-5215.

# Prevalence of Metabolic Syndrome*

## National Health and Nutrition Examination Survey 2009-2010




*Defined as presence of ≥3 risk factors meeting National Cholesterol Education Panel Adult Treatment Panel III (NCEP ATP III) criteria.

Beltrán-Sánchez H, et al. *J Am Coll Cardiol*. 2013;62:697-703.

Prediabetes Screening and Monitoring

# DIABETES RISK SCORES

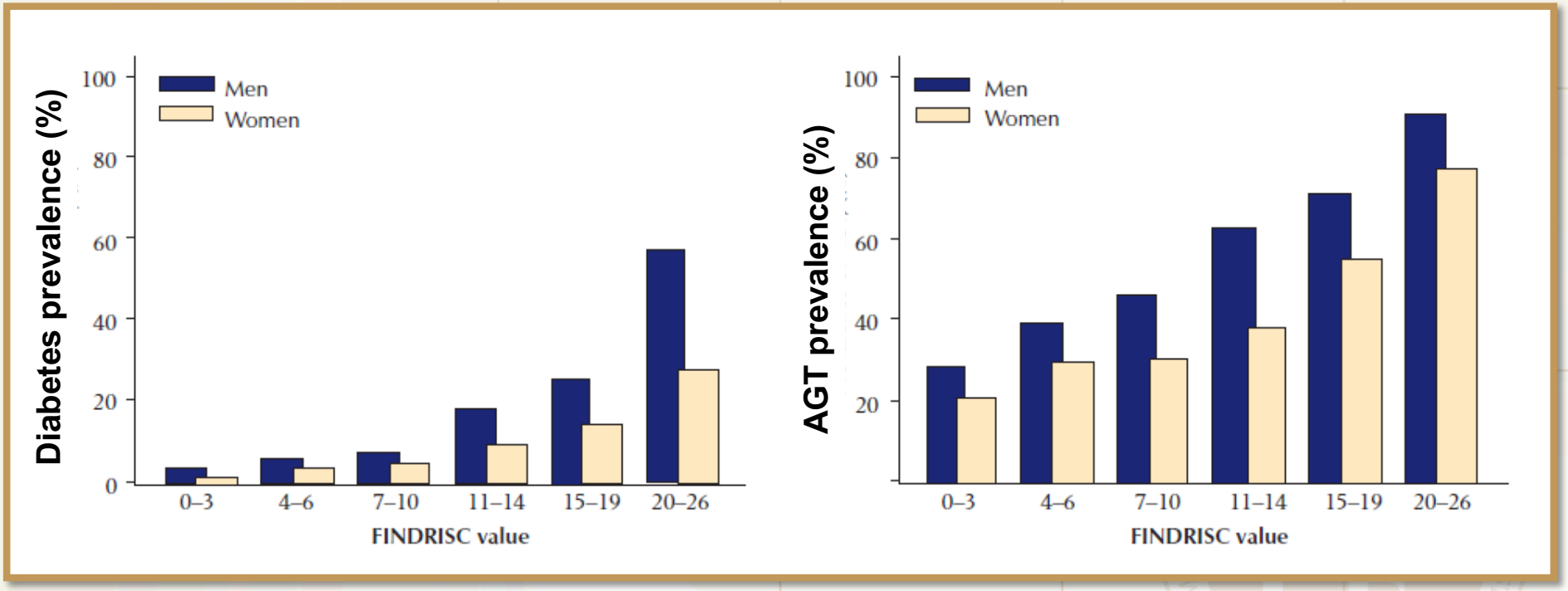
# Finnish Diabetes Risk Score (FINDRISC)

- Risk assessment tool based on random samples of patients 35-64 years of age, followed for 5 years
  - 1987 cohort (n=4746)
  - 1992 cohort (n=4615)
- Score range: 0-26
  - Score ≥9 predicts development of drug-treated diabetes within 10 years
    - Sensitivity 0.81 (1992 cohort)
    - Specificity 0.76 (1992 cohort)
    - Predictive value = 0.05 (1992 cohort)

Lindstrom J, Tuomilehto J. *Diabetes Care*. 2003;26:725-731.

# FINDRISC Scores and Abnormal Glucose Tolerance

## Prevalence of Diabetes and Abnormal Glucose Tolerance in Finnish Population (N=4622)




AGT, abnormal glucose tolerance; FINDRISC, Finnish Diabetes Risk Score.

Saaristo T, et al. *Diabetes Vasc Dis Res*. 2005;2:67-72.

# Finnish Diabetes Risk Score (FINDRISC)

| Question | Score |
|---|---|
| Age (years) | |
| 45-54 | 2 |
| 55-64 | 3 |
| ≥65 | 4 |
| BMI (kg/m$^2$) | |
| 25-30 | 1 |
| ≥30 | 3 |
| Waist circumference (cm) | |
| 94-102 (men), 80-88 (women) | 3 |
| >102 (men), >88 (women) | 4 |
| Physical activity, <30 min per day | |
| No | 2 |
| Consumption of vegetables and fruit | |
| Not every day | 1 |

| Question | Score |
|---|---|
| Hypertension medication | |
| Yes | 2 |
| History of blood glucose elevations | |
| Yes | 5 |
| Family history of T1 or T2DM | |
| 2$^{nd}$ degree relative | 3 |
| 1$^{st}$ degree relative | 5 |
| Total (maximum) | 26 |

| Total Risk Score | Risk of developing T2DM in 10 years |
|---|---|
| <7 | 1% |
| 7-11 | 4% |
| 12-14 | 17% |
| 15-20 | 33% |
| ≥20 | 50% |

Finnish Diabetes Association. Available at: http://www.diabetes.fi/files/1100/Type2diabetesRiskTest_.jpg.

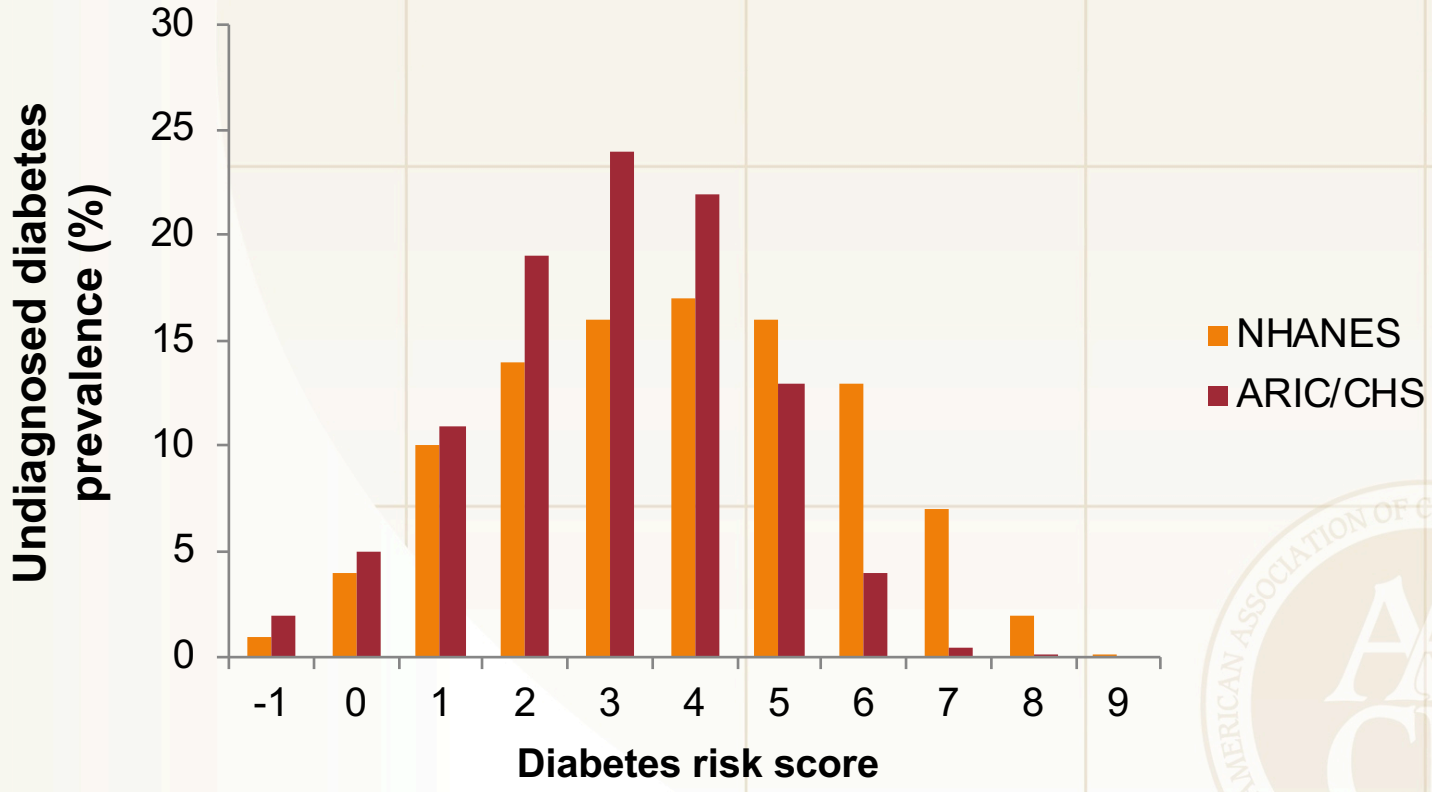
# ADA Diabetes Risk Score

- Risk assessment tool based on NHANES 2006 cohort ≥20 years of age (N=5258) and validated with ARIC and CHS cohorts (N=19,728 combined)
- Score range: 0-10
  - Score ≥5 predicts undiagnosed T2DM
    - Sensitivity 0.79
    - Specificity 0.67
    - Predictive value = 0.10

ARIC, Atherosclerosis Risk in Communities; CHS, Cardiovascular Health Study; NHANES, National Health and Nutrition Examination Survey.

Ban H, et al. *Ann Intern Med*. 2009;151:775-783.

# ADA Risk Scores and Prevalence of Undiagnosed Diabetes




AGT, abnormal glucose tolerance; ARIC, Atherosclerosis Risk in Communities; CHS, Cardiovascular Health Study; NHANES, National Health and Nutrition Examination Survey.

Bang H, et al. *Ann Intern Med*. 2009;151:775-783.

# ADA Diabetes Risk Score

| Question | Score |
|---|---|
| Age (years) | |
| 40-49 | 1 |
| 50-59 | 2 |
| ≥60 | 3 |
| Sex | |
| Male | 1 |
| Woman with history of gestational DM | 1 |
| Family history of T1 or T2DM | |
| 1st degree relative | 1 |
| Hypertension diagnosis | |
| Yes | 1 |

| Question | Score |
|---|---|
| Physical activity | |
| No | 1 |
| BMI | |
| 25-30 | 1 |
| 30-40 | 2 |
| ≥40 | 3 |
| Total (maximum) | 10 |

| Total Risk Score | Risk of developing T2DM in 10 years |
|---|---|
| ≥4 | High risk of having prediabetes or diabetes |
| ≥5 | High risk of having diabetes |

Bang H, et al. *Ann Intern Med*. 2009;151:775-783.
American Diabetes Association. Available at: http://www.diabetes.org/assets/pdfs/at-risk/risk-test-paper-version.pdf.