Introduction to the Diabetes Population Risk Tool (DPoRT)

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Evidence Guiding Health Care

VELUT ARBOR ÆVO

Learning Objectives

1. To understand the principles of risk prediction algorithms
2. To understand the development and validation of DPoRT
3. To identify DPoRT's applications to population based diabetes risk assessment and public health planning

Diabetes Population Risk Tool (DPoRT)

A decision-support tool that uses routinely collected population characteristics applied to a validated risk prediction algorithm to estimate the number of new and existing diabetes cases in a population of interest for the purpose of:

- Understanding distribution of risk in the population
- Prevention
- Resource planning
- Facilitating decision-making and priority setting

DPoRT Knowledge-to-Action Work

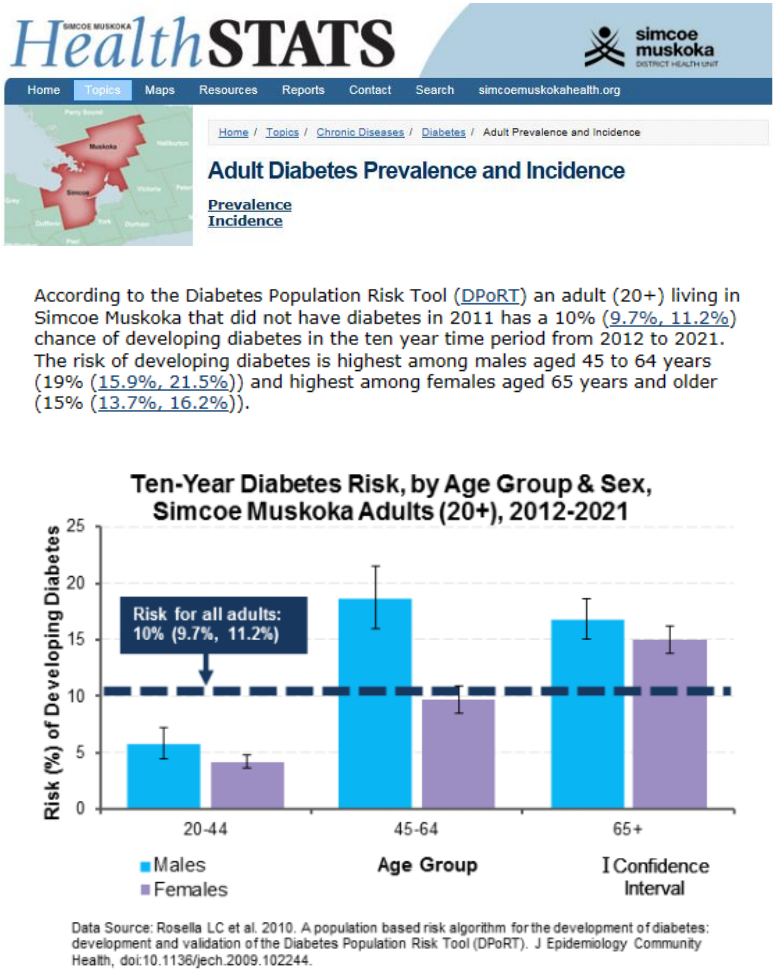
OVERALL GOAL

For researchers and decision-makers in varied health related settings to **work collaboratively** to **build capacity** and **facilitate the application of DPoRT** as a strategic aid for population-based risk assessment, intervention and planning decisions.

Examples of DPoRT in Action

Practice	• **Public Health Units** integrated DPoRT into staff training and operational protocols, public reporting on websites, and annual internal reporting
Advocacy	• **Medical Officers of Health** used DPoRT to estimate impact of "The Big Move" on decreasing diabetes incidence through active transportation • DPoRT findings presented to **Mississauga City Council** to advocate for active transport investment
Program/ Policy	• **Ministry of Health and Long-Term Care** used DPoRT to estimate impact of scaling up the Primary Care Diabetes Prevention Program

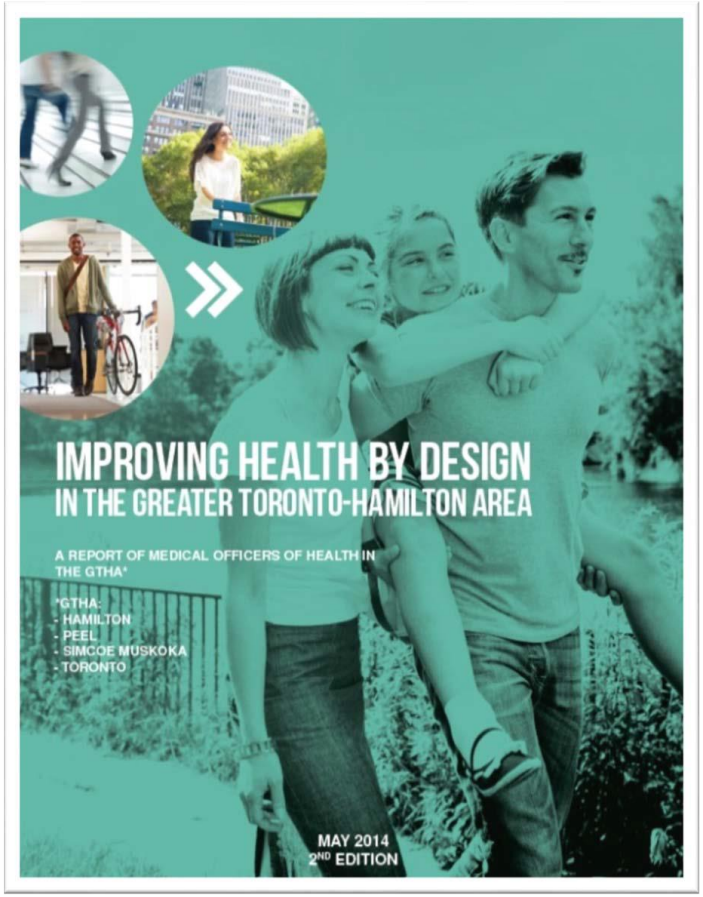
Examples of DPoRT in Action



- **Simcoe Muskoka District Health Unit, Health Stats webpage**
- **An example of using DPoRT for public health reporting**

Simcoe Muskoka District Health Unit, Health Stats webpage: http://www.simcoemuskokahealthstats.org/topics/chronic-diseases/diabetes/prevalence-and-incidence#Incidence .

Examples of DPoRT in Action



- **Improving Health by Design, Medical Officers of Health report**
- **An example of using DPoRT for advocacy**

Mowat D, Gardner C, McKeown D, Tran N, Moloughney B, Bursey G: Improving health by design in the Greater Toronto-Hamilton Area: A report of medical officers of health in the GTHA; 2014

Risk Algorithms

Risk algorithms

- Predicts risk of an outcome – usually a disease state
- Traditionally calculated for individuals
- Typically used when there are multiple factors that contribute to risk

Population-based risk tool

- Can be summarized for groups
- Can be applied as a decision-support and planning tool
- Have unique methodological and data challenges

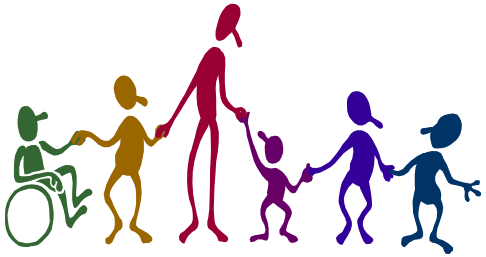
Individual vs. Population-based Risk Prediction Tools

E.g., Diabetes Risk Score
Farmingham Risk Score

Age
Body weight
Blood pressure
Ethnicity
Etc…

Likelihood of individual developing Type 2 diabetes (T2DM)
E.g. 20% in 10 years

Prevention approach
Treatment
*Individual focus



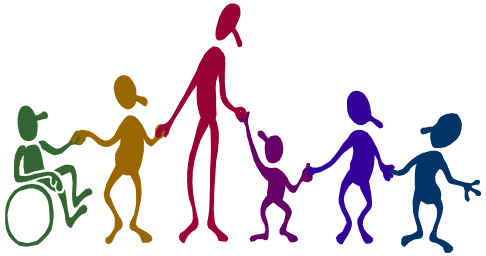
E.g., DPoRT

Age distribution
% obese
% hypertensive
Ethnic distribution
Etc...

Ten-year T2DM risk in a region
(country, province, health region)

Prevention approach
Targets
Magnitude and scale of burden

Improving Population Health



Age distribution

% obese

% hypertensive

Ethnic distribution

Etc...

Ten-year T2DM risk in a region

(country, province, health region)

Prevention approach

Targets

Magnitude and scale of burden

Inform changes to programs and policy:
Home, school and work environment
Food production
Walkability and active transport
Socioeconomic status

Development and Validation of DPoRT

Objective: To develop a population based risk tool for Type 2 Diabetes Mellitus that is valid, reliable and accessible for various levels of health

Validity in this context:

1. With the available factors is this the best model that can be found? (statistical)
2. Does the model predict accurately for its intended purpose? (policy relevant)

KEY CHALLENGE

Balancing accessibility, relevance and model performance

Rosella LC, Manuel DG, Burchill C, Stukel TA, for the PHIA-DM team. A population-based risk algorithm for the development of diabetes: Development and validation of the Diabetes Population Risk Tool (DPoRT). *Journal of Epidemiology & Community Health* (2010) 65; 613-620.

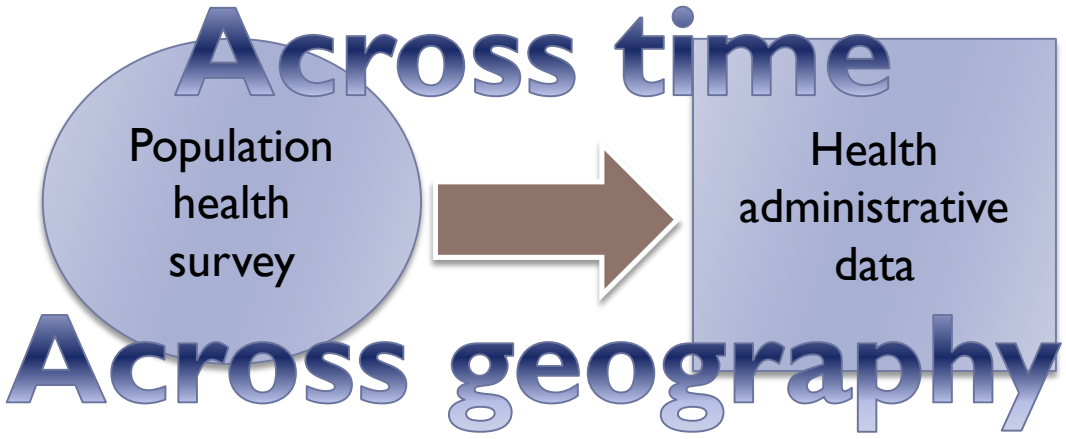
Development and Validation of DPoRT

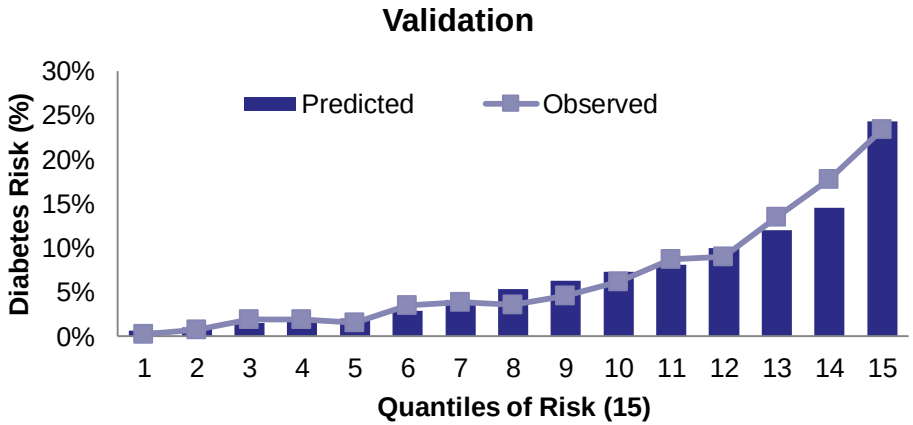
Linkage

- External validation in two provinces and two time points

Complex survey design + prediction

- Parametric survival models applied to survey data
- Optimal predictor determination
- Bootstrap variance
- Incorporate survey weights in prediction





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Development and Validation of DPoRT

Development Cohort: Linked 1996/97 NPHS in ON (N=23,403)

Validation Cohort 1: Linked 2000/01 CCHS in ON (N=37,463)

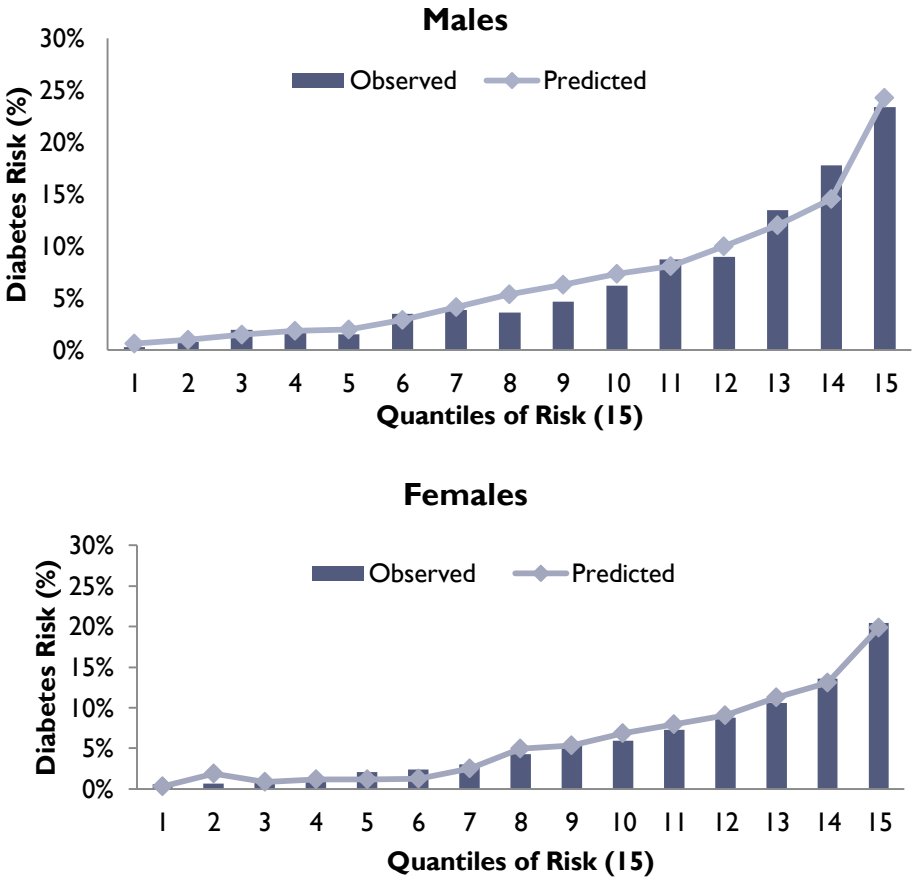
Validation Cohort 2: Linked 1996/97 NPHS in MB (N=10,118)

- Risk variables: only those that are routinely and publicly available (in the NPHS and CCHS)
- Outcome: physician-diagnosed type 2 diabetes (Ontario Diabetes Database & MB version)

Rosella LC, Manuel DG, Burchill C, Stukel TA, for the PHIA-DM team. A population-based risk algorithm for the development of diabetes: Development and validation of the Diabetes Population Risk Tool (DPoRT). *Journal of Epidemiology & Community Health* (2010) 65; 613-620.

DPoRT 2.0 – algorithm was recently updated

- Predicted versus observed incidence of diabetes for men and women in Ontario, validation datasets across quintiles (15) of risk



Rosella LC, Lebenbaum M, Wang J, Li Y, Manuel D. Risk distribution and its influence on the population targets for diabetes prevention. *Preventive Medicine* (2014) 58; 17-21.

DPoRT Risk Algorithm

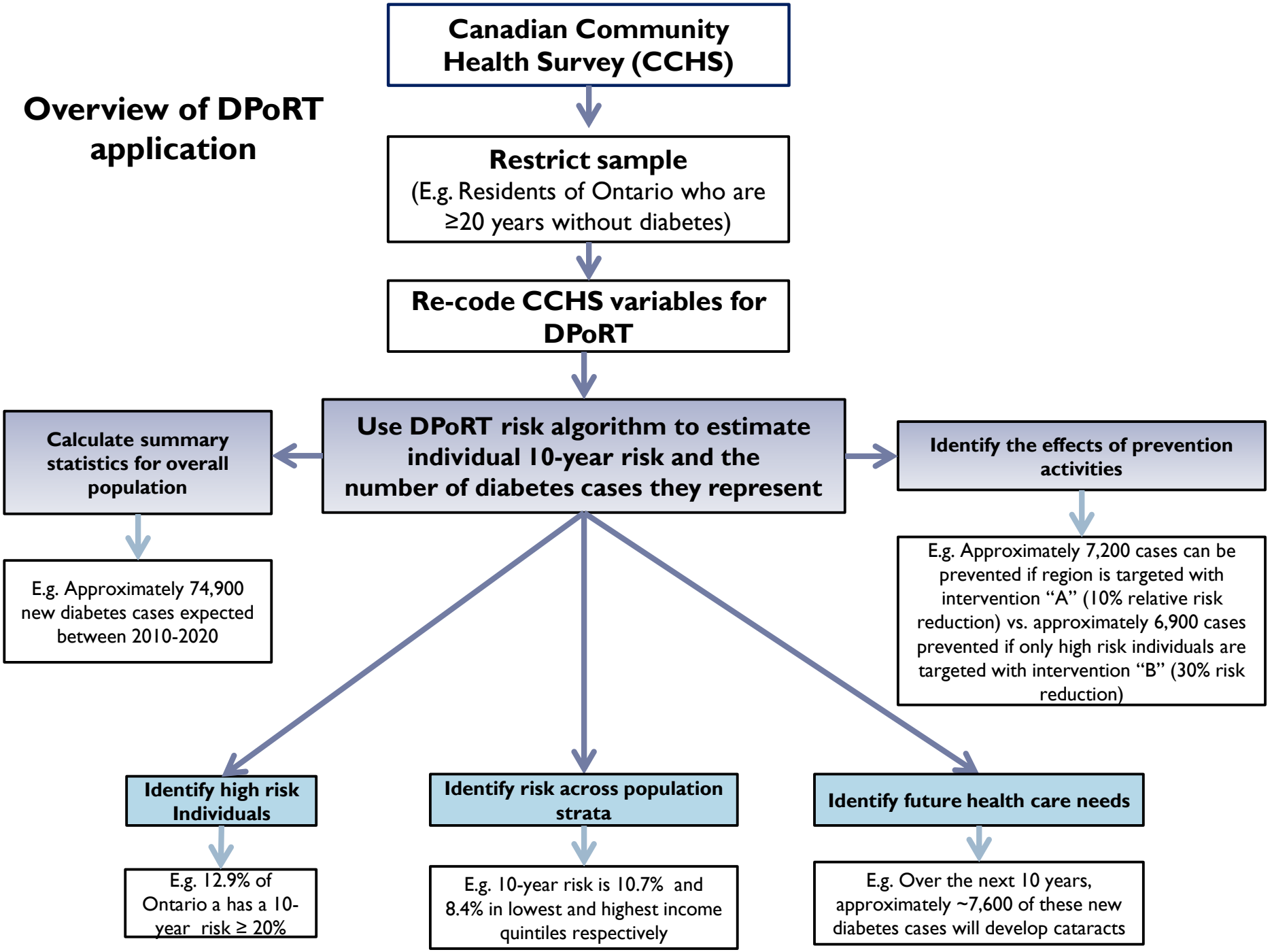
- Sex specific DPoRT models are applied to data in population health surveys (e.g., CCHS) for those who are ≥20 years and free from diabetes at baseline

DPoRT Risk Factor Variables	
Body mass index (BMI)	Income
Age	Immigrant status
Sex	Hypertension
Ethnicity	Heart disease
Education	Smoking status

Canadian Community Health Survey (CCHS)

- A cross sectional survey administered by Statistics Canada with questions on health status, determinants of health, and health care utilization
- Representative of 98% of the Canadian population 12 years and over

Overview of DPoRT application



DPoRT Risk Algorithm 2.0

Males:

$\mu = 10.3062 - 0.3629 \times \text{hypertension} - 0.3483 \times \text{heart disease} - 0.5697 \times \text{non-white ethnicity} - 0.0585 \times \text{smoker} + 0.1884 \times \text{attended post-secondary} + 0.1173 \times \text{top income quintile} - 0 \times (\text{BMI} < 23 \,\&\, \text{age} < 45) - 0.5520 \times (23 \le \text{BMI} < 25 \,\&\, \text{age} < 45) - 0.9521 \times (25 \le \text{BMI} < 30 \,\&\, \text{age} < 45) - 1.7162 \times (30 \le \text{BMI} < 35 \,\&\, \text{age} < 45) - 2.3310 \times (35 \le \text{BMI} \,\&\, \text{age} < 45) - 1.3602 \times (\text{BMI} < 23 \,\&\, \text{age} \ge 45) - 1.6537 \times (23 \le \text{BMI} < 25 \,\&\, \text{age} \ge 45) - 2.0563 \times 25 \le (\text{BMI} < 30 \,\&\, \text{age} \ge 45) - 2.5513 \times (30 \le \text{BMI} < 35 \,\&\, \text{age} \ge 45) - 2.9353 \times (35 \le \text{BMI} \,\&\, \text{age} \ge 45).$

Scale = 0.7994

Females:

$\mu = 10.5777 - 0.4098 \times \text{hypertension} - 0.4528 \times \text{non-white ethnicity} - 0.1477 \times \text{immigrant} + 0.1939 \times \text{attended post-secondary} - 0 \times (\text{BMI} < 23 \,\&\, \text{age} < 45) - 0.7432 \times (23 \le \text{BMI} < 25 \,\&\, \text{age} < 45) - 1.1521 \times (25 \le \text{BMI} < 30 \,\&\, \text{age} < 45) - 1.8479 \times (30 \le \text{BMI} < 35 \,\&\, \text{age} < 45) - 2.0562 \times (35 \le \text{BMI} \,\&\, \text{age} < 45) - 1.5832 \times (\text{BMI} = \text{missing} \,\&\, \text{age} < 45) - 0.7100 \times (\text{BMI} < 23 \,\&\, 45 \le \text{age} < 65) - 1.2338 \times (23 \le \text{BMI} < 25 \,\&\, 45 \le \text{age} < 65) - 1.8357 \times (25 \le \text{BMI} < 30 \,\&\, 45 \le \text{age} < 65) - 2.3742 \times (30 \le \text{BMI} < 35 \,\&\, 45 \le \text{age} < 65) - 2.6631 \times (35 \le \text{BMI} \,\&\, 45 \le \text{age} < 65) - 2.1988 \times (\text{BMI} = \text{missing} \,\&\, 45 \le \text{age} < 65) - 1.5956 \times (\text{BMI} < 23 \,\&\, \text{age} \ge 65) - 1.6144 \times (23 \le \text{BMI} < 25 \,\&\, \text{age} \ge 65) - 1.9830 \times (25 \le \text{BMI} < 30 \,\&\, \text{age} \ge 65) - 2.2148 \times (30 \le \text{BMI} < 35 \,\&\, \text{age} \ge 65) - 2.6448 \times (35 \le \text{BMI} \,\&\, \text{age} \ge 65) - 2.4209 \times (\text{BMI} = \text{missing} \,\&\, \text{age} \ge 65).$

Scale = 0.8419

Note: All independent variables are centered on the mean value for each province.

Note: Women with missing BMI have an elevated risk of diabetes. They are included in the model.

For both males and females:

$$m = \frac{\log(\text{follow-up time in days}) - \mu}{\text{scale}}$$

$$p = 1 - \exp(-m^{\exp})$$

$$\text{Number of diabetes cases} = p * \text{survey weight}.$$

Rosella LC, Lebenbaum M, Li Y, Wang J, Manuel D. Risk distribution and its influence on the population targets for diabetes prevention. *Preventive Medicine* (2014) 58; 17-21.

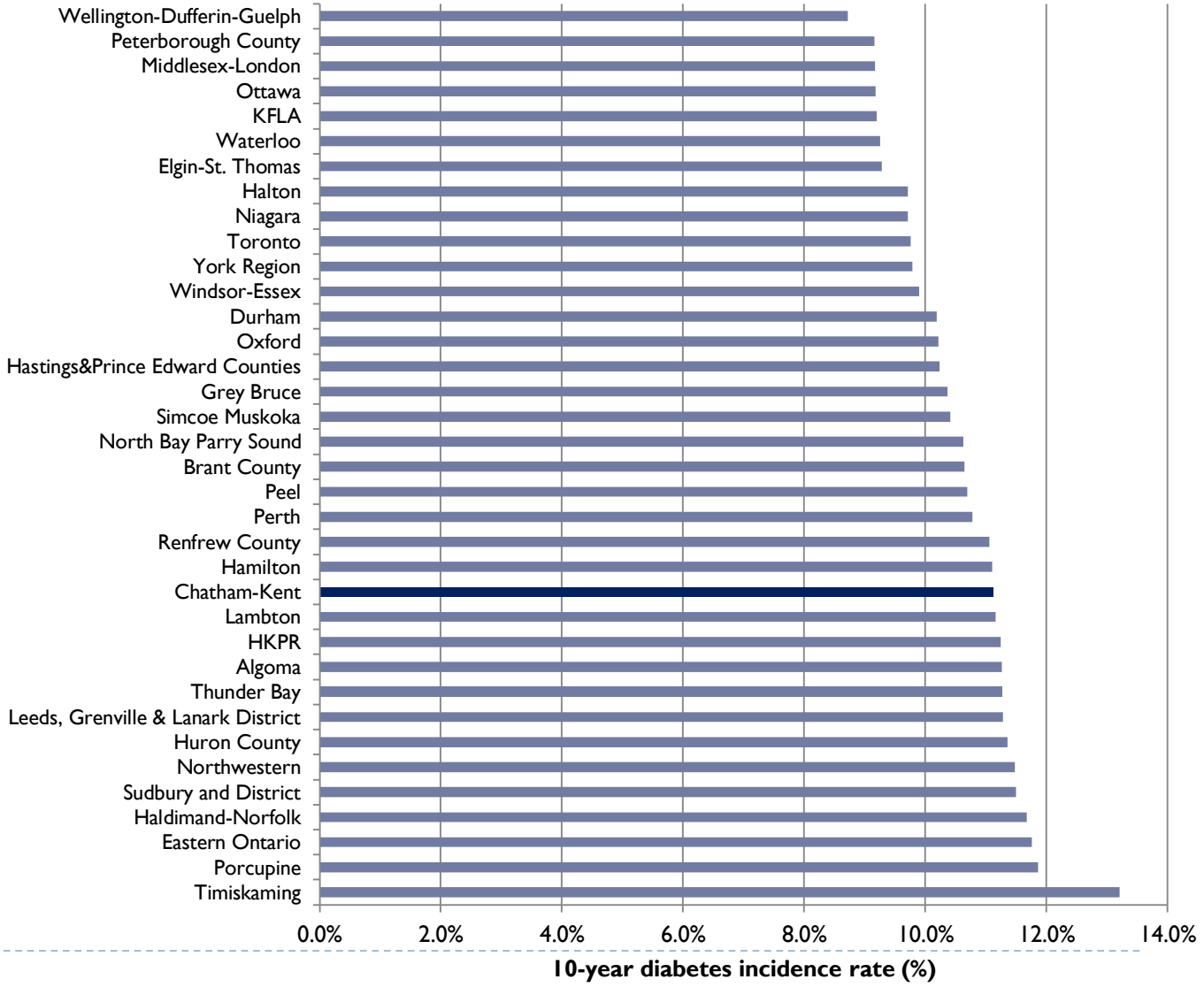
Interpretation of DPoRT Estimates

- Interpretation of the **baseline estimate** of the number of new diabetes cases

*Between 2007 and 2017, **1.9 million** Canadians aged 20 and older will be newly diagnosed with diabetes, based on 2007 BMI levels and other risk factors. Canadians' average baseline risk for developing diabetes in 2007 was **8.9%**. This means that about nine out of every 100 Canadians are predicted to develop diabetes during the 10-year period.*

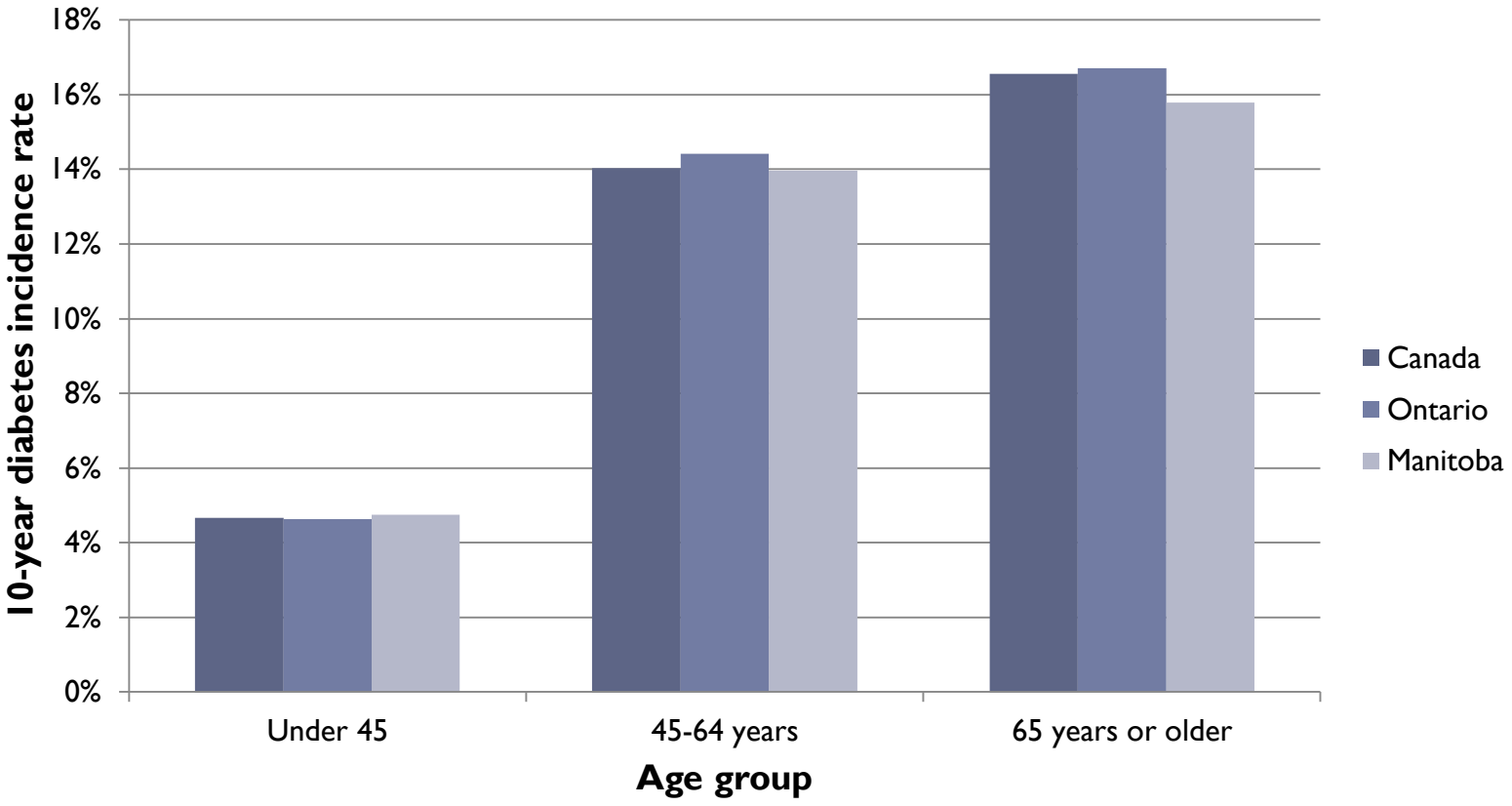
Project Diabetes Incidence by Geographic Region

Ten-year diabetes incidence rate by public health unit in Ontario (2011/12–2021/22)



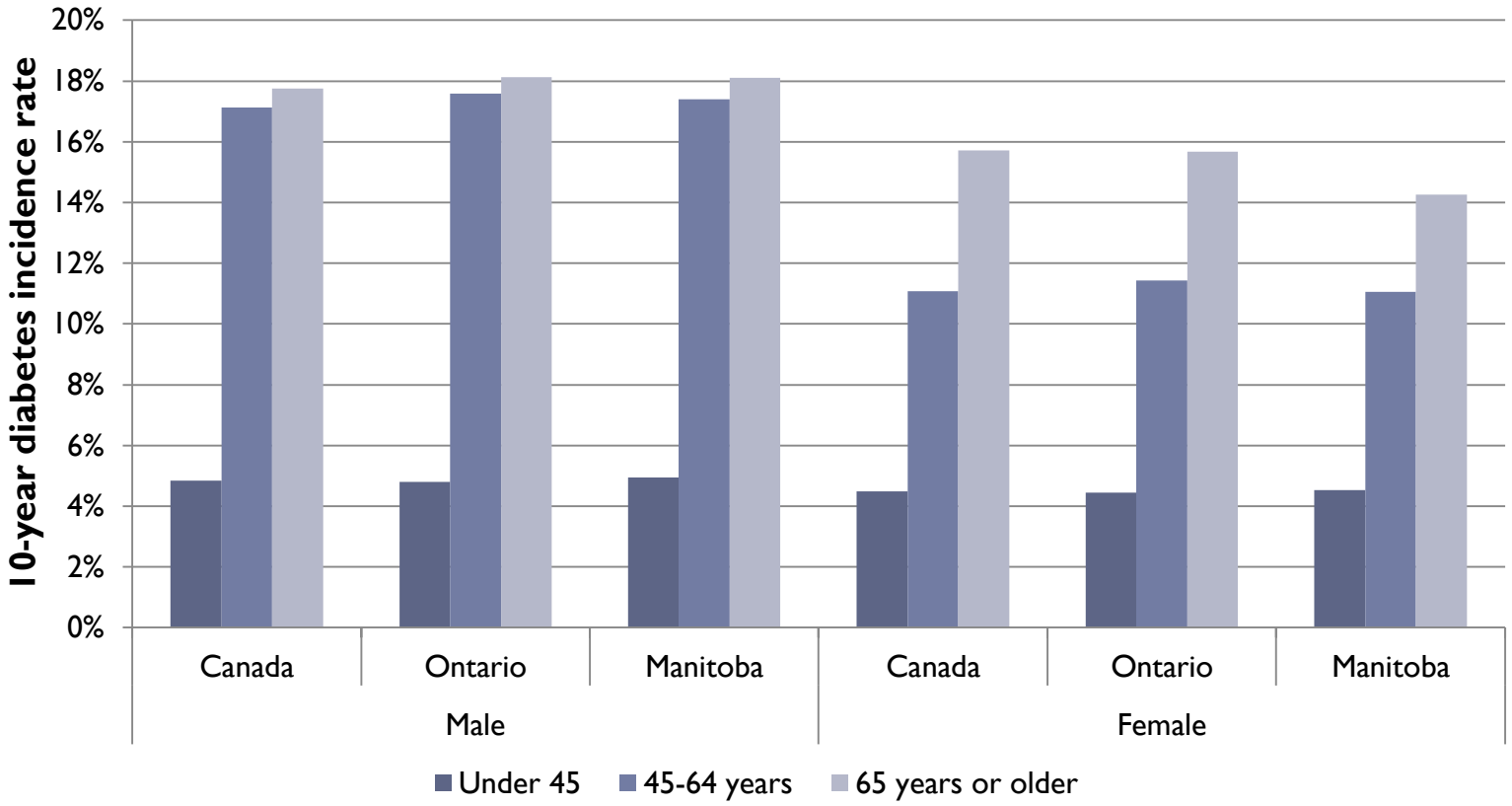
Project Diabetes Incidence by Target Groups

Ten-year diabetes incidence rate by age group and geographic region (2011/12–2021/22)

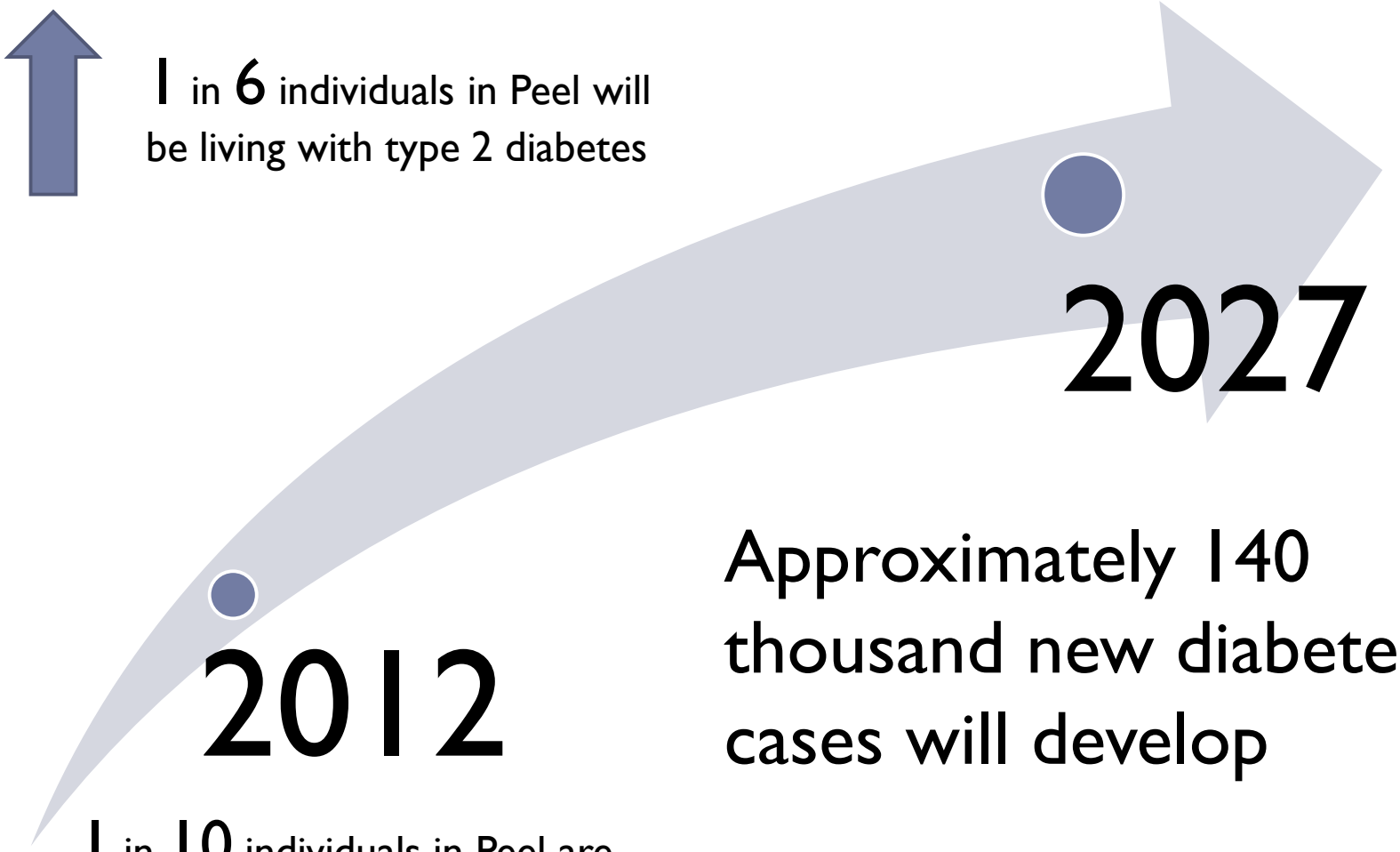


Project Diabetes Incidence by Target Groups

Ten-year diabetes incidence rate by age group, sex and geographic region (2011/12–2021/22)

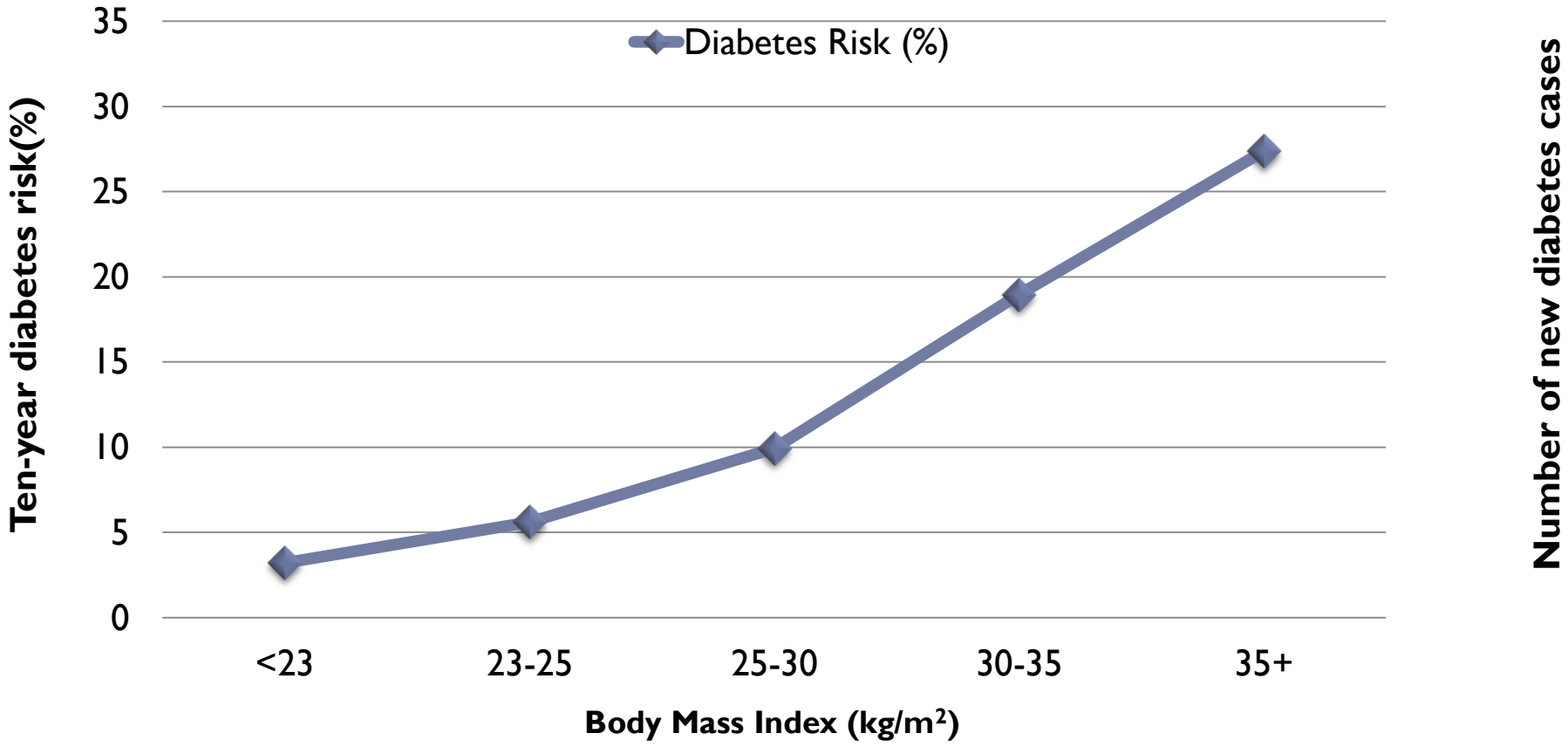


Growing burden of diabetes in Peel



Identify Targets for Diabetes Prevention Approaches

Ten-year diabetes risk according to DPoRT and number of new diabetes cases in Manitoba by BMI category (2011/12–2021/22)



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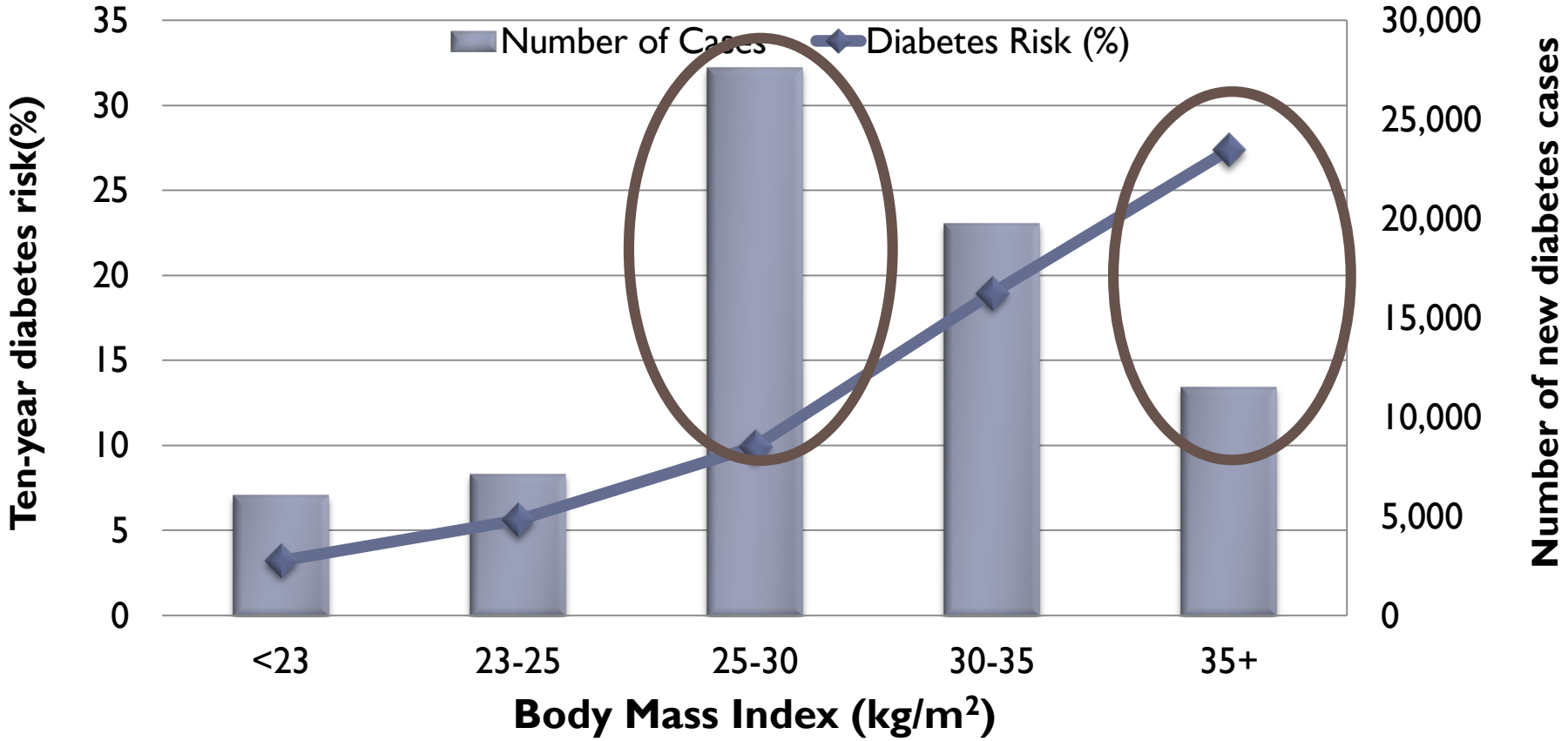
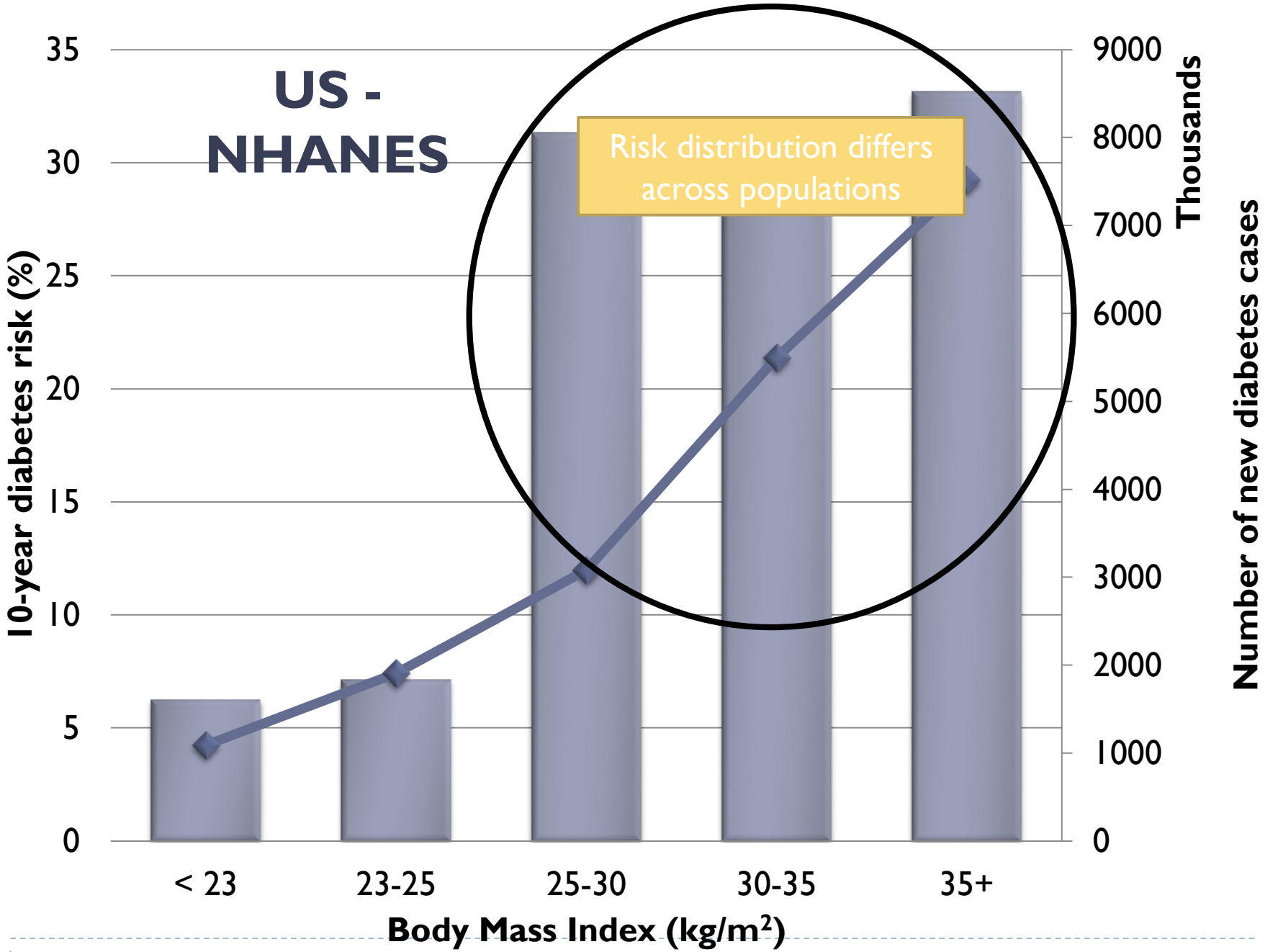
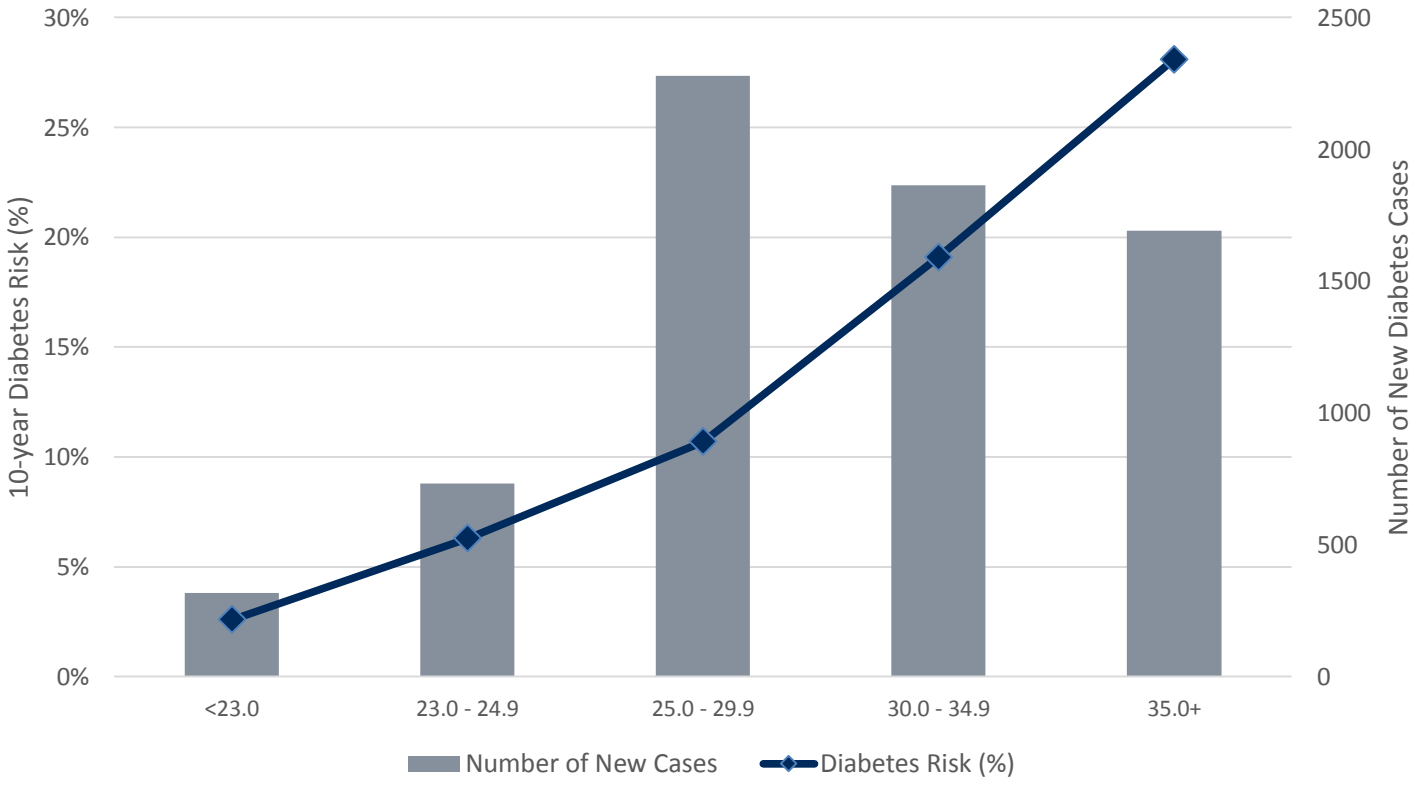




Rosella, L., Lebenbaum, M. Identifying individuals at high for Type 2 diabetes using a population risk tool. *Canadian Society for Epidemiology and Biostatistics (CSEB) Biennial Conference*. June 2013: St. John's, Newfoundland.

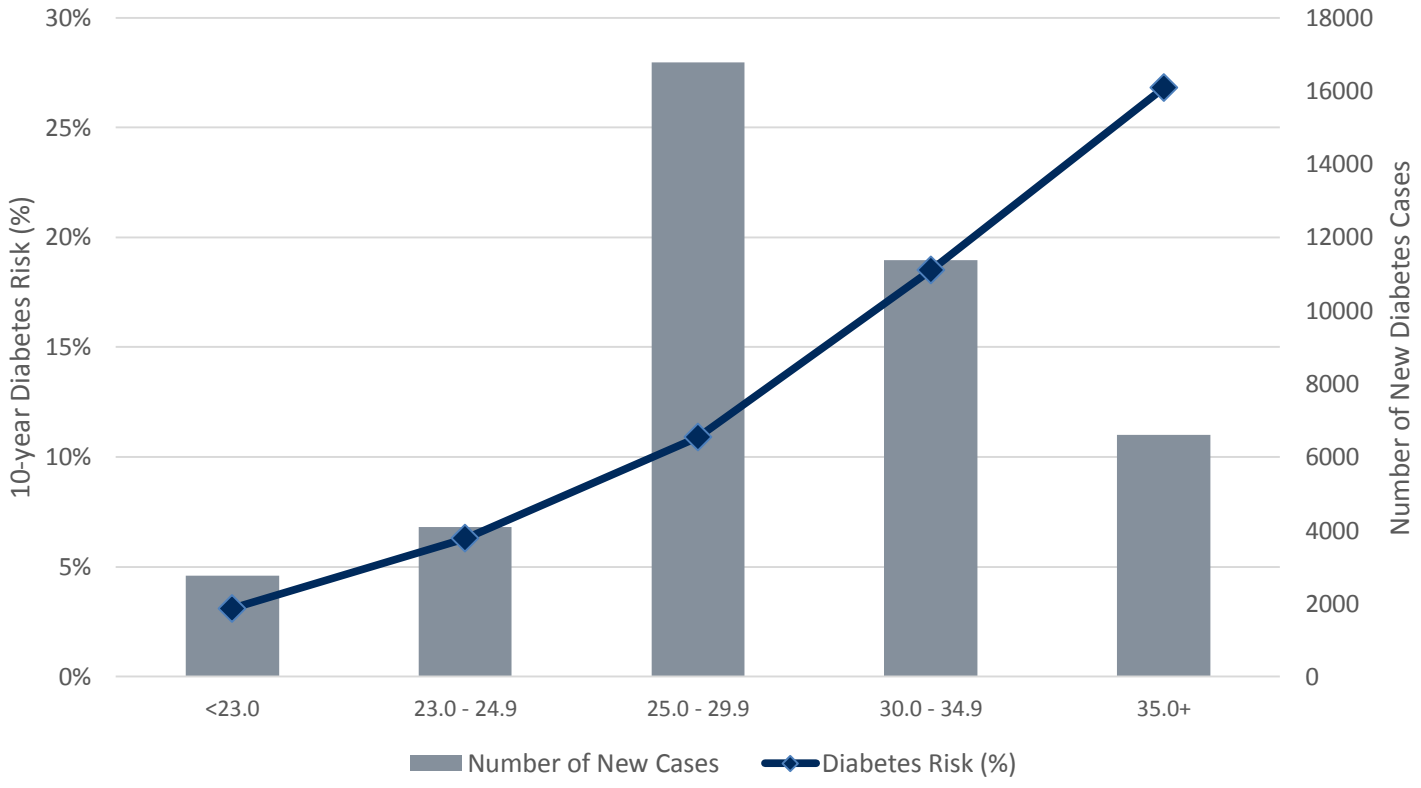
Estimate the Impact of Diabetes Prevention Approaches

Chatham-Kent Public Health Unit region baseline estimated ten-year diabetes incidence rate and number of new cases (2012/13 – 2022/23)



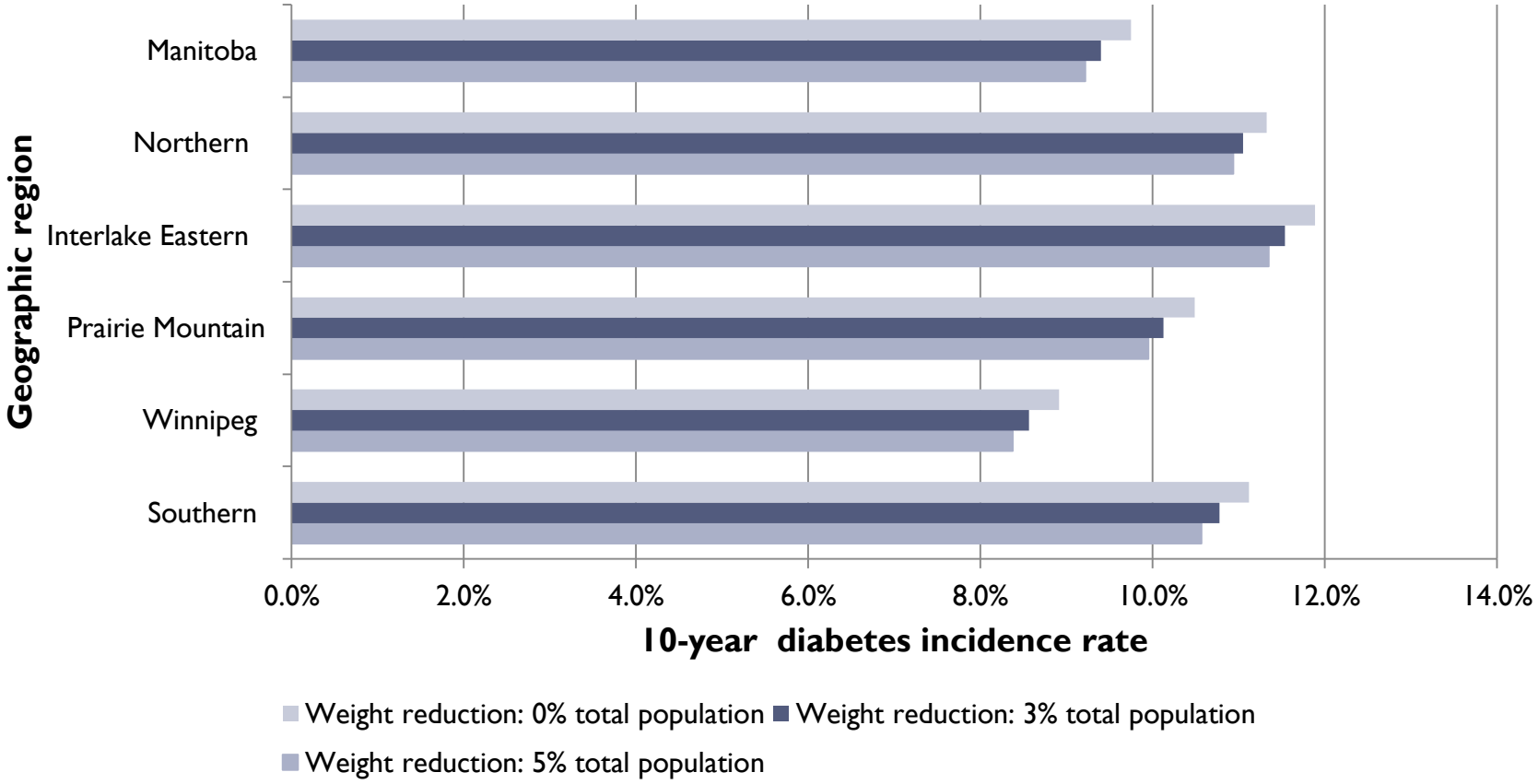
Estimate the Impact of Diabetes Prevention Approaches

Erie St. Clair Local Health Integration Network region baseline estimated ten-year diabetes incidence rate and number of new cases (2012/13 – 2022/23)



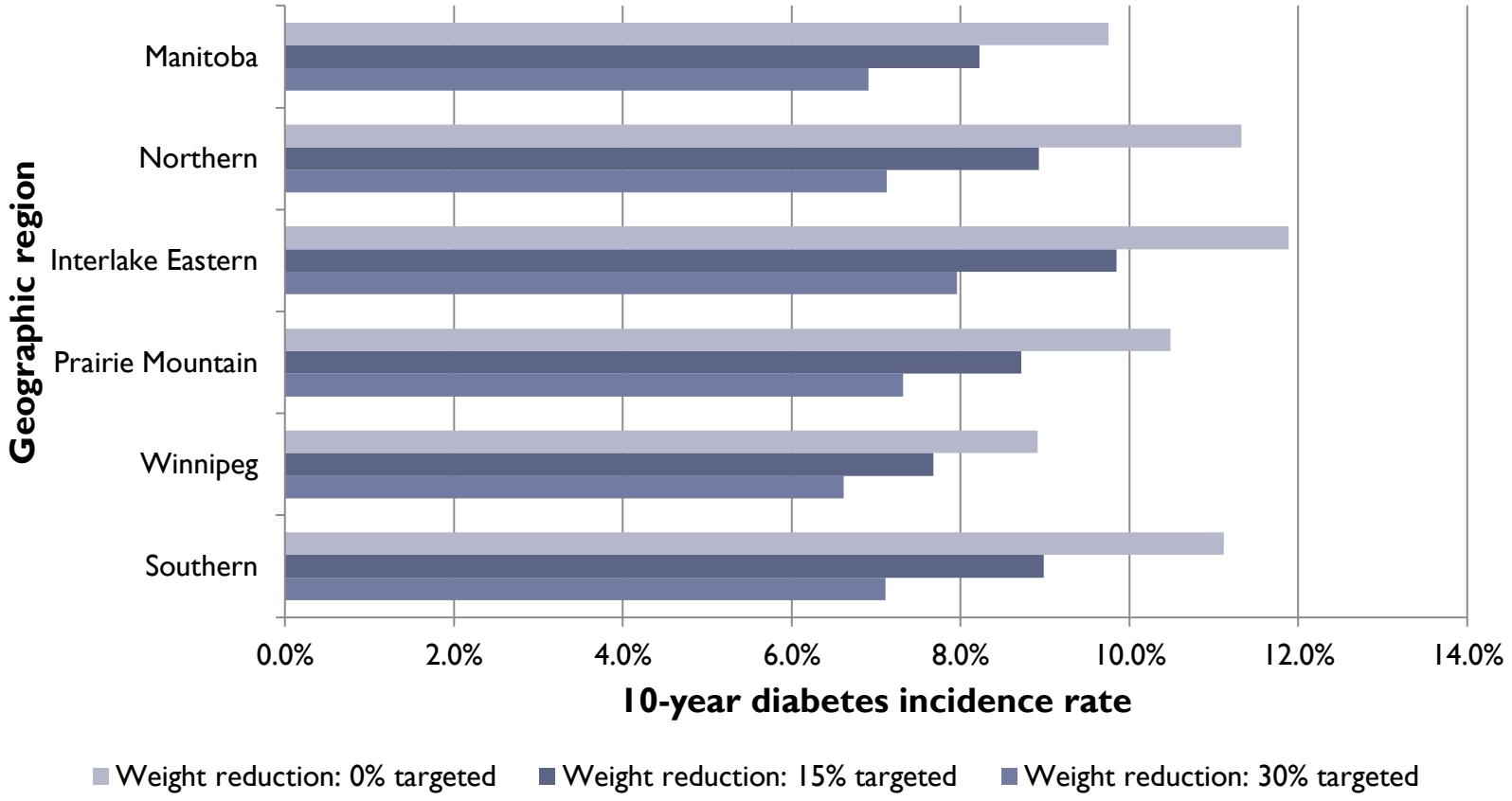
Estimate the Impact of Diabetes Prevention Approaches

Expected change in ten-year diabetes incidence rate in Manitoba as a result of population-level weight loss (2011/12–2021/22)



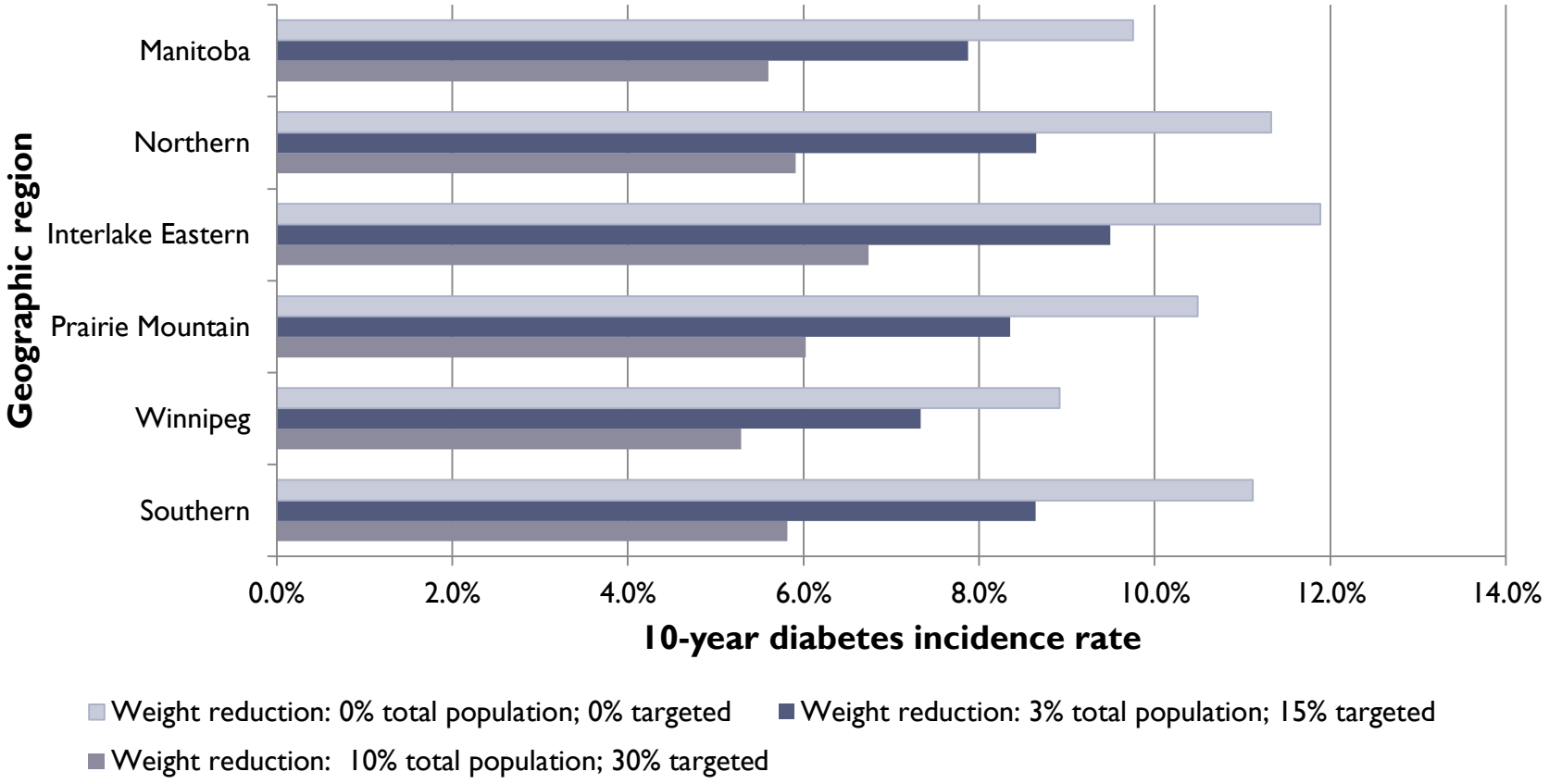
Estimate the Impact of Diabetes Prevention Approaches

Expected change in ten-year diabetes incidence rate in Manitoba as a result of weight loss among obese individuals (2011/12–2021/22)



Estimate the Impact of Diabetes Prevention Approaches

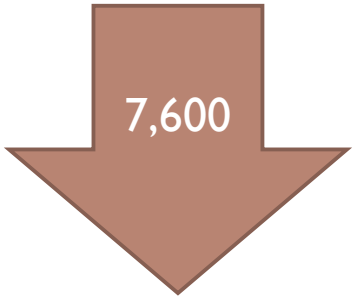
Estimated ten-year diabetes incidence rate in Manitoba as a result of a combination of population-level weight loss and targeted weight loss among obese individuals (2011/12–2021/22)



Making the Case for Funding Prevention
Example from Peel Public Health, Ontario

A lifestyle program implemented to all individuals at high risk (i.e. 10% of the population)

Reduction in future diabetes cases within 10 years

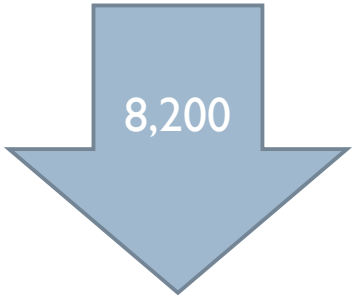


and

Total health care savings

A combination of population wide policies that result in a 2.5% reduction in weight

Reduction in future diabetes cases within 10 years



and

Total health care savings

Interpretive Cautions

- **Diabetes definition:** DPoRT estimates the number of individuals who will develop physician-diagnosed diabetes.
- DPoRT does not consider individuals with diabetes not recognized by themselves or their doctor.
- The estimates reflect cases identified in the National Diabetes Surveillance System (NDSS). There may be provincial differences in how people with diabetes are included in the NDSS.

Interpretive Cautions

Study population: DPoRT estimates represent community-dwelling Canadians living in the 10 provinces during data collection year of CCHS.

- DPoRT estimates do not represent:
  - residents of First Nation reserves,
  - people who live in institutions such as nursing homes,
  - full-time members of the Canadian Forces,
  - residents of certain remote regions, and
  - people who may immigrate to Canada during ten-year period following data collection year of CCHS

Self-Reported Height/Weight & Ethnicity

Height/weight:

- Shields *et al.* (2008) examined agreement between self-reported and measured BMI in a sub-sample of the CCHS population
- DPoRT's discrimination and calibration would be minimally affected at these levels

Ethnicity:

- Influence of ethnic groups was tested by examining modified versions of DPoRT models
- All models produced similar C statistics (differing only at the 0.01 place

Shields, Gorber & Tremblay. (2008). Estimates of obesity based on self-report versus direct measures. Statistics Canada Catalogue no. 82-003-X health reports. Retrieved from: http://www.statcan.gc.ca/pub/82-003-x/2008002/article/10569-eng.pdf;
Rosella et al. The role of ethnicity in predicting diabetes risk at population level. Ethnicity and Health, 2012

Summary

- DPoRT was successfully validated in two external validation cohorts and demonstrated good discrimination and calibration
- DPoRT allows us to empirically estimate the future risk and number of new cases of Type 2 diabetes in a population
- DPoRT can quantify the impact that changes in baseline risk factors will have on future diabetes incidence