

# Planning Tool Guidance

*Project Big Life*

*2019-07-29*



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## Chapter 1

# Welcome to Project Big Life's Planning Tool

*TO DO: Insert the image for the PBL planning tool*

### 1.0.1 What is the Project Big Life Planning Tool

*To do: Develop video showcasing the platform including what it is and why someone should use the platform*

### 1.0.2 Who made the Project Big Life Planning Tool?

The Project Big Life Planning Tool was developed by the Project Big Life Team. The Project Big Life Team is part of the ICES. The below video explains what ICES is.

`## PhantomJS not found. You can install it with webshot::install_phantomjs(). If it is installed, please`



# Chapter 2

## Introduction

The Project Big Life Planning Tool was developed in order to support health professionals: research, plan, develop, and evaluate evidence-based health interventions.

For instance Project Big Life Planning Tool helps:

- Public health professionals: assess the impact of preventative interventions that target health behaviours
- Health planners: assess the need for palliative care

### What types of questions can it answer?

The Project Big Life Planning Tool can answer the following types of questions:

- What is the burden of smoking on life expectancy?
- How many deaths would be prevented if everyone met their daily exercise requirements?

### How does it work?

- This tool provides health planners with access to multivariable predictive risk algorithms, created and housed by the Project Big Life Team.
- The multivariable predictive risk algorithms use distinct characteristics and health profiles of groups of people to assess the risk of a health outcome (e.g. Life Expectancy).
- The multivariable predictive risk algorithms are developed and validated using data routinely collected by Statistics Canada and provincial health agencies, and the algorithms have been published in various journals.
- More information about multivariable predictive risk algorithms can be found in the key concepts (Chapter 6).

### Why should I use it?

- It is **easy** and **flexible** to use.
  - The user only needs to upload their data and choose which calculation to run.
  - It can be used to assess the future risk of a health outcome.
  - It can be used to assess the effectiveness of different intervention scenarios (e.g. policy) on a health outcome.

- It generates **accurate** predictions.
  - It can be used to accurately assess the risk of a health outcome in populations that were not used in its development, and groups of people that account for only a fraction of the population.
- It is **private**.
  - Loaded data remains on your computer and is not uploaded or sent anywhere.



## Chapter 3

# Getting Started

To help you get started quickly with Project Big Life's Planning Tool, we built a Tutorial directly onto the platform.

The tutorial takes you through step-by-step how to use Project Big Life's Planning Tool. The tutorial will not explain the steps in detail (Chapter 4) nor will it provide reference material (Chapter 7), but it will give you an understanding of how easy it is to use the Planning Tool!

**To access the tutorial**, go onto Project Big Life's Planning Tool (<http://policy.projectbiglife.ca/>) and click on the Tutorial button in the top right corner!





# Chapter 4

## How To

These guides will cover the topics covered in the tutorial but in greater detail.

- Customize data
- Load data
- Select calculation
- Filter data
- Stratify data
- Run scenarios: Intervention and Cause-deleted
- Calculate results
- Visualize data (TBD)
- Export data (TBD)
- Resolve error messages (TBD)

### 4.1 Customize Data

Prior to using the Project Big Life Planning Tool you may want to manipulate your data set. Reasons include: custom filter(s) and/or custom stratification(s).

Data manipulation can occur on any programming software: R, SAS, STATA, etc, as long as you output your data set as a ‘csv’ file.

An example of customizing your data set is converting the variable: Body Mass Index (CCHS 2013 variable HWTGBMI) from a continuous variable into four distinct categories:

- Underweight: BMI less than 18.5
- Normal or Healthy Weight: BMI of 18.5 to 24.9
- Overweight: BMI of 25.0 to 29.9
- Obese: BMI greater or equal to 30.0

#### Steps

The following shows R code that would be used to create these stratifications:

1. Convert observations “Not stated” from 999.99 to N/A

```
data[data == 999.99] <- NA
```

2. Load the R package dplyr. This package is used for data manipulation.

```
library(dplyr)
```

3. Create a new column that contains four categories for BMI

```
data$newcolumn <- cut(data$HWTGBMI, breaks = c(0,18.5,25,30,Inf), labels=c("Underweight", "Healthy", "Overweight", "Obese"))
```

4. The output will be your data set + a new column with the corresponding category (“Underweight”, “Healthy”, “Overweight”, “Obese”) for that individual.

	HWTGBMI	newcolumn
1	22.68	Healthy
2	26.99	Overweight
3	NA	<NA>
4	34.44	Obese
5	23.77	Healthy
6	17.23	Underweight

This new column can be used with the Project Big Life Planning Tool for filtering or stratification.

## 4.2 Load data

Only one data set can be used on the platform for each calculation; a calculation cannot be preformed across multiple data sets.

**Note:** Data sets loaded to the Project Big Life Planning Tool remains on your computer and is not uploaded or sent anywhere.

There are two options for your data: use a sample file or load your own file.

**Note:** The Project Big Life Planning Tool can currently only support .csv data files from the 2013/2014 Canadian Community Health Survey. Both the PUMF and Shared 2013/2014 Canadian Community Health Survey files are accepted. *Need to confirm the geography variables*

- More information on the Canadian Community Health Survey and the types of accepted data can be found in Key concepts (Chapter 6) - “Data and Sample Files”.

### 4.2.1 Load sample files

If you don’t have your own data or want to explore the platform’s capabilities before using your data, you can use the sample files on the Project Big Life Planning Tool. There are **X** sample files you may use:

- MockPUMF2013.csv is a sub-sample of the Public Use Microdata File from the 2013 Canadian Community Health Survey. This file has all the required and recommended variables.
- SmallMockPUMF2013.csv *TO FIGURE OUT WHAT IT INCLUDES*

#### Steps

1. Click on the file name under “Sample files” to select it.

### 4.2.2 Load your own file

#### Steps

1. Click the **Browse** button under “Select a file to use in calculations”.
2. Locate the file on your computer, select, and open.
  - If the loaded file has all of the variables required and recommended for calculation, you will be able to continue with the planning tool.
  - If the loaded file does **not** have all the variables **required** for the calculation you will not be able to continue with the planning tool.
  - If the loaded file does **not** have all the variables **recommended** for calculation you will be able to continue with the planning tool, however the calculations may be less accurate.

## 4.3 Select calculation

There are two general types of calculations: summary measures and by row measures.

- **Summary measures:** When selected, the result will be a single measure for the entire dataset. For instance when Summary Measure - Life Expectancy (Summary Measure) is selected the result is a single life expectancy for the given for the population.
- **By row measures:** When selected, the result will be the measurement for each individual (e.g. row) in the dataset.

Summary measures must be selected for calculations that have stratifications, intervention scenarios, and cause-deleted scenario.

#### Steps

1. Check the box beside the calculation’s name under “Calculations” to select it. A single calculation or multiple calculations may be selected.
  - Once selected the name(s) of the calculation(s) will appear to the right of “Calculations”.

More details of what the calculations are and how they are preformed can be found in key concepts (Chapter 6) - “Calculations”.

## 4.4 Filter data

Use filters when you want to analyze only a subset of your data.

#### Steps

1. Click on the + **New** button under “Filters”.
2. Select the variable that you want to filter on by typing its variable name into the “search variables” text bar.

3. Filter **in** the categories/levels within the variable by:
  - **Categorical:** Clicking on the “Search categories” text bar. Scroll and select the category you want to **keep** in your data. Repeat this step to add additional categories.
  - **Continuous:** Click the “cycle button” found under the variable you have selected. Two new boxes will appear.
    - Select the minimum value for your subset data in the box on the left by typing the values or using the arrows.
    - Select the maximum value for your subset data in the box on your right by typing the value or using the arrows.
4. To add another filter repeat the steps above. A maximum of three filters are recommended to maintain statistical power (added filters reduce sample sizes and reduces statistical power).
- Once selected, the name(s) of the filtered variable(s) will appear to the right of “Filters”.

You are able to filter on all types of variables: required for calculation, recommended for calculation, and ignore variables (includes customized variables).

#### 4.4.1 Remove a filter

- To remove a filter entirely, click on the trash can beside the variable you want to delete.
- To remove a level within a filtered variable - categorical, click on the ‘x’ beside the variable level.

### 4.5 Stratify data

Use stratifications when you want to get a result for multiple strata (levels or classes).

A summary measure must be selected for stratifications, as only a summary measure will be outputted for each strata. By row measurements may also be selected but they will not be stratified.

#### Steps

1. Click the box beside either “Life Expectancy (Summary)” or “Deaths (Five Years)” under the “Calculation” drop down.
2. Select the variables you want to stratify on under the “Stratifications”. You are only able to stratify on categorical variables.
3. To add another variable for stratification repeat the steps above. A maximum of 3 stratifications are recommended to maintain statistical power (added strata reduce strata sample size and reduces statistical power).
- Once selected, the name(s) of the stratified variable(s) will appear to the right of “Stratifications”.

You are able to stratify on all types of categorical variables: required for calculation, recommended for calculation, and ignore variables (includes customized variables).

### 4.5.1 Remove a stratification

- To remove a stratification variable click on the ‘x’ beside the variable level.

## 4.6 Run scenarios

Scenarios can be used to predict the health outcomes when unhealthy behaviours:

- are modified in the population: **Intervention**, or
- were never present in the population: **Cause-deleted**

Scenarios can be used to inform potential health policies or programs.

### 4.6.1 Intervention scenarios

Interventions provide you with the ability to customize the scenarios. For example you can answer the questions:

- what if we only had 15% of the population smoked rather than the current 20%?
- what if everyone increased their physical activity by 10%?
- what if everyone ate 4 fruit servings each day?
- what if everyone drank 2 fewer drinks per week?

These intervention scenarios allow you to predict and compare the effectiveness of policies.

There are 3 types of intervention scenarios that you can select:

- **Absolute:** each individual in the population **changes** their health behaviour **by a value of x**.
- **Relative:** each individual in the population **changes** their health behaviour **by a ratio of y**.
- **Target:** each individual in the population **has a set value of z**.

More information on the specifics of each type of intervention scenario and how they are calculated can be found in Key Concepts (Chapter 6) - “Scenarios: Interventions”.

#### Steps

1. Click the box beside either “Life Expectancy (Summary)” under the “Calculation” drop down.
2. Check the button beside: “Intervention” under the “Scenario” drop down.
3. Click on the health behaviour you want to modify: e.g. Diet.
  - A drop down menu of all the possible variables of that health behaviour you can modify will appear.
4. Click the box beside the variable you want to modify: e.g. Daily consumption - fruit - (D).
  - A drop down menu of the scenario types: absolute, relative, and target, will appear.
5. Check the button beside the type of intervention you want to modify: e.g. Target.
6. Use the arrows beside the text box: “Decrease by” or “Increase by” to add the value you are modifying: e.g. The value of 4 is used for the scenario what if everyone ate 4 fruit servings each day?

Multiple health behaviours and variables within the health behaviours can be selected for a single calculation.

- Once selected, the name(s) of the health behaviour(s) that have been selected for the intervention will appear to the right of “Scenario”.

### 4.6.2 Cause-deleted scenarios

Cause-deleted scenarios provide you with the ability to see the best case scenario for the population. For example:

- what if no one in the population ever smoked?
- what if everyone in the population met their recommended physical activity levels (3.00 METs/week)?

More information on cause-deleted calculations and how they are calculated can be found in key concepts (*Chapter 6*) - “Scenarios: Cause-deleted”.

#### Steps

1. Click the box beside either “Life Expectancy (Summary)” under the “Calculation” drop down.
2. Check the button beside: “Cause-deleted” under the “Scenario” drop down.
3. Check the box beside the health behaviour that you want to have a cause-deleted calculation.

Multiple health behaviours can be selected for a single calculation.

## 4.7 Calculate results

1. Name your calculation in the text box: Calculation name.
  - Be specific when naming the calculation as it will make it easier to distinguish after running multiple calculations.

**Note:** the larger the data set is the longer the calculations will take. Depending on the size of the data set and the type of calculation being performed it could take an hour or more.

## 4.8 Visualize Data

*TBD: Need plots on the platform to work through the steps below - export - create your own(?)*

## 4.9 Download results

Click on the **Download results** button under the **Results** section.

Select which calculations you’d like to download.

*To Do: Screenshot of all the calculation options once the platform is fixed.*

## 4.10 Resolve warning or error messages

There are different types of warning and error messages that may appear.

Below describes some of the messages that are likely to occur and steps to resolve them.

*Waiting for the branch with the error messages to be finalized and merged*



**4.10.1 Invalid category**

**4.10.2 Out of range**

“Out of range” is when there are observation(s) in the data set that are not is beyond the limit of

**4.10.3 Not a number**

**4.10.4 Sample size is too small**



# Chapter 5

## Applications

This chapter provides you with examples of how Project Big Life’s Planning Tool can be used in your day-to-day operations. The examples will cover:

- analyses that can be included in a health status report,
- a national policy: What if Canada biked like the Dutch?
- a local policy: turning Ottawa into the healthiest Canadian region
- a

### 5.1 Health Status Report

In this example we will highlight statistics that could be reported in health status reports. Health status reports are a way to report the health state for a population and the factors that influence the population’s health. Information from health status reports are used to inform policy, planning, and resource allocation.

In this example we will calculate:

- The predicted number of deaths by strata
- The impact of eliminating unhealthy behaviours on life expectancy

For this example we will focus on the population of Alberta.

#### 5.1.1 Predicted number of deaths stratified by sex and level of education

By showing the number of deaths by strata, the reader can see the distribution of deaths across specific population characteristics. Any categorical variable can be used for stratification but in this example, we will use sex and level of education.

##### Steps

1. Select the sample file XXXX under “Sample files”.
2. Select the calculation: Summary Measure – Deaths (Five years)
3. Add filter: GEOGPRV – 48, which is the corresponding code for Alberta.
4. Add two stratifications: DDH\_SEX and EDUDR04

5. Title the calculation: Deaths by sex and education level
6. Click the calculate button

7. *To do: Results – walk through the results*

### **5.1.2 Impact of eliminating unhealthy behaviours: physical inactivity and poor diet, on life expectancy**

To show how much an unhealthy behaviour impacts life expectancy we use the scenario: cause-deleted. Cause-deleted scenarios can be used for the health behaviours: alcohol consumption, diet, physical activity, and smoking, individually or in any combination. In this example we will evaluate the impact of physical inactivity and poor diet, in combination, on life expectancy.

#### **Steps**

1. Select the sample file XXXX under “Sample files”.
2. Select initial calculation: Summary Measure – Life Expectancy (Summary)
3. Add filter: GEOGPRV – 48, which is the corresponding code for Alberta.
4. Click the text: Scenario.
5. Select Cause-deleted.
6. Select the causes to delete: physical activity and diet
7. Title the calculation: Alberta: Cause-deleted - physical activity and diet
8. Click the calculate button

9. *To Do: Walk through results*

## **5.2 Canada goes Dutch**

## **5.3 Healthy Cities**

## **5.4 Transportation**

# Chapter 6

## Key Concepts

This section explains some key concepts in Project Big Life’s Planning Tool. This section will explain how it works rather than how to do things.

- Data and sample files
- Multivariable predictive risk algorithms
- Calculations:
  - Summary vs. By Row
  - Risk of health outcome
  - Number of health outcomes
  - Life expectancy
- Scenario: Intervention
- Scenario: Cause-deleted
- Limitations

### 6.1 Data and sample files

The Project Big Life Planning Tool currently accepts **2013/2014 Public Use Microdata File and Shared File of the Canadian Community Health Survey (CCHS) in ‘csv’ format.**

#### 6.1.1 What is the Canadian Community Health Survey?

The CCHS is an annual cross-sectional survey preformed by Statistics Canada. The CCHS collects information related to health status, health care utilization, and health determinants for the Canadian population. Data is shared at the the sub-provincial geographic level (health region or combination of health regions).

- Details about the survey and its design can be found on Statistic Canada website (<http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=144170>).
- Details and access to the Public Use Microdata file (PUMF) can be found through the Odesi website (<https://search2.odesi.ca/#/details?uri=%2Fodesi%2Fcchs-82M0013-E-2013-2014-Annual-component.xml>)

### 6.1.2 Why can I only use the 2013/2014 Canadian Community Health Survey data?

Each year the CCHS changes a few variables it captures. This makes CCHS data sets from every year other than 2013/2014 incompatible with the algorithms used by the Project Big Life Planning Tool.

The Project Big Life Planning Team is currently working to adjust the algorithms so that they accept other CCHS years, and we will update the guidance when we are done.

### 6.1.3 Sample Files

- MockPUMF2013.csv is a subsample of the Public Use Microdata File from the [2013 Canadian Community Health Survey] (<https://www150.statcan.gc.ca/n1/en/catalogue/82M0013X>). It includes all required and recommended variables: age, sex, BMI, smoking habits, alcohol consumption, diet components, daily physical activity expenditure, chronic conditions, ethnicity, immigration status, and education.
- SmallMockPUMF2013.csv

## 6.2 Multivariable predictive risk algorithms

Multivariable predictive risk algorithms predict the future risk of health outcomes (e.g. Life Expectancy) for a population using routinely collected health data.

Multivariable predictive risk algorithms can be used to:

- Project the number of new cases of the health outcome
- Estimate the contribution of specific risk factors of the health outcome
- Evaluate effectiveness of health interventions
- Describe the distribution of risk in the population (diffused or concentrated)

Multivariable predictive risk algorithms are able to assess equity issues compared to competing population risk methods (e.g. World Health Organization Global Burden of Disease).

More information on what multivariable predictive risk algorithms are and how they can be used can be found the journal article: *Predictive risk algorithms in a population setting: an overview* (Manuel D, 2012)

### 6.2.1 Development of multivariable predictive risk algorithms

Data:

- Multivariable predictive risk algorithms are created using routinely collected data that includes information about risk factors (exposure) and health events (outcomes).
- Data is collected at an individual level through population health surveys (e.g. Canadian Community Health Survey) and administrative databases (e.g. Vital Statistics). Data sources are linked together when the individual has given permission too.
- Individuals are followed overtime until the health event (e.g. death or disease) occurs.
- Separate data is collected to create a derivation cohort and validation cohort(s).

- Note: The risk factors that are collected are from population health surveys and are self-reported; no clinical data (e.g. blood pressure) is collected. Risk factors focus on health behaviours (e.g. smoking) and sociodemographic factors, commonly associated with health outcome.

#### Algorithm generation:

- Multivariable predictive risk algorithms are cox proportional hazard models that analyze time to health outcome (e.g. death) *Question for Carol - The models are not cox-proportional hazard models but they are similar?*
- Multivariable predictive risk algorithms are developed and validated in 4 stages:
  - Algorithm derivation: the predictive risk algorithm is created using data from the derivation cohort
  - Algorithm validation: the predictive risk algorithm is applied to the validation cohort
  - Final algorithm generation: validation and derivation cohorts are combined to estimate the final application of the predictive risk algorithm
  - Derivation of the application algorithm: creation of a parsimonious (fewer predictors) algorithm that maintained discrimination, calibration, and overall algorithm performance
- In each stage of the algorithm development and validation, algorithm performance is assessed using measures of discrimination and calibration.

### 6.2.2 Multivariable predictive risk algorithms built in Project Big Life Planning Tool

- There is currently 1 multivariable predictive risk algorithm is built into to Project Big Life planning tool.

Title

Outcomes

Information

Mortality Population Risk Tool

5 year risk of death, Life Expectancy, Cause deleted

Appendix A

## 6.3 Calculations

### 6.3.1 Summary vs By Row

There are two general types of calculations Summary Measures and By Row Measures.

Summary measures: (ref:summarycalc)

By row measures: When selected, the result will be the measurement for each individual (e.g. row) in the dataset.

**Note:** Summary Measures are not the same as taking the average of By Row Measures. Summary measures account for the master weights in their calculations where as simply averaging the By Row Measures doesn't factor the weights.

### 6.3.2 Risk of health outcome

Risk of the health outcome (e.g. risk of dying) is the outcome of the multivariable predictive risk algorithm. Two multivariable risk algorithms are created for each health outcome: one algorithm for males, and one algorithm for females. An example of the multivariable risk algorithm is:

$$\text{Risk} = \sum_t h_0(t) * e^{\beta_{pred.smoking} * x_{smoking} + \beta_{pred.cancer} * x_{cancer} + \beta_{pred.age} * x_{age} + \dots}$$

Where:

- $t$  = survival time
- $h_0(t)$  = the baseline hazard
- $\beta_{pred}$  = predictive hazard ratios for the exposures
- $x$  = the exposure. The exposure can be continuous (e.g. age) or categorical (e.g. smoking status).
- Categorical exposures are represented by dummy/factor variables e.g. smoking status is categorical variable with categories: current, former  $\leq 5$  years, former  $>5$  years, or never smoked. Each type of dummy variable with:  $x_{currentsmoker} = 1$  if the individual currently smokes or 0 if the individual is another type of smoker).

### 6.3.3 Number of health outcomes

The number of health outcomes (e.g. Summary Deaths) is calculated through the following steps:

1. Risk of the health outcome is calculated for each individual in the data set using the multivariable predictive risk algorithm.
2. The weighted mean of all the risks is calculated using individual risk values and corresponding study weights (CCHS variable: WTS\_M for the Public Micro Use File or WTS\_S for the shared file).
3. The weighted mean is then multiplied with the total number of individuals in the population to generate the number of health outcomes (e.g. number of deaths in 5 years).

### 6.3.4 Life expectancy

Life expectancy is calculated using abridge life tables. Life expectancy is calculated by two methods: one for summary life expectancy, and a second for by row life expectancy.

#### 6.3.4.1 Summary Life Expectancy

Life expectancy is calculated separately for males and females.

**Males:**

1. The mortality risk for each male individual is calculated using the male mortality multivariable predictive risk algorithm for mortality (MPoRT). Details about the MPoRT can be found in Appendix A.
2. Male individuals are grouped into the 5-year age groups that are used in the 5-year abridge life tables (e.g. 40-44 years old).
3. The weighted average risk of death for each age group is calculated.



Weighted risk of death =  $\sum (\text{Individual risk of death} \times \text{Individual weight}) \div \text{Number of individuals in age group}$

4. A male 5-year abridge life table is created using the weighted average risks of death ( $q(x)$ ) for each age group.
5. The life expectancy for males is calculated using the weighted average risk of death ( $q(x)$ ) and the median age for each of the age groups.

### Females

Steps 1-5, used to calculate life expectancy for males, are repeated for females using the female MPoRT and a female 5-year abridge life table.

### Summary life expectancy

6. The summary life expectancy, or life expectancy of the entire population, is calculated by adding the male life expectancy with the female life expectancy, and taking its average.

### Summary life expectancy by strata

Steps (1-5) are repeated for each strata. There will be strata specific weighted risk of death and strata specific life tables.

Step 6 is repeated with the average life expectancy calculated across all strata.

#### 6.3.4.2 By row life expectancy

An individual's life expectancy is calculated by creating new life table specific to that individual.

These life tables are 1-year abridge life tables, and begin at the individual's age (e.g. an individual that is 43 years old, will have the life table start at 43 years).

The probability of death for each year/row of the life table ( $q(x)$ ) is calculated using the respective MPoRT (male or female), and the individual's health profile (e.g. never smoked, 15 drinks weekly, hypertension, Canadian Citizen, etc). The only factor that changes for each row is the age used in MPoRT ( $x_{age}$ ), and corresponds to the age of the row.

**Note:** By row life expectancy does not account for the individual's weight, and therefore can not be used to estimate the summary life expectancy.

## 6.4 Scenario: Intervention

How would life expectancy change if everyone increased their physical activity levels by 10%?

The health intervention scenario allows you to predict how changing the health behaviours: alcohol consumption, diet, physical activity, and smoking, of a population will affect the population health outcome (e.g. life expectancy). This feature can be used to predict the effectiveness of proposed policies or programs.

There are three types of scenarios: **absolute**, **relative**, and **target**.

- **Absolute:** each individual in the population **changes** their health behaviour **by a value of x**.
- **Relative:** each individual in the population **changes** their health behaviour **by a ratio of y**.
- **Target:** each individual in the population **has a set value of z**.

For target scenarios if the individual's value is already at the target value or beyond the target value then their value is not changed. E.g. If the target value for physical activity is 2.5 METs/week, then any individual that already has METs/week  $\geq 2.5$  METs/week then their value will not be adjusted.

The changes for each type of scenario for **alcohol**, **physical activity**, and **diet** are described in the following table:

Health.Behaviour

Absolute.change

Relative.change

Target

Each individual ...

Each individual ...

Each individual has the value ...

Alcohol Consumption

Decreases the number of drinks they have per week by x

Decreases the number of drinks they have per week by y %

z drinks per week

Physical Activity

Increases their own physical activity levels by x METs per week

Increases their own physical activity levels by y % METs per week

z METs per week

Diet

Increases the number of fruits they eat by x per week

Increases the number of fruits they consume by y % per week

z fruits per week

Increases the number of vegetables they eat by x per week

Increases the number of vegetables they consume by y % per week

z vegetables per week

Decreases the glasses of juice they drink by x per week

Decreases the their glasses of juice by y % per week

z glasses of juice per week

Decreases the number of potatoes the eat by x per week

Decreases the number of potatoes they consume by y % per week

z potatoes per week

The **smoking** health intervention scenario is different then the other types of health intervention scenarios as they adjust the prevalence of the health behaviour.

Health.Behaviour

Absolute.change

Relative.change

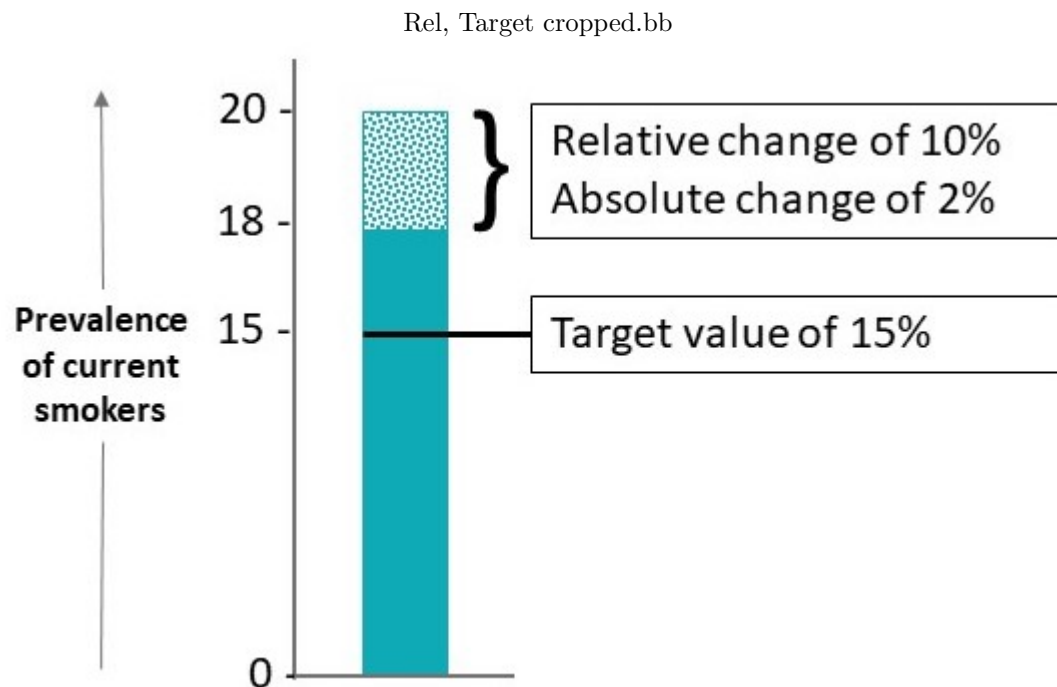


Figure 6.1: Comparison of health intervention scenario types

Target

Smoking

The prevalence of smokers decreases by  $x$  %

The prevalence of smokers decreases by  $y$  %

The prevalence of smokers is  $z$  %

Although each type of health intervention for smoking: absolute, relative and target, changes the prevalence of current smokers they are different. The following figure shows how each is different from one another.

To adjust the prevalence of smokers, the change is applied to every current smoker in the population; individuals are not selected at random. ....

## 6.5 Scenario: Cause-deleted

What would be the life expectancy of a population if be no one in the population ever smoked? This scenario is a cause-deleted scenario.

There are two distinct terms in cause-deleted calculations:

- **Cause-deleted life expectancy** is the estimated life expectancy for the counterfactual population where a specific cause (e.g. smoking) never existed. E.g. the counterfactual population was always never smokers.
- **Cause-deleted effect of life expectancy or life years lost due to the cause** is the full effect of the cause (e.g smoking) in the population. E.g. In a population 3 years of life are lost due to individuals in that population smoking: either currently or previously.

If multiple causes are selected (e.g. smoking and physical inactivity) the cause-deleted life expectancy calculated accounts for both of these effects and the cause-deleted effect of life expectancy (or life years lost) is calculated for each individual cause.

**Note:** Cause-deleted life expectancy of smoking and physical inactivity  $\neq$  Cause-deleted effect of smoking + Cause-deleted effect of physical inactivity

This is because individuals in the population may be both smokers and physically inactive.

*Insert table with the reference levels for each of the health behaviours*

### 6.5.1 Cause-deleted calculation

There are two parts to the calculations performed in cause-deleted scenarios: (A) calculate the risk, and (B) calculate the health outcome: life expectancy or number of deaths.

#### Part A: Risk calculations

The original multivariable predictive risk algorithm is:

$$\text{Risk} = \sum_t h_0(t) * e^{\beta_{pred.smoking} * x_{smoking} + \beta_{pred.cancer} * x_{cancer} + \beta_{pred.age} * x_{age} + \dots}$$

**Step 1.** Modify the original algorithm to include the external coefficient(s). This means replacing all predictive hazard ratios/betas related to the health behaviour to the causal hazard ratios/betas.

- Remove the original regression coefficient(s) for the health behaviour.
- Add the new external coefficient(s) to the algorithm. External coefficients are generated from either: causal models, or from systematic reviews or meta-analysis.

$$\text{External coefficient risk} = \sum_t h_0(t) * e^{\beta_{causal.smoking} * x_{smoking} + \beta_{causal.cancer} * x_{cancer} + \beta_{pred.age} * x_{age} + \dots}$$

**Step 2.** Risk is calculated using the modified algorithm created in Step 1 and the respondent's original profile (e.g. current smoker). This is the “external coefficient risk”.

$$\text{External coefficient risk} = \sum_t h_0(t) * e^{\beta_{causal.smoking} * (\text{current smoker}) + \beta_{causal.cancer} * x_{cancer} + \beta_{pred.age} * x_{age} + \dots}$$

**Step 3.** “Cause-deleted risk” is calculated by setting an exposure to a reference (non-exposed) value (all other risk exposures remain unchanged).

$$\text{Cause-deleted risk}' = \sum_t h_0(t) * e^{\beta_{causal.smoking} * (\text{never smoker}) + \beta_{causal.cancer} * x_{cancer} + \beta_{pred.age} * x_{age} + \dots}$$

**Step 4.** The “cause-deleted effect external” is calculated as “external coefficient risk” (Step 2) minus the “cause-deleted risk” (Step 3).

$$\text{Cause-deleted effect}_{external} = \text{External coefficient risk} - \text{Cause-deleted risk}'$$

**Step 5.** Original risk is calculated using the original algorithm and the original respondent's profile.

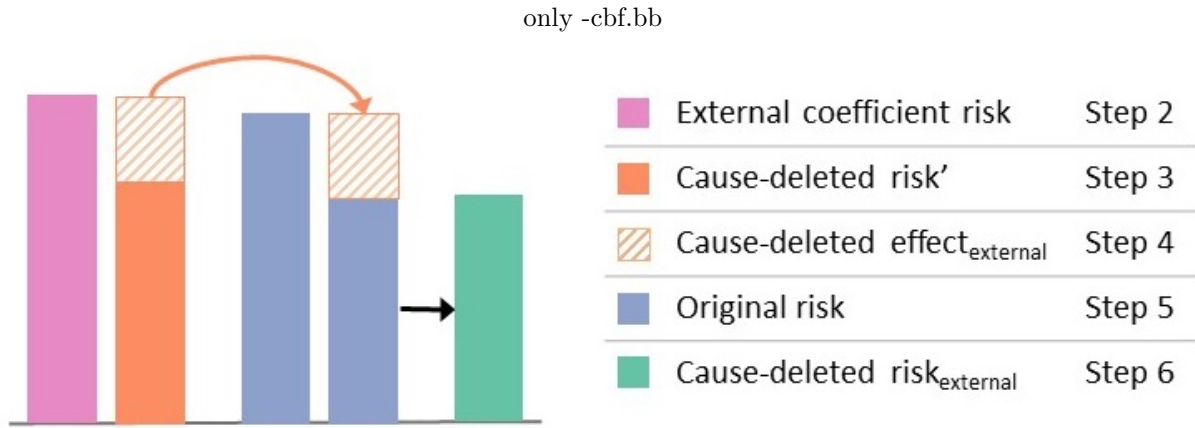


Figure 6.2: Risk portion of the cause-deleted calculations

$$\text{Original risk} = \sum_t h_0(t) * e^{\beta_{\text{pred.smoking}} * (\text{current smoker}) + \beta_{\text{pred.cancer}} * x_{\text{cancer}} + \beta_{\text{pred.age}} * x_{\text{age}} + \dots}$$

**Step 6.** The “cause-deleted risk external” is calculated by “original risk” (Step 5) minus the “cause-deleted effect external” (Step 4).

$$\text{Cause-deleted risk}_{\text{external}} = \text{Original risk} - \text{Cause-deleted effect}_{\text{external}}$$

### Part B: Health outcome calculations

Using risks generated above you can then calculate:

- cause-deleted life expectancy or life years lost attributable to a health behaviour (exposure)
- cause-deleted number of deaths or number of deaths attributable to a health behaviour (exposure)

### Life expectancy calculations

Step I: Calculate the original life expectancy by using the original risk (Step 5 above) in the sex-specific 5-year abridge period life tables.

Step II: Calculate the cause-deleted life expectancy by using the cause-deleted risk external (Step 6 above) in the sex-specific 5-year abridge period life tables.

Step III: Calculate life years attributable to a health behaviour by: original life expectancy (Step I) minus cause-deleted life expectancy (Step II):

$$\text{Life years due to exposure} = \text{Original life expectancy} - \text{Cause-deleted life expectancy}$$

If the life years attributable to a health behaviour are negative then the value represents the life years lost due to smoking.

### Number of deaths calculations

Step I: Calculate the number of deaths that would occur using the original risk (Step 5 above).

Step II: Calculate the number of deaths that would occur using the cause-deleted risk external (Step 6 above).

Step III: Calculate the number of deaths that are attributable to a health behaviour (exposure) by: original number of deaths (Step I) minus cause-deleted number of deaths (Step II):

$$\text{Deaths due to exposure} = \text{Original number of deaths} - \text{Cause-deleted number of deaths}$$

## 6.6 Limitations

# Chapter 7

## Glossary

### **5-year mortality risk**

The probability that an individual will die in the next 5 years.

### **Body Mass Index (BMI)**

A weight-to-height ratio used as an indicator of obesity and underweight. BMI is calculated by dividing an individual's body weight in kilograms by the square of height in metres (kg/m<sup>2</sup>).

### **Burden**

The impact or size of a health problem in an area, measured by cost, mortality, morbidity or other indicators. The burden of unhealthy behaviour is calculated by the differences in life expectancy based on individuals' exposure to four health behavioural risks for poor health relative to the healthy category.

### **By Row Measures**

When selected, the result will be the measurement for each individual (e.g. row) in the dataset.

### **Calibration**

The agreement between predicted risk generated from the model and observed risk generated from the data.

### **Canadian Community Health Survey**

An annual survey performed by Statistics Canada that collects information related to health status, health care utilization and health determinants for the Canadian population. Details about the survey can be found on Statistic Canada website (<http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=144170>).

### **Cause-deleted life expectancy**

A cause-deleted health outcome is the estimated health outcome of a population if a specific cause (e.g. smoking) did not exist in that population.

### **Discrimination**

The ability of the model to differentiate between high risk individuals and low risk individuals.

### **Error Message**

Error messages will occur when variables that are “**Required for Calculation**” are missing in the data. If the entire column for the variable is missing then the calculation cannot be performed on the data. If there are missing row entries for the variable then the entire row will not be used in the calculation.

### **Filter**

Chooses part of your dataset for analysis. If you filter on ‘Sex’ and then ‘Male’, calculations will only be performed on individuals that are ‘Male’ and ‘Females’ will be excluded. For example, when calculating Life Expectancy on the filter variable ‘Sex’ then ‘Male’ there will be a Life Expectancy estimate for ‘Males’ and *no* Life Expectancy estimate for ‘Females’.

### **Health Behaviour**

Actions people do that may affect their health, positively or negatively. Health behaviours are among the determinants of health and are influenced by the social, cultural and physical environments in which people live and work.(Statistics Canada, 2010) They are also shaped by individual choices and external constraints.(Statistics Canada, 2010) The four health behaviours of **smoking**, **alcohol consumption**, **diet**, and **physical activity** are specified in Project Big Life’s planning tool.

### **Ignored Variables**

Are not included in the calculation. It does not matter if your dataset includes these variables or not. Ignored variables can be used for filter and stratification.

### **Life Expectancy (LE)**

Life expectancy is a calculation of how long a person or population would be expected to live, on average, given unchanging risk of death from a specific point in time.

### **Metabolic Equivalent of Task (MET)**

The metabolic equivalent of task (MET) is a measure of the rate of energy expenditure from an activity; a measure of calories burned by type, duration and frequency of physical activity. The reference value of 1 MET is defined as the energy expenditure rate at rest which is equal to 1kcal/kg/day.

### **Predictor**

A variable that is used in the algorithm to predict the outcome.

### **Recommend for calculation**

Variables that are included in the calculation but not necessary for the calculation to run. Rather these variables increase the accuracy of the results.

### **Required for calculation**

Variables that are included in the calculations and are necessary for the calculation to run. If a dataset does not have these variables then the calculation will not run.

### **Risk**

The probability of a health event occurring at some point of time in the future.

### **Socioeconomic Position**

People in poorer socioeconomic circumstances generally have poorer health. Deprivation measures identify those who experience material or social disadvantage compared to others in their community. The Deprivation Index for Health in Canada developed by the Institut national de santé publique du Québec (INSPQ)(Pampalon R, Raymond G, 2000) is used in this planning tool. The index includes education, employment and income as measures of material deprivation; and single-parent families, living alone, or being divorced, widowed or separated as measures of social deprivation. The deprivation index was used to assign geographical areas into socioeconomic position groups (low, middle and high) based on material and social quintiles. High-deprivation neighbourhoods were those in the top two quintiles for both social and material deprivation. Low-deprivation neighbourhoods were those in the bottom two quintiles.

### **Stratification**

The separation of data into smaller strata (levels or classes which individuals are assigned to). If the variable ‘Sex’ is stratified it creates two strata: ‘Male’ and ‘Female’. Calculations are performed on each strata (level or class) and the outcome will be specific to that strata. For example, when calculating Life Expectancy



on the stratified variable 'Sex' there will be a Life Expectancy estimate for 'Males' and a different Life Expectancy estimate for 'Females'.

Stratification can only occur on categorical variables.

### **Summary Measures**

When selected, the result will be a single measure for the entire dataset. For instance when Summary Measure - Life Expectancy (Summary Measure) is selected the result is a single life expectancy for the given for the population.

When stratifications are selected, the summary measure will be given for each strata. For instance when Summary Measure - Life Expectancy and Stratification - Sex are selected, then two life expectancy measures will be given one for males and one for females.

### **Warning Message**

Warning messages will occur when variables that are **“Recommended for Calculation”** are missing in the data. If the entire column for the variable is missing the calculation will still be performed on the data. If there are missing row entries for the variable the row will still be used in the calculation



# Appendix A

## Mortality Population Risk Tool (MPoRT)

**Outcomes:** 5-yr risk of death, Life Expectancy, Cause-deleted Life Expectancy

### Calculations

Using MPoRT you are able to calculate:

- 5 year mortality risk
- Number of deaths
- Life Expectancy
- Cause-deleted deaths and life expectancy
- Burden of health behaviour in deaths and on life expectancy

### Types of Questions

- What is the burden of smoking on life expectancy?
- How many deaths would be prevented if everyone met their daily exercise requirements?

**Description:** A multivariable predictive risk model that estimates the future risk of all-cause death in Canada. It adjusts for health behaviours: smoking, unhealthy alcohol consumption, poor diet, and physical inactivity, and a wide range of other risk factors.

Versions of MPoRT have been developed since 2012 and used in various studies. Each version of MPoRT (v1.0, v1.2, v2.0) used the Ontario subset of the Canadian Community Health Survey (CCHS) for development and the survey respondents were linked to personal death records. In later versions of MPoRT (v1.2, v2.0) the following changes were made: (a) algorithm variables were adjusted to improve predictions, and (b) the algorithms were validated using: the Ontario subset of CCHS of the years that were not used in development and the National CCHS dataset (excluding Ontario).

**MPoRTv1.0** Was used in the “Seven More Years” report, a joint report with Public Health Ontario and IC/ES (<https://www.ices.on.ca/Publications/Atlases-and-Reports/2012/Seven-More-Years>). In summary, the algorithm estimated the risk of death associated with health behaviours: smoking, unhealthy alcohol consumption, poor diet, physical inactivity and stress. There were approximately 550,000 person-years of follow up and over 6000 deaths in the development dataset. The algorithm used categorical predictor variables for health behaviours and sociodemographic factors.

**MPoRTv1.2** Was published in PLoS (<https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1002082>). In summary, the algorithm estimated the risk of death associated with health behaviours:

smoking, unhealthy alcohol consumption, poor diet, and physical inactivity (stress was removed due to its low prediction ability). There were approximately 1 million person-years of follow up and over 9000 deaths in the development and validation datasets. The algorithm used multiple continuous predictor variables, and added chronic disease predictor variables and interaction terms.

**MPoRTv2.0 - The version used in Project Big Life’s Planning Tool** This version of MPoRT has not yet been published.

*Development:* This predictive risk model was developed using Ontario subsets of the 2001 to 2008 CCHS and participants were linked to personal health records. There were approximately 1.3 million person-years of follow-up and over 15,000 deaths in the developmental dataset.

*Validation:* This predictive risk model was validated using three different datasets: Ontario subset of the 2009 to 2012 CCHS, National dataset (except Ontario) of the 2003 to 2008 CCHS, and the National dataset of the 2000 and 2005 National Health Interview Survey in the United States of America. In all validation datasets individuals were linked to personal health records.

*Parameters:* The parameters used in this predictive risk model are:

Category

Variable

Scale

Description

Demographic

Age\*

Continuous

5 knot spline. Valid range 20 to 102

Sex

Dichotomous

Stratified Female/Male

Health Behaviour

Pack years of smoking

Continuous

3 knot spline. Valid range: 0 to 78 (Female), 0 to 112.5 (Male)

Smoking Status

Categorical

Non-smoker

Current Smoker

Former Smoker  $\leq 5$  years

Former  $> 5$  years

Alcohol (number of drinks per week)

Continuous

4 knot spline (Females) and 3 knot spline (Males). Valid range: 0 to 25 (Female), 0 to 50 (Male)

Former/non-drinker

Dichotomous

Yes/No

Simplified diet score

Continuous

3 knot spline. Valid range: -18.9 to 20.7 (Female), -16.8 to 18.4 (Male)

Leisure physical activity (MET)

Continuous

3 knot spline. Valid range: 0 to 12.4 (Female), 0 to 16 (Male)

Socio-demographic

Ethnicity

Categorical

White

Black

Chinese

Arab; South Asian; West Asian

Filipino; Japanese; Korean; Southeast Asian

Other; Indigenous; Latin American; Multiple origin; unknown

Immigrant

Dichotomous

Yes/No

Fraction of lifetime in Canada

Continuous

3 knot spline<sup>†</sup>. Valid range: 0 to 1

Education

Categorical

Less than secondary

Secondary School Graduation

Some Post-Secondary

Post-Secondary Graduation

Neighbourhood social and material deprivation

Ordinal

Low (1st or 2nd quantile)

High (4th or 5th quantile)

Moderate (all others)

Chronic Conditions

Diabetes

Dichotomous

Yes/No

High Blood Pressure

Dichotomous

Yes/No

Chronic Respiratory Disease

Dichotomous

Yes/No

Mood Disorder

Dichotomous

Yes/No

Cancer

Dichotomous

Yes/No

Dementia

Dichotomous

Yes/No

Heart Disease

Dichotomous

Yes/No

Stroke

Dichotomous

Yes/No

Epilepsy

Dichotomous

Yes/No<sup>‡</sup>

BMI

Continuous

3 knot spline. Valid range: 8.9 to 47.2 (Female), 8.6 to 43.7 (Male)

\* Age interaction included for all variables except immigrant, fraction of time in Canada, and ethnicity † Excluded in the male model, remains in the female model ‡ Excluded in the female model, remains in the male model

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