



Trends in Income-Related Health Inequalities in Canada

Methodology Notes

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Factors Influencing Health



Canadian Institute
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Institut canadien
d'information sur la santé



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Overview of Analytical Approach

The report *Trends in Income-Related Health Inequalities in Canada* examines the extent to which income-related health inequality has changed over time. This section of the Methodological Notes document provides detailed information on the indicator selection process and analytical approach used in this report. Additional methodological details specific to the calculation of each indicator are provided in the Indicator Definitions document.

Indicator Selection and Data Sources

In this report, 17 indicators that were generated using a variety of data sources were examined by income level over time. The selection of pan-Canadian indicators was carried out in consultation with experts in the field and was limited to indicators with evidence of a previously documented association with income or other measures of socio-economic status. The final selection was also largely driven by the availability of reliable data over time, including consistent indicator and income definitions and data capture over time.

The majority of the reported indicators had available reliable data spanning at least 10 years at the pan-Canadian and provincial levels; however, some indicators with a shorter time period and/or limited coverage across Canada were also included to provide a more complete picture of the effect of income on a range of health indicators. For example, Household Food Insecurity data had limited coverage across Canada but was included because, along with Core Housing Need, it is an important indicator of material circumstance. Similarly, Children Vulnerable in Areas of Early Development is an important early life indicator that has emerging data availability in Canada, and Hospitalized Heart Attacks and Alcohol-Attributable Hospitalization are health outcome measures reflecting different chronic conditions.

The majority of indicators were generated using administrative data (i.e., hospital discharge abstracts) or the Canadian Community Health Survey (CCHS). Table 1 lists each indicator profiled in this report along with its inequality disaggregator, reporting level, time period and data source.

Table 1: Indicators Summary Table

Indicator	Inequality Disaggregator	Reported by		Time Period	Data Sources
		Sex	Province		
1. Structural Factors Influencing Health					
Individual After-Tax Income	Quintiles (based on distribution of after-tax income)	No	Yes	1976 to 2011	Survey of Labour and Income Dynamics, Statistics Canada
University Participation	Parental income quintiles (based on self-reported income or income from tax files)	Yes	No	1993 to 2011	Survey of Labour and Income Dynamics, Statistics Canada
Unemployment Rate	a. Educational attainment	Yes	No	a. 1990 to 2013	a. Labour Force Survey, Statistics Canada
	b. Aboriginal identity			b. 2001, 2006	b. Census of Population (2001, 2006)
Individual After-Tax Income (Median)	Aboriginal identity	No	No	2000, 2005	Census of Population (2001, 2006)
2. Intermediary Factors Influencing Health					
Material Circumstances Indicators					
Core Housing Need					
a. Urban Households	Income quintiles (based on self-reported income or income from tax files)	No	No	a. 2002 to 2011	a. Survey of Labour and Income Dynamics, Statistics Canada, and Canada Mortgage and Housing Corporation
b. All Households				b. 2001, 2006, 2011	b. Census of Population (2001, 2006) and National Household Survey (2011), Statistics Canada
Household Food Insecurity	Self-reported adjusted household income	No	Selected provinces	National: 2007–2008 and 2011–2012 Provincial: 2005, 2007–2008 to 2011–2012	Household Food Security Survey Module, Canadian Community Health Survey, Statistics Canada
Early Life Indicators					
Small for Gestational Age	Neighbourhood-level income quintile	Yes	Yes	2001 to 2011	Canadian Vital Statistics, Birth Database, Statistics Canada
Children Vulnerable in Areas of Early Development	Neighbourhood-level income quintile	Yes	Selected provinces	Varies by province	Early Development Instrument, The Offord Centre for Child Studies, McMaster University

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Table 1: Indicators Summary Table (cont'd)

Indicator	Inequality Disaggregator	Reported by		Time Period	Data Sources
		Sex	Province		
Behavioural and Biological Indicators					
Smoking	Self-reported adjusted household income	Yes	Yes	2003 to 2013	Canadian Community Health Survey, Statistics Canada
Obesity	Self-reported adjusted household income	Yes	Yes	2003 to 2013	Canadian Community Health Survey, Statistics Canada
Health System Indicators					
Influenza Immunization for Seniors	Self-reported adjusted household income	Yes	Yes	2003 to 2013	Canadian Community Health Survey, Statistics Canada
Chronic Obstructive Pulmonary Disease (COPD) Hospitalization for Canadians Younger Than Age 75	Neighbourhood-level income quintile	Yes	Yes	2001 to 2012	Discharge Abstract Database and Hospital Morbidity Database, CIHI
3. Health and Well-Being Outcomes					
Injury Indicators					
Fall Injury Hospitalization for Seniors	Neighbourhood-level income quintile	Yes	Yes	2001 to 2012	Discharge Abstract Database and Hospital Morbidity Database, CIHI
Motor Vehicle Traffic Injury Hospitalization	Neighbourhood-level income quintile	Yes	Yes	2001 to 2012	Discharge Abstract Database and Hospital Morbidity Database, CIHI
Chronic Disease Indicators					
Mental Illness Hospitalization	Neighbourhood-level income quintile	Yes	Yes	2006 to 2012	Hospital Mental Health Database, CIHI
Alcohol-Attributable Hospitalization	Neighbourhood-level income quintile	Yes	Yes	2007 to 2012	Discharge Abstract Database and Ontario Mental Health Reporting System, CIHI
Hospitalized Heart Attacks	Neighbourhood-level income quintile	Yes	Yes	2008 to 2012	Discharge Abstract Database and Hospital Morbidity Database, CIHI; Fichier des hospitalisations MED-ÉCHO, ministère de la Santé et des Services sociaux du Québec
Diabetes	Self-reported adjusted household income	Yes	Yes	2003 to 2013	Canadian Community Health Survey, Statistics Canada

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Table 1: Indicators Summary Table (cont'd)

Indicator	Inequality Disaggregator	Reported by		Time Period	Data Sources
		Sex	Province		
Well-Being Indicator					
Self-Rated Mental Health	Self-reported adjusted household income	Yes	Yes	2003 to 2013	Canadian Community Health Survey, Statistics Canada
Mortality Indicator					
Infant Mortality	Neighbourhood-level income quintile	No	Yes	2001 to 2011	Canadian Vital Statistics, Statistics Canada

Analytical Approach

As described in the Introduction to the report, the following steps were taken to determine whether income-related inequalities have changed over time:

Step 1: Categorize the population into income levels and calculate indicator rates by income level for each time point.

Step 2: Quantify the difference between the rates for the highest and lowest income levels (i.e., income-related inequality) for each available time point using 2 inequality measures: disparity rate ratio (DRR) and disparity rate difference (DRD).

Step 3: Assess whether inequality has changed over time by comparing the inequality measures between the first and last time points.

Step 4: Examine the indicator rate trends for each income level to better understand which income level is influencing changes in income-related inequality.

Step 5: Quantify the extent of inequality across all income levels by calculating inequality impact measures that benchmark to the highest income level: potential rate reduction (PRR) and population impact number (PIN).

Step 1a: Categorize the population into income levels

For all indicators, the analysis is carried out with the population categorized by income quintiles (i.e., 5 groups or levels with roughly equal population or an equal number of small geographic areas). Quintile 1 refers to the lowest income level, while Quintile 5 refers to the highest income level. The approach of using income quintiles builds on previous analyses of income-related health inequality reported by CIHI and other health organizations across Canada.¹⁻⁹

Other approaches for analyzing income-related inequality include using more granular categorizations of the population by income (e.g., by deciles) or by analyzing income as a continuous variable. These methods have the advantage of providing a more detailed characterization of the relationship between income and health, such as by identifying the significant differences between the health of Canadians in the bottom 1% of the income distribution and those in the bottom 15%. Additionally, since income is only 1 component of a person's socio-economic position, some analyses use composite indices of social and material deprivation, such as the Deprivation Index developed by Pampalon and Raymond¹⁰ and the Canadian Marginalization Index.¹¹

This report primarily categorizes the population into income levels according to 1 of 2 measures of income: self-reported adjusted household income and neighbourhood-level income. As shown in Table 1, self-reported adjusted household income was used for indicators sourced from the CCHS and neighbourhood-level income was used for indicators with sources other than the CCHS. The income information from the Survey of Labour and Income Dynamics and the census can be a mix of self-reported and income reported in tax files. Respondents are asked for permission to link to their tax files, but if permission is not granted they are asked to self-report their total income. This applies to the following indicators: Individual After-Tax Income, Core Housing Need, University Participation (by parental income) and Individual After-Tax Income (Median) (by Aboriginal identity).

Self-Reported Adjusted Household Income

For indicators that use CCHS data, the distribution of household income at the provincial level was used to classify respondents into different income levels using the INCDRPR variable in the master CCHS file.¹² This income measure reflects the distribution of residents of each province in deciles (i.e., 10 levels, each with approximately 10% of residents, for each province) based on the adjusted ratio of their total household income to the low-income cut-off corresponding to their household and community size. Thus, for each respondent, it provides a relative measure of their household income to the household incomes of all other respondents in the same province.¹²

To analyze indicator results by income quintile, these deciles were collapsed into quintiles (i.e., 5 groups or levels, with respondents representing approximately 20% of the population in each income level) and used to generate national and provincial indicator estimates.

Limitations

A limitation of this measure is that survey respondents who do not state their income or provide a valid income or income range, as well as residents of the territories, are not assigned a household income quintile and are therefore not included in this analysis. The percentage of respondents missing income assignment by survey cycle is reported for each indicator in the Indicator Definitions document. Indicator rates for respondents with missing income are available [on request](#).

Neighbourhood Income

For indicators derived from sources other than the CCHS, the distribution of average incomes across neighbourhoods within a province was used to categorize individuals into income quintiles. Statistics Canada's Postal Code Conversion File Plus (PCCF+) software¹³ was used to assign individuals to these neighbourhood income quintiles by linking postal codes to census geography. This software links 6-character postal codes to standard Canadian census geographic areas (such as dissemination areas, or DAs) to facilitate the extraction of relevant census information (such as income) for each geographical area.

DAs (referred to as enumeration areas, or EAs, prior to the 2001 Census) have an average population of 400 to 700 people and are the smallest geographical unit of analysis for which census data is available.¹⁴ Using the PCCF+ (Version 5J), the postal code of the individual's place of residence at the time of the event was mapped to the corresponding census DA, and the neighbourhood income quintile of that DA was assigned to the individual.

The neighbourhood income quintiles available in the PCCF+ were constructed according to the method developed at Statistics Canada.¹⁵ A short description of the method is provided below.

Neighbourhood income quintiles are a measure of average after-tax income per single-person equivalent in a DA, adjusted for household size. To calculate average income per single-person equivalent for each DA, the total income of the DA was divided by the total number of single-person equivalents (a 2-person household counts as 1.24 persons, a 3-person household counts as 1.53 persons, etc.). Income quintiles for DAs with a household population of less than 250 were imputed based on the neighbouring DAs (where possible), because census data on income for these DAs was suppressed.

Next, the average income per person equivalent was used to rank DAs from lowest to highest in each census metropolitan area (CMA), census agglomeration (CA) or provincial residual area not in any CMA or CA. Finally, the population within each area was divided into approximate fifths (i.e., about 20% of DAs in each quintile) to create community-specific income quintiles. Community-specific income quintiles were constructed to minimize the potential effect of differences in income, housing or other living costs across different areas of the country.¹³ Neighbourhood income quintiles were available for the 2001 and 2006 census cycles. Hospitalization records used the neighbourhood income quintiles from the closest census year. For example, hospitalization records from 1999 to 2003 used neighbourhood income quintiles from the 2001 Census. As the relevant 2011 Census data was not available at the time of analysis, all hospitalization records subsequent to 2003 used neighbourhood income quintiles from the 2006 Census.

Limitations

A limitation of the neighbourhood-level income measure is that people with a missing or invalid postal code and those living in institutions, such as long-term care facilities, are not assigned a neighbourhood income quintile and are therefore not included in this analysis. Additionally, neighbourhood income quintiles derived from linking postal codes to the census are less accurate for rural areas because rural postal codes cover larger geographical areas.

For CCHS indicators, both sources of income data were available for use: self-reported adjusted household income was included in the CCHS master file and survey respondents' postal codes were available for linkage to neighbourhood-level income through the PCCF+ (see Box 1 for an overview of the choice of income variable and concordance of results based on these 2 types of income categorization). For indicators based on CCHS data, self-reported adjusted household income was used for the analysis. For indicators based on data sources other than the CCHS, neighbourhood-level income based on postal code was the only available option, because socio-economic information like income is not captured in data sources such as hospital discharge abstracts.

Box 1: Self-Reported Adjusted Household Versus Neighbourhood-Level Measurement of Income

- For this report, self-reported adjusted household income, rather than neighbourhood-level income, was used to disaggregate indicator rates based on CCHS data. This is because, where available, self-reported income is a more reliable source of an individual's income than methods that assign income based on the average income of a person's area of residence. Area-based methods rely on the assumption that household incomes will be somewhat uniform within small geographic areas¹⁶ and can be prone to misclassification of income where such an assumption is not met.¹⁷
- Since both self-reported household and neighbourhood-level income information was available for CCHS indicators, a weighted Kappa statistic was calculated for each indicator to determine the level of concordance between the 2 types of income categorizations. The values of the Kappa statistics ranged from 0.13 to 0.23, which can be interpreted as poor concordance.
- This is in agreement with the results of previous studies examining this issue, which have found that these 2 methods of categorizing a population into different income levels generally do not correlate well.^{16–21}
- Nevertheless, studies have also shown that health outcomes or factors influencing health can be independently associated with both neighbourhood-level and self-reported income. For example, this has been demonstrated for low birth weight, rates of being hospitalized (for any cause) and survival following coronary artery disease.^{22–24}
- Some studies have found that using neighbourhood-level income rather than self-reported individual-level income attenuates the association between income and health outcomes, particularly for those in the lowest income levels,^{19, 25} while others have found neighbourhood-level income to be a valid proxy for individual-level income.^{26–28}
- An emerging consensus within the population health research community is that neighbourhood-level and self-reported individual-level incomes explain different concepts of an individual's socio-economic position and that, where feasible, both should be included in population health analyses.^{19, 22, 24, 29}

Step 1b: Calculate indicator rates by income level for each time point

Indicator rates were calculated as event rates per 100,000 or 1,000 population in a given year or as a weighted proportion of survey respondents per 100 population at the time of the survey interview (for respondents with non-missing income data). Detailed numerator and denominator definitions, including weighting, specific to each indicator can be found in the Indicator Definitions document.

Note: All calculations in this report (e.g., deriving inequality measures, determining statistical significance, quantifying change over time) are conducted using all available decimal places; estimates are rounded for final presentation only.

Age-Standardization

Indicator rates were age-standardized by the direct method of standardization, using the 2011 Canadian population (from the 2011 Census) as the standard population. Standardization was based on 5-year age groupings. Age groupings can be found in the Indicator Definitions document. Please note that previously conducted CIHI analyses carried out age-standardization based on the 1991 Canadian standard population.

Age-standardized rate = (numerator ÷ denominator) × weight of standard population × multiplier

Note: For indicators that are per 100,000 population, the multiplier is 100,000; for those that are per 100 population, the multiplier is 100.

Measures of Precision

Variance was calculated using the following formula for indicators using CIHI administrative data:

$$Variance(Rate) = Weight^2 \times Rate_{crude} \times (100,000 - (Rate_{crude})) \div Population$$

The variance for CCHS indicators was derived using the bootstrapping technique.³⁰

The variance for the Small for Gestational Age and Infant Mortality indicators was provided by Statistics Canada.

The confidence interval for all the indicator rates is given by $\pm 1.96\sqrt{Variance(Rate)}$.

Data Suppression

When numerator counts were less than 5 for an indicator rate, the rate was suppressed. Unstable indicator rates were also suppressed if adding 1 case to the numerator would change the rate by more than 10%. Suppressed values are indicated with a double dagger (‡).

According to Statistics Canada's guidelines,¹⁵ values of indicators derived from the CCHS were suppressed if the coefficient of variation (CV) obtained via the bootstrapping technique was greater than 33.3%, indicating extreme sampling variability resulting in estimates that are too

unreliable to publish. Such estimates are denoted in tables with a double dagger (‡). Where the CV was between 16.6% and 33.3%, values were identified with a superscript single dagger (†), indicating that the estimate should be used with caution.

Step 2: Quantify income-related inequality using 2 simple inequality measures: disparity rate ratio (DRR) and disparity rate difference (DRD)

Disparity Rate Ratio

The DRR is a *relative* measure of inequality and is calculated by dividing the rate of the lowest income level (Q1) by the rate of the highest income level (Q5):

$$DRR = \text{Rate}_{Q1} \div \text{Rate}_{Q5}$$

The variance is calculated using the following formula:

$$\text{Variance} \left(\text{Log} \left(\frac{\text{Rate}_{Q1}}{\text{Rate}_{Q5}} \right) \right) = \frac{\text{Variance}(\text{Rate}_{Q1})}{\text{Rate}_{Q1}^2} + \frac{\text{Variance}(\text{Rate}_{Q5})}{\text{Rate}_{Q5}^2}$$

The DRR 95% confidence interval is given by $\text{Exp}(\log(DRR) \pm 1.96\sqrt{\text{variance}(DRR)})$.

The DRR is considered to be statistically significantly different from the null (i.e., DRR = 1) if the 95% confidence interval does not include 1. A DRR of 1 indicates no relative difference in the rate of an outcome among the income levels. A DRR of more than 1 indicates a higher rate of an outcome among the lowest income level, while a DRR of less than 1 indicates a lower rate among the lowest income level relative to the highest income level. For example, a DRR of 1.3 indicates a 1.3 times or 30% $((1.3 - 1) \times 100\%)$ higher rate of the outcome among the lowest versus the highest income level. A DRR of 0.80 indicates a 20% $((1 - 0.80) \times 100\%)$ lower or 1.25 times lower $(1 \div 0.80)$ rate of an outcome among the lowest versus the highest income level.

Disparity Rate Difference

The DRD is an *absolute* measure of inequality and is calculated by subtracting the rate of the highest income level (Q5) from the rate of the lowest income level (Q1):

$$DRD = \text{Rate}_{Q1} - \text{Rate}_{Q5}$$

The variance is calculated using the following formula:

$$\text{Variance}(DRD) = \text{variance}(\text{Rate}_{Q1}) + \text{variance}(\text{Rate}_{Q5})$$

The DRD 95% confidence interval is given by $DRD \pm 1.96\sqrt{\text{variance}(DRD)}$.

The DRD is considered to be statistically significant if the 95% confidence interval does not include 0.

A 0 value of DRD indicates no difference in the rate of an outcome among the income levels. A positive value of DRD indicates a higher rate of an outcome in the lowest income level versus the highest income level. Conversely, a negative value of DRD indicates that the rate of an outcome was lower in the lowest income level than in the highest income level.

Step 3: Assess whether rates or inequality changed over time by comparing the measures between the first and last time points

To assess whether there was a statistically significant change between the first (T1) and last (T2) time points for each indicator rate or measure of inequality (DRR and DRD), the 95% confidence intervals at T1 and T2 were compared. If the confidence intervals overlapped, then the change was not considered to be statistically significant. If the confidence intervals did not overlap, then the change between T1 and T2 was deemed to be statistically significant.

If the change was deemed to be **not** significantly different, the direction of change, percentage change and absolute change are denoted by an em dash (—), indicating no statistically significant change.

If the change was deemed to be significantly different, the direction and magnitude of change are presented:

- a. The direction of change is denoted using an upward-facing arrow (↑) or downward-facing arrow (↓) where the rate or income-related inequality increased or decreased, respectively, between T1 and T2.
- b. The percentage change between T1 and T2 is calculated as $((Estimate_{T2} - Estimate_{T1}) \div Estimate_{T1}) \times 100$ and presented with the corresponding 95% confidence interval.
- c. The absolute change between T1 and T2 is calculated as $Estimate_{T2} - Estimate_{T1}$ and presented with the corresponding 95% confidence interval.

Note: Some exceptions were made to the above-listed approach for measures of inequality, primarily to account for situations where the indicator rates at either T1 or T2 in the lowest income level were not statistically significantly worse than those in the highest income level.

Limitations

Notably, this approach of highlighting only statistically significant changes over time was taken to overcome the practical challenges of deriving key messages for a large report in a consistent fashion. As a result of using this approach, the findings that are discussed may yield a conservative summary of inequalities that have changed over time.

Exceptions to Assessment and Calculation of Change Over Time Measures

- For the DRD only, when the DRD estimate at T1 approached 0 (i.e., the 95% confidence interval of the DRD at T1 included 0), the percentage change is omitted and denoted by a section sign (§). The percentage change is not calculated in such cases because dividing by a value close to 0 results in a highly inflated percentage change that is difficult to interpret. This situation applies to 3 indicators: Fall Injury Hospitalization for Seniors (British Columbia, both sexes and women), Diabetes (Saskatchewan, both sexes) and COPD Hospitalization for Canadians Younger Than Age 75 (Prince Edward Island, men).
- When the direction of inequality reversed between T1 and T2 and income-related inequality decreased such that rates changed from being worse in the lowest income level to being worse in the highest income level (i.e., the DRR estimate changed from being above 1 to below 1, or the DRD estimate changed from being above 0 to below 0), the direction of change is denoted using 2 asterisks (**) and the percentage change and absolute change are not calculated. This situation applies to 1 indicator: Fall Injury Hospitalization for Seniors (Newfoundland and Labrador, both sexes and women).
- When the direction of inequality reversed between T1 and T2 and income-related inequality increased such that rates changed from being worse in the highest income level to being worse in the lowest income level (i.e., the DRR estimate changed from being below 1 to above 1, or the DRD estimate changed from being below 0 to above 0), the direction of change is denoted using an upward-facing arrow (↑) and the percentage change and absolute change are not calculated. This situation applies to 2 indicators: Fall Injury Hospitalization for Seniors (Saskatchewan, both sexes and women; British Columbia, men) and Diabetes (Saskatchewan, men).

Step 4: Examine the indicator rate trends by income level to identify which income levels are influencing changes in income-related inequality

Income-related health inequality can increase, decrease or stay the same for a number of reasons. For example, a reduction in income-related health inequality can be the result of improving rates in the lowest income level or worsening rates in the highest income level. As it is undesirable to narrow the gap by reducing health among the wealthiest individuals, worsening rates in the highest income level signal a negative trend, while improving rates in the lowest income level suggest a positive improvement in income inequality.³¹

In this report, trends in rates for the lowest and highest income levels (i.e., the 2 income levels that were used to calculate the inequality measures, the DRR and the DRD) were examined to determine which income level was influencing income-related inequality (e.g., “income-related inequality increased on the relative scale due to worsening rates among those in the lowest income level”).

Step 5: Quantify the current extent of inequality across all income levels by calculating the potential rate reduction (PRR) and population impact number (PIN)

Potential Rate Reduction

The PRR, commonly known as the population-attributable fraction or population-attributable risk,³² is a *relative* measure of the potential percentage reduction in a health indicator rate that would occur in the hypothetical scenario that each income group experienced the rate of the highest income group. This measure is ideally suited for scenarios where lower rates of an outcome are desirable and the RR is greater than 1. In cases where higher rates of an outcome are desirable (e.g., influenza immunization rates for seniors), a potential rate improvement (PRI) was calculated instead. The PRR and its 95% confidence interval were calculated in the following manner:

$$PRR = \frac{\sum_{i=1}^5 P_i \left(\frac{R_i}{R_5} - 1 \right)}{1 + \sum_{i=1}^5 P_i \left(\frac{R_i}{R_5} - 1 \right)} \times 100\%$$

P_i : Proportion of the study population in the i th income quintile

$\frac{R_i}{R_5}$: Age-standardized DRR of the outcome of interest in the i th income quintile relative to the reference income level R_5 (i.e., the age-standardized rate in the i th income quintile divided by the age-standardized rate in the reference [highest] income quintile)

The first step in calculating the 95% confidence interval for the PRR is calculating the confidence limits for the ratio of the sum of the population proportion (P_i) multiplied by the age-standardized rate (R_i) in the first to fourth income quintiles relative to the rate in the reference income level, the fifth income quintile:

$$\left(\frac{\sum_{i=1}^4 P_i R_i}{R_5} \right) \text{ also expressed as } \frac{R_{1:4}}{R_5}$$

The variance calculation for R_5 is straightforward and described above in Step 1b. The variance for $R_{1:4}$ is given by the following equation:

$$\sum_{i=1}^4 P_i^2 \text{Var}(R_i)$$

The variance and 95% confidence limits for $\frac{R_{1:4}}{R_5}$ can then be calculated using the same equations as for the DRR (see Step 2, above) by substituting $R_{1:4}$ for R_1 .

If we denote the confidence limits of $\frac{R_{1:4}}{R_5}$ with L_{R14} and U_{R14} , then the confidence interval for the PRR is as follows:

$$L_{PRR} = 1 - \frac{1}{P_5 + L_{R14}} \qquad U_{PRR} = 1 - \frac{1}{P_5 + U_{R14}}$$

The PRR is considered to be statistically significantly different from the null (i.e., $PRR = 0$) if the 95% confidence interval does not include 0. PRR values that were negative and statistically significant (i.e., L_{PRR} and U_{PRR} were both less than 0) were suppressed and given a value of 0 as they indicated a lack of any potential rate improvement.

Potential Rate Improvement

The potential rate improvement (commonly known as the prevented fraction) is a measure of *relative* inequality (analogous to the PRR) used in scenarios where higher rates of an outcome are desirable or the exposure is protective, and the RR is below 1.^{33, 34} In this report, the PRI was calculated for a single indicator, Influenza Immunization for Seniors, and represents the potential percentage increase in the immunization rate that would occur in the hypothetical scenario that each income group experienced the rate of the highest income group.

The PRI is related to the PRR in the following manner:³³

$$PRI = 1 - \frac{1}{1 - PRR}$$

Drawing on the variance calculation for the PRR (see Step 5 above), the variance of the PRI is given by the following equation:

$$\begin{aligned} Var(PRI) &= var\left(1 - \frac{1}{1 - PRR}\right) \\ &= var\left(\log\left(\frac{R_{1:4}}{R_5}\right)\right) = \frac{var(R_5)}{(R_5)^2} + \frac{\sum_{i=1}^4 P_i^2 var(R_i)}{(R_{1:4})^2} \end{aligned}$$

The 95% confidence interval of the PRI is given by the following equations:

$$L_{PF} = Exp[\log(PRI) - 1.96\sqrt{var}(PRI)]$$

$$U_{PF} = Exp[\log(PRI) + 1.96\sqrt{var}(PRI)]$$

As with the PRR, PRI values that were negative and statistically significant were suppressed and given a value of 0.

Population Impact Number

The PIN is an *absolute* measure of the potential reduction in the number of cases of an outcome that would occur in the hypothetical scenario that each income level experienced the rate of the highest income level. The PIN is calculated by multiplying the PRR (or PRI) by the overall indicator rate and by the total number of people in the population.³⁵ For this report, the PIN was calculated separately for men and women at the national and provincial levels when the corresponding sex-specific PRR was significantly different from 0 (based on the 95% confidence interval). For example, when the national PRR for women was statistically significantly different from 0, the national PIN for women was calculated. The national and provincial PINs for both sexes combined were calculated by summing the corresponding sex-specific PIN estimates. This included the rare situations where the sex-specific PRRs were statistically significant but the

PRR for both sexes combined was not, or when the sex-specific PRRs were not statistically significant but the PRR for both sexes combined was significant. For cases where the sex-specific PIN was not calculated because the corresponding PRR was not statistically significantly different than 0, the PIN was listed as 0. The PIN was also always listed as 0 when its corresponding PRR was set to 0 for being negative and statistically significant. This included the PIN for both sexes combined. All PIN values were rounded to the nearest 100 cases.

$$\text{PIN} = \text{Overall indicator standardized rate} \times N_{\text{total population}} \times \text{PRR (or PRI)}$$

Where $N_{\text{total population}}$ is the total 2011 standard population of men or women, and the PRR is based on rates that are age-standardized to the 2011 standard population.

Overview of Intervention Selection Approach

The report *Trends in Income-Related Health Inequalities in Canada* identifies examples of promising interventions for reducing income-related health inequalities. This section of the Methodological Notes document provides detailed information on the process and rationale used to select the interventions, including policies and programs, highlighted in this report.

Reducing Income-Related Health Inequalities

This report is informed by the WHO's conceptual framework for action on the social determinants of health (see Introduction, Figure 2), which depicts the complex factors that influence health. The WHO framework was chosen because it is based on theoretical and empirical evidence and is action-oriented.³⁶ 2 broad approaches to reducing health inequalities are identified:

1. Universal approaches: Interventions that address the entire social gradient and are applied across the whole population; and
2. Targeted (selective) approaches: Interventions that are targeted to improve the health of low socio-economic status groups.

Universal approaches apply to the whole population and are important for establishing a safety net and providing universal access to essential services, such as income protection programs for anyone unable to work. However, universal interventions may have the potential to increase inequalities. For example, increasing taxes on cigarettes has the potential to create a disproportionate financial burden on lower-income individuals who continue to smoke.³⁷ Targeted interventions help reduce income-related inequality by focusing on improving the health of populations with lower income levels. However, they can also risk further stigmatizing these populations by singling them out as needing additional help.³⁸ Moreover, targeted interventions may not address inequalities that affect the middle income levels.

Income-related health inequalities predominantly affect lower-income populations, but they also affect middle-income populations.^{6, 38–40} It is widely recognized that a variety of approaches, including both universal and targeted interventions, will be more effective at addressing income-related health inequalities and closing the gap between the highest and lowest income groups.⁴¹

This comprehensive approach would involve action across all income levels that is proportionate to the level of inequality—an approach commonly referred to as proportionate universalism.⁴²

In addition to a comprehensive approach that incorporates both targeted and universal interventions, strategies to address income-related health inequalities must also consider intersectoral action and the life course perspective. It is widely recognized that a number of factors both within and outside the health sector interact to influence health.³⁶ For this reason, intersectoral action—the involvement of multiple sectors (e.g., finance, social) and collaboration across all levels of government—is recognized as one of the most effective means by which health inequalities can be addressed.³⁶ For example, a comprehensive approach to address smoking might involve multiple sectors (e.g., primary care, hospitals, workplaces, the public sector) and all levels of government (e.g., municipal—smoking bans in public places; provincial—legislation to prohibit smoking in workplaces; federal—legislation on tobacco sales, pricing and labelling).⁴³

Health inequalities have a cumulative effect across the life course.³⁶ For example, parental income and/or education level can affect the health of an individual before and after birth, through differences in prenatal nutrition or access to resources and support that enable healthy development.^{44, 45} Children who are exposed to nurturing environments early in life have the best opportunities to grow up healthy and happy.⁴⁶ Adverse experiences in early life may affect education and employment opportunities later in life, which in turn may influence the resources available to support good health, such as appropriate nutrition or housing.⁴⁷ Literature shows that interventions targeted toward early child development have a favourable economic return.^{48, 49}

Intervention Selection

The objective of our analysis was to identify interventions across a range of dimensions, including the specific factor influencing health (e.g., material circumstances, health behaviours), the implementation level (e.g., federal, provincial, regional), settings (e.g., hospital, community) and target populations (e.g., low-income persons, seniors).

As shown in Table 2, our analysis identified a number of established and/or promising interventions for reducing income-related health inequalities, which are featured in the report.

Given the breadth of the issue, a systematic and comprehensive review of the literature concerning the reduction of income-related health inequalities was beyond the scope of this report. Academic literature was searched using the search engine OVID. A snowball sampling methodology was employed to follow up on relevant sources that may identify evaluations of promising interventions for reducing income-related health inequalities. When available, systematic reviews were prioritized as a source of evidence to identify effective interventions for reducing inequalities in health or improving the health of vulnerable groups.

Grey literature was also searched to identify evaluations of promising interventions published by provincial/territorial governments or other organizations. In addition, web-based tools, such as the Public Health Agency of Canada's Canadian Best Practices Portal,⁵⁰ were used to identify successful and relevant interventions.

To be selected as an intervention featured in the report, the intervention had to meet the criterion of having the potential to reduce income-related inequalities for the given indicator. Additionally, the overall selection of interventions aimed to balance the following considerations across the entire report:

- **Evaluation**

For some interventions, evidence from a formal outcome evaluation is highlighted, which demonstrates the effectiveness of the approach. For new, promising or innovative interventions where outcome evaluation data is not available, process evaluations are highlighted to illuminate the potential benefits of that intervention.

- **Implementation Level**

Interventions or approaches can be implemented at different levels, such as at the community, municipal, provincial/territorial, federal or international level. Canadian interventions were prioritized over international ones. Interventions were included both from within and outside the health sector. The interventions selected occurred in a variety of settings (e.g., hospitals, communities) in various geographic locations (e.g., different provinces).

- **Target Population**

Interventions were also selected to provide a range of examples of interventions that target different populations at various stages of the life course (e.g., children, seniors).

- **Different Approaches**

While some approaches, such as poverty reduction, are expected to play a role in shaping many health behaviours and health outcomes, the selection of interventions for this report aimed to highlight a variety of approaches to demonstrate the diversity of potential intervention mechanisms that can be implemented to reduce income-related health inequalities.

Due to attempts to balance these considerations when selecting interventions, the intervention selected for any particular indicator may not be the one with the most rigorous evaluation; rather, it may have been chosen to highlight a unique or novel approach. Selected interventions reflect the importance of incorporating multiple strategies at various levels to reduce income-related health inequalities.

Table 2: Summary of Interventions Included in the Report

Section of Report	Intervention	Year	Implementation Level	Setting	Geographic Area	Target Population
Structural Factors: A Focus on Income						
Education	Future to Discover	2004	Provincial	High School/ University	Manitoba and New Brunswick	Youth
Employment	Women in Trades Training	2012	Provincial	College/University/ Workshop	British Columbia	Women
Intermediary Factors Influencing Health						
Material Circumstances Indicators						
Core Housing Need	Housing Choices	2007	Provincial	Individual/ Classroom	Northwest Territories	Renters and Homeowners
Homelessness	At Home / Chez Soi	2009 to 2013	Local/Community	City	Vancouver, Winnipeg, Toronto, Montréal, Moncton	Homeless Populations
Household Food Insecurity	Community Food Centres	2012	Local/Community	Community Centres	Current: Toronto, Perth, Stratford Future: Dartmouth, Winnipeg, Calgary	Low-Income Individuals
	Newfoundland and Labrador Poverty Reduction Strategy	2006	Provincial	Individual	Newfoundland and Labrador	Low-Income Individuals
Early Life Indicators						
Small for Gestational Age	Canada Prenatal Nutrition Program	1995	National	Wide Variety of Community and Non-Profit Organizations	Canada	Mothers and Infants
Children Vulnerable in Areas of Early Development	Better Beginnings, Better Futures	1991	Local/Community	Preschool/ Primary School	Ontario (Guelph, North Kingston, Southeast Ottawa, Toronto, Walpole Island, Cornwall, Highfield, Sudbury)	Children
Behavioural and Biological Indicators						
Smoking	Nimi Icinohabi Program	2007	Local/Community	School	Alberta	Youth
Obesity	Healthy Alberta Communities	2006 to 2009	Local/Community	Neighbourhood	Alberta (Bonnyville, St. Paul, Norwood/ North Central Edmonton, Medicine Hat)	Communities
Health System Indicators						
Influenza Immunization for Seniors	Pharmacy-Based Influenza Vaccine Clinics	2009–2010	Local/Community	Pharmacy-Based Influenza Clinics	British Columbia	Seniors
COPD Hospitalization for Canadians Younger Than Age 75	COPD Integrated Pathway Project	2011	Local/Community	Individual/ Hospital	Manitoba	Patients With COPD

(cont'd on next page)

Table 2: Summary of Interventions Included in the Report (cont'd)

Section of Report	Intervention	Year	Implementation Level	Setting	Geographic Area	Target Population
Health and Well-Being Outcomes						
Injury Indicators						
Fall Injury Hospitalization for Seniors	Home Adaptations for Seniors' Independence	1992	National	Individual	Canada	Seniors
Motor Vehicle Traffic Injury Hospitalization	Reducing Speed Limits in Residential Areas	Varies	Local/Community	Neighbourhood	Various Municipalities	Victims of Motor Vehicle Accidents
Chronic Disease Indicators						
Mental Illness Hospitalization	Integrated Mobile Crisis Response Team	2004	Local/Community	City	Rural British Columbia	Individuals With Mental Illness
Alcohol-Attributable Hospitalization	Kwae Kii Win Centre Managed Alcohol Program	2012	Local/Community	Homeless Shelters	Ontario, British Columbia, Alberta, Manitoba, Nova Scotia	Homeless Populations With Alcohol Addictions
Hospitalized Heart Attacks	B.C. Physical Activity Strategy	2006	Provincial	Individual/Community	British Columbia	Communities
Diabetes	Latino Families in Action	Varies	Local/Community	Families	Ontario (London, Ottawa, Toronto)	Children
Well-Being Indicator						
Self-Rated Mental Health	Nobody's Perfect	1987	National	Classroom	Canada	Parents and Children

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