PAN-CANADIAN HEALTH INEQUALITIES REPORTING INITIATIVE— SUMMARY MEASURES

PROTECTING AND EMPOWERING CANADIANS TO IMPROVE THEIR HEALTH

Public Health Agency of Canada
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TO PROMOTE AND PROTECT THE HEALTH OF CANADIANS THROUGH LEADERSHIP, PARTNERSHIP, INNOVATION AND ACTION IN PUBLIC HEALTH.

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Several summary measures have been used in the public health field to assess health inequalities. In this project, three effect measures[1] and three impact measures were calculated to assess the distribution of inequality between population groups (Table 1).

TABLE 1: Summary measures for estimating the magnitude of health inequality

Effect Measures—magnitude of the inequality between two population groups	**Rate Ratio (RR)** *Relative inequality* **Rate Difference (RD)** *Absolute inequality* **Attributable Fraction (AF)** *Percent (%) rate reduction in a sub-population*
Population Impact Measures—impact of the magnitude of the inequality between two population groups within the total population	**Population Attributable Rate (PAR)** *Absolute rate reduction in the total population* **Population Attributable Fraction (PAF)** *Percent (%) rate reduction in the total population* **Population Impact Number (PIN)** *Absolute number of cases reduced in the total population*

INTERPRETING THE MEASURES OF INEQUALITY

All of the summary measures of health inequality used in this project reflect the potential change in rate in the hypothetical situation whereby the health status of the most advantaged group is achievable by other population groups.[2]

- **RR and RD** express the difference between the rates of two population groups in terms of relative and absolute inequality, respectively, whereas **AF** represents the proportion (%) of the rate that is attributable to the observed inequality experienced by one population group compared to another.
- **PAR, PAF and PIN** express the change (absolute, percent, or absolute number, respectively) in the occurrence (rate) of a health outcome within the entire population in the hypothetical situation whereby the less advantaged group experienced the health status of the most advantaged group. Moreover, these measures not only reflect the health inequality rates but also their impact at the population level. As such, larger groups experiencing high rates (high occurrence (or prevalence) of the outcome) and high inequalities, will show a larger potential rate reduction in the total population.

[1] Mackenbach JP, Kunst AE Measuring the magnitude of socio-economic inequalities in health: an overview of available measures illustrated with two examples from Europe. Soc Sci Med. 1997 Mar;44(6):757–71.

[2] A *population group* is a category within a social stratifier referring to an underlying social characteristic that is used to categorize an overall population into different population groups of interest (e.g. lowest income quintile corresponds to one population group within the income stratifier). A *reference group* is a specific population group that is used for comparisons with other population groups within a social stratifier. Typically, the reference group is the population group with the most presumed social advantage (e.g., highest income quintile is the reference group within the income stratifier), but other population groups may also be used as the reference group.

- Although inequalities are frequently calculated and reported for two extreme groups of the distribution (most advantaged to least advantaged groups), for the purpose of this project, we have chosen to report inequality measures for all sub-groups to better capture how the inequalities are distributed and to highlight possible inequality patterns (e.g., each income group is compared to the reference group).
- Depending on the indicator and its data source, either incidence rates (or mortality rates) or prevalence rates have been reported and used to calculate the summary measures.
- All the summary measures are based on the age-standardized rates (the crude rates when the age-standardized rates are not available) and do not take into account the complex intersections between different social identities or different social determinants of health that may vary between the groups.

SUMMARY MEASURES OF INEQUALITY—DEFINITIONS, FORMULAS AND EXAMPLES

Rate Ratio (RR):

The rate ratio (RR) quantifies the **relative magnitude of inequality** of an outcome (i.e., a health indicator) between a population group of interest and the reference group within a social stratifier. The RR shows how many times higher or lower the rate of an outcome is, in a population group of interest compared to the reference group.

FORMULA:

$$RR_i = \frac{R_i}{R_o}$$

RR_i: Rate Ratio for the i-th population group of interest relative to the reference group

R_i: Rate of outcome among the i-th population group of interest

R_0: Rate of outcome among the reference group

RR = 1 implies that the rate among the population group of interest is the same as in the reference group

RR > 1 (positive value) implies that the rate among the population group of interest is higher than in the reference group

RR < 1 (negative value) implies that the rate among the population group of interest is lower than in the reference group

EXAMPLE 1—RATE RATIO:

Question: In Population A (Table 2), how many times was the prevalence rate of obesity higher or lower among high school graduates compared to university graduates?

Calculation (Figure 1): Data on the prevalence of obesity among adults in Population A show that persons with a high school diploma (group of interest; Category 4) had a higher rate of obesity (R_4 = 36 cases per 100) than those with a university degree, the reference group (R_0 = 12 cases per 100 persons). To calculate RR_4, we would divide 36/100 by 12/100, which gives us 3.

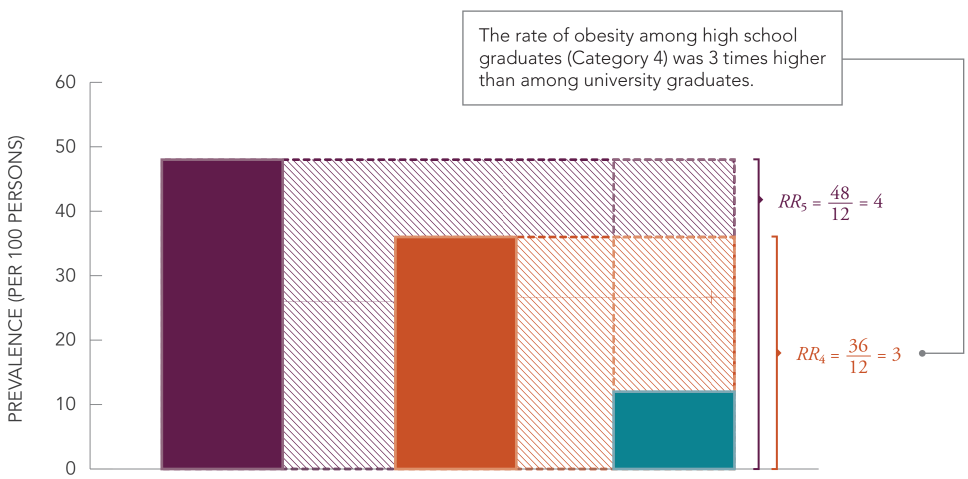
Answer: In Population A, the rate of obesity among high school graduates was 3 times higher than among university graduates.

Similarly, we can say the rate of obesity among the population group with less than a high school education was 4 times higher than among university graduates.

TABLE 2: Obesity in Population A–Stratified by level of education

Level of education (Category)	Total population	Proportion of total population	Obesity cases (number)	Proportion of all cases	Obesity rate (prevalence)
Less than high school (category 5)	400	20%	192	32% (P_5)	48/100 (R_5)
High school graduates (category 4)	500	25%	180	30% (P_4)	36/100 (R_4)
Some postsecondary (category 3)	450	22.5%	126	21% (P_3)	28/100 (R_3)
Community college/ Technical school/ Certificate (category 2)	350	17.5%	66	11% (P_2)	19/100 (R_2)
University graduates (reference, category 1)	300	15%	36	6% (P_0)	12/100 (R_0)
TOTAL	**2000 (N)**	**100%**	**600**	**100%**	**30/100 (R_t)**

FIGURE 1: Illustration of Rate Ratio in Population A



	Less than high school (Category 5)	High school graduate (Category 4)	University graduate (Reference)
Prevalence Rate	48	36	12
Rate Ratio	4	3	–

Rate Difference (RD):

The Rate Difference (RD) quantifies the **magnitude of inequality, based on the absolute difference in rates** between the population group of interest and the reference group.

FORMULA:

$$RD_i = R_i - R_o$$

RD_i: Rate Difference for the *i*-th population group of interest relative to the reference group

R_i: Rate of outcome among the *i*-th population group of interest

R_0: Rate of outcome among the reference group

RD = 0 implies that the rate in the population group of interest is the same as in the reference group

RD > 0 (positive value) implies that the rate in the population group of interest is higher than in the reference group

RD < 0 (negative value) implies that the rate in the population group of interest is lower than in the reference group

EXAMPLE 2—RATE DIFFERENCE:

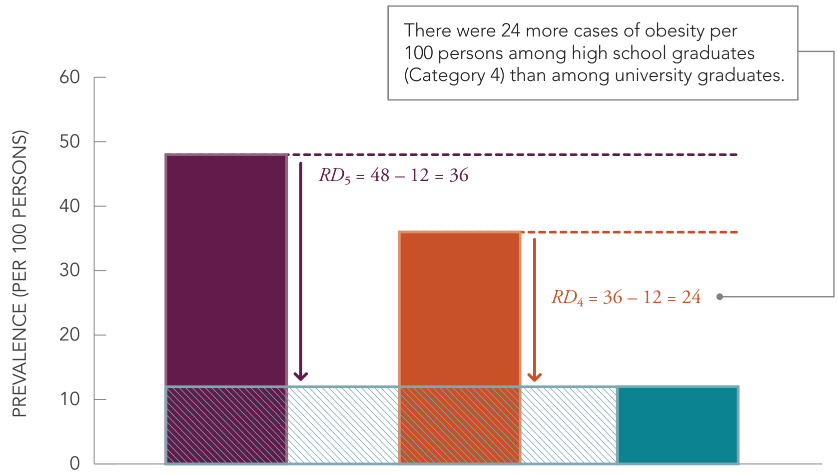
Question: How many more cases of obesity, per 100 persons, were reported in the population group of high school graduates compared to the population group of university degree graduates?

Calculation (Figure 2): Using the same example as above, persons with a high school diploma (group of interest) experienced a higher prevalence of obesity (R_4 = 36 cases per 100 persons) than those with a university degree, the reference group (R_0 = 12 cases per 100). To calculate RD_4, we would subtract 12/100 from 36/100, which gives us 24/100.

Answer: In Population A, there were 24 more cases of obesity per 100 persons among high school graduates compared to university graduates.

By using the same calculation method, we can also say that there were 36 more cases of obesity per 100 persons among the group with less than a high school education, compared to university graduates.

FIGURE 2: Illustration of Rate Difference in Population A



	Less than high school (Category 5)	High school graduate (Category 4)	University graduate (Reference)
Prevalence Rate	48	36	12
Rate Difference	36	24	–

Attributable Fraction (AF):

Attributable fraction (AF) quantifies the **potential rate reduction** (expressed as a percentage) **that could be achieved in the population group of interest** if they experienced the same rate as the reference group.

FORMULA:

$$AF_i = \left(\frac{R_i - R_o}{R_i}\right) \times 100$$

AF_i: Attributable fraction for the i-th population group of interest relative to the reference group

R_i: Rate of outcome among the i-th population group of interest

R_0: Rate of outcome among the reference group

AF < 0 (negative value) complex interpretation, result not presented, implies that the rate among the population group of interest is lower than in the reference group

EXAMPLE 3—ATTRIBUTABLE FRACTION:

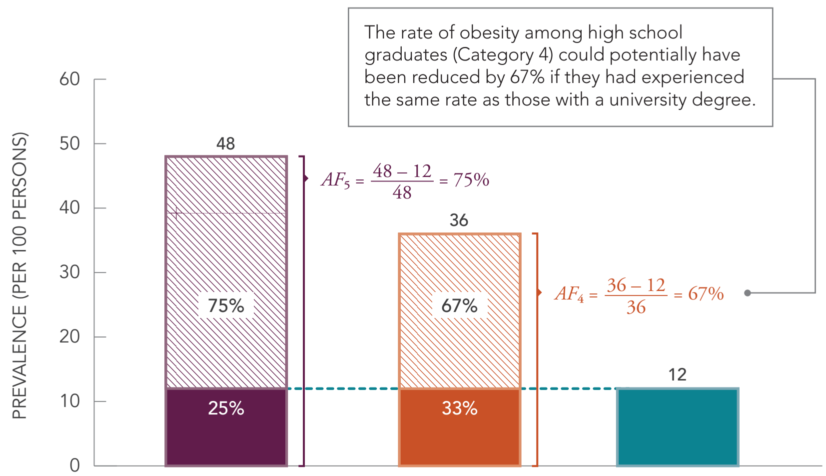
Question: What is the hypothetical reduction in obesity (expressed as a percentage) in the population group of high school graduates **if** they had had obesity rates identical to the population group of university graduates?

Calculation (Figure 3): Using the same example as above to calculate AF_4, we would subtract 12/100 from 36/100, which gives us 24/100. We would then divide 24/100 by 36/100 (R_4, the rate in the group of interest), which gives us 0.67, which we then multiply by 100 to get a percentage, resulting in 67%.

Answer: In Population A, the rate of obesity among high school graduates could potentially have been reduced by 67% if they had experienced the same rate as those with a university degree.

We can also say that the rate of obesity among the group with less than a high school education could have been reduced by 75% if they had experienced the same rate as those with a university degree.

FIGURE 3: Illustration of Attributable Fraction (AF) in Population A



	Less than high school (Category 5)	High School graduate (Category 4)	University graduate (Reference)
Prevalence Rate	48	36	12
Rate Difference	36	24	–
Attributable Fraction (%)	75%	67%	–

Population Attributable Fraction (PAF):

The Population Attributable Fraction (PAF), also known as Potential Rate Reduction (PRR), quantifies the **potential rate reduction** (expressed as a percentage) **that could be achieved in the total population** in the hypothetical situation in which a population group of interest experienced the same rate as the reference group.

FORMULA:

$$PAF_i = P_i \left(\frac{RR_i - 1}{RR_i} \right) \times 100$$

PAF_i: Population Attributable Fraction specific to the i-th population group of interest

P_i: Proportion of total cases in the population associated with the i-th population group of interest

RR_i: Rate Ratio for the i-th population group of interest relative to the reference group

PAF > 0 (positive value) value by which the rate in the total population could be reduced if the population group of interest had the same rate as the reference group

PAF < 0 (negative value) complex interpretation, result not presented, implies that the rate among the population group of interest is lower than in the reference group

POPULATION PREVENTABLE FRACTION (PPF):

PPF was used in scenarios where higher rates of an outcome are desirable (i.e., the outcome is protective), such as having access to dentist or medical doctor, or reporting high fruit and vegetable consumption. PPF represents the **potential rate increase** (in protective outcome, expressed as a percentage) in the **total population** if a population group of interest experienced the same rate as the reference group.

FORMULA:

$$FPP_i = \frac{P_i(1 - RT_i)}{P_i(1 - RT_i) + RT_i} \times 100$$

PPF_i: Population Preventable Fraction specific to the i-th population group of interest

P_i: Proportion of total cases in the population associated with the i-th population group of interest

RR_i: Rate Ratio for the i-th population group of interest relative to the reference group

EXAMPLE 4—POPULATION ATTRIBUTABLE FRACTION:

Question: By what proportion would the prevalence of obesity have been reduced in Population A if high school graduates had experienced the same obesity rates as university graduates?

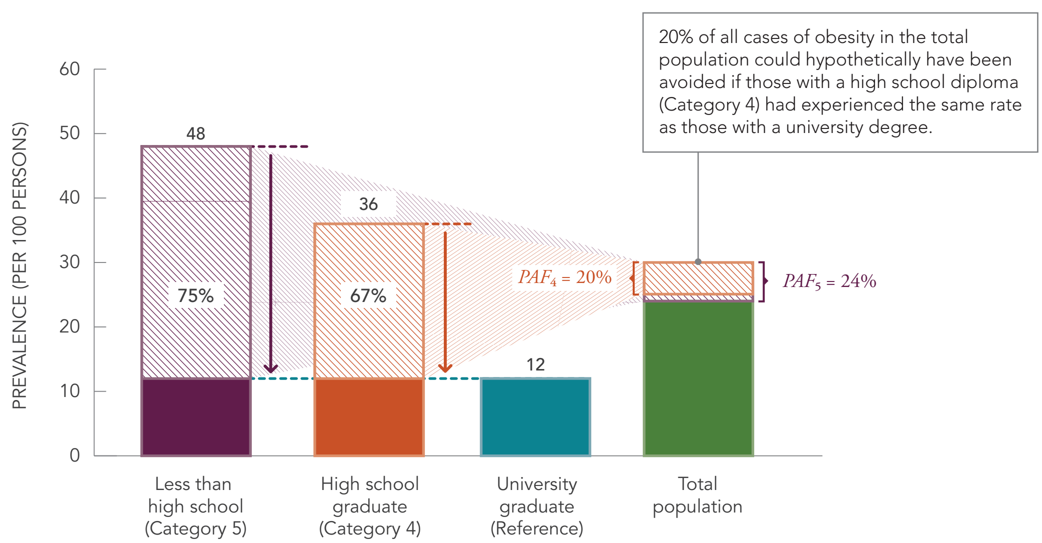
Calculation: (Figure 4): Continuing with the same example as above, we already calculated a RR_4 of 3. In order to calculate PAF_4 we need to know P_4, the percentage of all cases of obesity in the population that fall in the group of interest (high school education, Category 4). Table 2 shows that 30% of all cases of obesity fall into that group, therefore PAF_4 would equal:

$$0.3 \left(\frac{3-1}{3}\right) \times 100 = 20\%$$

Answer: In Population A, 20% of all cases of obesity in the total population could hypothetically have been avoided if those with a high school diploma had experienced the same prevalence of obesity as those with a university degree.

Similarly, if those with less than a high school education had experienced the same prevalence of obesity as those with a university degree, 24% of all cases of obesity in the total population could hypothetically have been avoided.

FIGURE 4: Illustration of Population Attributable Fraction (PAF) in Population A



Population Attributable Rate (PAR):

The Population Attributable Rate (PAR) quantifies the potential **absolute rate reduction in the total population that could be achieved** if the population group of interest experienced the same rate as the reference group.

FORMULA:

$$PAR_i = P_t \times PAF_i$$

PAR_i: Population attributable rate specific to the i-th population group of interest

P_t: Proportion of total outcome in the total population

PAF_i: Population Attributable Fraction specific to the i-th population group of interest

PAR > 0 (positive value) value by which the rate in the total population could be reduced if the population group of interest had the same rate as the reference group

PAR < 0 (negative value) complex interpretation, result not presented, implies that the rate among the population group of interest is lower than in the reference group

EXAMPLE 5—POPULATION ATTRIBUTABLE RATE:

Question: What would the potential rate[3] reduction have been in the **total obesity prevalence in Population A** if high school graduates had experienced the same obesity prevalence as university graduates?

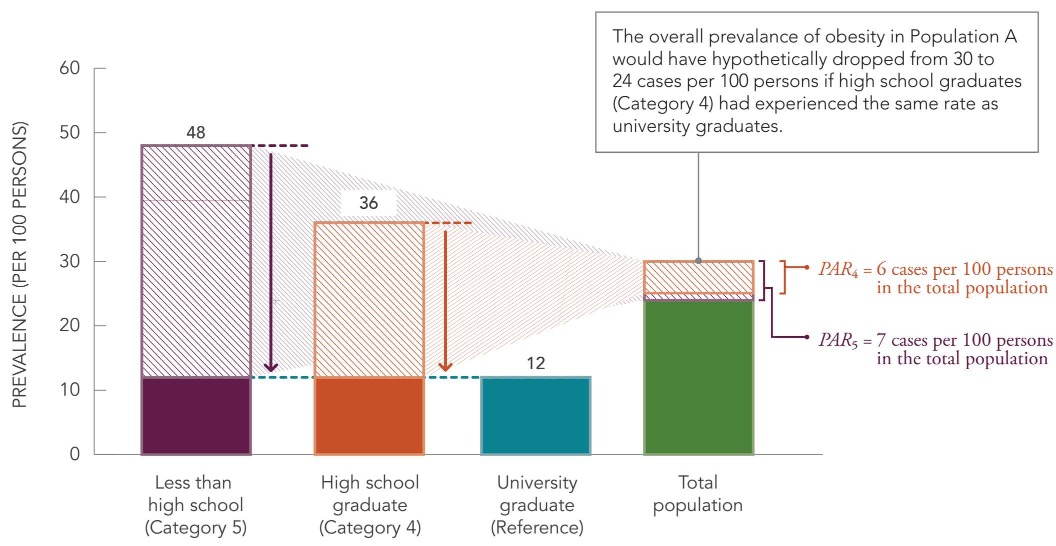
Calculation: Continuing with the same example as above, we already calculated a PAF_4 of 20%. In order to calculate PAR_4 we need to know P_t, the prevalence of obesity in the total population. The data provided in Table 2 show that P_t is 30 cases per 100 persons. PAR_4 would therefore equal 0.3 x 0.2, giving us 0.06 (or 6 cases per 100 persons).

Answer: The total prevalence of obesity in Population A could have been reduced by 6 cases per 100 persons if high school graduates experienced the same prevalence of obesity as university graduates. This would have represented a drop from 30 cases per 100 persons to 24 cases per 100 persons; in other words, the prevalence of obesity in Population A would have dropped from 30% to 24%.

We can also say that the total prevalence of obesity in Population A could have been reduced by 7 cases per 100 persons if people with less than a high school degree had experienced the same prevalence of obesity as university graduates. This would have represented a drop from 30 cases per 100 persons to 23 cases per 100 persons; in other words, the prevalence of obesity in Population A would have dropped from 30% to 23%.

[3] **NOTE:** Prevalence rate is expressed as a percentage (%), i.e., per 100 persons

FIGURE 5: Illustration of Population Attributable Rate (PAR) in Population A



Population Impact Number (PIN):

The Population impact number (PIN) quantifies the **potential reduction in the number of cases that would occur in the <u>total population</u>** in the hypothetical situation in which the population group of interest experienced the same rate as the reference group.

FORMULA:

$$PIN_i = N \times (P_t \times PAF_i)$$

or

$$PIN_i = N \times (PAR_i)$$

PIN_i: Population Impact Number specific to the i-th population group of interest

N: Number of people in the population

P_t: Proportion of the total population experiencing the outcome

PAF_i: Population Attributable Fraction specific to the i-th population group of interest

PAR_i: Population Attributable Rate specific to the i-th population group of interest

PIN < 0 (negative value) not interpretable, result not presented, implies that the rate among the population group of interest <u>is lower</u> than in the reference group

EXAMPLE 6—POPULATION IMPACT NUMBER:

Question: How many reported cases of obesity in Population A could have been avoided if high school graduates had experienced the same obesity rates as university graduates?

Calculation: Continuing with the same example as above, we calculated a PAR_4 of 0.06. In order to calculate PIN_4 we need to know N, the number of people in the population. Table 2 shows us that N equals 2,000 persons. Therefore, PIN_4 would equal 2,000 x 0.06, giving us 120 cases.

Answer: In Population A, 120 cases of obesity could have been avoided in the total population if those with a high school diploma had experienced the same rate as university graduates.

By using the same calculation method, we can also say that In Population A, 140 cases of obesity could have been avoided in the total population if those with less than a high school education had experienced the same rate as university graduates.

FIGURE 6: Illustration of Population Impact Number (PIN) in Population A