Standardized Incidence or Mortality Ratio tool methodology

SIMR is a summary measure of the indirect method for the rate standardization. Before defining SIMR, it is important to know the concepts of Crude Rate, Specific Rate and Age Standardized Rate by the Indirect Method.

1. Crude rate (CR)[1–3]

- X: Number of events
- N: Population at risk

$$\mathrm{CR} = \frac{\mathrm{X}}{\mathrm{N}} \cdot 100000 \text{ person-year}$$

2. Specific Rate (SR) by age group[1–3]

- X_i: Number of events for the i-th age group where $\sum_{i=1}^{k} X_i = X$, i = 1, ..., k
- Ni: Population at risk for the i-th age group where $\sum_{i=1}^{k} N_i = N$, i = 1, ..., k

$$\mathrm{SR_i} = \frac{\mathrm{X_i}}{\mathrm{N_i}} \cdot 100000 \text{ person-year}$$

3. Age Standardized Rate by the Indirect Method (ASR_{IM})[1–4]

Let us define:

- w_i: weight of the population of study for the i-th age group where $\sum_{i=1}^{k} w_i = 1$ for i=1, …, k.
- SR_i^*: the reference population age-specific rate for i = 1, …, k

Then, ASR_{IM} is defined as:

$$\mathrm{ASR_{IM}} = \sum_{i=1}^{k} \mathrm{SR_i^*} \cdot \mathrm{w_i} \text{ person-year}$$

4. Standardized Incidence or Mortality Ratio (SIMR) [1–4]

The SIMR is the ratio of a study population's mortality or incidence rate (CR) divided by its ASR_{IM}:

$$\mathrm{SIMR} = \frac{\mathrm{CR}}{\mathrm{ASR_{IM}}} \cdot 100$$

If we break down CR as follows:

$$\mathrm{CR} = \frac{\mathrm{X}}{\mathrm{N}} = \frac{\sum_{i=1}^{k} \mathrm{X_i}}{\mathrm{N}} = \frac{\sum_{i=1}^{k} \mathrm{N_i} \frac{\mathrm{X_i}}{\mathrm{N_i}}}{\mathrm{N}} = \frac{\sum_{i=1}^{k} \mathrm{N_i SR_i}}{\mathrm{N}} = \sum_{i=1}^{k} \mathrm{w_i\ SR_i}$$

Then,

$$\mathrm{SIMR} = \frac{\mathrm{CR}}{\mathrm{ASR_{IM}}} \cdot 100 = \frac{\sum_{i=1}^{k} \mathrm{w_i \cdot SR_i}}{\sum_{i=1}^{k} \mathrm{w_i \cdot SR_i^*}} \cdot 100 = \frac{\sum_{i=1}^{k} \frac{\mathrm{N_i}}{\mathrm{N}} \cdot \frac{\mathrm{X_i}}{\mathrm{N_i}}}{\sum_{i=1}^{k} \frac{\mathrm{N_i}}{\mathrm{N}} \cdot \mathrm{SR_i^*}} \cdot 100 = \frac{\sum_{i=1}^{k} \mathrm{X_i}}{\sum_{i=1}^{k} \mathrm{N_i \cdot SR_i^*}} \cdot 100 = \frac{\mathrm{X}}{\sum_{i=1}^{k} \mathrm{N_i \cdot SR_i^*}} \cdot 100$$

where:

$$\sum_{i=1}^{k} \mathrm{N_i \cdot SR_i^*} = \mathrm{E}$$

So, the SIMR can be interpreted as the ratio of cases or deaths observed (X) to those expected (E) on the basis of the incidence or mortality rates of some population.

$$\mathrm{SIMR} = \frac{\mathrm{X}}{\mathrm{E}}$$

An SIMR of 100% means that there are no differences between the number of observed cases in the study population and the number of expected cases in the reference population.

5. Confidence intervals for SIMR[1,2,5,6]

Poisson distribution is used to calculate a 100 (1-α)% confidence interval for the observed number of cases, and then the upper and lower limits of that confidence interval are used into the standard formula of SIMR to obtain the confidence interval for SIMR.

The 100 (1-α)% confidence interval for the number of cases is calculated as follow:

- If X > 0, then, the lower limit (LL) and the upper limit (UL) for the number of cases are:

$$\mathrm{LL(X)} = \frac{\chi^2\left(\frac{\alpha}{2},\ 2 \cdot \mathrm{X}\right)}{2}$$

$$\mathrm{UL(X)} = \frac{\chi^2\left((1-\alpha) + \frac{\alpha}{2},\ 2(\mathrm{X}+1)\right)}{2}$$

- If X = 0, then, the lower limit (LL) and the upper limit (UL) for the number of cases are:

$$\mathrm{LL}(\mathrm{X}) = 0$$

$$\mathrm{UL}(\mathrm{X}) = -\log(\alpha)$$

Finally, the lower and upper limits of SIMR are calculated as:

$$\mathrm{LL}(\mathrm{SIMR}) = \frac{\mathrm{LL}(\mathrm{X})}{\mathrm{E}}$$

$$\mathrm{UL}(\mathrm{SIMR}) = \frac{\mathrm{UL}(\mathrm{X})}{\mathrm{E}}$$

Where E are the expected cases defined above.

REFERENCES

1. Jensen O, Parkin D, MacLennan R, Muir C, Skeet R, editors. Cancer Registration: Principles and Methods. IARC Sci Publ. Lyon; 1991;95:1–288.
2. Esteve J, Benhamou E, Raymond L. Statistical Methods in Cancer Research. Volume. IV. Descriptive Epidemiology. IARC Sci Publ. Lyon; 1994;128:1–302.
3. Breslow NE, Day NE. Statistical methods in cancer research. Vol. II. The design and analysis of cohort studies. IARC Sci Publ. Lyon: International Agency for Research on Cancer; 1987;82:1–406.
4. Rué M, Borrell C. Los métodos de estandarización de tasas. In: Porta M, Álvarez-Dardet C, Ruiz MT, Guardiola E, editors. Revisiones en salud pública, 3. Barcelona: Masson, S.A.; 1993. p. 263–95.
5. Washington State Department of Health. Guidelines for Using Confidence Intervals for Public Health Assessment [Internet]. 2013. Available from: http://www.doh.wa.gov/Portals/1/Documents/5500/ConfIntGuide.pdf
6. Department of Mathematics and Statistics McMaster University. Confidence Intervals for the Mean of a Poisson Distribution [Internet]. 1997 [cited 2016 Oct 20]. Available from: http://ms.mcmaster.ca/peter/s743/poissonalpha.html