

Disease Mapping Spatial Statistics

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- Recall basic concepts of standardisation
- Apply these to some examples
- Learn about limitations of standardisation

Why use standardization?

- Incidence of most diseases is age-dependent
- Mortality is age-dependent
- Age structure differs between countries or regions
- Age-standardization is important when comparing rates!

Types of standardization

- Direct standardization
- Indirect standardization

- Direct standardization refers to the age distribution in a standard population.
- Indirect standardization refers to the age-specific rates in a reference population.

$$\text{Standardised Rate} = \frac{\sum_{i=1}^k N_i \cdot p_i}{\sum_{i=1}^k N_i}$$

- N_i : Number of individuals in i -th age stratum of the standard population
- p_i : Age specific rate in the i -th age stratum of the population of interest

$$\text{Standardised Rate} = \frac{\sum_{i=1}^k r_i}{\sum_{i=1}^k n_i \cdot P_i}$$

- n_i : Number of individuals in i -th age stratum of the population of interest
- P_i : Age specific rate in the i -th age stratum of the reference population
- r_i : Age specific rate in the i -th age stratum of the population of interest

$$\sum_{i=1}^k n_i \cdot P_i : \text{Expected number of events}$$

- Direct standardization: Results in rates
- Indirect standardization: Results in a ratio without dimension („SMR“)

Direct standardization: Please calculate!

Number at Risk in Age Stratum	Cases in Age Stratum	Rate (per 100,000)
10,000	6	60
20,000	15	75
30,000	75	250
40,000	160	400
50,000	300	600

Number at Risk in Age Stratum of Standard Population	Percent in Age Stratum	Cases in Age Stratum of Standard Population	Rate (per 100,000)
12,000,000	12	NA	NA
16,000,000	16	NA	NA
20,000,000	20	NA	NA
24,000,000	24	NA	NA
28,000,000	28	NA	NA

Waller LA et al. Applied Spatial Statistics for Public Health Data.
Wiley (New York) 2004

Indirect standardization: Please calculate!

Number at Risk in Age Stratum	Cases in Age Stratum	Rate (per 100,000)
10,000	NA	NA
20,000	NA	NA
30,000	NA	NA
40,000	NA	NA
50,000	NA	NA
(total = 556)		

Number at Risk in Age Stratum of Standard Population	Percent in Age Stratum	Cases in Age Stratum of Standard Population	Rate (per 100,000)
12,000,000	12	7,200	60
16,000,000	16	16,000	100
20,000,000	20	40,000	200
24,000,000	24	72,000	300
28,000,000	28	140,000	500

Waller LA et al. Applied Spatial Statistics for Public Health Data.
Wiley (New York) 2004

Standardization is no cure-all solution:

- Crude rates reflect the real situation (irrespective of underlying causes)
- What if rates vary in different ways across various strata?
- Stratification may be useful...
- ...but only if numbers in strata are not too small...
- ...and if there are not too many strata.

For examples regarding different ways of variation across different strata see e.g.:

- Kitagawa EM. Theoretical considerations in the selection of a mortality index, and some empirical comparisons. *Human Biology* 1966; 38: 293-308
- El-Badry MA. Higher female than male mortality in some countries of south Asia: A digest. *Journal of the American Statistical Association* 1969; 64:1234-1244

Think about this...

Age-specific rates of abnormal lung functioning in males employed in manufacturing or service industries.

Age interval	Manufacturing		Service	
	N	% Abnormal	N	% Abnormal
20-<29	403	2.2	256	4.8
30-<39	688	3.2	525	3.2
40-<49	683	2.2	599	2.8
50-<59	539	6.9	453	6.6
60 +	133	12.8	155	9.0

Fleiss JL. Statistical Methods For Rates And Proportions. Wiley (New York) 1981

- Standardization accounts for e.g. different age distribution in regions.
- Crude rates reflect the real public health situation.
- Standardization is no cure-all solution.
- Results have to be evaluated with care.