

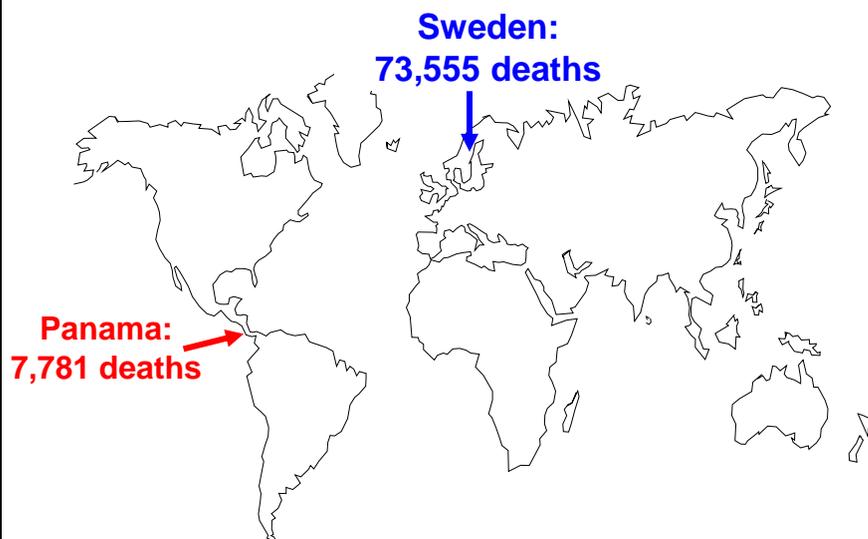
DIRECT and INDIRECT STANDARDIZATION

comparing populations with different sex- age-
structure

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Mortality in 1962



Mortality in 1962

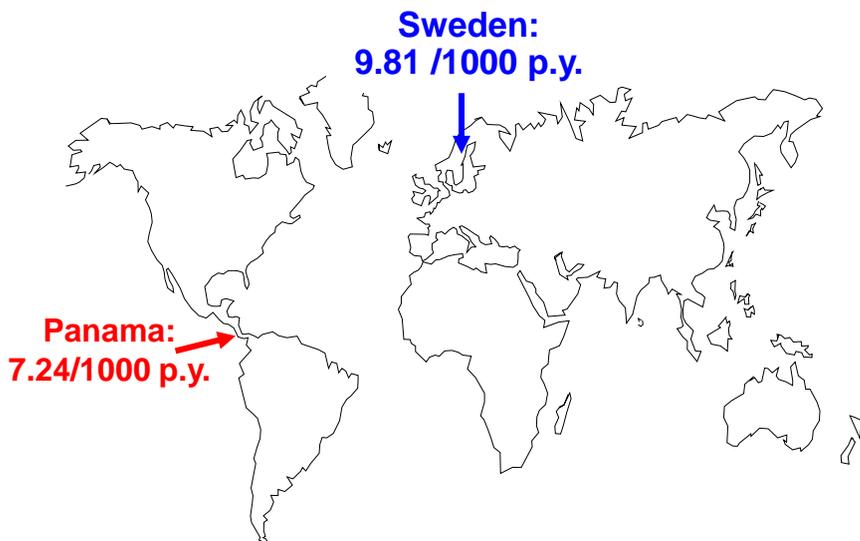
in Sweden:

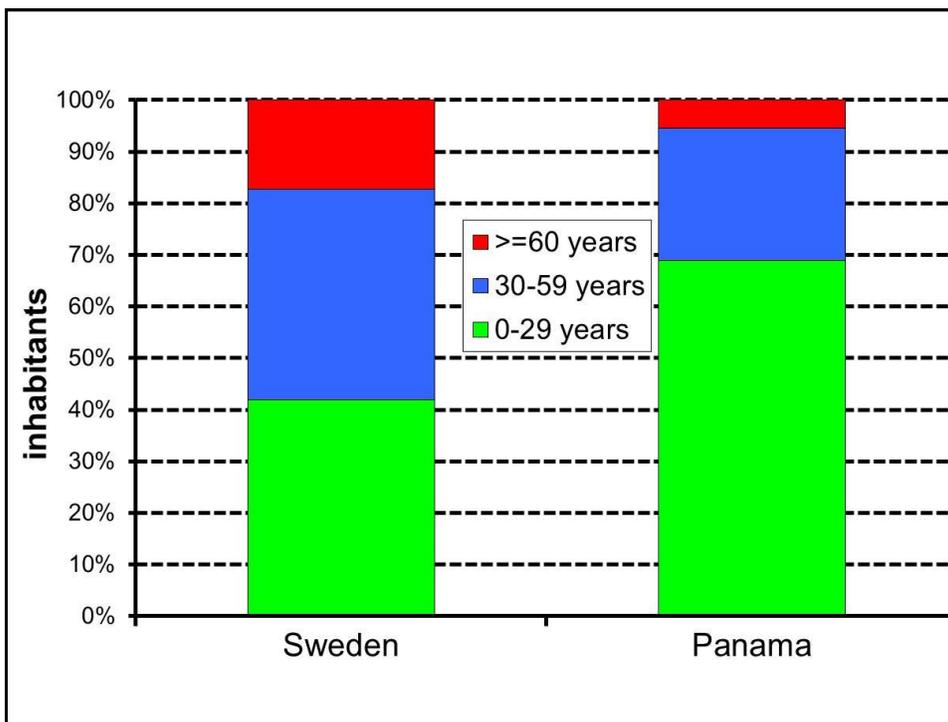
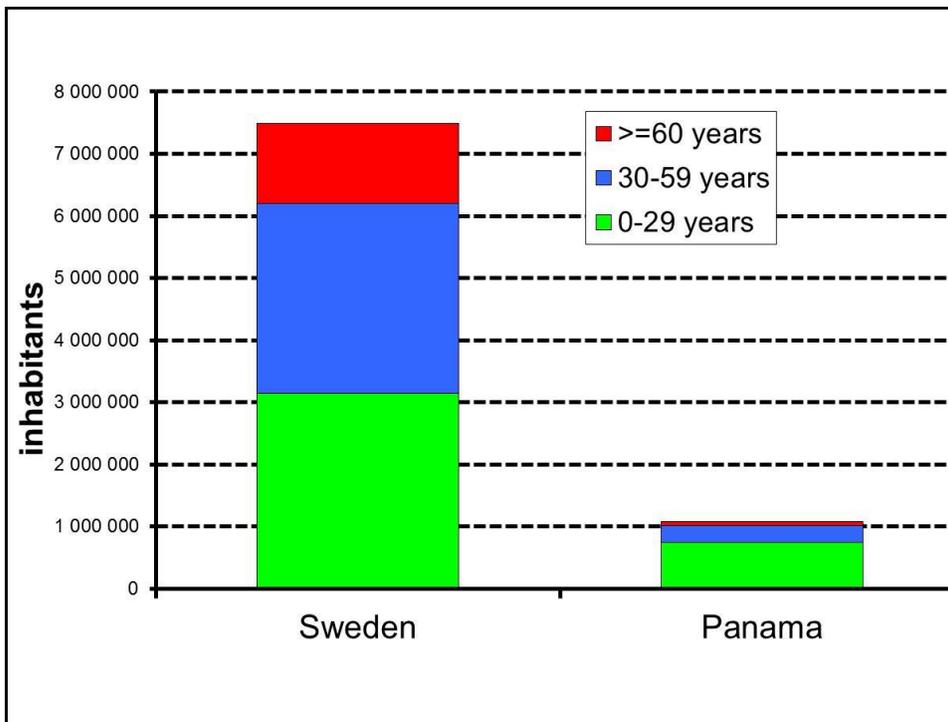
deceased = 73,555
population = 7,496,000
crude mortality rate = $73,555/7,496,000 = 9.81/1000$ person*years

in Panama:

deceased = 7,781
population = 1,075,000
crude mortality rate = $7,781/1,075,000 = 7.24/1000$ person*years

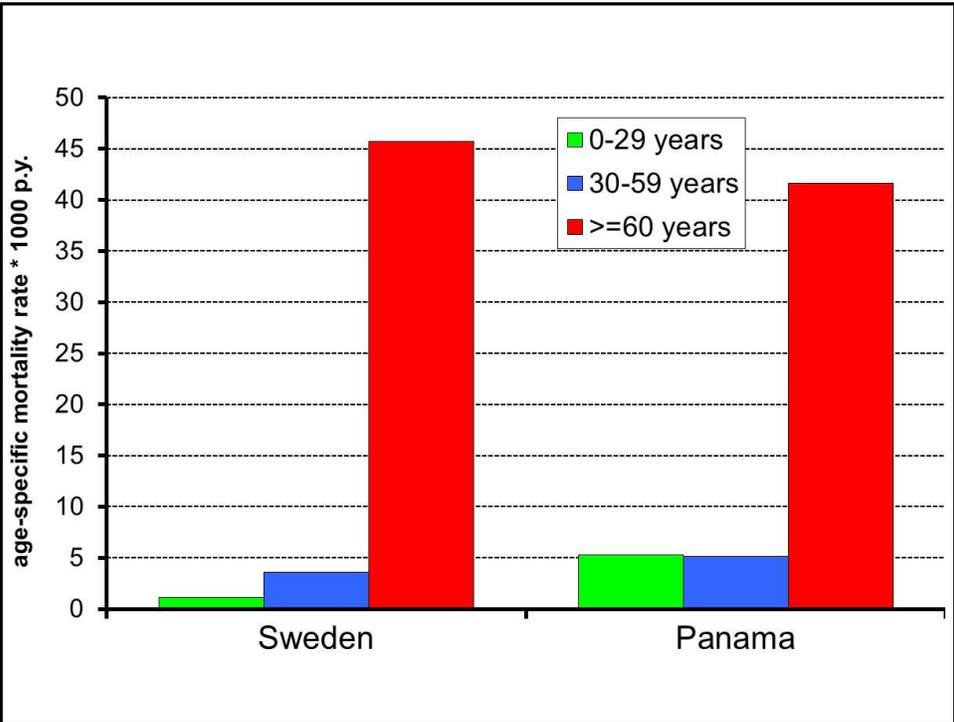
Mortality rate in 1962





SWEDEN			
	0-29 years	30-59 years	>=60 years
deaths	3,523	10,928	59,104
Population	3,145,000	3,057,000	1,294,000
Mortality rate	1.12 / 1000 py	3.57 / 1000 py	45.68 / 1000 py

PANAMA			
	0-29 years	30-59 years	>=60 years
deaths	3,904	1,421	2,456
Population	741,000	275,000	59,000
Mortality rate	5.27 / 1000 py	5.17 / 1000 py	41.63 / 1000 py



STANDARDIZATION = Statistical technique which enables to adjust mortality (incidence) rates by taking into account the different age- sex- structures of populations under comparison.

This technique employs a **set of weights**, which are common to the populations to compare.

A reference population is used, to recalculate the number of deaths.

$$\text{deaths} = \text{inhabitants} * \text{mortality rate}$$

Direct standardization:
The reference population provides the inhabitants for sex- age-specific classes.

Indirect standardization:
The reference population provides the sex- age-specific mortality rates

Usefulness of Standardization with respect to sex- age-specific rates:

1. A single synthetic index for a given population is easier to compare with synthetic indexes of other populations.
2. If the number of events is low in some strata, corresponding rates are imprecise and unreliable.

Direct standardization

INFORMATION NEEDED TO APPLY THE METHOD:

- Sex- age-specific mortality rates of the population under study
- Sex- age-structure of the reference population

The method computes the EXPECTED deaths in the reference population, if the latter had the same mortality of the population under study.

DIRECT STANDARDIZATION

Let's use the following population structure	<u>Age classes</u>	<u>Class size</u>
	0-29 years	400,000
	30-59 years	400,000
	<u>≥ 60 years</u>	<u>200,000</u>
	total	1,000,000 inhabitants

	Age	Specific rate	Inhabitants (Reference pop.)	Expected deaths	Standardized rate
Sweden	0-29 years	1.12/1000 p.y. *	400,000 p.y. =	448	
	30-59 years	3.57/1000 p.y. *	400,000 p.y. =	1428	11,012/1,000,000 p.y. 11.0/1000 p.y.
	≥ 60 years	45.68/1000 p.y. *	200,000 p.y. =	9136	
Panama	0-29 years	5.27/1000 p.y. *	400,000 p.y. =	2108	
	30-59 years	5.17/1000 p.y. *	400,000 p.y. =	2068	12,502/1,000,000 p.y. 12.5/1000 p.y.
	≥ 60 years	41.63/1000 p.y. *	200,000 p.y. =	8326	

Standardized Rate Ratio (SRR) = $\frac{12.5/1000 \text{ p.y.}}{11.0/1000 \text{ p.y.}}$ = 1.135
 (Rapporto tra tassi standardizzati)

Mortality in Panama is 13.5% higher than in Sweden.

Indirect standardization

INFORMATION NEED TO APPLY THE METHOD:

- Number of deaths in the population under study
- Sex- age-structure of the population under study
- Sex- age-specific mortality rates of the reference population

The method computes the EXPECTED deaths in the population under study, if the latter had the same mortality of the standard population.

Indirect standardization

Let's standardize mortality rate in Panama, using as reference the Swedish population.

$$\begin{aligned} \text{Standardized mortality ratio (SMR)} &= \\ \text{(Rapporto di mortalità standardizzato)} &= \\ &= (\text{observed deaths}) / (\text{expected deaths}) \end{aligned}$$

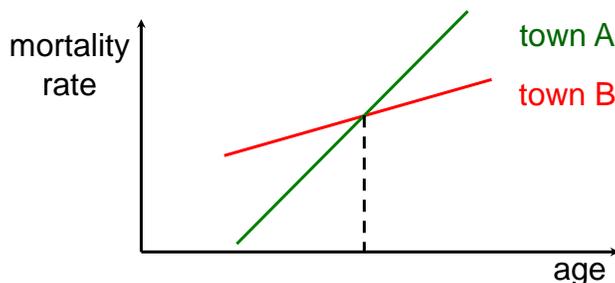
Observed deaths in Panama = 7781

Expected deaths in Panama = ?

Age	Inhabitants (Panama)	Specific rate (Reference pop.)	Expected deaths	SMR
0-29 years	741,000 p.y. *	1.12 / 1000 p.y.	= 829.9	
30-59 years	275,000 p.y. *	3.57 / 1000 p.y.	= 981.75	7,781/4506.8 =
>= 60 years	59,000 p.y. *	45.68 / 1000 p.y.	= 2695.1	
			4506.75	1.73

CHOOSING THE APPROPRIATE REFERENCE POPULATION

The reference population is usually the national, European or world population. It can also be the largest population among those considered or the average population. The choice of the reference population can largely affect the results, especially when the age pattern of mortality differs between the populations under comparison.



Reference population	standardized rates
if: the weights are all equal	A = B
the weights are greater for the elderly	A > B
the weights are greater for the youngsters	A < B

Which is better ? Direct or indirect standardization ?

Direct method

Advantages: the population structure is taken from the reference population, and hence is kept constant. Hence standardized rates are directly comparable.

Disadvantages: precision of the estimates is lower, especially when there are few cases in some age strata.

Indirect method

Advantages: the population structure, being taken from the populations under study, changes from one population to another one. Hence SMRs are not directly comparable.

Disadvantages: As mortality rates are taken from the reference population, estimates are more precise. The indirect method is the method of choice when cases are few.

CRUDE ANALYSIS						
Age classes	general female population			diabetic women		
	population	deaths	mortality rate deaths/1000 py	population	deaths	mortality rate deaths/1000 py
0-29 years	25000	25	1,00	100	0	0,00
30-59 years	40000	80	2,00	800	6	7,50
>=60 years	25000	750	30,00	2500	100	40,00
total	90000	855	9,50	3400	106	31,18
			rate in diabetics / rate in the general population			
			Rate ratio = 31,18 / 9,50			
			(Rischio relativo)= 3,282			

Does diabetes mellitus increase mortality three-fold in women?

DIRECT STANDARDIZATION				
The reference population provides the population structure				
	general female		diabetic women	
Age classes	Population		mortality rate	Expected deaths
			deaths/1000 py	
0-29 years	25000	*	0,00	= 0,00
30-59 years	40000	*	7,50	= 300,00
>=60 years	25000	*	40,00	= 1000,00
total	90000			1300
total expected deaths / reference population				
Standardized rate		=	1300 / 90000	
(tasso standardizzato)		=	14,44 /1000 person*years	
Standardized rate / rate in the reference pop.				
Standardized Rate Ratio		=	14,44 / 9,50	
Rapporto di tassi standardizzati		=	1,52	

INDIRECT STANDARDIZATION				
The reference population provides mortality rates				
	general female		diabetic women	
Age classes	population		population	expected deaths
	mortality rates		per age classes	
	Morti/1000 pa			
0-29 years	1,00	*	100	= 0,10
30-59 years	2,00	*	800	= 1,60
>=60 years	30,00	*	2500	= 75,00
total				76,70
observed deaths / expected deaths				
Standardized Mortality Ratio (SMR)		=	106 / 76,70	
(Rapporto di mortalità standardizzato)		=	1,382	

Diabetic women present a three-fold higher mortality than the female general population because they are older: mean age (\pm SD) of Verona diabetic women was 68.3 ± 12.2 years in 1986.

Diabetes mellitus does not triplicate mortality in women, but rather increases mortality by 40-50%.

Standardization can be applied to studies dealing not only with mortality but also with incidence.

In the latter case indirect standardization yields SIR (Standardized Incidence Ratio) rather than SMR (Standardized Mortality Ratio).