

Lexis diagram and system of demographic indicators

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Lexis diagram

- a. Deaths at completed age 2 years, from birth cohort 1989
- b. Deaths at reached age 2 years from birth cohort 1989
- c. Death at completed age 2 years in 1991.
- d. Deaths at completed age 11 years during 2002–2003
- e. Deaths at reached age 11 years during 2002 and 2003
- f. Deaths at completed age 2 years in 1991 from birth cohort 1989
- g. Deaths at completed age 11 and 12 years in 2002–2003
- h. Persons living at exact age 36 in years 2002–2003
- i. Persons living at completed age 15–17 at 1. 7. 1998.

Demographic indicators (I)

Absolute measures

- Components of population change ($P_{t+1} = P_t + N_t - D_t + I_t - E_t$)

Relative measures

- Relative frequencies, proportions (extensive)
- Rates and probabilities (intensive)

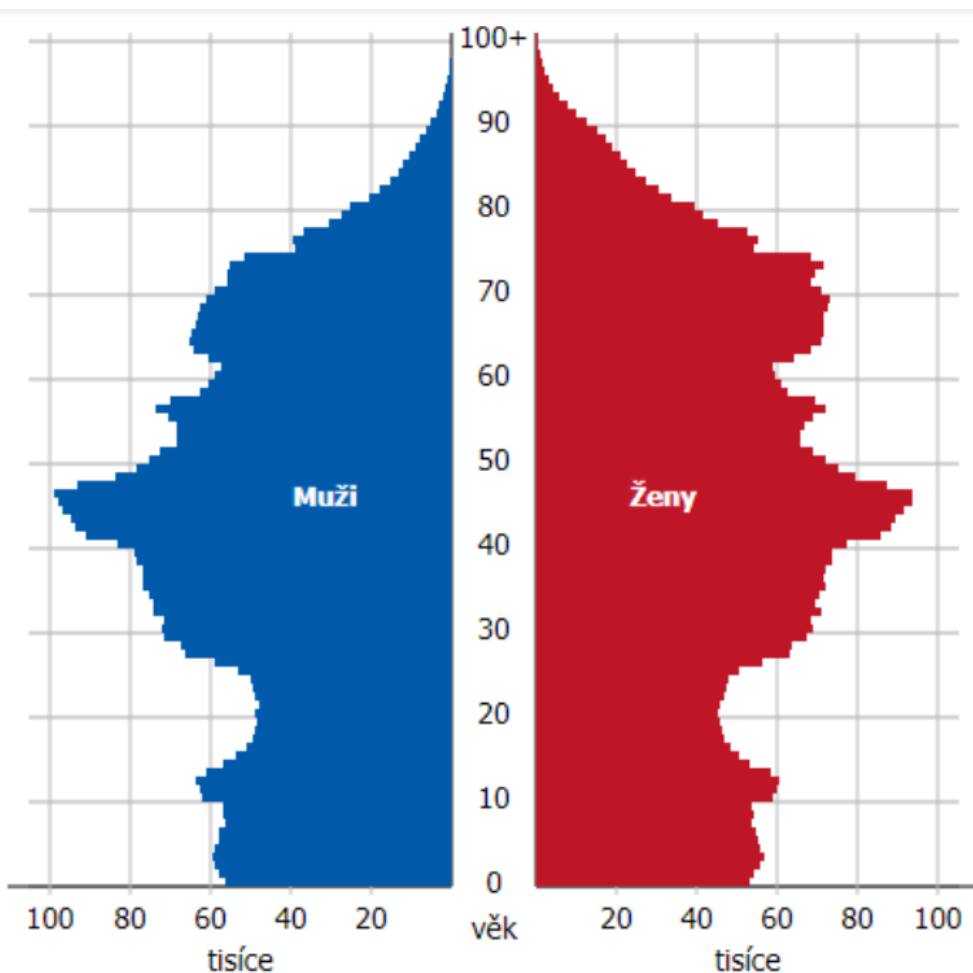
Ratios

- Indices

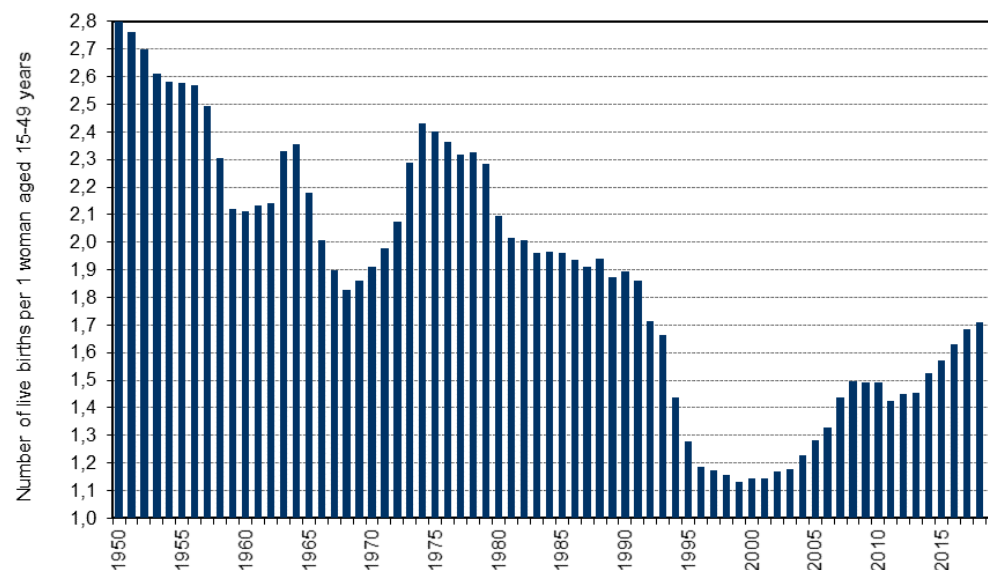
Demographic indicators (I) – drawbacks

Drawbacks examples: Analysing fertility with absolute numbers, severe covid and vaccination thru relative measures, age specific index of abortion

Age structure of Czechia at 1. 1. 2021



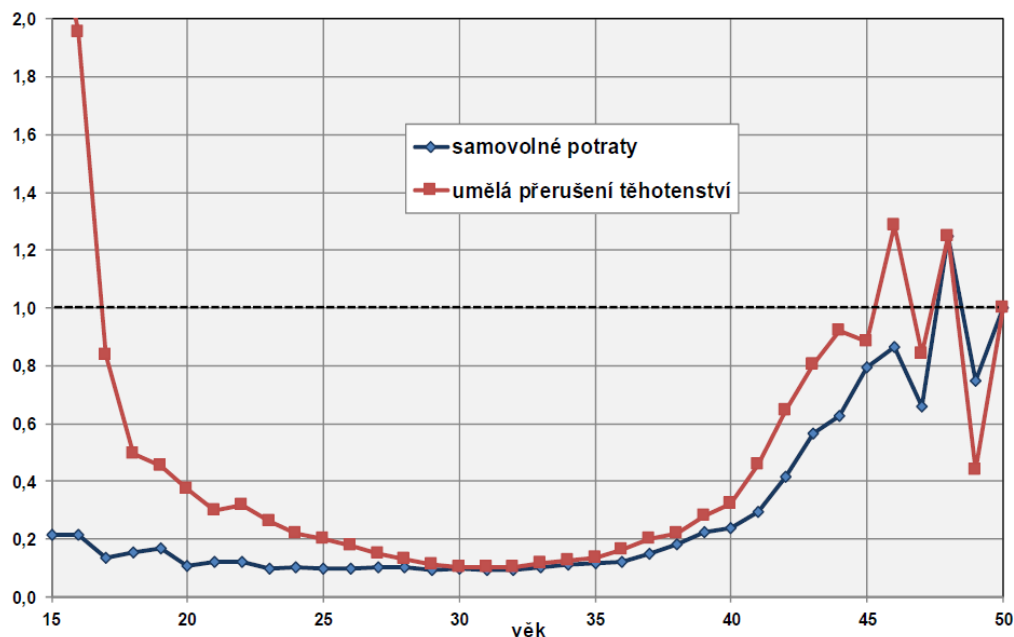
Total fertility rate (average number of children per woman), Czechia, 1950–2019



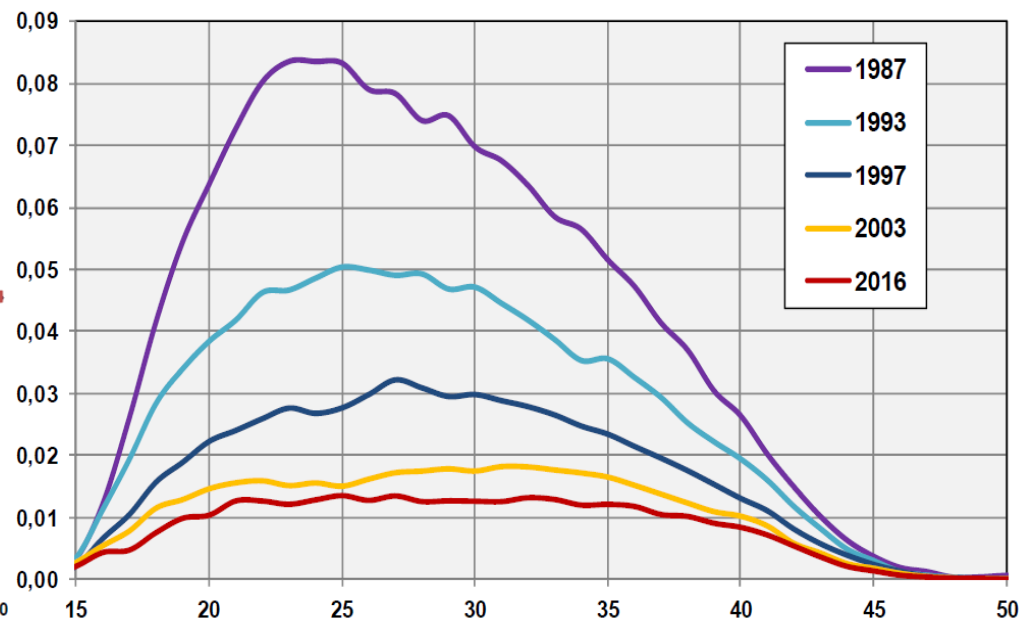
Demographic indicators (I) – drawbacks

Drawbacks examples: Analysing fertility with absolute numbers, severe covid and vaccination thru relative measures, age specific index of abortion

Age specific index of abortion, Czechia, 2016



Age specific abortion rates, Czechia, 2016



Demographic indicators (II)

Crude

- Crude death rate, crude birth rate...

General

- General fertility rate...

Analytical (synthetic)

- Total fertility rate, life expectancy...

Specific

- Age specific death rate...

Differential

- Age specific death rates by educational attainment, by parity...

Standardized, adjusted, corrected

- Standardized death rate...

Demographic indicators (III)

Provisional

Final

Revised

Corrected

Rates and probabilities

= Two major categories of measures used by demographers.

$$\text{rates} = \frac{\text{Number of occurrences of events}}{\text{Exposure}}$$

Exposure ~ Average size of a population during a given period ~ Number of person years
exposure to risk ~ Mid-year population at risk

$$\text{probabilities} = \frac{\text{Number of occurrences of events}}{\text{Population at risk at the beginning of the interval}}$$

Population at risk at the beginning of the interval ~ Population on 1st of January

Age specific mortality rate is denoted as u_x or m_x . Age specific probability is denoted as q_x . From that, these measures are sometimes called *m-rates* and *q-rates*, even though **both of them are not rates**.

Age specific mortality rates

- Events are either evitable (**avoidable**; birth of a child) or inevitable (**unavoidable**; death). Events can also be **repeatable** (birth of a child) or **unrepeatable** (death). These differences have implication for computations of rates and probabilities.
- If the events are avoidable, we distinguish between
 - Rates of the first type** (conditional rates, occurrence-exposure rates)
 - Rates of the second type** (unconditional rates, reduced rates)

Age specific unconditional fertility rate:	$f_x^i = \frac{N_x^i}{P_x^F}$	i	birth order of a child
		F	female
		x	age
Age specific conditional fertility rate:	$f_x^i = \frac{N_x^i}{P_x^{F,i-1}}$	N	number of birth
		P	population exposure

Age specific mortality rates

- Mortality rates can also be distinguished according to the sets of events they belong to.

1st primary sets

- Rates by horizontal parallelograms
- Rates by age completed and cohort



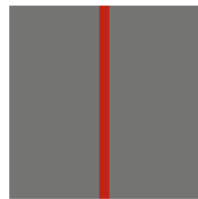
2nd primary sets

- Rates by vertical parallelograms
- Rates by age reached and a cohort

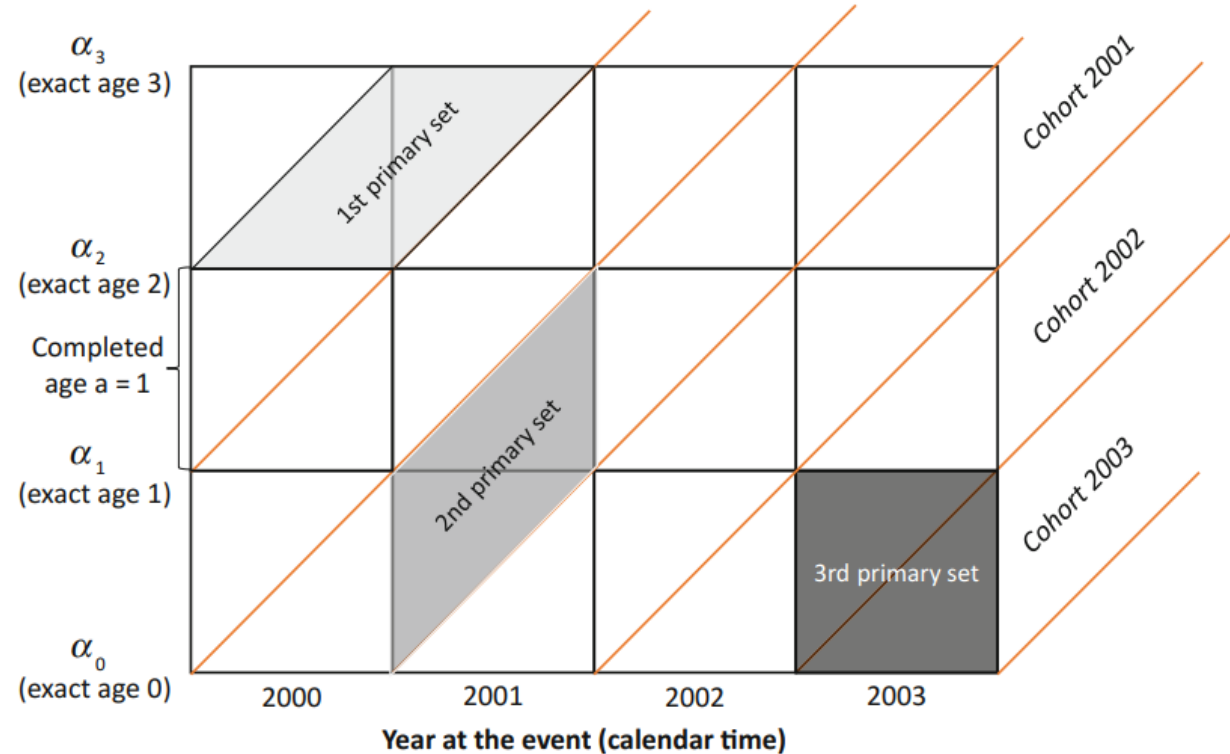


3rd primary sets

- Rates by squares
- Rates by age completed and a year (period)

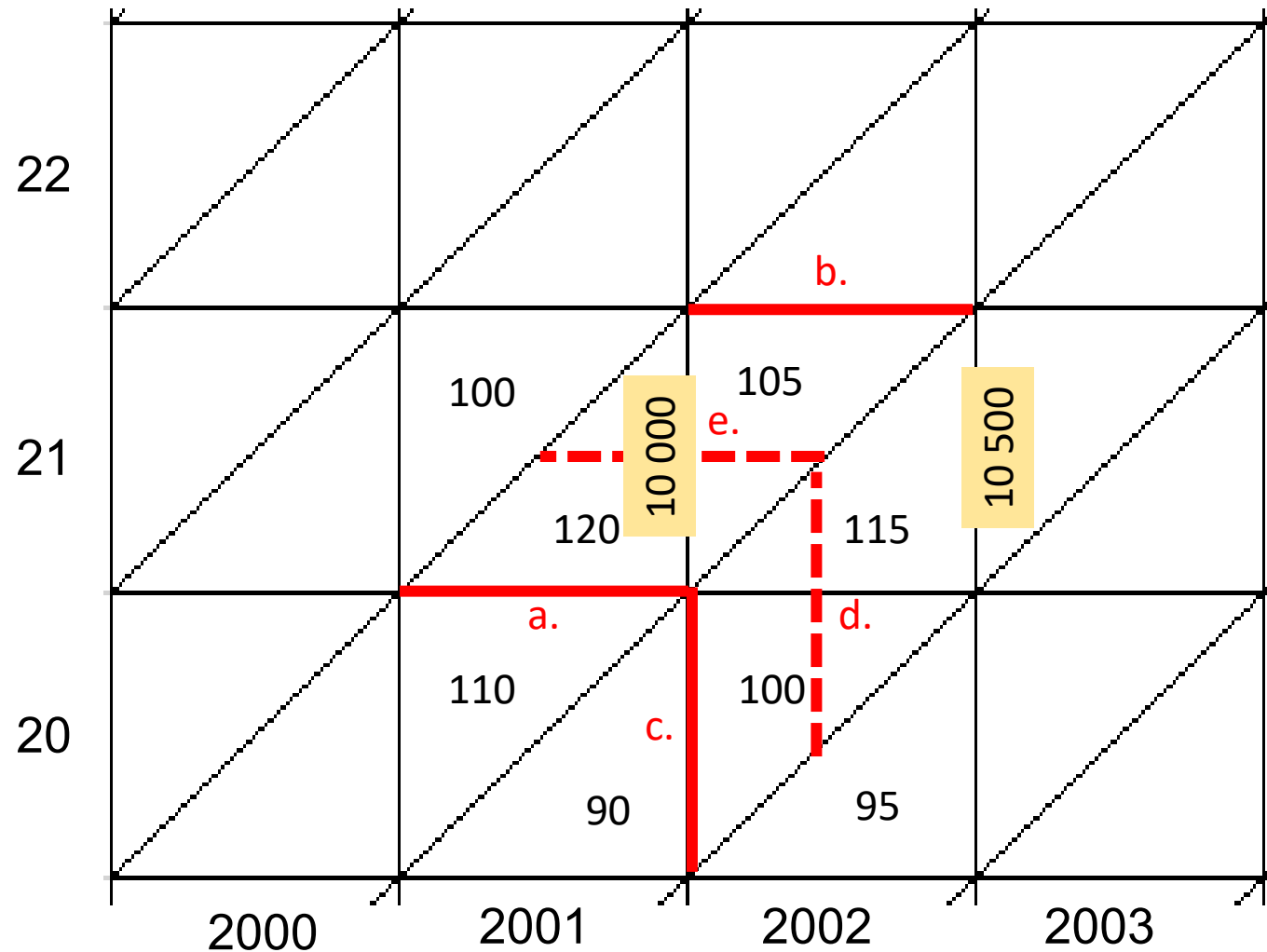


To calculate the rates, we need to sum right elementary sets and consequently, estimate population exposure.



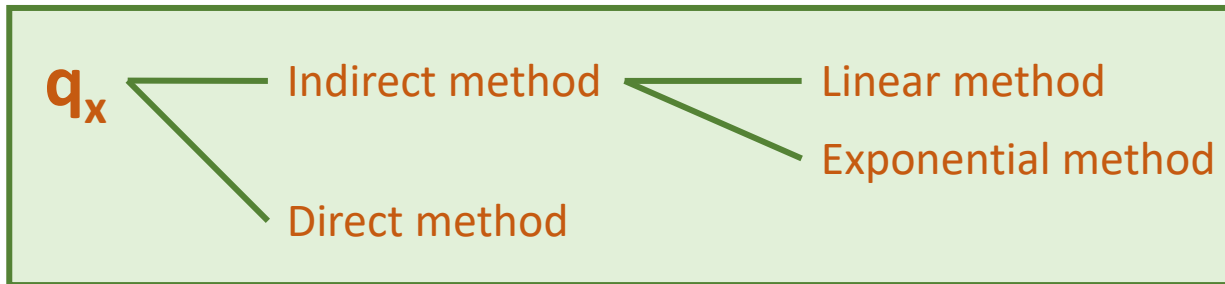
Exercise 2

Estimate a., b., c., d. and e.

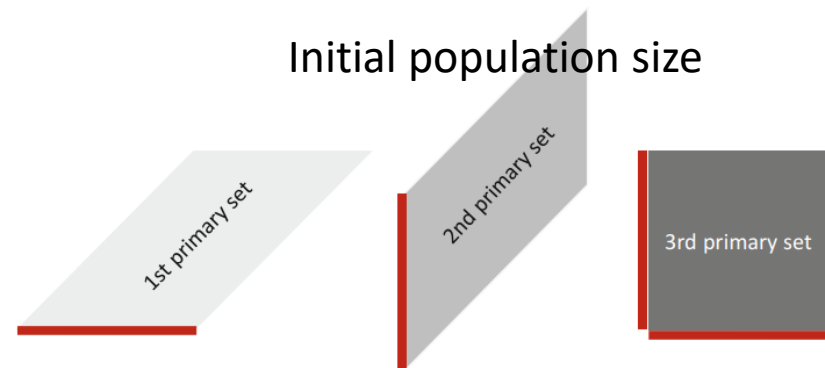


Age specific probabilities of death

- Age specific probabilities of death can be computed either directly or indirectly.
- The **indirect estimation** relies on derivation of probabilities from mortality rates.
- The **direct estimation** relies in direct computations from data (dividing events by population at the beginning of the interval, in other words by the initial population).



Today we will only estimate the probabilities with direct method, however, this does not mean, that this approach is more or less important than the other one.



Direct calculation of rates and probabilities: example

Draw following data to Lexis diagram:

Age	Birth cohort	1996D _x	Birth cohort	1997D _x	1.1.1996P _x	1.1.1997P _x
50	1946	351	1947	360	67 125	82 567
	1945	285	1946	349		
51	1945	307	1946	374	70 224	66 609
	1944	342	1945	319		

another
cohort **D** *attribute*
period *age*

Calculate age specific mortality rates a probabilities of dying:

1996–1997m₅₀
1996m_{50–51}
1996m₅₁
1996–1997q₅₀
1996q_{50–51}
1996q₅₁

Can be directly estimated from Lexis diagram

Can be directly estimated from Lexis diagram and a formulae has to be applied

Remember (in 3rd sets of events)

$${}^{c-c+1}_tq_x = (q_1 + q_2) - (q_1 \times q_2)$$

$$q_1 = \frac{\text{Deaths in upper elementary set of events}}{\text{Population on 1.1. at given period}}$$

$$q_2 = \frac{\text{Deaths in lower elementary set of events}}{\text{Population at given exact age}}$$

Homework

Submit to Moodle 2 Exercise 1 (Lexis diagram)

Try to make the computations from previous slide and submit in Excel to Moodle 2.