

ProCivicStat © - Teacher's Manual, 5.303

**Ageing Society -using population pyramids to investigate**

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What?	Teaching Material for learning about Ageing society and the use of population pyramids
Why?	Learning statistics with real data. Ageing society has an impact on our life, future. This module helps to discover this problem.
Statistics topics	data interpretation, metadata, visualizations, population pyramids, forecasting
Level	Basic
Prerequisites	bar chart, ratios, distribution
Digital tools	Interactive population pyramid visualization at different webpages, databases of Statistical Agencies
Resources needed	The module's introductory part doesn't require resources. The ageing society tasks require PCs or notebooks with access to the internet. This material contains different links to population pyramids thus it is possible to tailor this module to different environment. For instance, if you download the visualizations/ images or datasets in advance you will manage classes without Internet or computers.
Lesson time	3-4 hours if you have access to the internet 2-3 hours if you use paper-based resources
Further remark	Suitable for group work or homework assignment

### What is Civic Statistics?

To be fully engaged, citizens need to be aware of and understand statistics regarding past trends, present situations, and possible future changes in diverse areas of importance to society such as demographics, employment, wages, migration, health, crime, poverty, access to services, energy, education, environment, human rights, and other domains. Statistics and data about these and related topics are collectively called here civic statistics. Information about civic statistics is provided by official statistics agencies and other public and private/non-profit



statistics providers, and some of it is mediated to the public via print and visual media. Understanding of civic statistics is required for participation in democratic societies, but involves data that often are open, large-scale, official, multivariate in nature, and/or presented dynamically. Such statistics are usually not at the core of regular statistics instruction. These materials fill an important gap, not addressed in general education at school or university level.

ProCivicStat is a cooperative project of six partners in five countries, funded through the Erasmus+ program of the European Union. ProCivicStat developed new methods for statistics instruction for high schools and universities that will contribute to young people's ability to understand quantitative evidence about key social phenomena that permeate civic life. ProCivicStat offers a platform for continuing cooperation, exchange of ideas, exploration and dissemination of theoretical concepts and concrete teaching materials for promoting civic engagement via exploration of evidence and understanding of statistics about society.

Visit the ProCivicStat website: <http://www.procivicstat.org>

## Introduction

This document is intended not only for statistics teachers and instructors but also for both secondary school and university teachers who teach social issues in classes. The material contains a summary of ageing society (causes: fertility rate, mortality rate, life expectancy, migration), the indicators of ageing society (median age, average age, age distribution, old age dependency ratio, ageing index, growth rate of population), and some commentary on how a population pyramid can be interpreted and created with online tools.

Appended to this document a student worksheet of this module is available. This document contains the module description for teachers with notes and the solutions of the student's worksheet. After reading this plan, you will have a deeper understanding on:

- ✓ The importance of ageing society;
- ✓ The measurement possibilities of ageing society that can be covered when using this lesson plan;
- ✓ Visualizations that can be used;

### 1. Why does an ageing society matter?

Ageing society, which is a multivariate phenomenon, is a social challenge which also has social and economic causes and impacts for instance on taxes, pension system, government spending, dependency ratio.

### 2. What topics will your students engage with if the teacher uses this lesson plan?

- Visualizing age distribution with population pyramids
- Relative rates and absolute numbers
- Formalize critical questions, measurement possibilities
- Statistical description and indicators of ageing society
- Reflecting on context and communicating results
- Importance of metadata
- Issues of projections

### 3. Student's statistical/ mathematical pre-requisites and helpful context knowledge

- Basic knowledge of descriptive statistics bar chart, ratios, distribution
- Basic knowledge of visualization

### 4. What programs should be used for visualisation and analysis?

In this topic online visualization tools and databases are used:

- [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids)
- <http://www.worldlifeexpectancy.com/world-population-pyramid>
- <https://populationpyramid.net>
- <https://www.census.gov>
- Eurostat data and metadata

### 5. Advantages and disadvantages for using different online tools:

Advantages:

- Free, browser-based, web applications
- User-friendly
- Easy to understanding and easy to use for students with no background in statistical analysis.
- From databases the available indicators are downloadable.

Disadvantages:

- Statistics and data analysis capabilities are limited
- Still under development
- There is an option for importing data in the offline version
- From visualizations the interpreted data are not downloadable
- Several times age brackets are fixed
- The different web applications use different assumptions in projection methods
- The different web applications use different description of the age distribution: a part of them uses frequencies another part of them uses relative frequencies. It could lead to comparability limitations.

### 6. Where to start?

Proceed to the following pages to learn more about lesson plan.

### 7. More information about the context

- [http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015\\_Report.pdf](http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf)
- [http://ec.europa.eu/eurostat/statistics-explained/index.php?title=People in the EU - statistics on an ageing society](http://ec.europa.eu/eurostat/statistics-explained/index.php?title=People_in_the_EU_-_statistics_on_an_ageing_society)
- <http://www.who.int/topics/ageing/en>
- <https://www.populationeducation.org/content/what-are-different-types-population-pyramids>



## Promoting Civic Engagement via Exploration of Evidence: Challenges for Statistics Education

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### *Videos*

- Population pyramids: Powerful predictors of the future – Kim Preshoff  
<http://ed.ted.com/lessons/population-pyramids-powerful-predictors-of-the-future-kim-preshoff>
- OVERPOPULATED - BBC Documentary <https://www.youtube.com/watch?v=-UbmG8gtBPM>
- [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids)
- <http://www.worldlifeexpectancy.com/world-population-pyramid>
- <https://populationpyramid.net>
- <https://www.census.gov>
- <https://www.gapminder.org/population/tool>

## Introductory tasks' solutions– Explore population pyramids

1. What is the age structure of a population?

**A potential answer:** *“The proportionate numbers of persons in successive age categories in a given population.” (Encyclopaedia Britannica)*

2. What are the typically used age brackets?

**A potential answer:** Typical brackets:

- 1-year brackets
- 5-years brackets (for instance: 10-14, 15-19)
- 10-years brackets (for instance: 10-19, 20-29)
- 0-14 (child population); 15-64; 65+ (elderly people)

3. How do the official statistics define the year of age?

- a. For instance, in 2016 the 0-year-old population was 91 746 in Hungary. Who are they?
- b. Who are the members of 0-4 year age group?

**A potential answer:** *“Year of age is the age completed (expressed in years) at the date of the observation. Those persons belong to the same year of age who completed already a certain year of age but have not yet attained the following one.” (Hungarian Statistical Office)*

Consequently, a person is 0-year old if the person hasn't yet attained year 1; the members of 0-4-year group hasn't yet attained year 5.

4. How can we visualize the age structure of a population?

**A potential answer:** The age structure of a population can be visualized for instance with the help of line chart, bar chart, population pyramid.

5. What is a population pyramid?

**A potential answer:** *“A population pyramid, also called an age structure diagram or an age-sex pyramid, is a graphical illustration - typically in the shape a pyramid - which depicts the distribution of various age groups for each gender in a geographical area.” (Eurostat glossary)*

Be careful when you use a population pyramid! The next few questions will help you understand some important features of population pyramids.

6. This example contains 3 pyramids which represent the Hungarian age structure in 2015. In the case of the different representations
  - a. What can we find on the vertical axis? What is the effect of the different aggregation level?
  - b. What can we find on the left and right sides?
  - c. What can we find on the horizontal axis?
  - d. What does a bar represent?
  - e. What does the shape of the pyramid show? What are the typical shapes? What are the meanings of an expanding pyramid, a contracting pyramid and a stationary pyramid?

**A potential answer:** The vertical axis contains the age groups the oldest age group is on top, the youngest one at the bottom; men are usually on the left side, women on the right. A bar represents a ratio of a male or female age group within the given society. The horizontal axis shows the frequencies or the relative frequencies.

*“Stationary” pyramid: A pyramid can be described as stationary if the percentages of population (age and sex) remains constant over time. Stationary population is when a population contains equal birth rates and death rates.*

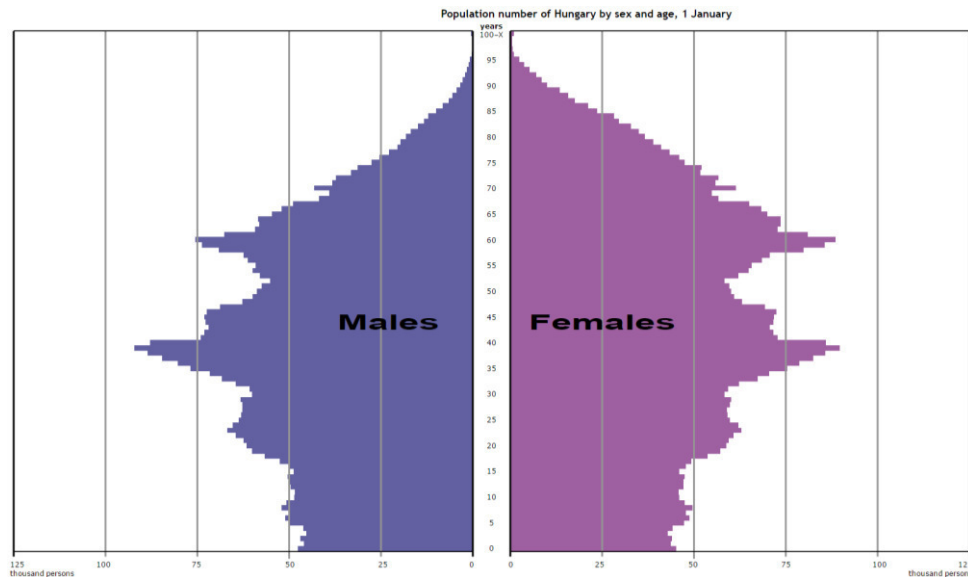
*“Expansive” pyramid: A population pyramid that is very wide at the younger ages, characteristic of countries with high birth rate and low life expectancy. The population is said to be fast-growing, and the size of each birth cohort gets larger than the size of the previous year.*

*“Constrictive” pyramid: A population pyramid that is narrowed at the bottom. The population is generally older average, as the country has long life expectancy, a low death rate, but also a low birth rate. However, the percentage of younger population are extremely low, this can cause issues with dependency ratio of the population. This pyramid is more common when immigrants are factored out. This is a typical pattern for a very developed country, a high level of education, easy access to and incentive to use birth control, good health care, and few negative environmental factors.” (Wikipedia)*

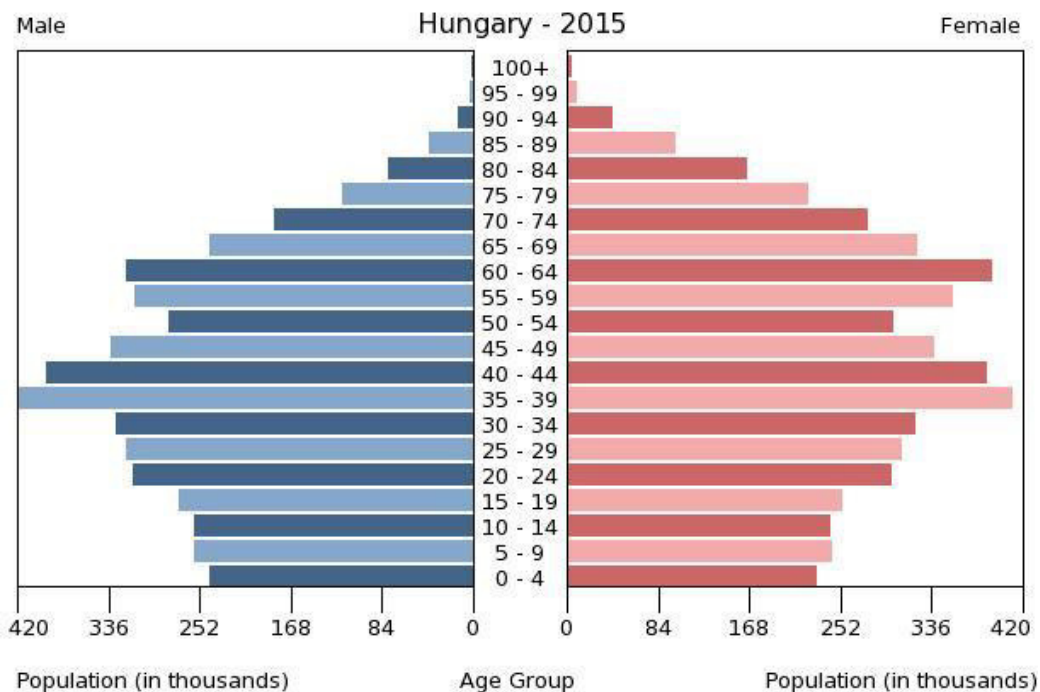
7. Can we see or calculate the population size in the different cases?
8. Do the different data displays contain the same data?

**A potential answer:** The 3 figures don't contain the population size, but the webpages contain this data. The different applications use different data sources, projection methods. It is available at the websites.

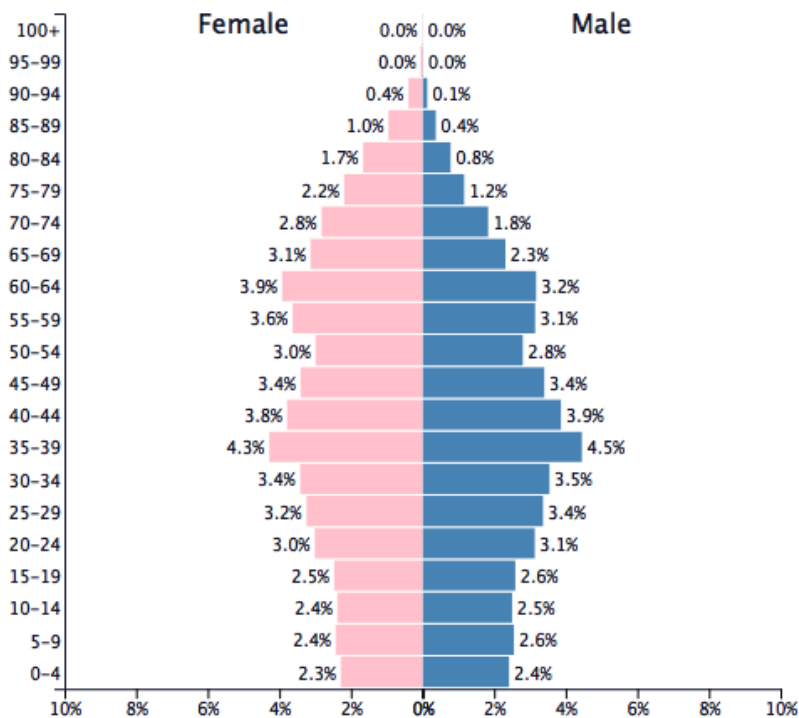
### Population of Hungary by sex and age, 2015



Source: [https://www.ksh.hu/interaktiv/korfak/orszag\\_en.html](https://www.ksh.hu/interaktiv/korfak/orszag_en.html)



Source: <https://www.census.gov/data-tools/demo/idb/region.php?N=%20Results%20&T=12&A=separate&RT=0&Y=2015&R=-1&C=HU> (Download: 04/June/2018)



Source: <https://www.populationpyramid.net/hungary/2015/>

9. The next 3 pyramids represent Mongolia in different years. Which of the following statements are true and which are false?
- A) In 1950, 6.1% of the males were in the 0-4 age group; **False**
  - B) In 1950, 6.1% of the population were men in the 0-4 age group; **True**
  - C) In 1950, 12.2% of the population were in the 0-4 age group; **True**
  - D) In 2015, the number of people in the 0-4 age group was higher than in 1950; **Although we have information about the ratio of this agegroup, we know nothing about the population size, so we can't consider it as true.**
  - E) In 2050, the number of people in the 0-4 age group was higher than in 2015; **Although we have information about the ratio of this agegroup, we know nothing about the population size, so we can't consider it as true.**
  - F) In each year, half of the population is male; **False**
  - G) In 2050, the growth rate of the population is less than in 1950 and 2015. **we know nothing about the population size, so we can't consider it as true.**

(What about your answers if we know that the population was 780.000 in 1950, 2.9 million in 2015 and the the estimated population in 2050 is about 4 million in Mongolia?)





## Promoting Civic Engagement via Exploration of Evidence: Challenges for Statistics Education

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**Potential answer:** In this case number of people in the 0-4 age group

- in 2050 was  $780.000 \times 0,122 = 0.09516$  million
- in 2015 was  $2.9 \times 0.114 = 0.3306$  million
- in 2050 will be  $4 \times 0.073 = 0.292$  million

It means that although the proportion was lower, the number of the people in the given age bracket was higher. So Point D is true, but Point E is false.

The population was 3.7 times higher in 2015 than in 1950, it means 2% annual growth rate between 1950 and 2015.

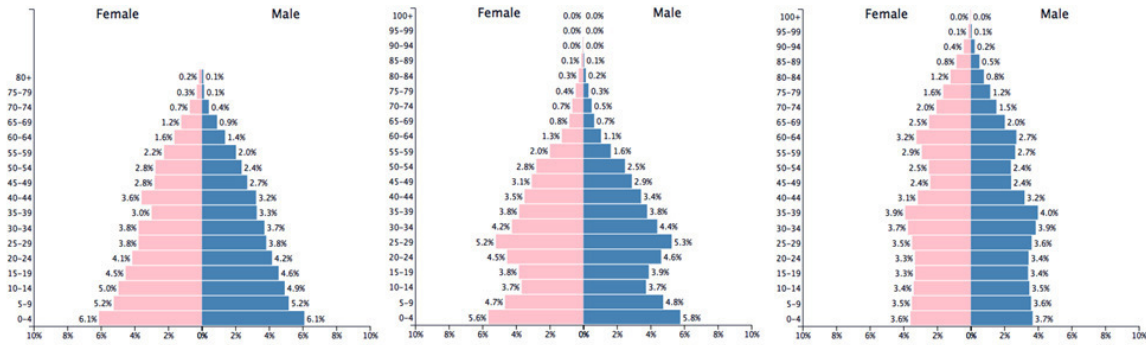
The population was 1.4 times higher in 2050 than in 2015, it means 0.95% annual growth rate between 2015 and 2050.

## Population of Mongolia by sex and age

1950

2015

2050



source: <https://www.populationpyramid.net/mongolia>

## Comments on Ageing society tasks

The solutions of this part are based on the selected tools and countries, so instead of the solutions comments are available for these tasks.

1. Group discussion: What is an ageing society? What could be the causes and consequences? Try to identify a number of potential components in each.

Ageing society: “growth in the number and proportion of older persons in their population.” (UN)

### Potential causes:

- increasing life expectancy
- declining birth rates
- net migration levels
- increasing death rate

### Potential consequences:

- increasing number of elderly people
- increase in the retirement age
- Increase in the dependency ratio
- increasing government expenditures on health care and pensions
- higher taxes
- shortage of workers
- changing economy and services

2. How can statistics visualize it? With the help of <https://populationpyramid.net> or <http://www.worldlifeexpectancy.com/world-population-pyramid> or <https://www.gapminder.org/population/tool/> or <https://www.census.gov/data-tools/demo/idb/informationGateway.php> (Select report: Population Pyramid Graph) or [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids) select your country and analyse the population pyramid!
  - a. What does the visualization suggest to you?



- b. Compare your country with other countries!
- 
3. What do you think about future trends, forecasts?
    - a. What are the differences and the common points of these estimations?
    - b. Can we say which the best one is?

**Methodological comment:** The different applications use different assumptions during the projections. You can check those conditions partly on the websites. For instance: in the case of Eurostat: [http://ec.europa.eu/eurostat/statistics-explained/index.php/Statistics\\_on\\_regional\\_population\\_projections](http://ec.europa.eu/eurostat/statistics-explained/index.php/Statistics_on_regional_population_projections). We can't say which is the best forecasting method.

4. How could you measure/examine an ageing society?
5. Find your data and try to visualize it with Excel/SPSS/etc.

**Methodological comment:** Before discovering the official statistical indicators of ageing society at this point we give the opportunity to the students to think of the measurement possibilities of ageing society and to create, collect and critically evaluate their own indicator to describe the ageing society.

6. Consider the official statistical indicators. How do official statistics measure/examine ageing societies?

The meaning of key terms is available at [http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Category:Population\\_glossary](http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Category:Population_glossary).

- a. *"The **old age dependency ratio** is the ratio of the number of elderly people at an age when they are generally economically inactive (i.e. aged 65 and over), compared to the number of people of working age (i.e. 15-64 years old).*
- b. ***Ageing index** is the ratio of the number of elderly people (65-X years) as a percentage of the child population (0-14 years).*
- c. *Growth rate of population is the ratio of total population growth during a time period.*
- d. *The **median age** is the age that divides a population into two groups that are numerically equal.*

- e. **Fertility rate** is the mean number of children who would be born to a woman during her lifetime
- f. **Mortality rate or death rate** is the mortality (number of deaths for a given area during a given period ) expressed as a proportion of the population.
- g. **Life expectancy** at a certain age is the mean additional number of years that a person of that age can expect to live, Life expectancy being expressed as the number of years persons of different ages may expect to live, starting from age zero, life expectancy at birth is the mean number of years a newborn child can expect to live if subjected throughout his or her life to the current mortality conditions, the probabilities of dying at each age.
- h. **Migration**: the number of people changing their residence to or from a given area (usually a country) during a given time period (usually one year).” (Eurostat Glossary)

More details are available in the Glossary.

7. With the help of <http://ec.europa.eu/eurostat/data/database> or <https://www.census.gov/population/international/data> (population by broad age group) or your national statistical office’s data (for instance in Hungary: [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids)) compare the past, the present and the future with Old age dependency ratio, ageing index and growth rate of population! How can you interpret your results?

**Methodological comment:** At this point we give the floor to the students to calculate or collect, compare and critically evaluate indicators and translate the statistical result to the common language.

## References

<http://www.un.org/en/sections/issues-depth/ageing/>

[http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Category:Population\\_glossary](http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Category:Population_glossary)

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## Ageing Society – using population pyramids to investigate

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Artist: Macha Selbach, copyright reserved by Ludwigsburg University of Education for Erasmus + ProCivicStat



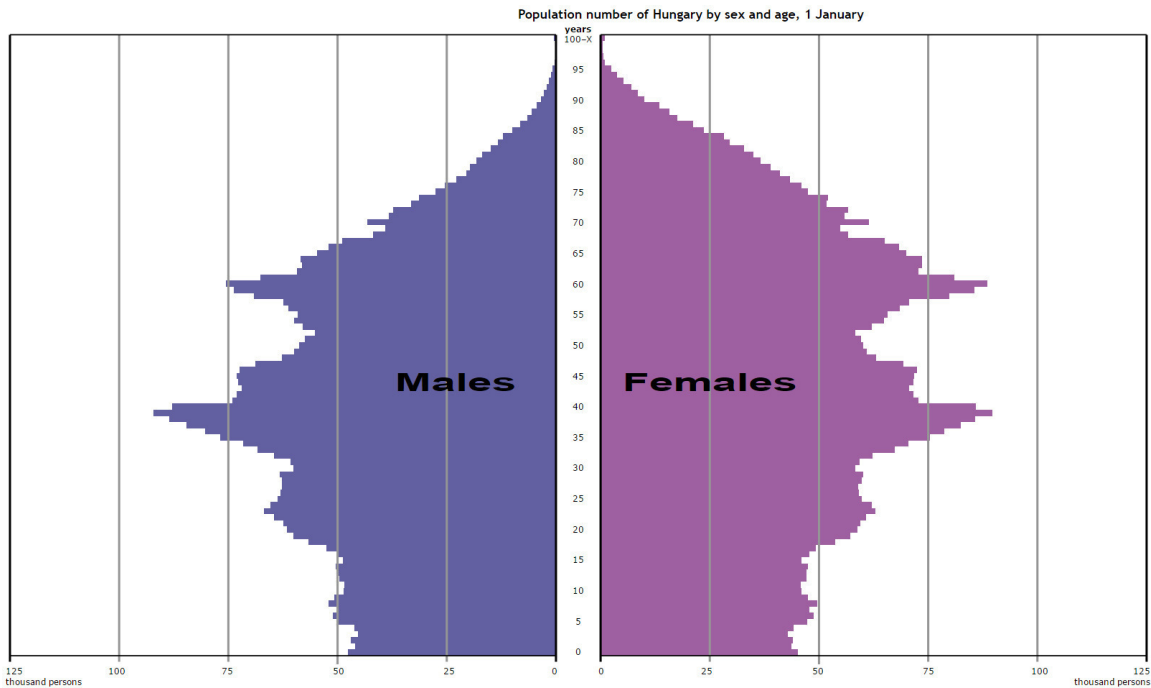
*Ageing society is a societal challenge not only in Europe but also in Asia with social and economic impacts as well.* The main goal of this module is to discover the possibilities of exploring ageing societies from a statistical perspective, to clarify the importance of checking the data and the elements of the same visualization method, focusing on the possible differences among the different tools and databases. What are the causes and the consequences? How can we measure and visualize ageing society and the age structure of a society?

### Introductory tasks – Explore population pyramids

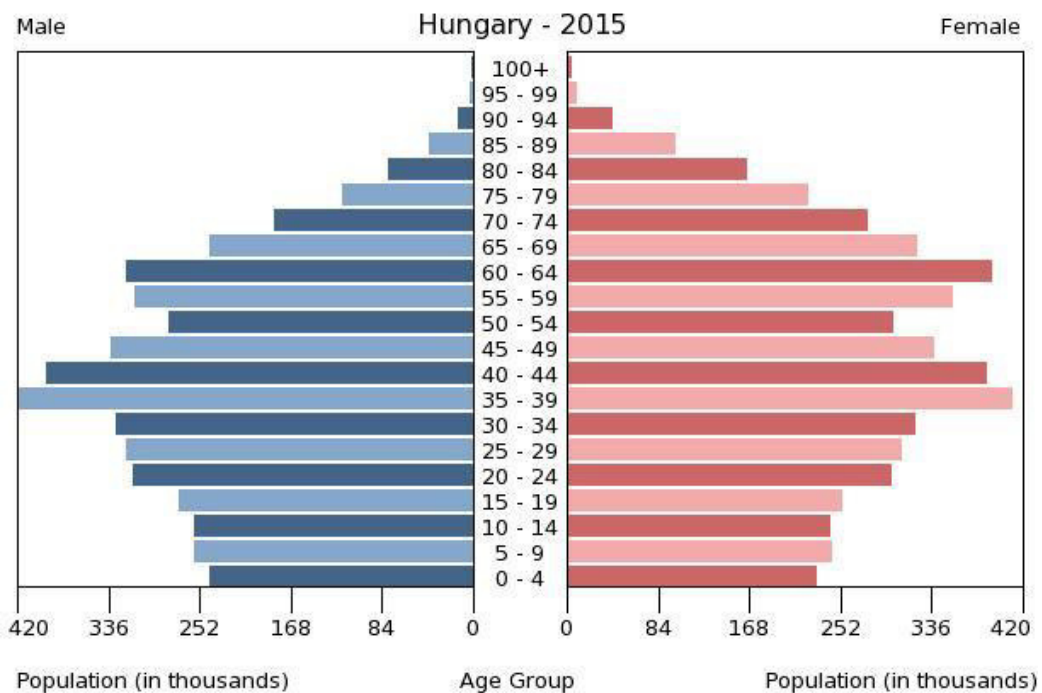
1. What is the age structure of a population?
2. What are the typically used age brackets?
3. How do the official statistics define the year of age?
  - a. For instance, in 2016 the 0-year-old population was 91 746 in Hungary. Who are they?
  - b. Who are the members of 0-4 years age group?
4. How can we visualize the age structure of a population?
5. What is a population pyramid?

Be careful when you use a pyramid! The next few questions will help you understand some important features of population pyramids:

6. This example contains 3 pyramids which represent the Hungarian age structure in 2015. In the case of the different representations
  - a. What can we find on the vertical axis? What is the effect of the different aggregation level?
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7. Can we see or calculate the population size in the different cases?
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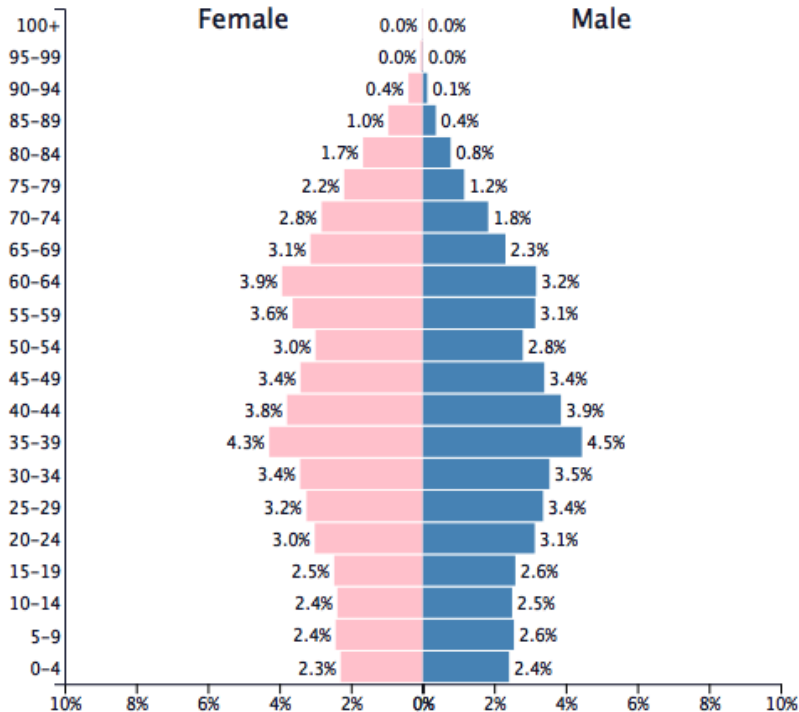


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Population of Hungary by sex and age, 2015



Source: <https://www.populationpyramid.net/hungary/2015/>

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  - B) In 1950, 6.1% of the population were men in the 0-4 age group;
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  - E) In 2050, the number of people in the 0-4 age group was higher than in 2015;
  - F) In each year, half of the population is male;
  - G) In 2050, the growth rate of the population is less than in 1950 and 2015.

(What about your answers if we know that the population was 780,000 in 1950, 2.9 million in 2015 and the the estimated population in 2050 is about 4 million in Mongolia?)

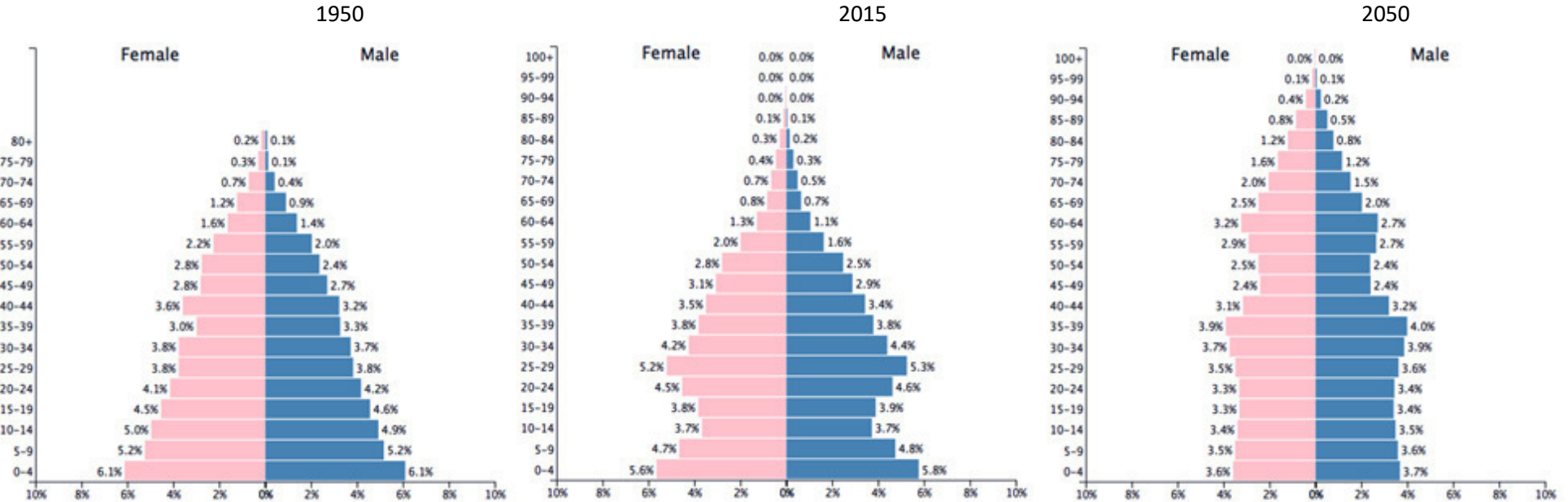


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## Population of Mongolia by sex and age



source: <https://www.populationpyramid.net/mongolia>



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### Ageing society tasks

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2. How can statistics visualize it? With the help of <https://populationpyramid.net> or <http://www.worldlifeexpectancy.com/world-population-pyramid> or <https://www.census.gov/data-tools/demo/idb/informationGateway.php> (Select report: Population Pyramid Graph) or [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids) select your country and analyse the population pyramid!
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3. What do you think about future trends, forecasts?
  - a. What are the differences and the common points of these estimations?
  - b. Can we say which the best forecast is?
4. How could you measure/examine an ageing society?
5. Find our data and try to visualize it with Excel/SPSS/etc!
6. Consider the official statistical indicators.
7. How do official statistics measure/examine ageing societies? What are the meanings of
  - a. Old age dependency ratio;
  - b. Ageing index;
  - c. Growth rate of population;
  - d. Medium age;
  - e. Fertility rate;
  - f. Mortality rate;
  - g. Life expectancy;
  - h. Migration.
8. With the help of <http://ec.europa.eu/eurostat/data/database> or <https://www.census.gov/population/international/data> (population by broad age group) or your national statistical office's data (for instance in Hungary: [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids)) compare the past, the present and the future with Old age dependency ratio, ageing index and growth rate of population! How can you interpret your results?



## Resources, Literature

- [https://www.ksh.hu/interactive\\_agepyramids](https://www.ksh.hu/interactive_agepyramids)
- <http://www.worldlifeexpectancy.com/world-population-pyramid>
- <https://populationpyramid.net>
- <https://www.census.gov>
- [http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015\\_Report.pdf](http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf)
- [http://ec.europa.eu/eurostat/statistics-explained/index.php/People\\_in\\_the\\_EU\\_%E2%80%93\\_statistics\\_on\\_an\\_ageing\\_society](http://ec.europa.eu/eurostat/statistics-explained/index.php/People_in_the_EU_%E2%80%93_statistics_on_an_ageing_society)
- <http://www.who.int/topics/ageing/en/>
- <https://www.populationeducation.org/content/what-are-different-types-population-pyramids>

### *Videos*

- Population pyramids: Powerful predictors of the future – Kim Preshoff  
<http://ed.ted.com/lessons/population-pyramids-powerful-predictors-of-the-future-kim-preshoff>

OVERPOPULATE