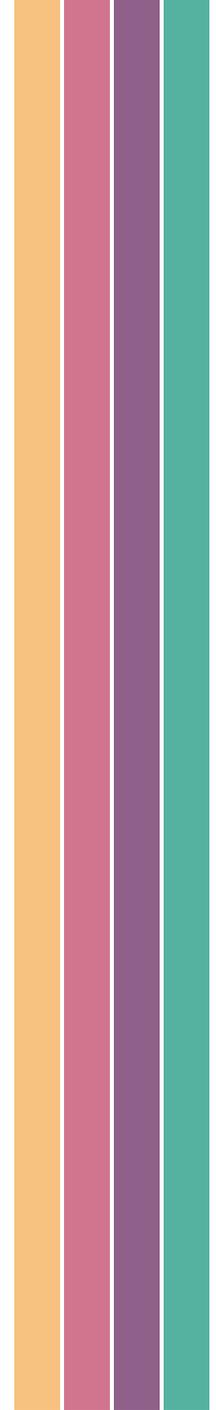


Analysis of Population Age Structure



Lanlan Wang
Department of Population and Employment Statistics,
National Bureau of Statistics

2019.11



Basic concepts

1

Commonly used statistic indicators

2

Analytical methods

3

Empirical evidences

4

Basic Concepts



Basic concepts



The age structure of a population refers to the proportionate numbers of people in different age categories in a given population for a defined time. It is a natural characteristic of a population in a country or a region.



The age structure is closely related to the birth rate, death rate and migration of a population. In the region with high birth rate, the proportion of children tends to be higher, whereas in the region with low birth and death rate, the percentage of elderly population tends to be higher.



Basic concepts



The characteristics of marriage status, birth rate, death rate, migration, education level, ethnic groups, and economy differ significantly in different age groups.



The investigation into age structure/distribution is important in identifying potential school age population, labour force, army, elector, etc. It is also an essential component in the prediction of population changes and population planning.

Commonly used statistic indicators





Commonly used statistic indicators

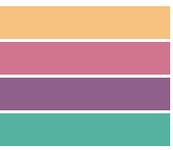
1. Proportion of children population refers to the proportion of the population aged 0-14 in the total population.

$$\text{Proportion of Children population} = \frac{\text{Population aged 0-14}}{\text{Total population}} \times 100\%$$

E.g.: Among 1339724852 people involved in the census in 2010, the total number of people aged 0-14 is 222459737. Therefore, the proportion of children in 2010 in China is:

$$\text{Proportion of Children population} = \frac{222459737}{1339724852} \times 100\% = 16.6\%.$$

$222459737/1339724852 \times 100\% = 16.6\%$



Commonly used statistic indicators

2. Proportion of elderly population refers to the proportion of the elderly population in a total population. The elderly population is usually defined as people with age above 60 or 65 years old.

$$\text{Proportion of elderly } (\geq 60 \text{ yrs}) \text{ population} = \frac{\text{Number of people with age of 60 or above}}{\text{Total Population}} \times 100\%$$

$$\text{Proportion of elderly } (\geq 65 \text{ yrs}) \text{ population} = \frac{\text{Number of people with age of 65 or above}}{\text{Total Population}} \times 100\%$$

The “**Aging population**” refers to the situation or process where the proportion of elderly keeps rising. After the proportion of elderly is obtained, it is necessary to analyse the changes of proportion of elderly population, the underlying causes of the aging population and its impact on social economics.



Commonly used statistic indicators

3. Elderly-to-youth ratio refers to the ratio between elderly population and children population. It is used to compare the scale of two populations. If 65 years old is taken as the starting age for elderly population, the calculation would be:

$$\text{Elderly-to-youth Ratio} = \frac{\text{Elderly population with age of 65 or above}}{\text{Children population with age between 0 to 14}} \times 100\%$$

E.g. In 2010, the number of people with age of 65 or above is 118831709 in 2010, and the number of children with age of 0-14 is 222459737. Therefore, it can be calculated that the "elderly-to-youth ratio" is 53.4 in China in 2010. In the areas with prominent aging population, the elderly population has exceeded the children population, and the ratio tends to be high. For example, the elderly to youth ratio went up to 117.3 in Shanghai in 2010.

Commonly used statistic indicators

4. Average age refers to number given when the sum of all individual ages divided by the number of whole population. This indicator reflects a representative age of the given population.

When each age group with an interval of 1 year old:

$$\text{Average age} = \frac{\sum (\text{Age of the age group} \times \text{Number of people at this age})}{\text{Total population}}$$

When each age group with an interval of 5 years old:

$$\text{Average age} = \frac{\sum (\text{Lower limit of the age group} \times \text{Number of people within this age group})}{\text{Total population}} + \frac{\text{Age interval}}{2}$$



Commonly used statistic indicators

E.g.: In a survey about the working population, the number of people who age 18-23yrs was obtained ([calculation example](#)). To calculate the average age of this population:

$$\text{Average age} = \frac{12033861}{590380} = 20.38\text{yrs}$$

E.g.: In another survey about the working population, the number of people in an age group with an 5yrs interval was obtained ([calculation example](#)). To calculate the average age of this population:

$$\text{Average age} = \frac{19623935}{714973} + \frac{5}{2} = 27.45 + 2.5 = 29.95$$



Commonly used statistic indicators

- **Average age** not only can reflect the composition of a total population, but also can also be used to reflect a representative age of a given population.
- For example, the average age of working population, of university students, of elderly population, etc.
- A high average age indicates a high proportion of population of larger ages.



Commonly used statistic indicators

5. Median age refers to the specific middle age when all the age values are arranged in an ascending or descending order. It can reflect the overall changes in the total population and is considered as one of the fundamental indicators in characterising aging population.

Median age = The lower limit of age group where locates the median age +

$$\frac{\frac{\text{total population}}{2} - \text{the cumulative number of people in the age group locates before the median age}}{\text{Number of people in the of age group where median age locates}}$$

- Calculation step:
1. Determine the number of half of the total population
 2. Determine the age group that locates the median age
 3. Use formula to calculate



Commonly used statistic indicators

E.g.: If the total population in a given area is 95464, and number of people in each age-specific group is known ([calculation example](#)), to calculate the median age:

1. Divide the total population by 2 and obtain the number of half population is 477473.

2. Determine the age group that locates the median age, (i.e. what age group would include median age that can divide the population into two halves) , and so obtain the age group of 25-29 as the group with median age.

3. Use formula to calculate

$$\text{Median age} = 25 + \frac{477473 - 456433}{200168} \times 5 = 25 + 0.53 = 25.53$$



Commonly used statistic indicators

6.Total dependency ratio: used to measure the impact on social economics by a given age distribution. It refers to the ratio of combined youth population (ages 0-14) and elderly population (ages 65+) per 100 people of working age (ages 15-64).

It indicates the burden on working-age population to support and provide social services for youth and elderly persons, who are often economically dependent. A lower total dependency ratio is often beneficial for social economics development.

$$\text{Total dependency ratio} = \frac{\text{Children population with age 0–14} + \text{Elderly population with age 65 or above}}{\text{Working age population with age 15–64}} \times 100$$



Commonly used statistic indicators

$$\text{Youth dependency ratio} = \frac{\text{Children population with age 0–14}}{\text{Elderly population with age 15–64}} \times 100$$

$$\text{Elderly dependency ratio} = \frac{\text{Elderly population with age 65 or above}}{\text{Working population with age 15–64}} \times 100$$

$$\text{Total dependency ratio} = \text{Youth dependency ratio} + \text{Elderly dependency ratio}$$



Commonly used statistic indicators

E.g.: In the China Population Census in 2010, the children population with age 0-14 is 22245973, the working population with age 14-64 is 99843340, and the elderly population with age 65 or above is 118831709.

Calculation:

$$\text{Youth dependency ratio} = \frac{22245973}{99843340} \times 100 = 22.28$$

$$\text{Elderly dependency ratio} = \frac{118831709}{99843340} \times 100 = 11.90$$

$$\text{Total dependency ratio} = 22.28 + 11.90 = 34.18$$

Analytical methods



Types of Population age structure

Divide the entire population into three main age groups: children population with age 0-14, working population with age 15-64, and elderly population with age 65 and above

Index for characterizing different types of age structure

Statistical index	Young	Mature	Old
% of population aged 0-14	> 40%	30-40%	< 30%
% of population aged ≥ 65	< 4%	4-7%	> 7%
Elderly to Youth ratio	< 15%	15-30%	> 30%
Median age	< 20 yrs	20-30yrs	> 30yrs

Types of Population age structure

Statistics from China Population Census

Statistical index	1953	1964	1982	1990	2000	2010
% of population aged 0-14	36.28	40.70	33.59	27.69	22.89	16.60
% of population aged ≥ 65	4.41	3.56	4.91	5.57	6.96	8.87
Elderly to Youth ratio	12.16	8.76	14.61	20.13	30.40	53.43
Median age	22.74	20.20	22.91	25.26	30.00	34.93



Types of Population age structure

- It can be understood from the statistics that, the age structure of Chinese population in 1953 has a typical young structure, and got even younger in 1953. However, it transitioned to mature type in 1982. By 1990, all statistical indexes of age structure started to approximate to those characterising old type of age structure. In 2000, the age structure had a typical old structure, with an increased aging rate.



Types of Population age structure

- In the statistics obtained from census, the population numbers for different gender and age groups can be obtained. It is therefore possible to calculate the proportions of age/gender specific groups in the male, female and total populations, as to understand the age structure more clearly.

[Form: The statistics for age/gender specific groups from Chinese population census in 2000.](#)



Types of Population age structure

- From the statistics, the second peak of birth rate in China lasted for 15 years, from 1962 to 1976.
- In the census in 2000, it can be interpreted that the characteristics of people who were born during this period include 1) the currently existing population is larger than 20 million 2) the percentage of each age group is larger than 1.6%.
- The numbers of people with age of 30 or 37 yrs old were the largest among all age groups.



Population Pyramid

- The population pyramid is a graphical illustration that shows the distribution of age groups of different genders and ages in a population. This tool can be used to visualize the age structure, age structure types and future changes.
- For different analysis, population pyramid can be plot using either absolute numbers or relative ratios.
- It can be plot directly when the statics are available for each age groups.
- When the statics is only available for age groups with an interval of 5 years, the population pyramid can also be plot using numbers for each age group.

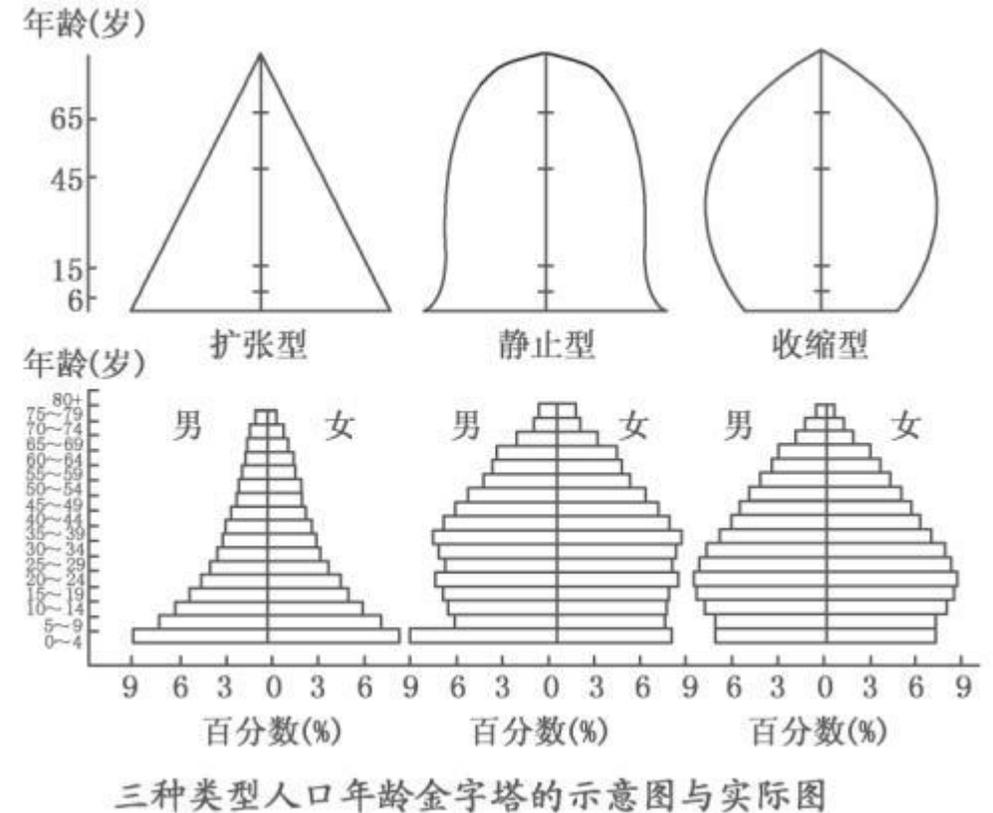


Population Pyramid

- The characteristics of population pyramid:
 - A horizontal bar diagram that consists of stacked-histogram bars, making it a horizontal bar diagram. Each histogram represents an age-specific group.
 - The age groups are arranged in an ascending order. At the bottom is the 0yr age group, or 0-4yrs age group. Older age groups are placed as it goes upwards. Usually, the oldest age group is the one with age of 85/90 and above.
 - Each side of the pyramid represent the population of different gender. The male population is situated at the left of the vertical y-axis, whereas the female is situated at the right.
 - The vertical y-axis represent different ages, and the horizontal x-axis represents the proportion of age-specific groups in the total population.

Population Pyramid

- Types of population pyramid:
 - Expansive: A population pyramid that is very wide at the younger ages but narrow at the older ages, indicating a larger children population but a smaller elderly population. The age structure adopts a young age structure type. It implies that in the future, an increasing number of people would get married and the death rate will remain high. The population will keep growing.





Population Pyramid

- Types of population pyramid:
 - Constrictive: A population pyramid that is narrowed at the bottom. The population is generally older on average, with a long-life expectancy, a low death rate, but also a low birth rate. The percentage of younger population are extremely low. The population may keep shrinking in the future.
 - Stationary: The top and bottom of the pyramid do not differ significantly in size and has a rather smooth curve across all age groups. The age structure adopts a mature age structure type. The number of people getting married will not change significantly in the future. The percentages of population (age and sex) remains constant over time.



Population Pyramid

- Use of population pyramid:
 - Visualize the size of each age group and determines the age structure type, allowing the prediction of population growth.
 - Helps to understand the past, current, and future situations of a given population. It is an essential component in population control and policy making.



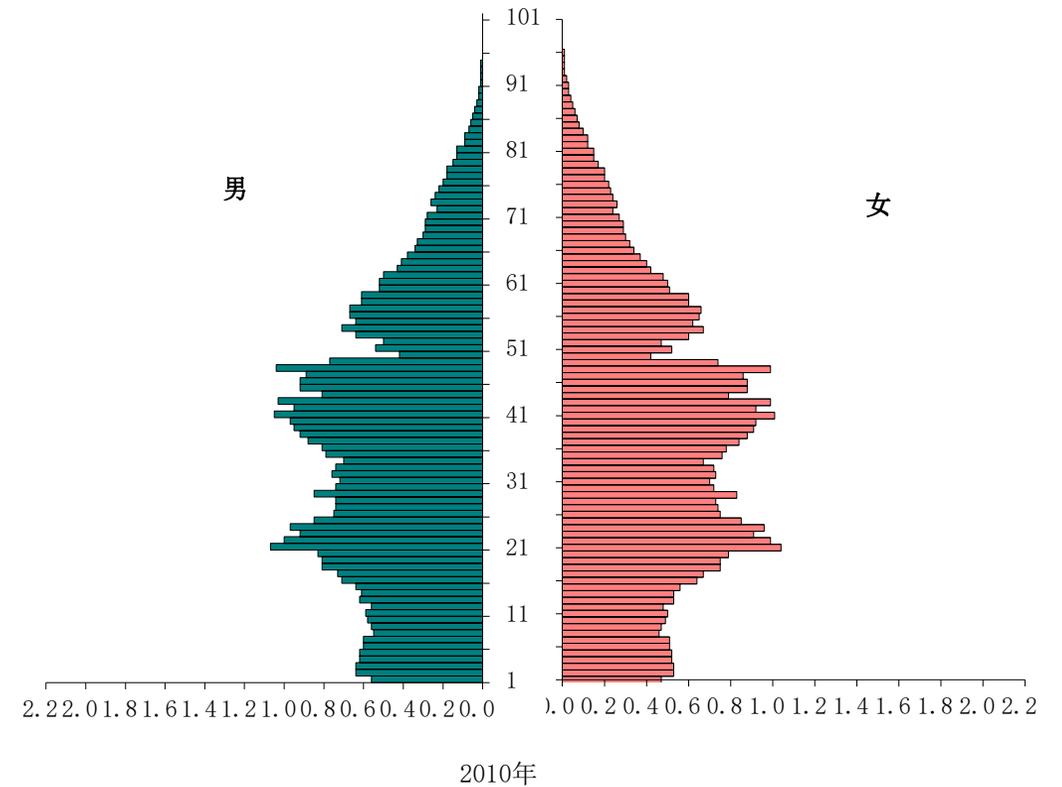
Population Pyramid

- Use of population pyramid:
 - Visualize the size of each age group and determines the age structure type, allowing the prediction of population growth.
 - Helps to understand the past, current, and future situations of a given population. It is an essential component in population control and policy making.

Population Pyramid

- Each horizontal line represents the proportion of male and female population of each age group in the whole population.
- It can be determined from the graph that which age group has the largest population, and which has the smallest. The population of younger age is shrinking, but female population of higher age exceeds the male population of higher age. It could also be implied from the pyramid that China has experienced peak and trough of birth rate.
- Dividing the pyramid into two parts, the upper part (≥ 55 yrs) shows a typical expansive pyramid structure, whereas the lower part (≤ 55 yrs) is constrictive overall.
- The top of the pyramid is very narrow, but it is evident that the aging population has started aging. A low birth rate is the main underlying reason.

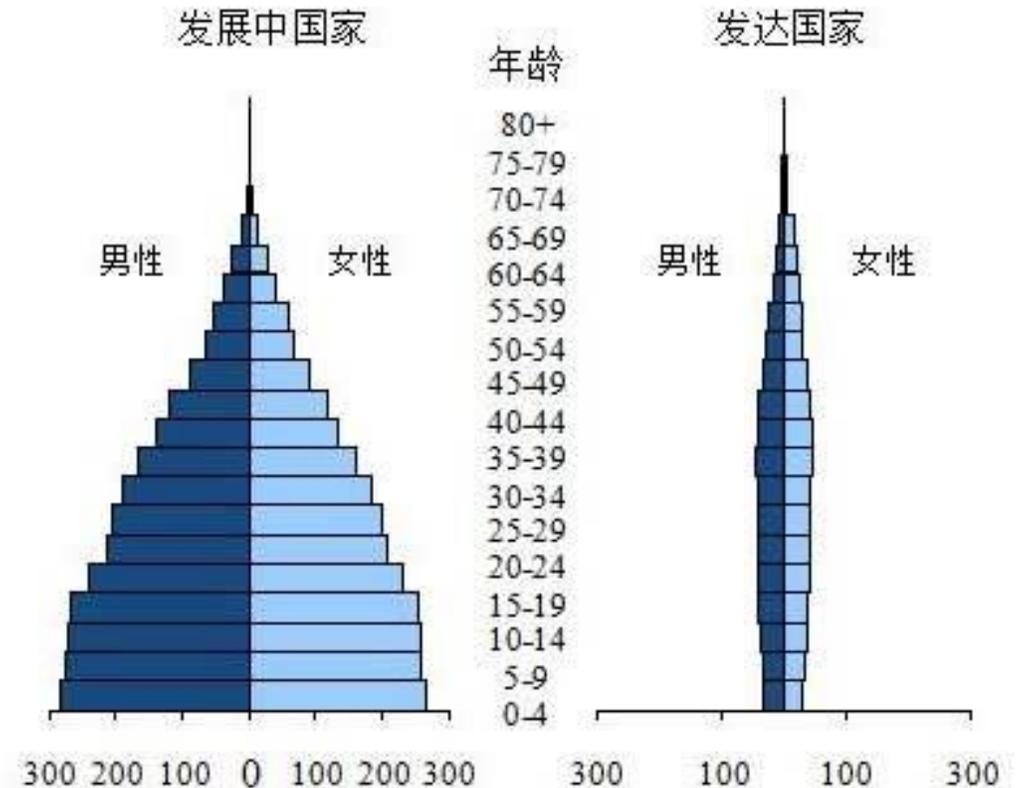
The population pyramid of China in 2010



Population Pyramid

- The population pyramid with absolute numbers can show the difference between sizes, in addition to genders and age structures.
- The population pyramid in developing country has a pyramidal shape, whereas the developed country has a shape of date.
- Each bar represents the size of population. It can also be interpreted that the population size of age below 65yrs is much larger in developing countries, but the population size of age above 65yrs is much equal.
- It indicates that the low death rate has a positive influence on the survival rate in the elderly population.

2005年发展中国家和发达国家人口金字塔（单位：百万人）



Empirical Evidences



Analysis of current age structure and its future changes

- In the sixth Chinese Population Census in 2010, among the population 31 provinces in mainland, autonomous region, municipality and army

Population with age 0-14yrs is 222459737 (16.60%)

Population with age 15-59yrs is 939616410 (70.14%)

Population with age 60yrs or above is 177648705 (13.26%)

Population with age 65yrs or above is 118831709 (8.87%)

The population age structure in China is aging

Compared to the fifth Chinese Population Census in 2000: :

Percentage of population with age 0-14yrs decreased for 6.29%

Percentage of population with age 15- 59yrs increased for 3.36%

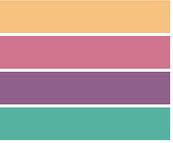
Percentage of population with age above 60yrs increased for 2.93%

Percentage of population with age above 65 increased for 1.91%

Analysis of current age structure and its future changes

The sample survey of the Chinese population census from 1953-2015 for population age structure

Years	Percentage of age group (%)			Dependency ratio (%)			Elderly to youth ratio	Median Age (yrs)	Average Age (yrs)
	0-14	15-64	65+	Youth dependency	Elderly dependency	Total dependency			
1953	36.28	59.31	4.41	61.17	7.44	68.61	12.16	22.7	26.5
1964	40.7	55.74	3.56	73.02	6.93	79.41	8.76	20.2	24.9
1982	33.59	61.5	4.91	54.62	7.97	62.6	14.62	22.9	27.1
1990	27.7	66.72	5.58	41.52	8.37	49.89	20.14	25.3	28.7
2000	22.89	70.15	6.96	32.63	9.92	42.55	30.41	30.8	32.5
2010	16.6	74.53	8.87	23.67	12.65	34.17	53.43	34.9	36.1
2015	16.52	73.01	10.47	22.63	14.34	36.97	63.38	37.8	37.8

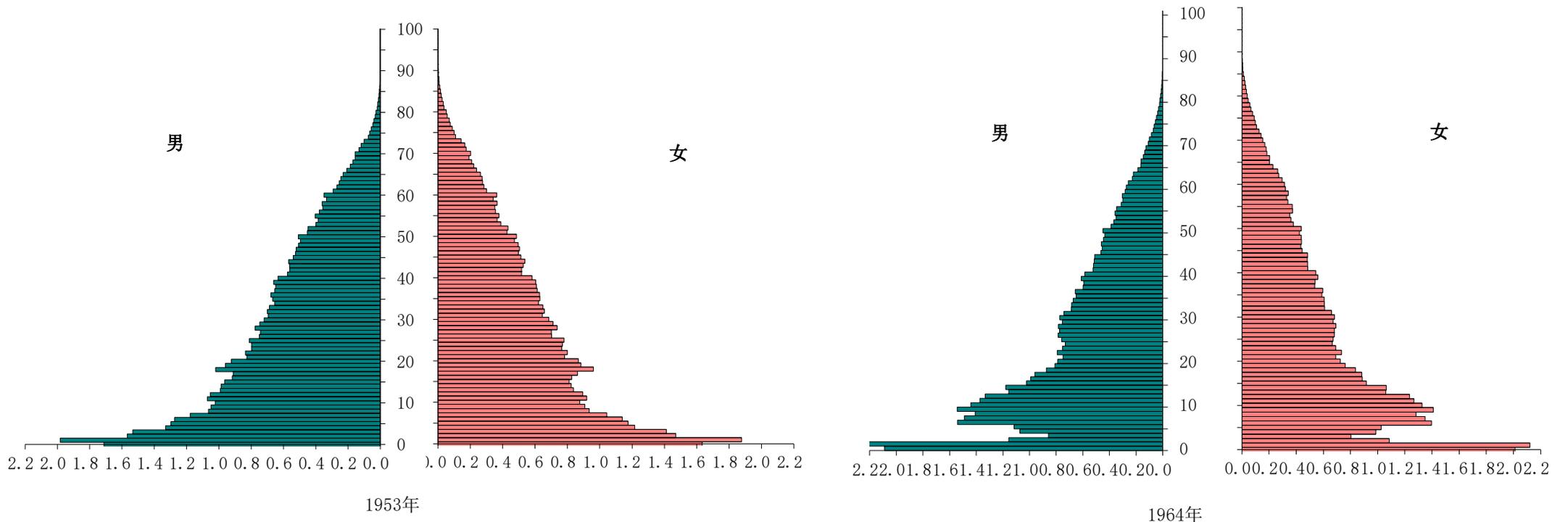


Analysis of current age structure and its future changes

- Based on the observation from the first Chinese population census in 1953 until 1964, there are evidences that the Chinese population were getting younger at some point, i.e. the percentage of children population increased, and elderly population decreased, the elderly-to-youth ratio decreased, the median and average ages decreased. The Chinese population in 1964 is the youngest, with 40% of the population being under the age of 15.
- Since 1964, the percentage of children population and youth dependency ratio have been decreasing, whereas the percentage of elderly population ($\geq 60/65$) and elderly dependency ratio have been increasing; the elderly-to-youth ratio, average and median ages have also been increasing.
- In the population census in 2010, the working population and total dependency showed a change in general trend, i.e. the percentage of working population changed from an increasing trend to a decreasing trend, the total dependency ratio changed from a decreasing trend to increasing trend.
- This means that the demographic dividend in Chinese population started to decrease.

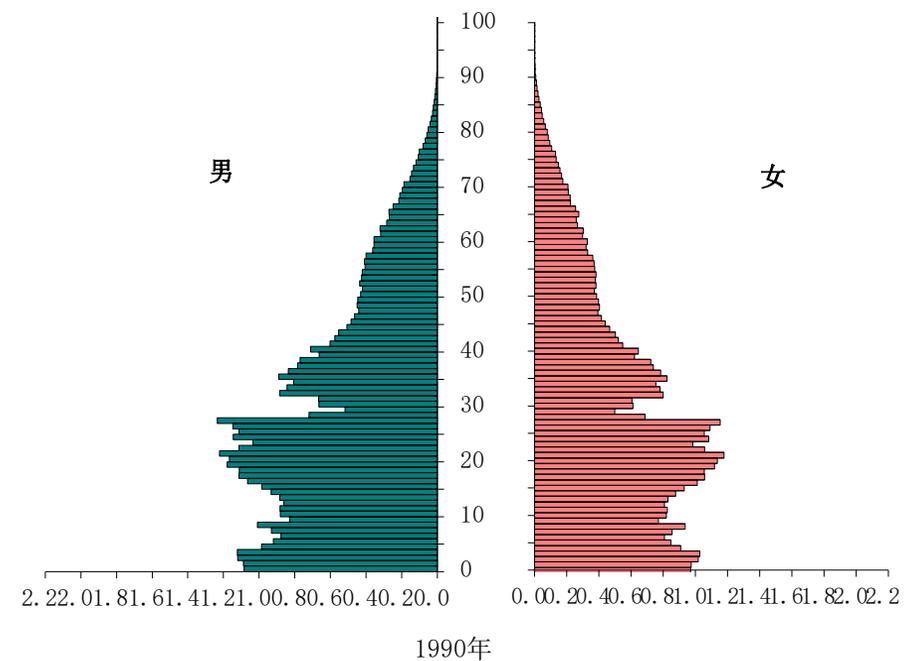
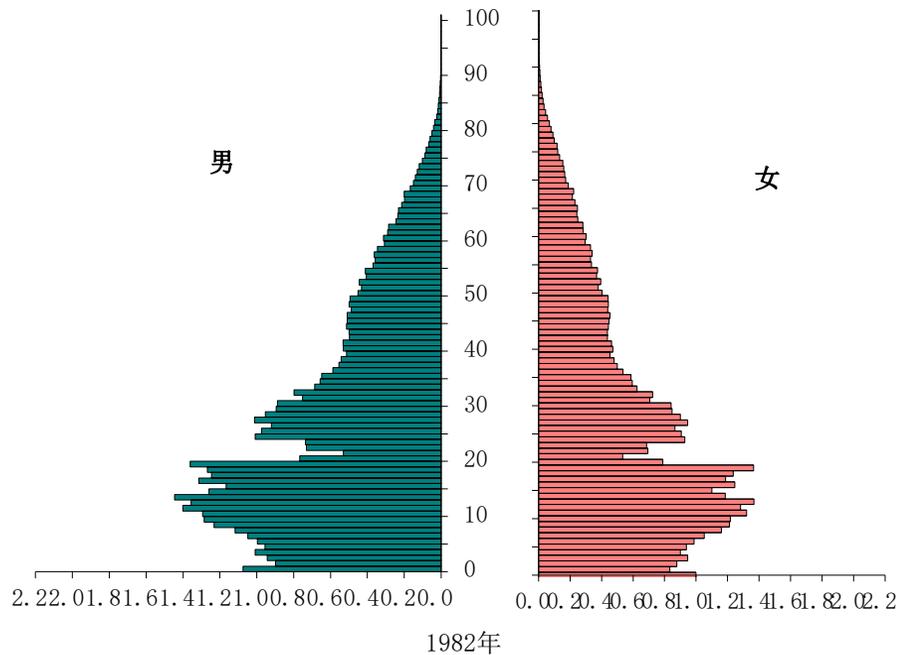
Analysis of changes in the population pyramid

- In 1953, the population pyramid in China has a typical pyramidal shape (narrow at top and wide in the bottom), with a regular and stable age structure.
- In 1954, the population age structure showed significant changes. The population showed negative growth. The main reason is a drop in the birth rate and an increase in death rate during 3 years with economic difficulties (1958-1961). With improvement in economy, the birth rate increased and reached a new peak.



Analysis of changes in the population pyramid

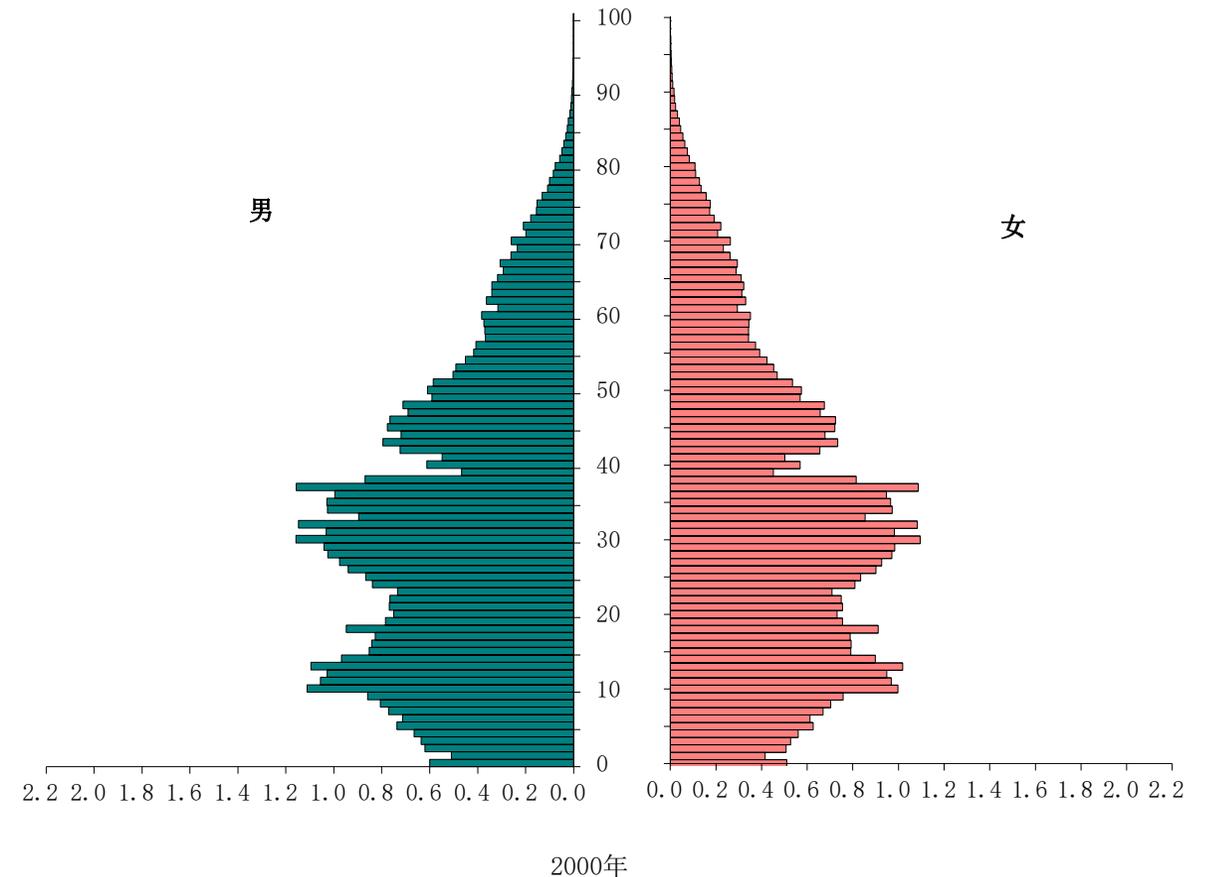
- The population pyramid in 1982 is dramatically different from ones in 1953 and 1964, with entirely different age structure. The difference is mainly shown in the bottom of the pyramid: among population groups with age 10-20, some are large, but some are small. This shows the birth rate was fluctuating at that time. The age group below 10yrs shrank rapidly, indicating the initial efficacy of population control policy.
- In 1990, the population pyramid shows a gourd shape, with irregular fluctuation. The big fluctuation indicates three peaks in the birth rate that took places on the 50s, the 60s, the end of 80s, and the start of 90s.



Analysis of changes in the population pyramid

- In 2000, the upper and lower parts of the population pyramid differ significantly from each other. The part including ages groups larger than 30yrs old still shows a typical expansive age structure.
- Although the bottom of the pyramid shows a peak in birth rate in the end of 80s, it shows an overall constrictive trend.
- The reason is because since the social development and implement of population control policy on the 70s in 20th century, the birth rate has kept decreasing and so led to a reduction in young population.

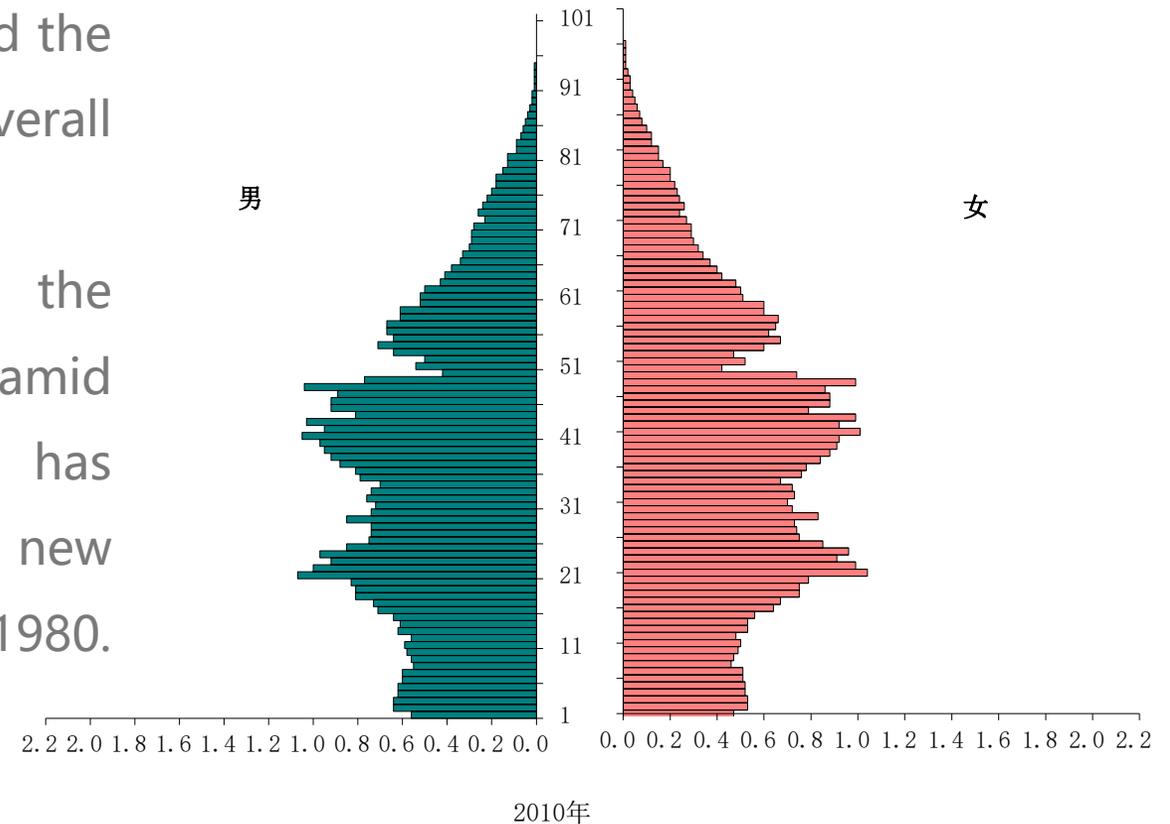
The Chinese population pyramid in 2000



Analysis of changes in the population pyramid

- In 2010, the upper and lower parts of the population pyramid still show difference. The population of age group above 47 yrs still showed expansive age structure. In contrast, although the lower part has experienced the peak birth rate in the end of 80s, it shows overall constrictive structure.
- Compared to the population pyramid in 2000, the constrictive trend at the bottom of the pyramid becomes more prominent. Although China has experienced another increase in birth rate in new century, the increase is much less than in 1960 and 1980.

The Chinese population pyramid in 2000



Analysis of changes in the dependency ratios

- The change in the age structure would also lead to change in the proportion of **working population**, thereby having an impact on social economics in different aspects. The most direct statistical indicator is **the dependency ratio**.
- The dependency ratio is often considered as a measurement of the financial burdens on the working population. If the 60yrs old is taken as a starting age in the calculation of dependency ratio, when the ratio is below 50, such time period would be considered as a period with low-dependency, or “demographic dividend period” .
- The total dependency ratio in 2010 was only 42.72. In another word, **for every 100 people with working age, there are 43 people that need to be raised or need support**.
- In 2010, Chinese population still had sufficient labor resource and relative lighter dependency burden, with demographic dividend that was beneficial for social economic development.

Analysis of changes in the dependency ratios

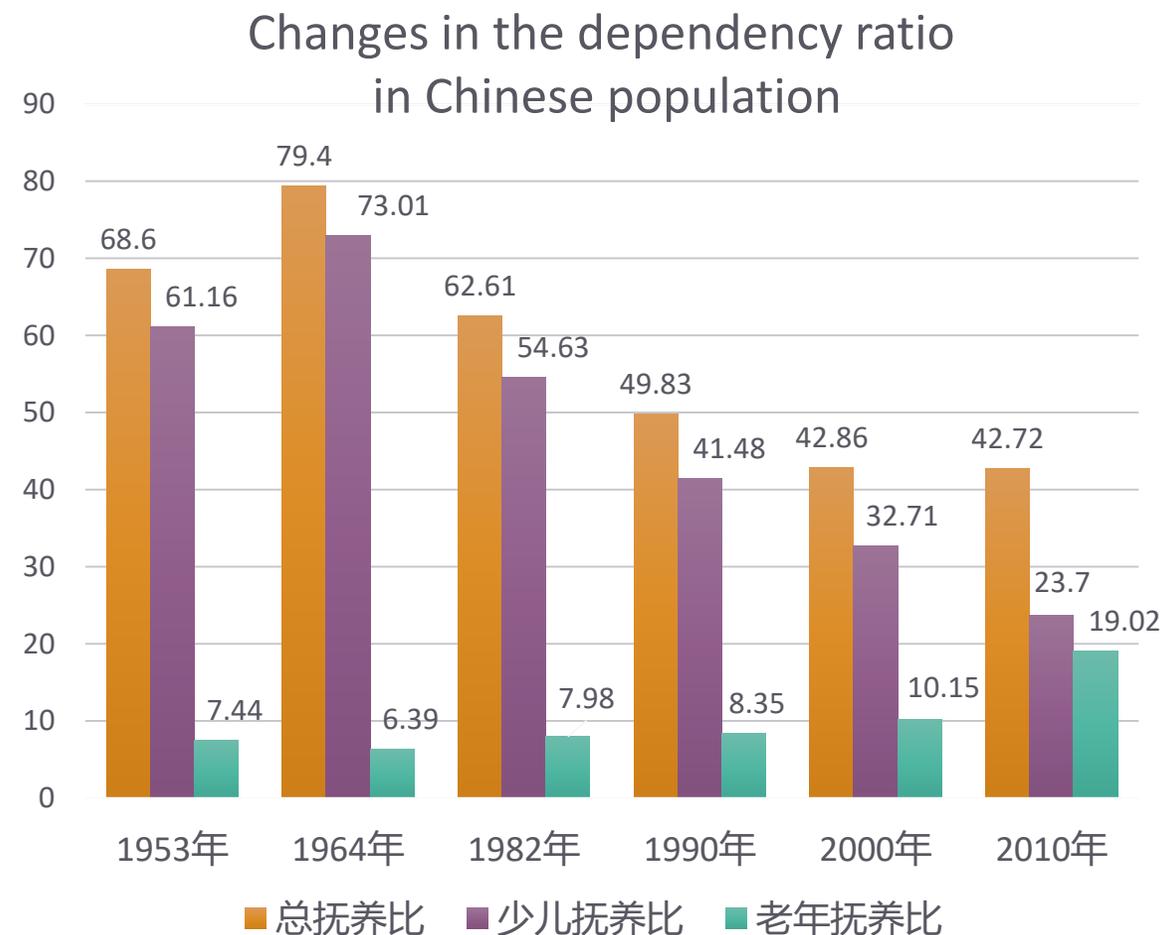
- Since the census in 1964, the total dependency ratio has been decreasing. It was at the peak during the census in 1964, at 79.4%, but at the lowest point at census in 2010, at 42.72%.

The dependency ratio from the past Chinese population census (take 60yrs as starting age for elderly)

Dependency ratio	1953	1964	1982	1990	2000	2010
Total dependency	68.60	79.40	62.61	49.83	42.86	42.72
Youth dependency	61.16	73.01	54.63	41.48	32.71	23.70
Elderly dependency	7.44	6.39	7.98	8.35	10.15	19.02

Analysis of changes in the dependency ratios

- For the composition of total dependency ratio in 2000 and 2010, the youth dependency ratio decreased dramatically, from 32.71 to 23.70. At the same time, the elderly dependency ratio increased at a very high rate, from 10.15 to 19.02.
- Overall, the decrease in the birth rate since 1990 cancels out a higher elderly dependency resulted from the aging population, thereby alleviating the total dependency burden in society.



Analysis of elderly population

- In the past 30 years, the percentage of population aged 65 and above has kept increasing.
- The the rate of elderly population expansion has also been increasing. In 8 years from 1982 to 1990, the percentage of population aged 65 and above increased for 0.66%; in 10 years from 1990 to 2000, the percentage of population aged 65 and above increased for 1.39%; in 5 years from 2010 to 2015, the percentage increased for 1.6%
- The rate of elderly population expansion has dramatically increased, and the aging of population continues.

The percentage of population aged 65 and above from 1982 to 2015 (%)

Year	1982	1990	2000	2010	2015
Population aged 60 and above	7.64	8.57	10.45	13.26	16.15
Population aged 65 and above	4.91	5.57	6.96	8.87	10.47



Analysis of elderly population

- Since 1964, the age structure of entire population started aging; the rate of aging has become faster since the implementation of birth control policy.
- In the future, the rate of population aging is not only related to a reduction in the birth rate, but also related to changes in the death rate of different age groups and an increase in expected life expectancy. The increase in the aging process predated the rapid decrease in the birth rate.
- Would the the birth control poly and the rapid reduction in the birth rate further facilitate the aging process of Chinese population?

Analysis of elderly population

- Three statistical indicators were used to reveal the changes in the age structure (elderly-to-youth ratio, median age, average age). The changes in these indicator were calculated using the census statistics since 1964.

The average increase in the elderly-to-youth ratio
median age and average age (%)

Time intervals	Elderly-to-youth ratio	Median age	Average age
1964-1982	2.89	0.70	0.47
1982-1990	4.61	1.25	0.72
1990-2000	3.70	1.94	1.22
2000-2010	5.80	1.54	1.06
2010-2015	3.47	1.04	0.92



Analysis of elderly population

- If the elderly-to-youth ratio is used to reflect the change in the aging process, the ratio increased the fastest from 2000 to 2010, with an average increase rate of 5.80%. However, the increase rate was reduced to 3.47% after 2010. Although the growth rate of elderly-to-youth ratio remains high, but it has started to get lower.
- In terms of the median age and mean age, the fastest growth rates took places from 1990 to 2000, whereas from 2000 to 2010 and from 2010 to 2015, the average growth rate has been declining.
- In conclusion, from 2010 to 2015, the aging process of Chinese population has become slower.

Analysis of elderly population

- The elderly population is divided into three classes based on age: the young-old (approximately 60–69), the middle-old (ages 70–79), and the old-old (over age 80).
- The Chinese elderly population mainly consists of young-old elderly population.

The age structure of Chinese elderly population

Year	60-69	70-79	≥80	Total
2000	58.84	31.93	9.23	100.00
2010	56.18	32.00	11.82	100.00
2015	59.91	28.30	11.79	100.00



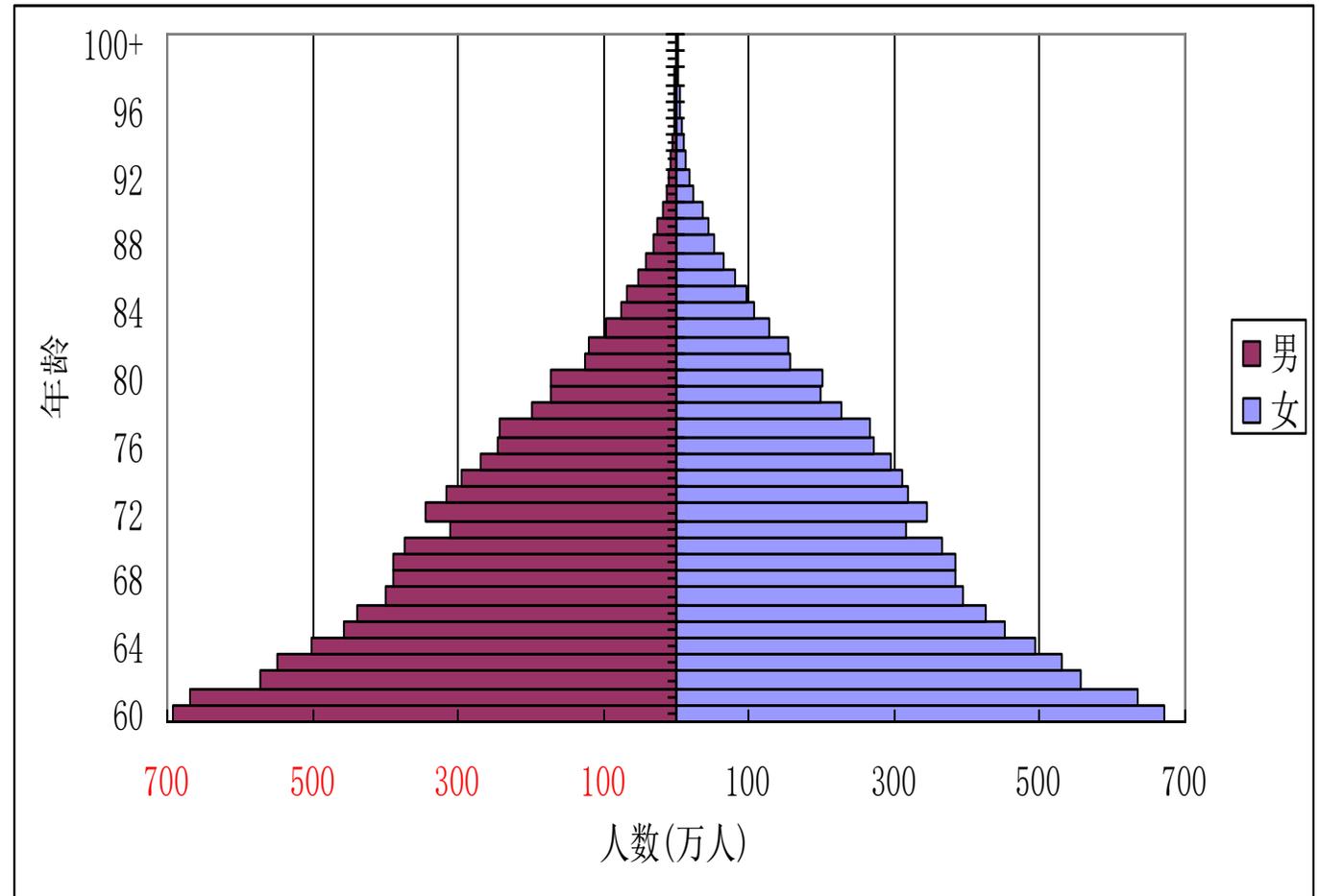
Analysis of elderly population

- Compare between 2010 and 2000, the aging of population was more prominent. The old-old (over age 80) population made up 11.82% of total elderly population, which increased for 2.6% in ten years.
- Compare between the census in 2010 and 2015, the percentage of young-old (approximately 60–69) population has increased, the percentage of middle-old (approximately 70–79) population has decreased, and the percentage of old-old (over age 80) population remained the same.
- It can be interpreted that, on the one hand, the aging process in the Chinese population was not rapid from 2010 to 2015; on the other hand, the aging process will continue for a while, due to an increase in the young-old population.

Analysis of elderly population

- The elderly population in China forms a typical pyramidal shape. Except for a relatively low population of people aged 71, there are more elderly people in younger ages than older ages
- It indicates that more people will join the elderly population in the following year, and the elderly population will keep expanding.

The elderly population pyramid in China, 2010





Analysis of elderly population

- In the young-old elderly population, the male population is larger than female population. The gender ratio decreases as the age increases. In the age group above 73, the female population is larger than male population.
- Due to a higher death rates in male elderly population than female population, the gender ratio in the elderly population decreases as the age increases. Above age of 92, the female population is more than double amounts of the male population. Above age of 100, the female population is three times of the male population.
- Therefore, in the elderly population, the percentage of female population increases as the age increases.



THANK YOU!

