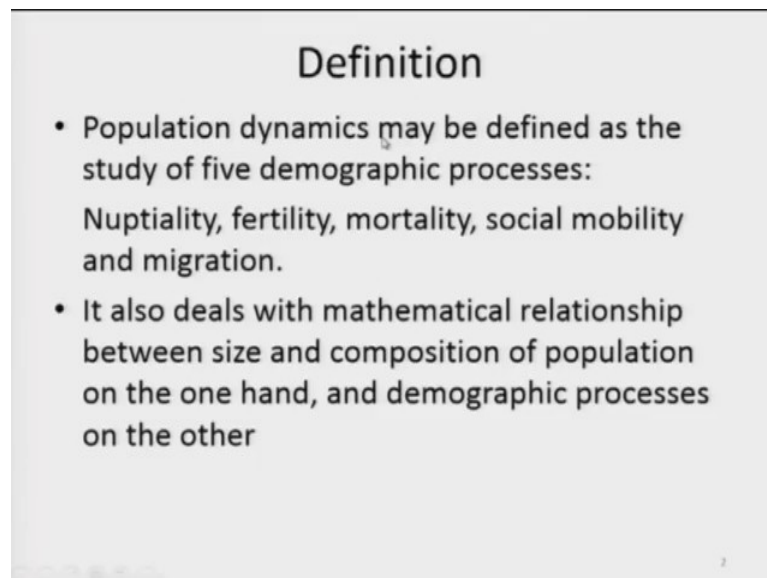**Population Studies**
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Lecture - 05
Population Dynamics I

So, friends this is our 3rd lecture and this is on Population Dynamics.
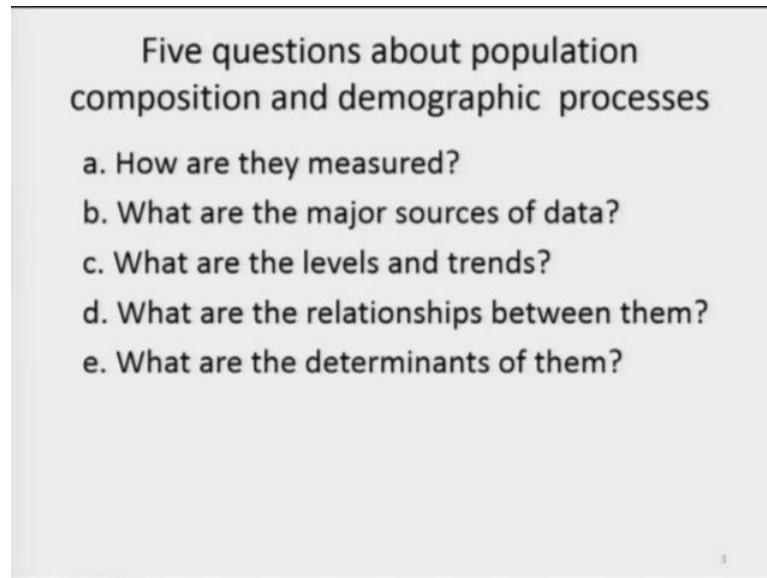
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So, we begin with the definition of population dynamics. Earlier we have made a difference between demography as a quantitative study population processes, and population studies, as qualitative study, of determinants and consequences of population. Now, population dynamics may be defined as the study of 5 demographic processes. Nuptiality; nuptiality means marriage, fertility; fertility means birth performance, mortality which means deaths.

Social mobility assuming that a society is stratified; means it is layered into several classes and these classes can be hierarchically arranged in terms of prestige, wealth and power, movement of people intra generational and intergenerational from one class to another upward or downward is called social mobility, and migration. Movement of people from one place to another. Now, population dynamics also deals with mathematical relationship between size and composition of population on the one hand, and growth processes on the other.

Demographic processes, growth processes and demographic process, nuptiality, fertility, mortality, social mobility and migration. So, how do these demographic processes interact with size and composition of population that is what constitutes the subfield of population dynamics. Now, friends I was thinking of what kind of questions can be asked in the study of dynamics there are 5 questions.

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Five questions about population composition and demographic processes

a. How are they measured?
b. What are the major sources of data?
c. What are the levels and trends?
d. What are the relationships between them?
e. What are the determinants of them?

First of all how are they measured? How will you measure fertility? How will you measure mortality? How will you measure migration? How will you measure social mobility and so on and what are the major sources of data?

In the first lecture I talked about sources of population data in India. And, you know by now that Census, SRS, NFHS, NSSO etcetera are the major sources of data, but all the sources of data do not provide information on all demographic processes. So, some specialized surveys will have to be conducted for example, for the study of intra generational and intergenerational mobility.
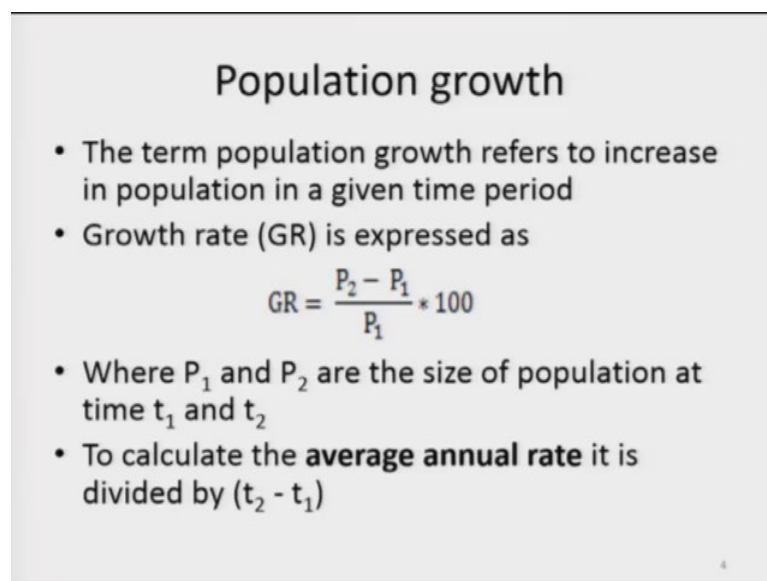
Then, what are the levels and trends, what are the present levels? What is fertility level of India, what was fertility level of India at the time of say independence? What are future projections? And, thus what are the trends at what rate is the level of fertility changing.

Then, what are the relationships between them are the demographic processes interrelated, does fertility affect mortality, does death rate, infant mortality rate, maternal mortality rate, affect birth rate of a country and what are the determinants of them?

Now, determinants are demographic that is why I said earlier that demographic studies consist of a study between demographic processes on the one hand and age and other compositions of population and size and growth rate of population on the other. So, what are the determinants? Demographic determinants, socio economic determinants, and also psychological determinants, or values, or personality structures, now size is size?

So, I do not have to define size of population this, size means how many people are living in a particular geographically or nationally defined area; like we can say that the present size of India's population is around 1.3 billion or the size of world population is 7.7 billion. Then comes the issue of at what rate is population growing. So, we have to calculate growth rate of population.

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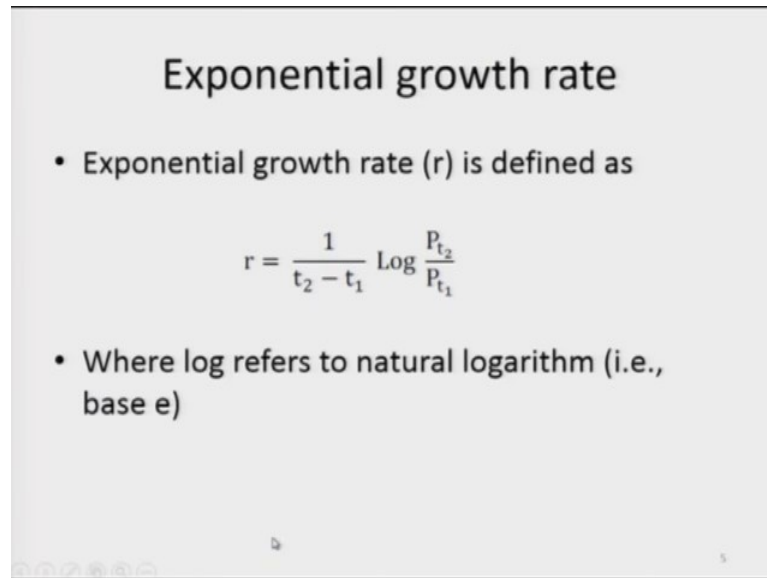
Population growth

- The term population growth refers to increase in population in a given time period
- Growth rate (GR) is expressed as

$$GR = \frac{P_2 - P_1}{P_1} * 100$$

- Where P_1 and P_2 are the size of population at time t_1 and t_2
- To calculate the **average annual rate** it is divided by $(t_2 - t_1)$

The term population growth refers to increase in population in a given time period. So, growth rate may be expressed, as growth rate equal to population at a later time minus population at the previous time, divided by population at the previous time, multiplied by 100.Here, I have written that P 1 and P 2 are the size of population at time t 1 and t 2.

And, this gives you at what percentage population has change between t 1 and t 2. If, you want to convert this into average annual rate of growth of population as population growth rate is of an expressed, then it has to be divided by t 2 minus t 1.

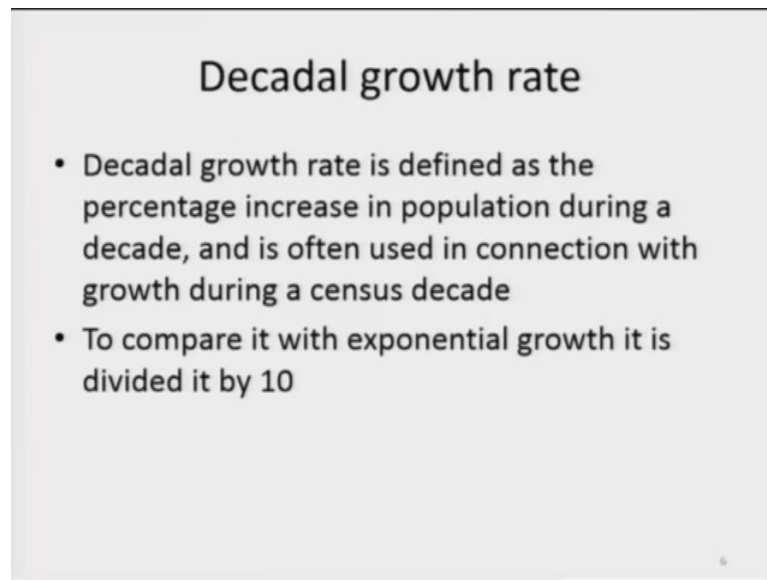(Refer Slide Time: 06:37)

Exponential growth rate

- Exponential growth rate (r) is defined as

$$r = \frac{1}{t_2 - t_1} \, \text{Log} \, \frac{P_{t_2}}{P_{t_1}}$$

- Where log refers to natural logarithm (i.e., base e)

Some time for analytical purposes, we define exponential growth rate. Exponential growth rate of a population is defined as r equal to 1 upon t 2 minus t 1 time difference, time duration and into log of P t 2 divided by P t 1, where log refers to natural logarithm. Exponential growth rate of population is quite interesting and we will see that this can also be expressed in terms of doubling time.

Decadal growth rate is another concept; decadal growth rate is defined as the percentage increase in population during a decade, and is often used in connection with growth during a census decade.

So, if I have population for the 2001 census and 2011 census, I can calculate decadal growth rate as population in 2011 minus population in 2001 divided by population of 2001. And to compare it with the exponential growth rate, it is divided by 10, because the time duration between 1 and 11 is 10. So, then it becomes average annual growth rate of population of India. There is another interesting term regarding growth rate that is called natural growth rate.

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Now, natural growth rate is defined as Birth rate of a country, minor Death rate. What is birth rate? Birth rate is number of births per 1000 population or total number of births in a year, divided by population in the middle of the year or average population of the year, or median population and is multiplied by 1000. Similarly, death rate is the number of deaths divided by median population in 2000. This shows this natural growth rate difference between birth rate and death rate.

This shows that in absence of migration population changes, because the births, because of deaths, and because of migration. Now, this natural growth rate would show that in absence of migration at what rate would a population be growing. Because demographers are more interested, they are interested in everything, but they are more interested in fertility and mortality for policy reasons.
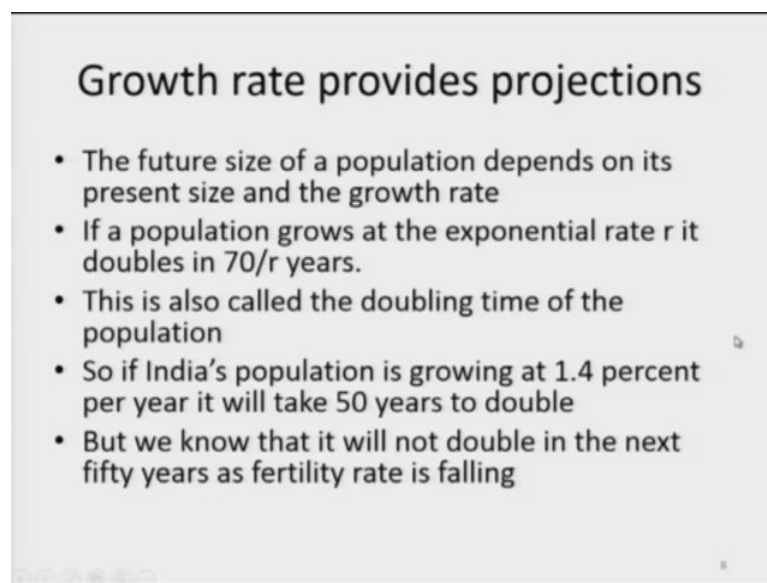
According to population reference Bureau around 2018 in India, every year 20 children per 1000 population are born. So, you can say that the birth rate of India is 20, in year 2018. And, in the same year on a population of 1000, 6 children die or 6 persons die not only children, but people of all the ages 6 people die; 6 people of all the ages, 0 to 100, 6 people die.

So, death rate of India becomes 6, birth rate of India is 20 death rate of India is 6 and so, the difference of the 2. The natural growth rate of India becomes 20 minus 6; 20 minus 6 equal to 14, but this 14 is per 1000 to express this in terms of percentage, you can say

that the natural growth of India is 1.4 percent per year. Actual growth of a population or actual growth rate of a population would be natural growth rate plus net migration rate.

So, if net migration rate is positive means more people are coming, then the number of people that are leaving the country, then the actual growth rate would be higher than the natural growth rate and otherwise it will be lesser than the natural growth rate. Natural growth rate of the world population will be same as the actual growth rate of world population, because there is no migration.

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Growth rate provides projections

- The future size of a population depends on its present size and the growth rate
- If a population grows at the exponential rate r it doubles in 70/r years.
- This is also called the doubling time of the population
- So if India's population is growing at 1.4 percent per year it will take 50 years to double
- But we know that it will not double in the next fifty years as fertility rate is falling

Now, growth rate can be used for simple projections of population. The future size of a population depends on it is present size and the growth rate. If, the population grows at the exponential rate r, then it doubles in 70 divided by r years. This is also called the doubling time of the population.

So, if India's population is growing at 1.4 percent per year then it will take 70 divided by 1.4 of 50 years to double. So, 2018 population after 50 years means in 2068 would be double the population of 2018, but this is unlikely to happen. Because, we know that in the next 50 years, the fertility rate would not remain same, it would be falling. I also guess that the death rate will slightly increase.

Ironically the death rate of the developed countries is higher than the death rate of the less developed countries. The reason is that death rate also depends on the age

distribution and since in the developed country there are more people at older ages at with death rates are higher. So, in overall population through death rate is higher in the developed countries, it is in the vicinity of 12 per 1000. India death rate is 6 it does not mean that health conditions in India are better, its the sheer effect of age distribution.
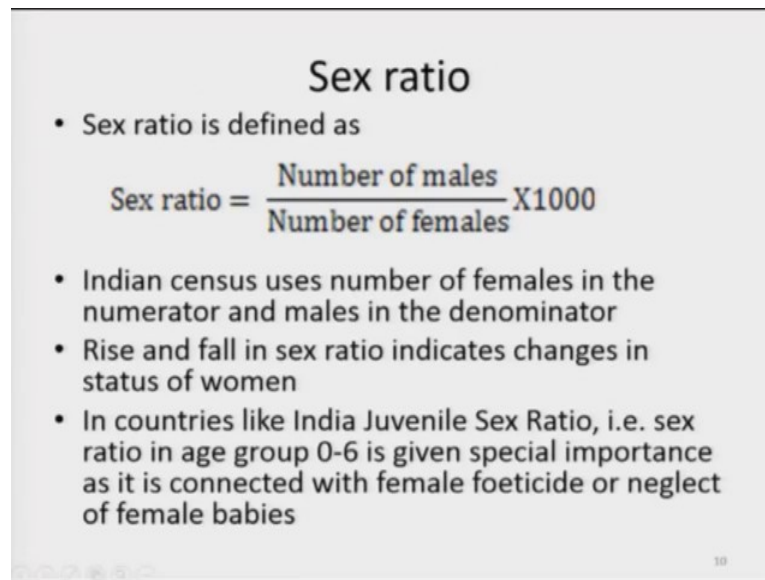
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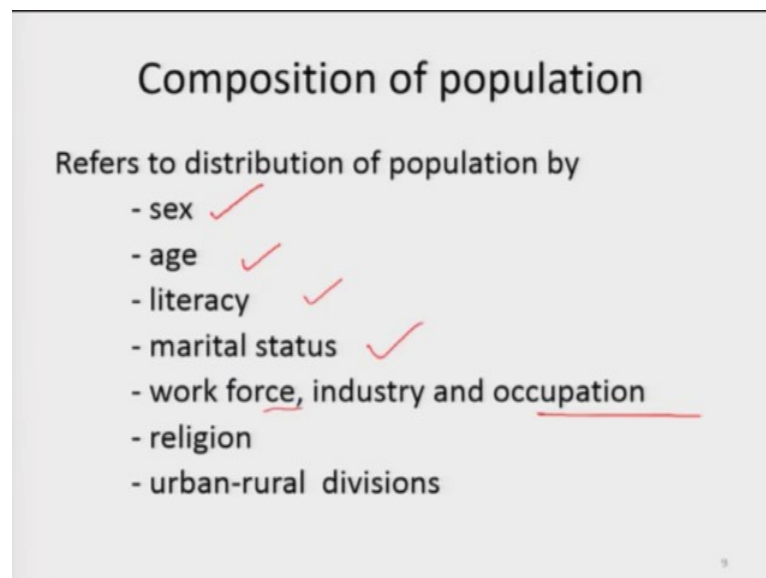
Now, composition of population is often defined in terms of sex first most important thing is sex, then age ,what age distribution of population, how many are literate and illiterate, how many are married, unmarried, widowed, divorced, separated, how many are workers, how many are non-workers, how many are working in which industry, and in what occupations?.

And, then religion is a big issue, religion, ethnicity, these are other issues and we often calculate percentages of population in different religious groups, ethnic groups. We also sometimes need geographical statewide distribution of population, what percentage of population lives in say Uttar Pradesh, what percentage of population in Kerala, and at what rates are populations of different states growing. The differences in growth rates of population of different states would affect the geographical or statewide distribution of population and then the urban rural divisions.

Sex ratio is defined worldwide; sex ratio is defined as number of males, divided by number of females into 1000, but in case of India, we define sex ratio age number of females, divided by number of males multiplied by 1000. We expect sex ratio to be around 1000 or slightly more, because at the time of birth more number of male babies are born.

In case of India we expect sex ratio to be slightly less than 1000 and rise and fall in sex ratio indicates, changes in the status of women. It is an important topic to be studied in demography, what is happening to sex ratio in India. Now, in the recent decades overall sex ratio has been improving, which means a state of the women I improved, but juvenile sex ratio is declining.

What is Juvenile Sex Ratio? It is sex ratio in the age group 0 to 6. So, number of females in age group 0 to 6 divided by number of males in the same age group multiplied by 1000. Because, this is falling demographers and social scientists are particularly worried about this issue, because this is happening largely, because of female feticide or neglect of female babies.

Age composition is often measured in terms of distribution of population by single year or in five year age groups. Although five year age groups data provide less details, but it is considered to be superior to singular age data, because single year age data, suffers from what is called age heaping. At the time of enumeration of data people have a tendency to report ages in figures ending in digit 0 and 5.

So, imagine that somebody has age 19 years. It is likely that to census enumerator he or she will report the age 20 or somebody is of age 21 years, he or she may also report the age to be 20. So, there will be heaping a sudden rise of number of persons at age 20 and shortfall at ages 19 and 21. 0 to 5, 5 to 10, 10 to 15 means five year age groups data are relatively free from age heaping's under enumeration and over enumeration.

Usually in a broad sense 3 categories of age are made 0 to 14, 15 to 64 and 65 plus, they are of a special importance 0 to 14 is considered to be children 15 to 64 adults or working population, and this 65 plus is considered to be dependent population, childhood, adulthood, and old age.

Old age may also be divided into 23 category young old and modestly old and old old. Then, there is dependency ratio number of children 0 to 14 plus old persons 65 plus divided by number of adults 15 into 64. This is very interesting ratio which tells us in what direction or and whether the present distribution of population in terms of age is conducive to development or not.

If, this ratio is high then it means that there is high dependency ratio, children are dependents old person 65 are also considered to be dependent. So, per adult there are more dependents and if this declines, then dependency ratio declines and that is conducive to economic development.

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United Nations defined population support ratio, which is reverse of dependency ratio this is number of children 0 to 14 plus old 65 plus divided by 15 into 64. This tells us how many adult persons are needed to support one old person. Actually, this formula includes both 0 to 14 and 65 plus. And, therefore, we can say that this formula as such shows how many adult persons are needed to support a child and an old person, but if you divide old 65 plus by number of adults 15 into 64, then you have adult persons needed to support one old person.

Old persons are of a special interest that is why I have written this, because in the developed countries where fertility has declined proportion of old people is rising and old age dependency is a serious problem. With time in population support ratio there is a fall, but a time will come when it will start rising, there is a fall because fertility is declining. Now, eventually when old number of old people 65 plus starts increasing, then the population support ratio will start increasing and that will be bad for the economy.

Age distribution is often shown in the form of a sex pyramid, it is a graphical display of population by age and sex, age is taken on horizontal axis, number of persons on vertical axis, females on the right hand, males on the left hand.
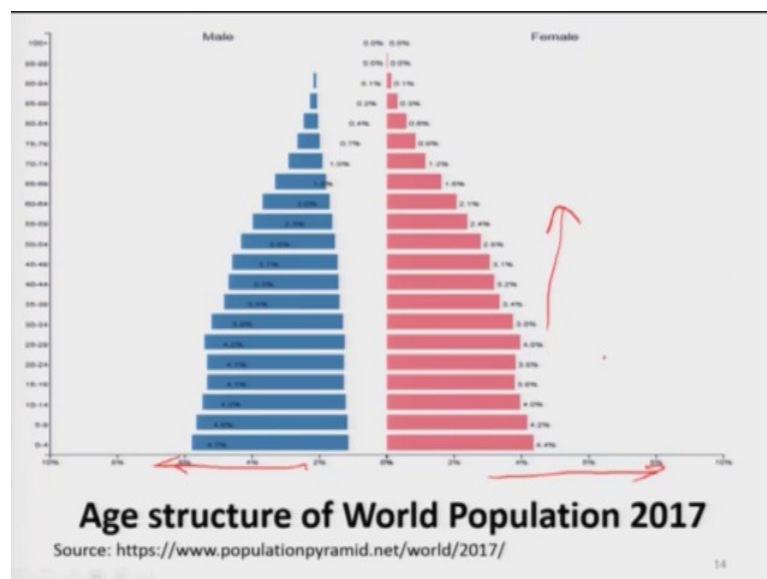
And, an age structure may look like this. This is males, this is females, these are numbers, number of persons, here along with these bars percentages in different age groups are also shown.
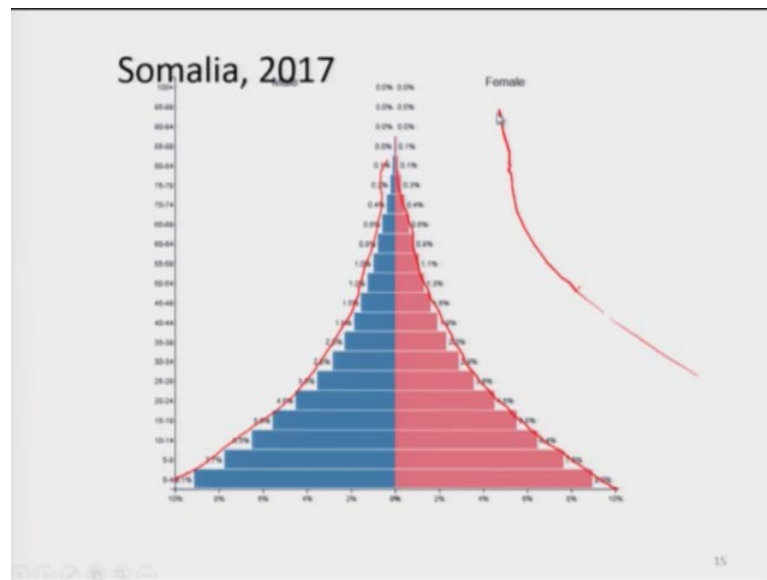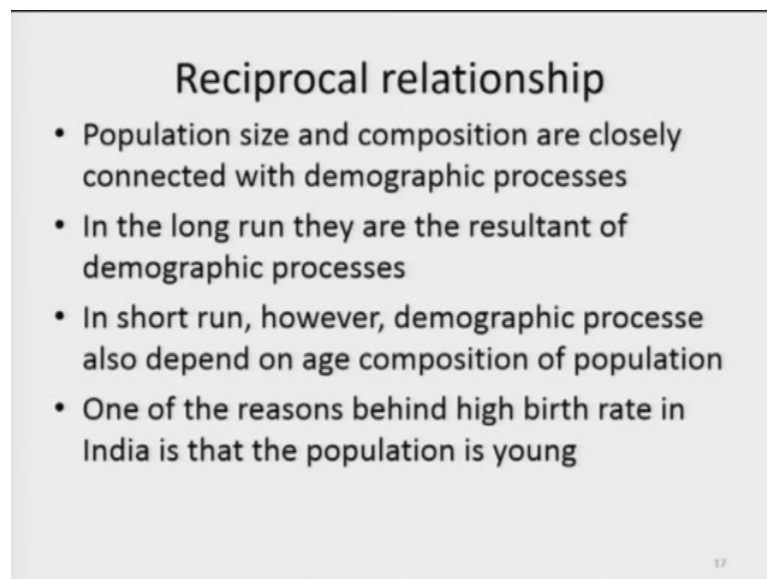
Let us look at to have a more in depth understanding of age and sex structure. Let us look at this age and sex pyramid of Somalia. Now, this shows that a large number of children are born in Somalia in 2017 males and females, large number of children are born and because of high death rate they start dying; they start dying early. So, there is a steep decline in number of survivors and then in very old age there are very few persons, this is what this age sex pyramid of Somalia shows.
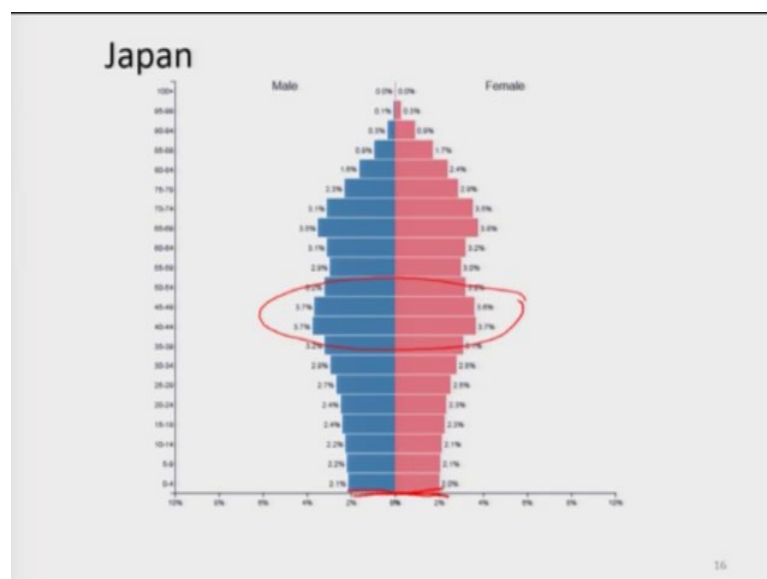
Now, if you look at Japan. Now, Japan due to decline significant decline in fertility base of the age pyramid has been narrowed down and there are more persons here, which shows that around 45 49 years ago fertility in Japan was much better and then the numbers declined. So, age composition of a population is reflective of fertility, mortality, migration patterns and also wars, because a large number of deaths especially of males take place in war.
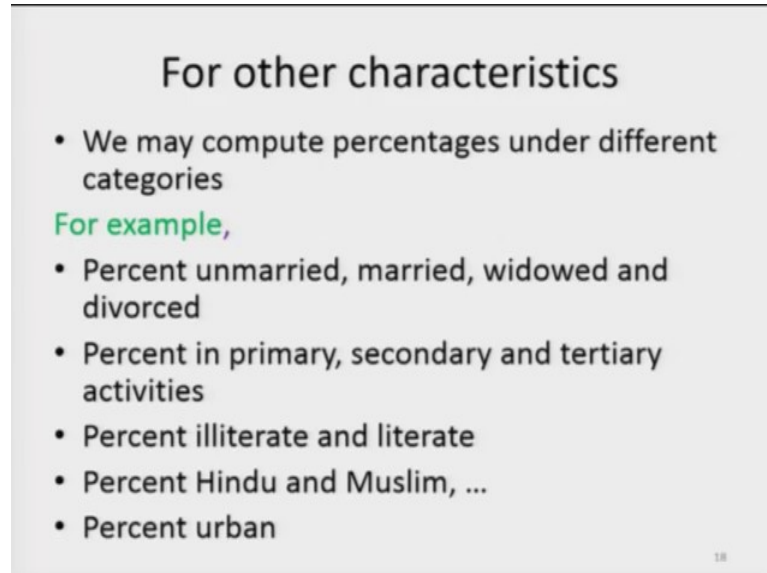
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The relationship between size and composition are and demographic processes is reciprocal both affect each other. In the long run they are the resultant of demographic processes. They means size and composition, a fertility declines, then the proportion of children immediately started declining. If, death rate declines there is no immediate effect, but in the long run decline in death rate and decline in birth rate, will lead to what is called aging of population and the median age of population goes up.

In short run; however, demographic processes also depend on age composition of population. I remember there was a statement in tenth five year plan, that one of the major reason the 60 percent reason behind why India's growth rate is high is the younger age distribution. 20 percent was due to unmet needs for family planning and 20 percent was due to high mortality.

So, 6 when I read it first time I could not understand how 60 percent contribution to high growth rate of India's population is the younger age composition, but that is true; that

means, if fertility and mortality remains same in the future, simply due to aging of population birth rate will start declining and death rate will start increasing.

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For other characteristics

- We may compute percentages under different categories

For example,

- Percent unmarried, married, widowed and divorced
- Percent in primary, secondary and tertiary activities
- Percent illiterate and literate
- Percent Hindu and Muslim, …
- Percent urban

For other characteristics, because I said that age composition is one part of composition of population, there are other factors according to which composition is studied, marriage, literacy; literacy religion, etcetera etcetera. So, we may compute one of the simple thing to describe composition of population according to these things is to show percentages.

Frequency distribution or categories and number of people belonging to those categories and percentage. For example, to describe marital status composition of India's population, you can show what is the percentage of unmarried, what is the percentage of married, what is the percentage of widowed, and what is the percentage of divorce population or separated population.

You can show these figures separately for different age groups also, because age is a determinant of marital status. So, you can show these things according to age. Similarly, you can show percentage in primary school, percentage in secondary school, percentage in tertiary colleges schools, and overall percentage of illiterate and percentage of literate.

Similarly, you can calculate percentage of Hindus, Muslims, Jains, Sikhs, in the recent time there has been some concern, about percentage of population of Muslims rising.

And, that is because Muslims are experiencing demographic transition a little later, than Hindus and other communities Jains, Sikhs, Parsis, started experiencing.

As time will pass due to demographic transition among them also birth rate will start falling and growth rate will also a start falling, we expect that eventually growth rates of all the religions will become same and therefore, religious composition of population will become unchanged. Similarly, we can calculate percent urban, these percent, simple percentages of are of great great immense interest, you know ah like percent urban at the time of beginning of the last century in India.

Only about 10 percent of the population lived in urban areas and today about 33 percent population lives in urban area. This is a great process of urbanization, which has shaped the socio economic conditions of the country, and aspects of integration, disintegration, alienation and many other things in society.

Thank you, so on the issue of composition I just wanted to say this much, sometime in some books like a if you read UN's determinants and consequences of population trends, which I mentioned in the earlier lecture. You find that for certain characteristics like a sex marital status they use the term composition and for other things they use the term distribution, it does not matter you call it composition or distribution.

Basically, the purpose is to show how different characteristics of population are manifested in the population and what kind of changes are taking place in them. So, what is the religious profile of the country, what percentage of people are in the work, what is the percentage of workers, what is the percent of non-workers, what is the percentage of unemployed and so on.

Similarly, what is the percentage of SCs, what is the for policy planning purposes we need what is the percentage of SCs, what is the percentage of STs, OBCs and percentage of others these figures are of immense importance, and due to the process of demographic transition taking place at different points of time, the growth rates of these categories differ and some categories are rising faster than others.

Thank you.