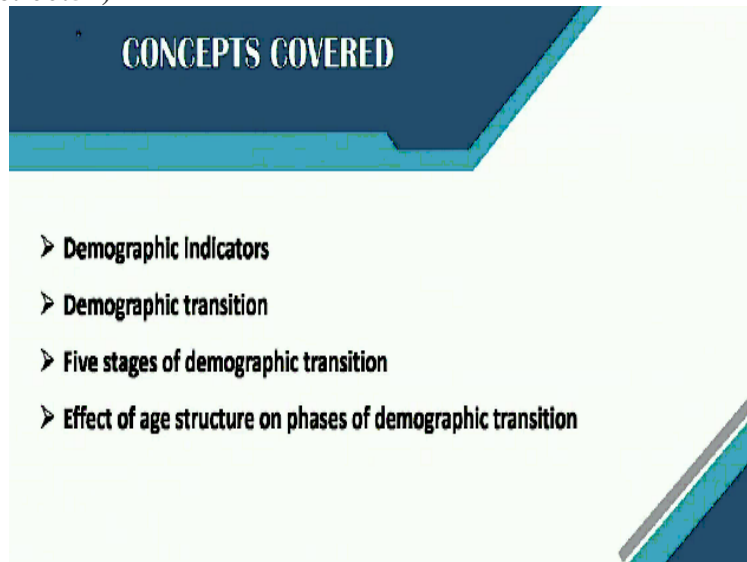


Urban Landuse and Transportation Planning
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Lecture - 16
Demographic Transition

Welcome to module 4 of the Urban Land Use and Transportation Planning course. In this module, we will cover microsimulation and population synthesis. For synthesizing the population for an urban area, the first step is to understand how the demographic transition is taking place for that particular urban area and what is the projected population for that particular area. In lecture 16, we will cover demographic transition.

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The different concepts that would be covered in this particular lecture are demographic indicators, demographic transition, five stages of demographic transition, and the effect of age structure on phases of demographic transition.

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Demography is defined as the 'the study of the size, territorial distribution, and composition of population, changes therein, and the components of such changes' By Hauser and Duncan (1959)

Components: Population by sex and age (2 dimensional)


Fertility and nuptiality based models: 'one-sex' modeling

Mortality based models: both sex are considered (mortality rate is lower for women)

Likelihood of an event occurring changes with age of an individual (Age gradient of various life events).

Demographic transition of an individual and a society are both important in urban planning.

Demographic transition of a society is closely linked to migration and economic development.



Hauser and Duncan defined demography as the study of the size, territorial distribution and composition of the population, changes therein, and the components of such changes. Demography is not only the study of the total population but also how it is spread over a particular area and the total composition of the population and the division of the population into different components such as based on gender, different age groups, and income of the different households.

The population can be divided in a 2 dimensional way or a 3 dimensional way. For example, when all three components like income category, age group, and gender are considered then, it is a 3 dimensional way of categorizing the population. Similarly, if only age and sex are considered, then it is a 2 dimensional way of categorizing the population. Hence, the study of demography not only determines the total population at a certain point of time and its composition but also how it changes over time i.e., how the composition of these groups change over time and what are the effects of these changes.

There are different ways to model this change and modeling techniques consider fertility and nuptiality of women which could be used to estimate the number of new births (i.e. new population) based on marriages of women.

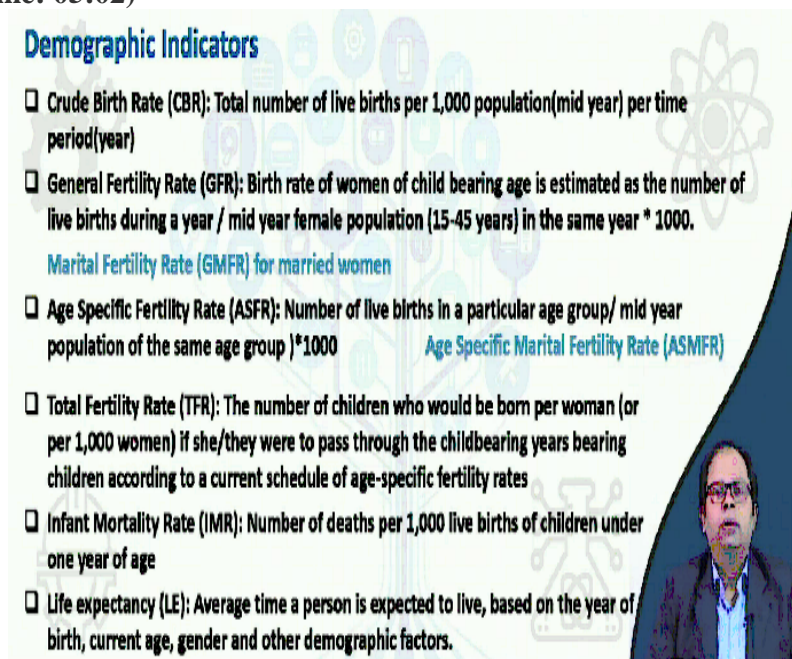
This will help to determine the growth of that particular area. Similarly, in mortality-based models mortality rate by genders is determined along with the estimation of survival rate by age groups and gender groups which also help to predict the future population.

The demographic indicators (i.e. fertility, mortality) change at different ages i.e., likelihood of an event to occur, changes with the age of an individual which is called the age gradient of various life events. For example, the likelihood of a person who is older to die is more, compared to a person of younger age.

Demographic transition of an individual and a society (i.e. how a particular individual is changing from one age group to another after a certain point of time, how the entire society is moving, and what implications it have in urban planning) are both important in urban planning.

The demographic transition of a society is closely linked to migration and economic development. The demographic pattern of a particular society influences the migration to that particular area because different demographic structures indicate different kinds of economic development or different kinds of activity rates in a particular population.

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Demographic Indicators

- ❑ **Crude Birth Rate (CBR):** Total number of live births per 1,000 population (mid year) per time period (year)
- ❑ **General Fertility Rate (GFR):** Birth rate of women of child bearing age is estimated as the number of live births during a year / mid year female population (15-45 years) in the same year * 1000.
Marital Fertility Rate (GMFR) for married women
- ❑ **Age Specific Fertility Rate (ASFR):** Number of live births in a particular age group / mid year population of the same age group * 1000 **Age Specific Marital Fertility Rate (ASMFR)**
- ❑ **Total Fertility Rate (TFR):** The number of children who would be born per woman (or per 1,000 women) if she/they were to pass through the childbearing years bearing children according to a current schedule of age-specific fertility rates
- ❑ **Infant Mortality Rate (IMR):** Number of deaths per 1,000 live births of children under one year of age
- ❑ **Life expectancy (LE):** Average time a person is expected to live, based on the year of birth, current age, gender and other demographic factors.

Demographic indicators

The demographic indicators are ways to define different aspects of demography.

Crude Birth Rate (CBR)

The crude birth rate is defined as the total number of live births per 1000 population per time period. This time period could be a decade or a particular year or as per the particular study. Mid-year population means within a time period the value at the middle of the time period whichever is the number of the average value for that particular mid-year period would be taken (i.e. total number of live births per 1000 population per time period is the total number of live births at around the mid-year period)

General Fertility Rate (GFR)

It is the birthrate of women of childbearing age is estimated as the number of live birth during a year divided by mid-year female population of 15 to 45 years (i.e. childbearing age) in the same year and is multiplied with 1000.

Marital Fertility Rate (GMFR)

Similar to the general fertility rate, in marital fertility rate calculation, only married women are considered.

Age-Specific Fertility Rate (ASFR)

In the age-specific fertility rate (SFR) calculation, the number of births in a particular age group per mid-year population of the same age group is multiplied with 1000.

The mid-year population of the same age group is considered because the population may fluctuate during the entire year. Similarly, in age-specific marital fertility rate estimation, married women are only considered.

Total Fertility Rate (TFR)

The total fertility rate (TFR) is defined as the number of children who would be born per women or it would be per 1000 women if she or they were to pass through the child bearing years

bearing children according to a current schedule of age-specific fertility rates. For different age groups, fertility rates differ i.e., the women at the age of 15 and the women at the age of 45 will have different fertility rates. If a woman passes through the entire childbearing years, starting from 15 to 45 and survives during the entire period, the total number of children who could be born during that period is the total fertility rate.

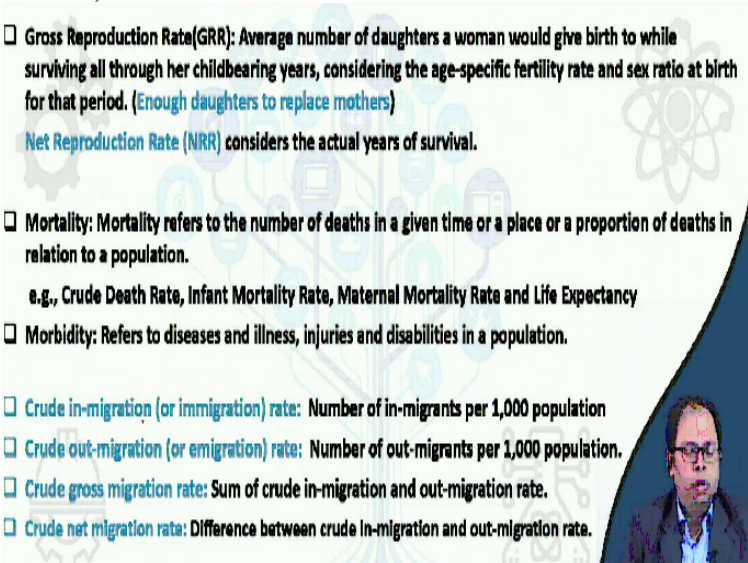
Infant Mortality Rate (IMR)

The infant mortality rate is the number of deaths per 1000 live births of children under one year of age.

Life Expectancy (LE)

Life expectancy is the average time a person is expected to live based on the year of birth current age, gender, and other demographic factors.

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- Gross Reproduction Rate(GRR):** Average number of daughters a woman would give birth to while surviving all through her childbearing years, considering the age-specific fertility rate and sex ratio at birth for that period. (Enough daughters to replace mothers)
Net Reproduction Rate (NRR) considers the actual years of survival.
 - Mortality:** Mortality refers to the number of deaths in a given time or a place or a proportion of deaths in relation to a population.
e.g., Crude Death Rate, Infant Mortality Rate, Maternal Mortality Rate and Life Expectancy
 - Morbidity:** Refers to diseases and illness, injuries and disabilities in a population.
 - Crude in-migration (or immigration) rate:** Number of in-migrants per 1,000 population
 - Crude out-migration (or emigration) rate:** Number of out-migrants per 1,000 population.
 - Crude gross migration rate:** Sum of crude in-migration and out-migration rate.
 - Crude net migration rate:** Difference between crude in-migration and out-migration rate.

Gross Reproduction Rate (GRR)

Gross reproduction rate (GRR) is the average number of daughters a woman would give birth to while surviving through the childbearing years considering the age-specific fertility rate and sex ratio at birth for that period i.e., whether there would be enough daughters who could replace their mothers. This is a measure to determine if the society or if that particular population is having enough number of daughters so that the future fertility (i.e. the future population growth) is ensured.

Net Reproduction Rate (NRR)

In gross reproduction rate, it is assumed that the women go through the entire childbearing years and survives during this entire period, whereas in net reproduction rate, the actual years of a woman's survival are considered because the mortality rate differs across the age groups and it is obvious that all women will not survive throughout this particular time (i.e. from 15 to 45 years).

Mortality

Mortality refers to the number of deaths in a given time or a place or proportion of deaths concerning a particular population. There are some ways to estimate mortality such as crude death rate, infant mortality rate, maternal mortality and life expectancy.

Morbidity

Morbidity which is important in studies where the number of days a person loses work because of feeling or falling sick is determined. This refers to diseases and illnesses, injuries, and other disabilities in a population. Moreover, the likelihood that a population will be sick for a certain amount of time is estimated.

Migration indicators

There are different migration indicators like crude in migration rate or which is also called immigration rate which is the number of immigrants, per 1000 population. The crude out-migration rate or emigration rate is the number of migrants per 1000 population. The crude gross migration rate is the sum of crude in-migration and out-migration rates. The crude net-migration rate is the difference between crude in-migration and out-migration rates.

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- ❑ Crude rate of natural increase (CRNI): Difference between the crude birth rate and the crude death rate.
(Population can be both growing or declining)
- ❑ Overall population growth rate: Sum of crude rate of natural increase and crude net migration rate.
 - ❑ Migration also varies with age.
Age-specific out-migration rate: Number of out-migrants of an age group per 1,000 population of that age group during a particular period.
 - ❑ Migrant population also goes through the same demographic experiences like births deaths etc.
(These are considered during population projection by estimating the same for half the time of the projection period.)
- ❑ Total Fertility Rate of 2.1 is known as 'replacement level fertility' in low mortality countries.



Crude rate of natural increase (CRNI)

After knowing the mortality, the fatality, and the migration rates, the crude rate of natural increase, and the total overall population growth rate can be determined. The crude rate of natural increase is defined as the difference between the crude birth and the crude death rate that means if the crude death rate is higher, the population would be declining if the crude birth rate is higher then the population would be growing.

Overall population growth rate

The overall population growth rate is the sum of the crude rate of natural increase and crude net migration rate that means both migration and the natural increase are included to determine the overall population growth rate for an urban area. Migration also varies with age i.e., people from different age groups are more likely to have different rates of migration.

For example, a person who is within the age group of around 25 to 35, is more likely to migrate to a new area. The number of out-migrants of an age group per 1000 population of that age group during a particular period is a specific outmigration rate. Similarly, in-migration rates also as per the different demographic or different population groups can be estimated. The migrant population also goes to the same demographic experiences like births, deaths, etc.

During the estimation of the total population of a particular area, the existing population is divided into different age and gender groups. Similarly, the migrant population also needs to be

taken through the same processes. Population projection for these migrants is estimated for half of this time period i.e., during the estimation of these values for a certain time period (e.g. 10 years) the average value for the migrants of the time period is considered. Some of the migrants have come at the beginning and some of them have come at the end. Hence, the average of them is taken with an assumption that the entire population has arrived in the middle, and based on that, statistical or mathematical calculations are carried on.

A total fertility rate of 2.1 is known as 'replacement level fertility' in low mortality countries i.e., in low mortality countries where the death rate is low, a fertility rate of 2.1 is minimum required to replace the existing population and in high mortality countries, a higher fertility rate is required.

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Demographic transition theory

- Demographic transition theory was proposed by the American demographer Warren Thompson in 1929.
Adolphe Landry of France (1934)
- This theory explains the changes in a country's demography, society and economy based on the relationship between birth rate (CBR) and death rate (CDR).
- All countries experiences these changes in population at different rates and are in any one of the stages of demographic transition.
- 4 recognized stages of growth are popular, but 5th stage is introduced recently by some demographers.

Stage	Birth Rate (CBR)	Death Rate (CDR)	Total Population
Stage 1	High	High	Low
Stage 2	High	Declining	Increasing
Stage 3	Declining	Low	Increasing
Stage 4	Low	Low	High
Stage 5	Very Low	Very Low	Very High

Demographic transition theory

The demographic indicators involve a particular population group or even a particular individual. Thus, in the case of the entire society, it is important to analyse how the demographic transition takes place in society and how it affects that particular society. This also influences the future population of that particular society.

The demographic transition theory was proposed by the American demographer Warren Thompson in 1929 and this was extended by Adolphe Landry of France during 1934. This theory explains that the changes in a country's demography, society, and economy are based on the

relationship between birth rate (CBR) and the death rate (CDR) of a particular area either urban or rural for a particular country.

The extension part of this theory states that, all the countries experience this change in the demographic pattern of the population structure because of the difference in birth rate and death rate at different periods.

All countries experience these changes at a different rate because of this particular transition, For example, in the above figure, in the first phase of transition, both birth rate and death rate are more or less similar or fluctuating (i.e. sometimes the birth rate is higher and sometimes death rate is higher) and the population is more or less stable and at a lower level. Then, in stage 2, as the death rate is coming down and the birth rate is stable, the population has started to grow. In the next stage, the same pattern continues with a slightly lower birth rate. Hence, in stage 3, the population is still growing, but the rate of growth starts coming down. In stage 4, the rate almost stagnates and finally in stage 5, as the birth rate has fallen below the death rate, the population starts to decline. So in short, in this transition, first initially death rate and birth rate both are high and then the death rate falls down and finally, the birth rate also falls.


This transition pattern is experienced by most of the countries. But the speed of this transition varies across the countries. For example, some countries go through these phases for around 200 years, whereas many economies in Asia have gone through these phases in a much smaller time period. However, all countries have to go through these particular phases and there are 4 recognized phases.

But recently the fifth stages were also introduced by some demographers where there may be a permanent fall in the death rate or there could be a situation where the population is either increasing or there could be a situation where the population is falling depending on the birth rate and the fertility rate.

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Five Stages of Demographic Transition

- ❑ **Low Growth: Very high birth and death rate.**
Preindustrial society. Limited food supply.
- ❑ **High Growth: CDR goes down while the CBR stay the same.**
Improvement in food supply and sanitation. Industrial revolution.
New farming techniques. Female literacy and health education.
- ❑ **Moderate Growth: Drop in CBR and CDR both and the gap between them reduces.**
Urbanization. Female participation in workforce.
- ❑ **Low Growth: CBR equals the CDR.**
CDR may have even increased due to obesity etc. Shrinking population.
- ❑ **Low/No Growth: Higher CDR than CBR and irreversible population decline.**
Pollution, Life style change, lower birth rate.
Below-replacement fertility(Pessimistic view),
Increase in fertility(Optimistic view)



Five stages of demographic transition

1. Low Growth: Very high birth and death rate

In the first stage of demographic transition, high birth rate, and death rate results in a low growth phase and this is primarily in a preindustrial society. There is a limited food supply. Hence, there is competition for food and high mortality rate. The birth rate is also to some extent low because of all the hardship in this society.

2. High Growth: CDR goes down while the CBR stay the same

Then, there is the high growth stage. As CDR goes down while CBR stays the same i.e., the birth rate more or less stays the same, whereas, the death rate is coming down, there is a gradual improvement in food supply and sanitation and societies gradually becomes industrialized. The society also learns new farming techniques for producing more amount of food. Female literacy starts and health education also start in society.

3. Moderate Growth: Drop in CBR and CDR both and the gap between them reduces

In the moderate growth phase, both CBR and CDR drop and the gap between these two starts reducing, and this is the phase of urbanization. Society progresses and more amounts of females participate in the workforce resulting in a little bit of drop in the birth rate.

4. Low Growth: CBR equals the CDR

At present, most societies in the developed world are going through the low growth phase, where CBR equal to CDR i.e., the birth rate falling to a point where it matches the death rate and the population is more or less shrinking.

5. Low/No Growth: Higher CDR than CBR and irreversible population decline

Finally, in the fifth phase which is the extension of the fourth phase, a higher CDR than CBR could be observed which will lead to an irreversible population decline. But the opposite can also happen in some societies based on whatever policies the societies adopt. This means that the society recognizes this problem and can increasingly adopt policies that can reverse this. In that case, the CBR can increase.

Hence, there are two ways to look into this. The pessimistic view is below replacement fertility levels i.e., the attained fertility level cannot replace the population. Hence, the population is on a permanent decline. As per optimistic view, when this kind of situation is faced by society, it takes some measures which increase fertility resulting in higher growth.

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Effect of age structure on phases of demographic transition

Change in age structure of a population influences economic and social development and is not a new phenomenon. These phases of transition may last for even 200 years.

Population ageing Industrialized countries above 60 years
China: Rapid fall in fertility rates.

Increase in old age dependency rate
Labour shortages
Inability to finance social security and old age care

- Child phase,
- Young adult phase,
- Phase of population maturity,
- Phase of ageing.

Demographic transition influences both age structure and population growth.

(A small video inset in the bottom right corner shows a man with glasses speaking.)

Effect of age structure on phases of demographic transition

The demographic transition theory revolves around the changing birth rate and death rate and how it influences the society and the entire demographic structure whereas some demographers also argue that, the effect of age structure also plays a big role in demographic transition i.e.,

changes in the age structure of a population through influencing economic and social development.

For example, in industrialized countries most of the population is above 60 years of age and China is also showing a rapid fall in fertility rates. As old people increases in society, old-age dependency rates are increasing leading to an increase in old-age care and labor shortages followed by inability to finance social security. As the numbers of people supporting the older age groups are lower, there is a problem with financing. Since, young people pay taxes, there is a problem of having enough amount of money to finance the social security and the old-age care and other services that the society provides to its entire population and especially to the older population. In short, more people in the older age groups lead to this kind of societal problems.

Hence, it can be concluded that the demographic transition influences both demographic structure and population growth and along with the demographic transition there are societal transitions (i.e. a child phase, young adult phase, population maturity, and phase of aging).

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Child phase	Young adult phase
<ul style="list-style-type: none"> Decreasing death rate. Number of children increases. After 30 to 40 years with fertility remaining unchanged the population age sex pyramid shows a concave shape. Consumption exceeds production capacity. High child dependency rate (population under 18 years / 18 to 64 years population x 100.) Women spends time and resources in child rearing. Widespread poverty, child labour. Exploitation of natural resources, forest land and intense land reclamation. Foreign capital and imports <p>India (1960)</p>	<ul style="list-style-type: none"> Decreasing fertility rate, total number of birth reduces. Increasing participation of women in labour force. The base of the pyramid gets narrower and shows a convex shape. The population bulge is at the young adult age group. Young population willing to work. This leads to agricultural transformation, liberalization, emigration, urbanization, industrialization, railway building etc. Democratisation and more extensive state intervention (welfare state). Overpopulation, low wage rate, low savings, low living standards. <p>Germany (1870-1930) China (1963 to 1995)</p>

Child Phase

At the beginning of the child phase, both birth rates and death rates are high and this is almost like a pre-industrial society. Then gradually the death rate starts decreasing and the number of children starts increasing in this particular society. After 30 to 40 years (i.e. number of years may be different for different geographies or different countries) when fertility remained unchanged

the population age-sex pyramid shows a concave shape that means there are more number of people in that lower age groups and a smaller number of people in the higher age groups.

Though, the number of children are high, there are only a few people working. Thus, consumption exceeds production capacity. Women spend most of the time in childbearing and also child-rearing limiting themselves to household activities resulting in widespread poverty, child labor, exploitation of natural resources (i.e. forest land), and intense land reclamation for agriculture and construction of industries.

In this phase, the society is walking towards providing for itself as foreign capitals and inputs are also very low. India was in this phase during the 1960s.

Young adult phase

In this phase, the fertility rate decreases i.e., the increasing fertility rate of the young adult phase starts coming down and the total number of births reduce.

Increasing participation of women in the labor force is one of the causes of lower fertility rates. Hence, the base of the pyramid gets narrower and shows a convex shape.

The young population is willing to work even at lower wages which leads to agricultural transformation, liberalization, immigration, urbanization, industrialization, railway building, etc. As there is a lot of a young person they are also asking for their rights. So democratization takes place and the state also intervenes into the life of the people by providing certain facilities.

Hence, societies start gradually moving to a welfare state system which leads to overpopulation, low wage rate, low savings, low living standards during this particular years because the total number of people that has to be supported is still on a higher side like Germany during 1870s to 1930s which is a pretty long phase of 60 years and China during 1965 to 1995 which is the much shorter phase (i.e. 30 years).

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Population maturity phase

- ❑ The population bulge gradually rises up the entire age structure.
- ❑ The population bulge is at the middle age group.
- ❑ Period of sustained growth.
- ❑ Adequate labor supply.
- ❑ Women engaged in child rearing and domestic activities.
- ❑ Higher savings.
- ❑ Savings pattern change from housing to financial assets.
- ❑ Most prosperous stage.....transformation to industrialized state.

Korea from 1960s.
Brazil, Colombia and China from 1985.

Phase of aging

- ❑ Decline in economic growth.
(Lowering of per capita income growth, productivity growth, rate of capital formation in business)
- ❑ Increasing long term interest rates.
- ❑ Growing public expenditure and budget deficits.
- ❑ Increase in spending for old age care and services, health care.
- ❑ Women's labour force participation increases.
- ❑ Discontent arising from tax and other issues.
- ❑ This phase is similar to the first phase due to the high dependency rate of older population.

Japan and many European nations.

Population maturity phase

In this phase, the population bulge gradually rises and the middle age group shows the biggest bulge. This is a period of sustained growth because middle-aged people have experience and connections. Besides, as there is adequate labor supply and people are earning good wages, women can go back to child-rearing and domestic activities resulting in some amount of reduction in the number of women engaged in offices working in the different sectors. Besides, there are higher savings. Saving pattern also changes from housing to financial assets. People instead of buying houses start buying secure financial assets. This is the most prosperous stage and gradually countries start transforming into an industrialized state. This was Korea from the 1960s onwards and Brazil, Colombia, and China from 1990, 85 and 90 onwards respectively. This is the best phase because this is the most prosperous phase and this is when cities or countries become industrialized or they become stable.

Phase of aging

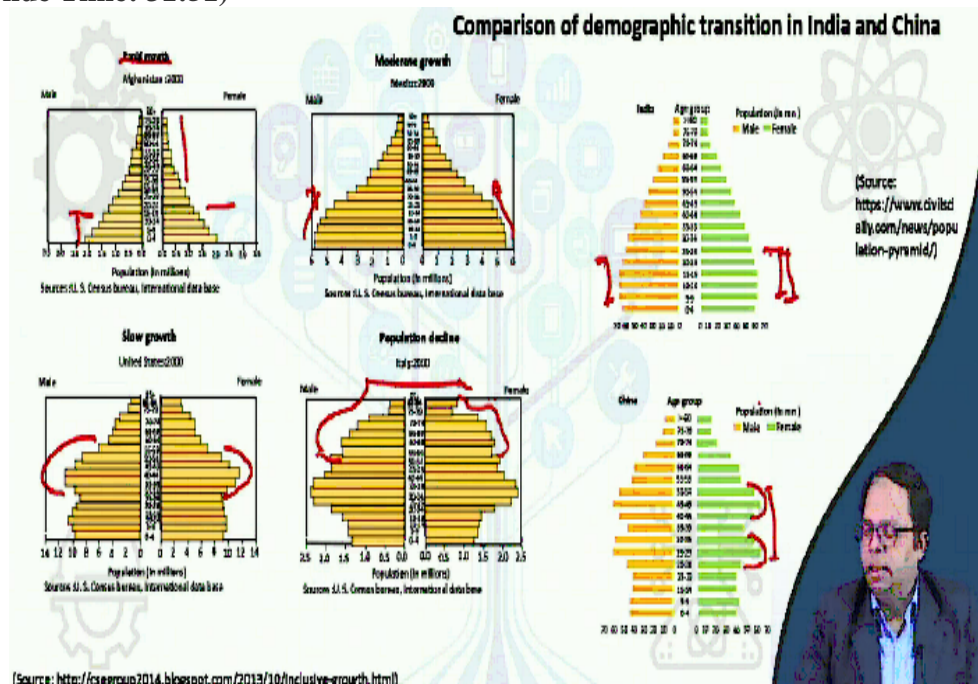
In the phase, economic growth has declined because of the lowering of per capita income growth. As people have aged they cannot actively participate in the workforce resulting in low productivity growth. The rate of capital formation in business is also lower.

So this also increases long term interest rates, public expenditure, and budget deficits because the government has to spend more on supporting the different kinds of social services for old people

(e.g. old age care) and other population groups. Women's labor force participation also increases and there may be increase in discontent arising from tax and other issues.

Hence, this phase is almost similar to the first phase where the dependency rate of the younger people was high and here dependency rate of the older population is high. So, again, the young working-age population has to work more and women also have to get work. This is true for Japan and many European nations.

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(Source: <http://csegroup2014.blogspot.com/2013/10/inclusive-growth.html>)

In the first figure (i.e. top left most), this is a period of rapid growth (i.e. the first phase) where like in Afghanistan in the year 2000, most of the population is in the lower age groups and in the upper age groups, there are very few people. The next figure shows Mexico in 2000. This figure is showing moderate growth where the population bulge is gradually moving upward. So there are more people in the younger age groups like around 20 to 24 and 15 to 19.

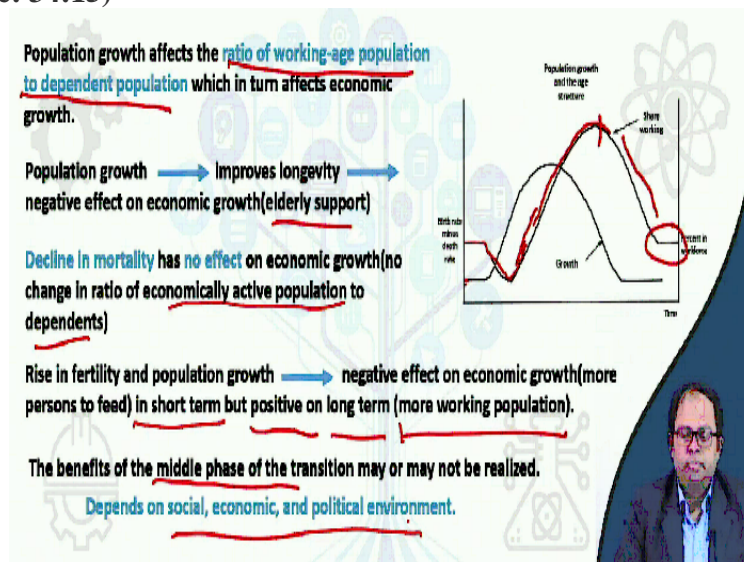
Then in the period of slow growth, a bulge in the middle age population for both males and females can be observed in the United States in the year 2000. In the population decline phase, a bulge is going up and there is a huge number of people in the older age groups like Italy in 2000.

Comparison of demographic transition in India and China

In India, most of our population is concentrated in the age groups of around 20 to 14, whereas China is in between the moderate growth phase and the slow growth rates. Hence, it can be said that China's demographic dividend is more or less at a position where it is gradually declining i.e., more people are going to be in the senior age group in China in the coming years.

The comparison of demographic transition between the 2 countries gives an idea of how the society will grow and what would be the expected economic development in society or what would be the expected changes in society etc. So demographic transition can also tell us about the changes that are forthcoming in the society as well and how it is related to population growth.

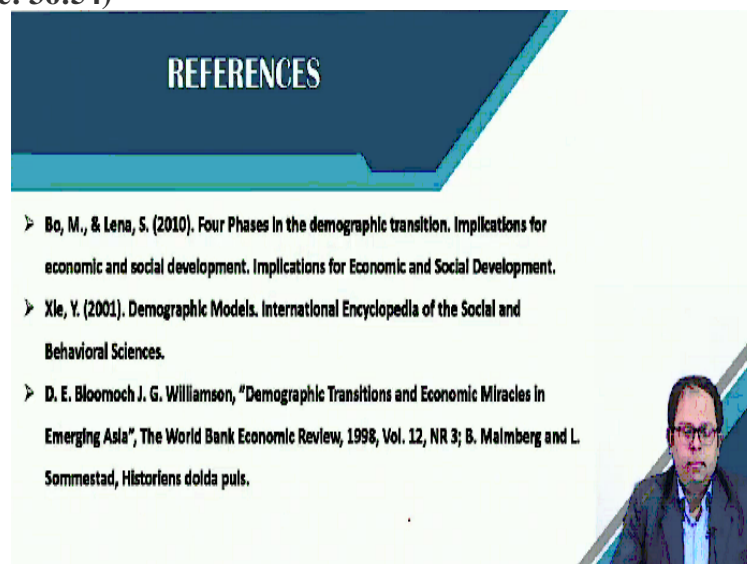
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So to summarize this discussion, it can be said that, population growth affects the ratio of the working-age population to the dependent population, which in turn affects economic growth. So the ratio of the working-age population to the dependent population is an important phenomenon to analyse. In the above figure, initially growth rate increases and then falls. Similarly, initially, the share of the working age population is stable. Then the share of the working age population curve comes down a bit because there is more growth and then it picks up because the population bulge is moving on. Then it reaches a stage when it is maximum and then it starts falling, which again leads to a lot of problems.

Population growth and improved longevity has a negative effect on economic growth because of various reasons like elderly support. Declining mortality does not affect economic growth because there is no change in the ratio of the economically active population to dependents. Rising fertility and population growth have a negative effect on economic growth in the short term because more persons have to be fed. But it is a positive influence in the long term as there will be more working population in the future years. So, rising fertility is not negative, it is both positive as well as negative during different time periods. The benefits of the middle phase of transition may or may not be realized. That population bulge, when it moves into the middle ages may lead to a lot of economic development for a country but depending on the social, economic, and political environment of an area, this benefit may or may not be realized for a particular country.

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CONCLUSION

Demographic indicators help us to analyze demographic transition more objectively.

While, population growth rate influences economic growth as suggested by both population pessimists and optimists, age structure and particularly working age population plays a big role.

Population age sex pyramids can help us to understand the likely demographic, social and economic changes for an urban area.

Demographic transitions take place over several decades. However, this time varies in different geographies and societies.

Conclusion

Demographic indicators help us to analyze demographic transition more objectively.

Population growth rate influences economic growth, as suggested by both population pessimists and optimists and age structure and particularly the working-age population plays a big role.

Population age-sex pyramids can help us to understand the likely demographic, social, and economic changes for an urban area. Demographic transitions take place over several decades. However, this time period varies in different geographies and societies.

Thank you.