Population Studies
Prof. Arun Kumar Sharma
Department of Humanities and Social Sciences
Indian Institute of Technology, Kanpur

Lecture - 12
Techniques of Population Analysis II

Well friends, we are talking about Techniques of Population Analysis. In the previous lecture, I introduced crude birth rate, crude death rate, age specific fertility rates, then life table life expectancy and DALY, Disability Adjusted Life Years. In this presentation, I will include some more important measures of demography on which planners need data and which tell us the story of demographic transition in the country.

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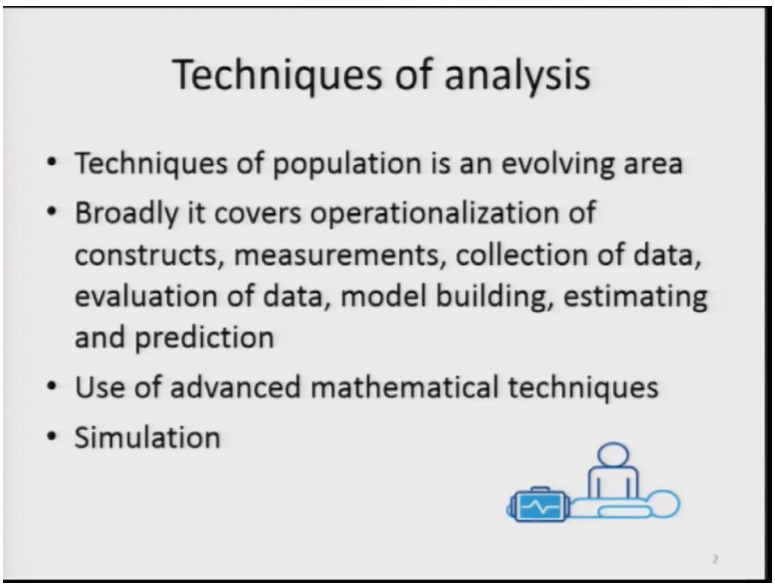

Techniques of population is an evolving area, lot of researches are going on. For example, in construction of life table I mentioned that the most crucial aspect of life table construction is conversion of age specific death rates into probabilities of dying, other things are routine. And demographers and mathematical demographers particularly are still engaged in finding an appropriate formula for conversion of age specific death rates into probabilities of dying or surviving.

Now, this area covers operationalization of constructs measurements collection of data, evaluation of data, model building estimating and prediction. Sometime you need measurements for checking quality of data quality of age data, quality of sex data and

under estimation or over estimation in fertility, mortality, migration data etc. And in this area of population studies, we use advanced mathematical techniques and sometimes simulation.

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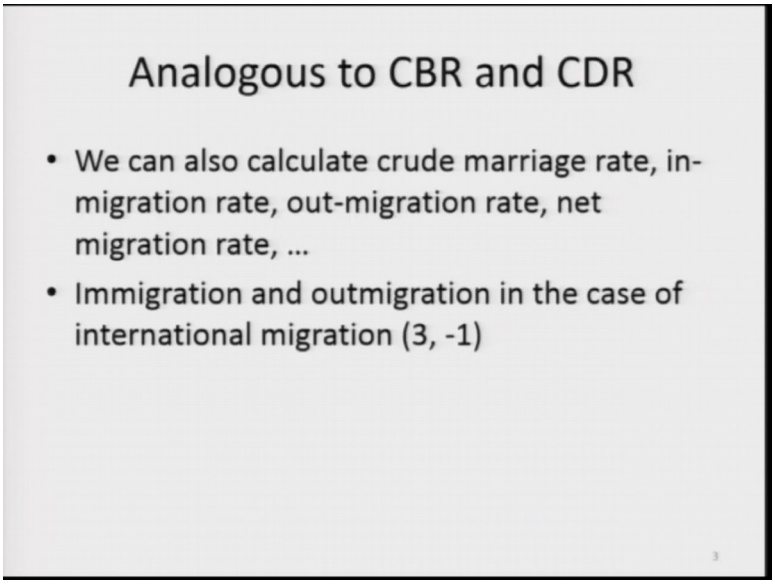

Analogous to crude birth rate and crude death rate, we can also calculate crude marriage rate: in migration rate, out migration rate and net migration rate. In migration rate would be number of in migrants in a given year or in sometime defining interval divided by average population of the area, country, state, region, district anything multiplied by 1000. Similarly out migration rate would be number of out migrants divided by average population multiplied by 1000, and net migration rate is defined as in migration rate minus out migration rate.

Similarly, for international migrants, we can calculate immigration rate and out migration rate called emigration in the international migration context. Immigration and emigration for example, immigration rate in the developed countries is 3 per 1000; that means, every year on 1000 people in more developed countries 3 persons are added due to international migration some come, some leave. The net migration is immigration and the rate is 3. In case of less developed countries, the net international migration rate stands at minus 1; that means, they lose, but they lose 1 per 1000, they are large countries usually and they lose 1 per 1000.

This these figures also show that while emigration from less developed countries may not help much in reducing the burden of population. In more developed countries these 3 per 1000 adds to the existing population or becomes burden sometime if the linguistic cultural, religious composition of migrants is different. And it is usually different is different from that of natives creates cultural problems identity problems.

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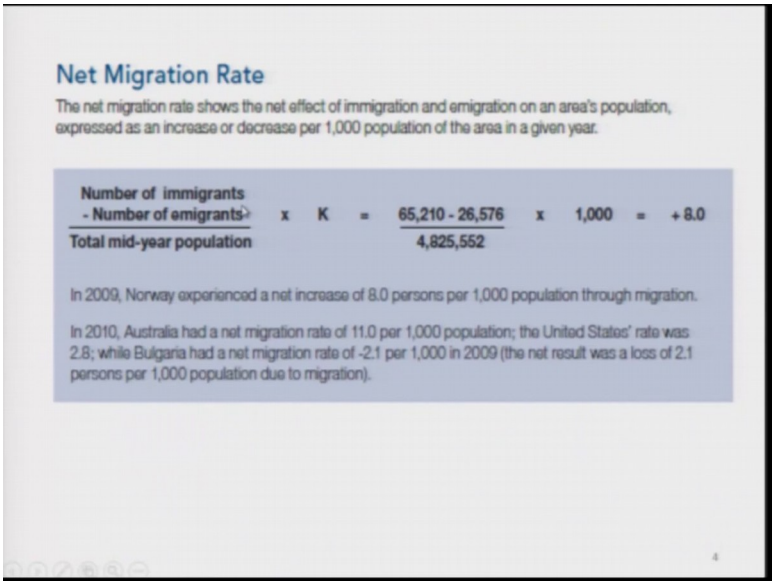

Net migration rate is therefore, defined as number of immigrants minus number of emigrants divided by total midyear population and for descriptive purposes, we always add K multiplied by K. And this shows the calculation that in 2009 Norway, Norway received 65210 migrants lost 26576 migrants. The average population or midyear population of Norway in 2009 4825552 and therefore, in 2009 Norway's net migration rate is plus 8.0, quite high. For developed countries, it was plus 3.0, for Norway alone it is plus 8.0.

In 2010, Australia had a net migration rate of 11 per 1000; the United States rate was 2.8 which is much less then that of Norway or Australia, it is typical a more developed countries while Bulgaria had a net migration rate of minus 2.1 per 1000 in 2009. The net result was a loss of 2.1 persons per 1000 population due to migration.

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Rates for a specific groups or issues, sometimes we calculate certain rates for specific groups; age groups, sex groups, occupational groups and for certain specific issues. For example, infant mortality rate is of special importance for human development index. This is the number of deaths during infancy divided by number of births into 1000. This is also important from policy perspective and infants are often divided into neo natal deaths and post neo natal deaths. Those infant deaths which take place in the first month of life are called neo natal and those which take place between first month and twelfth month; they are called post neo natal. Usually their reasons are considered to be different and therefore, this division.

Neo natal are mostly due to internal problems, constitutional problems of the infant and post neo natal usually reflect the communicable diseases and quality of environment and portable water. That is why this infant mortality is often taken to be an indicator of quality of environment.

Similarly, another measure of mortality which is of a specific interest is maternal mortality rate and sex ratio at birth. I will show you some figures of maternal mortality and sex ratio at birth. Maternal mortality rate tells us about the risk of dying due to reasons associated with child birth and sex ratio at birth tells us about gender bias. They are of special significance for the studies of gender equality or gender bias.

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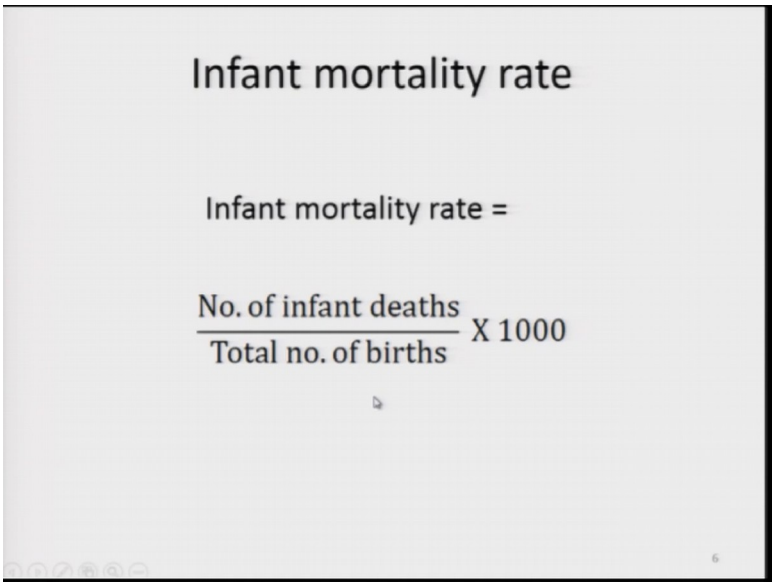

Infant mortality rate as I told you can be calculated by using this formula; number of infant deaths divided by total number of births multiplied by 1000. So, if India's death rate infant mortality rate, death rate for age group 0 to 1 or infant mortality rate is 40. It means when 1000 children are born 40 of them die before enjoying their first birthday.

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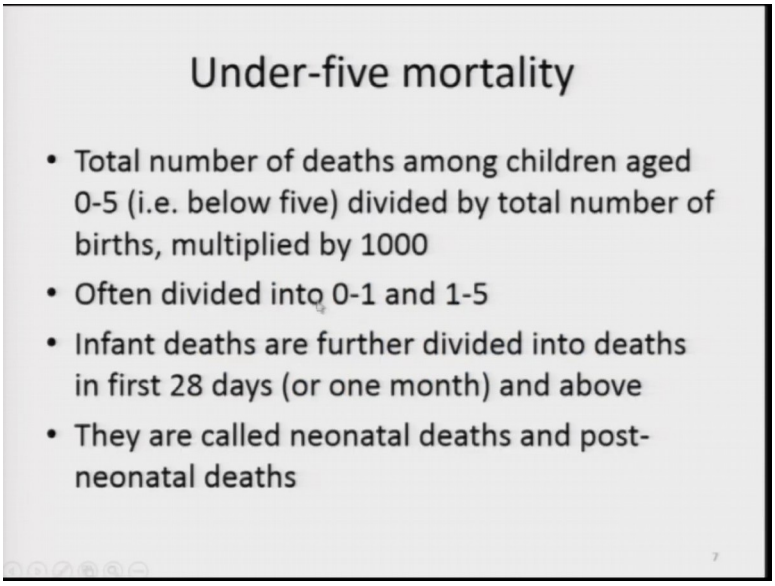

Under-five mortalities, another important issue next to infant mortality; if infant mortality is high, it does not mean that at first birthday children become free from risk of dying. Risk of dying is a continuous process and it continues for 5 to 10 years.

So, we calculate under 5 mortality total; which is calculated as total number of deaths among children aged 0 to 5, means below 5 years divided by total number of births and is multiplied by 1000 as is the case with infant mortality rate. This 0 to 5 is often divided into 0 to 1 and 1 to 5 because of special importance of infant mortality and then is added to arrive at mortality indicator for 0 to 5. Infant deaths are further divided into deaths into first twenty days or one month neo natal and our post neo natal.

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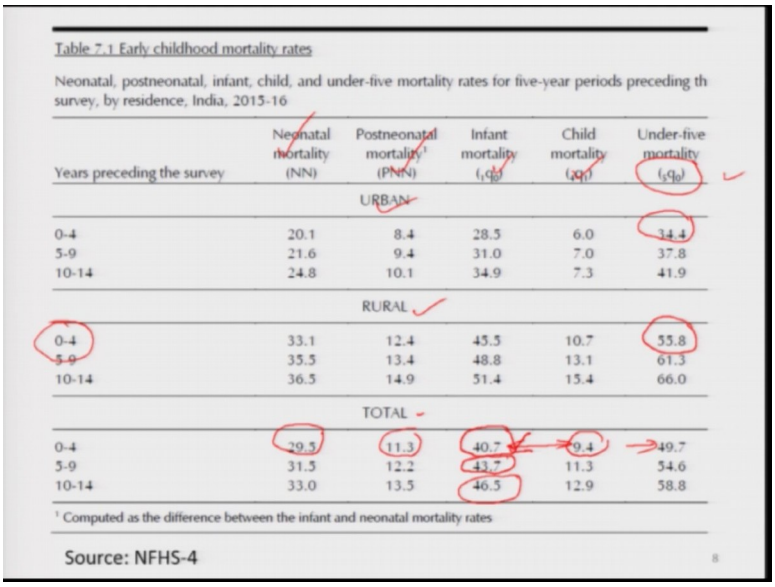

Table 7.1 Early childhood mortality rates

Neonatal, postneonatal, infant, child, and under-five mortality rates for five-year periods preceding th survey, by residence, India, 2015-16

Years preceding the survey	Neonatal mortality (NN)	Postneonatal mortality[1] (PNN)	Infant mortality ($_1q_0$)	Child mortality ($_4q_1$)	Under-five mortality ($_5q_0$)
URBAN					
0-4	20.1	8.4	28.5	6.0	34.4
5-9	21.6	9.4	31.0	7.0	37.8
10-14	24.8	10.1	34.9	7.3	41.9
RURAL					
0-4	33.1	12.4	45.5	10.7	55.8
5-9	35.5	13.4	48.8	13.1	61.3
10-14	36.5	14.9	51.4	15.4	66.0
TOTAL					
0-4	29.5	11.3	40.7	9.4	49.7
5-9	31.5	12.2	43.7	11.3	54.6
10-14	33.0	13.5	46.5	12.9	58.8

[1] Computed as the difference between the infant and neonatal mortality rates

Source: NFHS-4

Here are some data these data are from National Family Health Survey-4. These data are given for the year 2015-16, NFHS - 5 is going on and for 2018-19, we will get figures after a few years. The latest year for which NFHS figures are available today is 2015 to 2016 nothing much must have changed after that.

So, this is the data for total, means combining urban and rural areas, then this is for urban areas separately and this is for rural areas. The first of all we would like to know what is infant mortality of India total that is 40.7, infant mortality 40.7. Then this NFHS also gives us figures for 0 to 4 years prior to the survey, 5 to 9 years prior to the survey and 10 to 14 years prior to the survey. 0 to 4 years which is of more interest to us is 40.7; that means, 0 to 4 years before during last 5 years means in 5 years preceding in simple terms, you can say in 5 years preceding the survey our infant mortality was 40.7.

How many of 40 children who died in 0 to 1 died in neo natal period, first month of life and how many of them in the later 11 months? The figures are the 29.5 of them. Roughly

30 of them died in the first month of life or in the neo natal period and 11 of them died during the post neo natal period.

If you calculate child mortality which is number of deaths in 1 to 4 and divided by the proper denominator, then it is 9.4. Thus if you add this these two figures, this is number of deaths 0 to 1 divided by births in 2000. This is number of deaths 1 to 4 divided by births. If you add that 2, you arrive at under 5 mortality or 5 q 0, you know it is not same thing as age specific death rates for 0 to 5 or 0 to 4 because age specific death rates would be number of deaths in 0 to 4 divided by average population of 0 to 4. While in under 5 mortality it is number of deaths 0 to 5 or 0 to 4 as the convention is divided by number of births multiplied by 1000 that is why we use life table symbol 5 q 0 for that. This is probability of dying in the first 5 years of life.

There are strong urban and rural differences in rural areas this under 5 is 55.8 of all the 1000 births which took place during the 5 year period preceding the survey in rural areas, you find that 55.8 out of 1000 died and in urban areas. The figure is 34.4. In urban areas probability of dying 0 to 5 is quite less as compared to that in the rural areas.

So, this is NFHS data on neo natal mortality, post neo natal mortality, infant mortality which is the sum of the 2, child mortality and under 5 mortality separately for urban rural areas and for the country as a whole.

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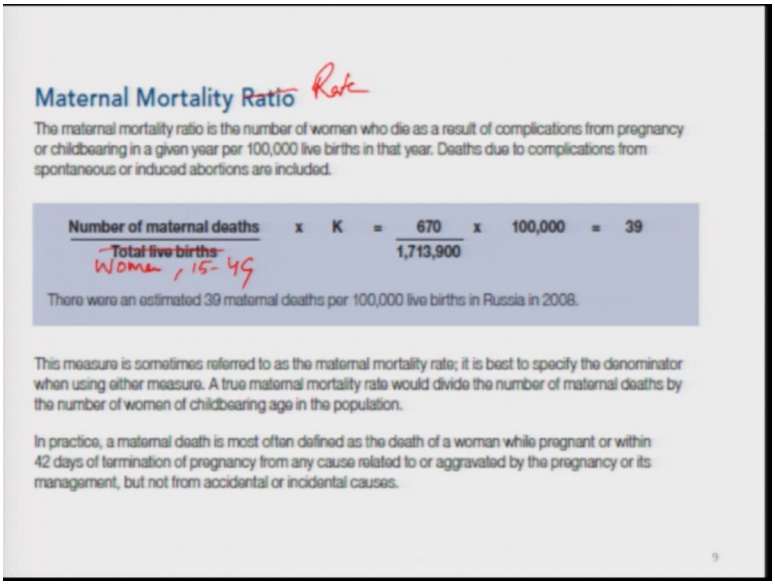

Another measure of interest to planners is maternal mortality ratio. This maternal mortality ratio is the number of women who die as a result of complications from pregnancy or childbearing in a given year per 100,000. This is not 1000 remember this is 100,000; 1 lakh live births in that year. Deaths due to complications from spontaneous or induced abortions are included.

Now maternal mortality has to be defined first what is maternal mortality and then number of maternal deaths divided by total number of live births multiplied by K; K in this case is not 1000 as in case of crude death rate, crude birth rate or infant mortality rate, but 100,000 or 1 lakh because maternal mortality ratio per 1000 would be quite low. That can be calculated per 1000 also, but that will be quite low.

So, it is calculated on per lakh basis and in India maternal deaths divided by total live births called maternal mortality ratio. We have seen earlier these figures are for Russia 2008, 39 very low figure as compared to India. India still has a very high maternal mortality rate. This measure is because maternal mortality rate is not a matter of medical interventions only. It depends on gender bias, attitude towards women safety, transportation facilities, awareness and whether delivery takes place at home or in a health facility and a number of other factors malnutrition, anaemia.

Anaemia is a major factor of complication among maternal death. Anaemia often leads to postpartum haemorrhage and that is a major cause of maternal deaths in India. This maternal mortality ratio this measure is sometime referred to as the maternal mortality rate it is best to specify the denominator when using either measure. A true maternal mortality rate would divide the number of maternal deaths will be same in case of rate you know; sometime people confuse between ratio and rate, this is ratio. If you want to calculate maternal mortality rate, the advantage of rate would be that it can be given a meaning in terms of probability then the denominator is replaced by total number of women in the reproductive ages.

When you; so, a true maternal mortality rate would divide the number of maternal deaths by number of women of childbearing age in the population. In practice, a maternal death is most often defined you know this is the technical definition, but ordinary health workers understand or can be made to understand maternal death. This is death of a woman while pregnant or within 42 days of termination of pregnancy from any cause

related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes.

So, if you remove these total live births by women in reproductive ages means 15 to 49, then it becomes maternal mortality rate. This is a major difference between maternal mortality ratio and maternal mortality rate; quite often we calculate maternal mortality ratio. But this cannot be given a meaning in terms of probability for that you calculate rate.

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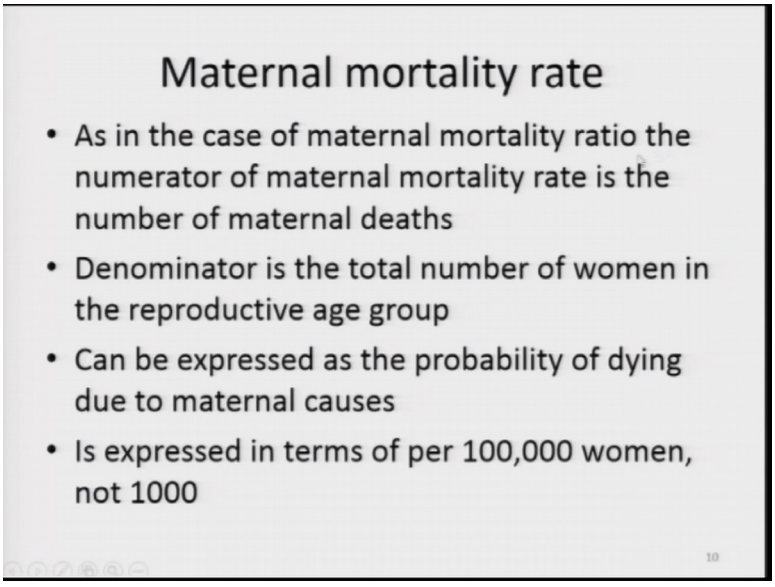

As in the case of maternal mortality ratio, the numerator is the same maternal deaths, denominator is the total number of women in the reproductive age group. And it can be expressed as the probability of dying due to maternal causes and is expressed in terms of per 100, 000 women and not 1000 as usually age specific death rates are shown.

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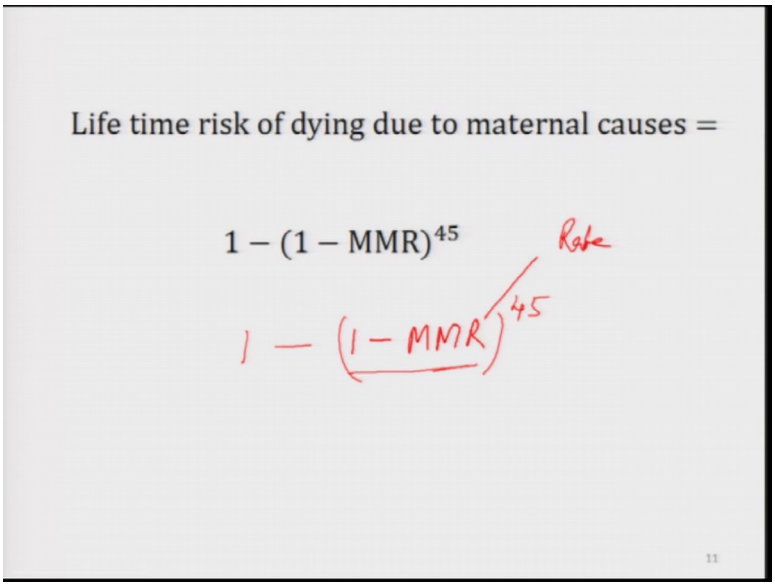

From maternal mortality rate, we arrive at a very interesting measure of gender gap and this is called lifetime risk of dying due to maternal causes and it is defined as 1 minus in bracket 1 minus MMR raised to power 45. Why this lifetime risk? Now, what is the probability that a woman will survive in a particular year that will be 1 minus MMR, because MMR defined as Maternal Mortality Rate. This is R is rate defined as maternal mortality rate, this is the probability of dying, 1 minus this will be probability of survival.

So, the probability that a woman survives in the reproductive ages for 45 years will be this, for 45 years. Assuming that survival at say age 29 does not depend on survival at age 28. So, by using law of multiplicative rule of probability this is 1 minus MMR raised to power 45, this is probability of survival. Then probability of dying due to maternal causes during childbearing period will be 1 minus MMR raised to power 45.

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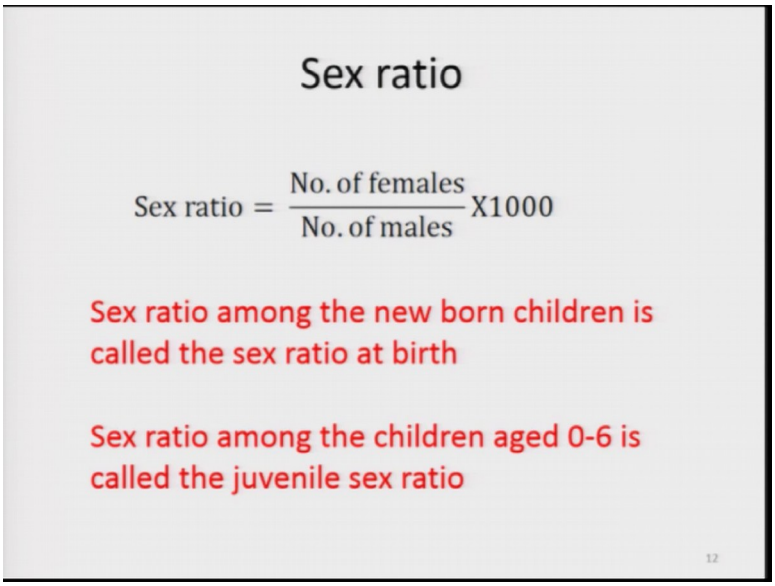

Another interesting story is of demographic and socio cultural biases against women is told by sex ratio. Sex ratio is defined as number of females divided by number of males into 1000. In this is the way it is defined in India; otherwise in some other countries it is mostly defined in terms of number of males divided by number of females into 1000.

And when the sex ratio is calculated for new born babies, then it is called sex ratio at birth means say in 2018, how many female babies were born and how many male babies were born. If you divide number of female babies born by number of male babies born, then you get sex ratio at birth. And this is of a special importance because it tells us about a very sensitive and repugnant phenomenon of female foeticide in our country.

Now sex ratio among children 0 to 6 all children up to 6, this combines the effect of female foeticide and also the neglect of female babies and this is called juvenile sex ratio. And juvenile sex ratio is also of a special interest to registrar general India planners, government, NGOs and academicians and those involved in families movements. look at this figures for India.

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Sex ratio (female per 1000 male) at birth by residence, India and bigger States/UTs, 2014-2016

India and bigger States/UTs	Total	Rural	Urban
India	**898**	**902**	**888**
Andhra Pradesh	913	923	888
Assam	896	898	880
Bihar	908	912	871
Chhattisgarh	963	995	833
Delhi	857	917	856
Gujarat	848	867	820
Haryana	832	835	824
Himachal Pradesh	917	921	852
Jammu & Kashmir	906	903	919
Jharkhand	918	927	882
Karnataka	935	965	883
Kerala	959	972	946
Madhya Pradesh	922	913	957
Maharashtra	876	872	882
Odisha	948	959	871
Punjab	893	876	921
Rajasthan	857	862	838
Tamil Nadu	915	926	903
Telangana	901	940	841
Uttar Pradesh	882	871	923
Uttarakhand	850	857	832
West Bengal	937	938	932

These figures sex ratio female per 1000 males at birth by residence; residence means separately for urban and rural areas for India as a whole and for bigger states. Now, first thing we would like to know is what is sex ratio at birth in India as a whole that is 898. That means, on every 1000 males there is a shortage of 102 females. Why does this happen? Two sex ratio at birth is never exactly 1000, usually by law of nature relatively more male babies are born as compared to female babies. But the distortion cannot be so much which can explain a shortage of 102 females for every 1000 males in the country. So, this is certainly the result of female foeticide

And if you look at state wise, state wise the some of the highest figures are for Chhattisgarh and Kerala. Chhattisgarh is predominantly a tribal state and among tribes sex discrimination is not so much. In Kerala, Kerala is one of the most educated states with a long history of socialist and feminist movement and legal consciousness, there also sex ratio is not all that bad. But in some states like Punjab, Haryana; Haryana 832, Punjab 893, Rajasthan 857, you know Uttarakhand is also bad 850.

So, in some of these states, you find that sex ratio is particularly disturbed Delhi; all neighbouring state Delhi, Punjab, Gujarat, Haryana and Punjab have a rather low sex ratio at birth. There are also urban rural differences. The problem of shortage of females is more pronounced in urban areas rather than in rural areas. And some surveys have shown, some surveys conducted by us also and other surveys national and regional level

surveys show that female bias is associated with other indicators of socio economic development. Unfortunately it is in the upper caste urban areas and advanced states that bias against female children is more and that also show that urban sex ratio at birth is lower than the rural sex ratio at birth.

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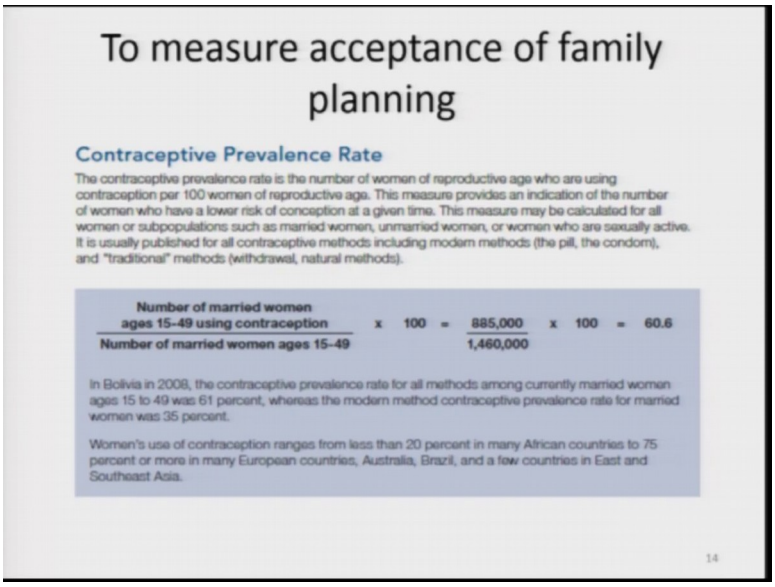

Another measure which is of interest to demographers and policy makers is couple production rate. To measure acceptance of family planning we calculate contraceptive prevalence rate, contraceptive prevalence rate is the number of women of reproductive age who are using contraception per 1000 women of reproductive age.

This measure provides an indication of the number of women who have a lower risk of conception. Why lower risk of conception? Because, all the methods of family planning all the contraceptive methods are not 100 percent efficient at a given time; this measure maybe calculated for all women or sub populations such as married women unmarried women or women who are sexually active. It is usually published for all contraceptive methods including modern methods and these data we have seen. We have seen that in India, the most commonly used method is the female sterilization.

So, overall; we calculate this overall and also separately for methods and urban and rural areas and we can also calculate this for different caste groups, classes, wealth index according to wealth index. We can calculate religion wise we can calculate and state wise we can calculate and there are lot of data on this for the country from NFHS and

other sources. Here is an example number of married women ages 15 to 49 using contraception in Bolivia in 2008 was 885000 and number of married women in age group 14 to 49 was 1460000. So, this 885000 divided by 1460000 and multiplied by 100 become the couple protection rate. In our early days of planning; early days of you can say, population planning our target was to attain a couple production rate of 60, but we are still less than that.

And in the recent years as NFHS-4 data show that couple production rate has slightly declined. This says in Bolivia in 2008, the contraceptive prevalence rate for all methods age 15 to 49 was 61 percent where as the modern method contraceptive prevalence for married women was 35. You can calculate that separately that was 35; that means, the difference 61 and 35. These women were using some traditional method of contraception. Women use of contraception ranges from less than 20 percent in many African countries which have high fertility 275 percent or more in many European countries, Australia, Brazil and a few countries in East and South East Asia.

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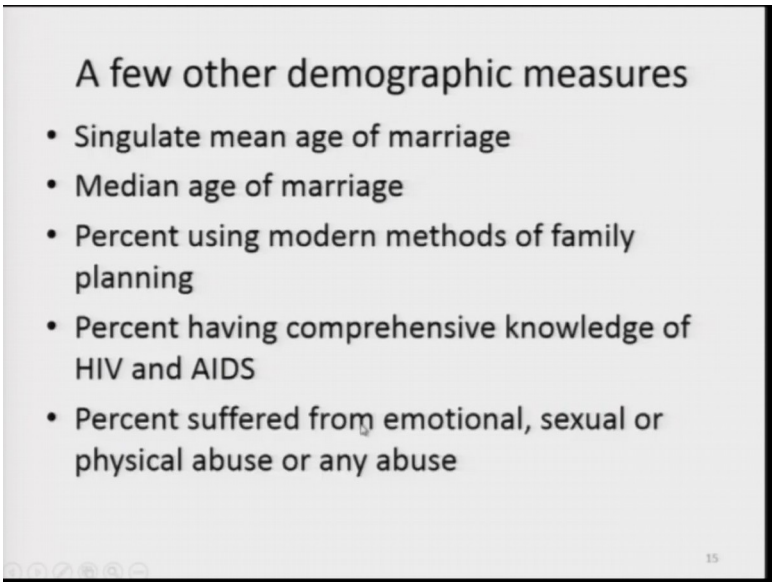

A few other demographic measures which are often used by demographers and planners are singulate mean age of marriage, median age of marriage, percent using modern methods of family planning, percent having comprehensive knowledge of HIV and AIDS, NGFHS 4 gives us data on a this comprehensive knowledge is not simply that you have heard about HIV and AIDS. There are various rootes of transmission and

knowledge of all routes of transmission is considered to be having comprehensive knowledge like blood transfusion by birth and sexual route and so on. So, then some other measures used by demographers, these days are persons suffered from emotional sexual or physical abuse.

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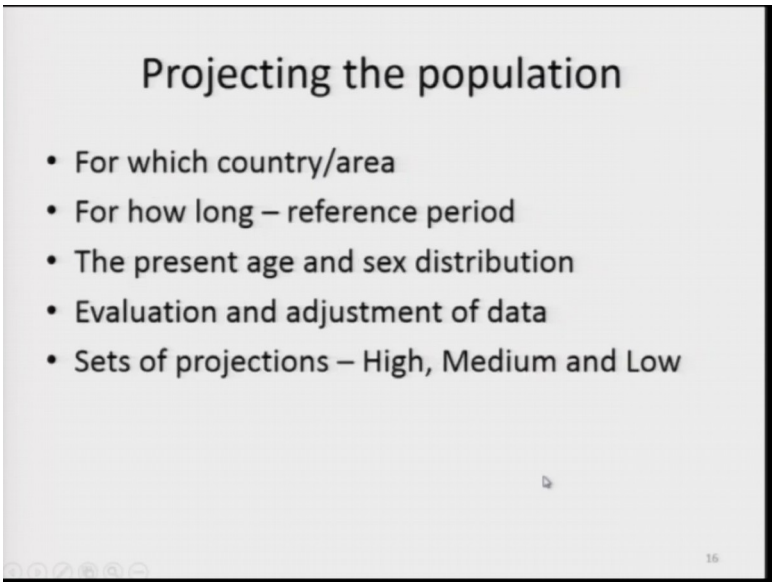

Another issue in population study is projecting the population. For projecting the population, you need reference period like you may like to project population of India 5 years from now, 10 years from now. You need age and sex distribution at the moment, then you evaluate and adjust the data and calculate sets of projections high medium and low and say that population from these age specific fertility rates and mortality rates is likely to lie between this figure a low figure and this figure a high figure.

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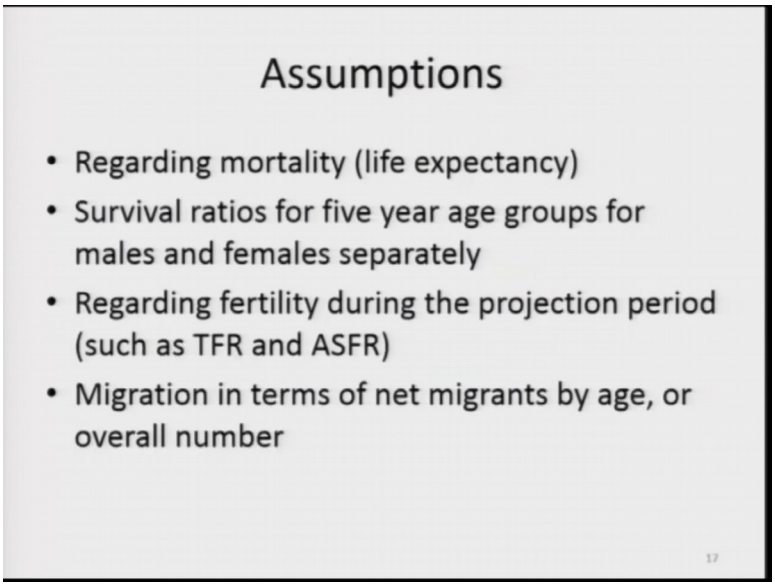

We make certain assumptions for the projection period regarding life expectancy, survival ratios for 5 year age groups, fertility which can be measured in terms of total fertility rate or age specific fertility rates and migration. Usually projections of migrants are made separately and added to projections of population at the end. The estimate of future populations are obtained by multiplying the present population.

This is actually an interesting and specialized branch of projections. What I can say in this introductory lecture is that we use data on present age and sex distribution and probabilities of survival for the reference period to calculate, future population in age group 5 plus. And for 0 to 5 we estimate first number of births which will take place during this period by using the assumption of fertility, total fertility, age specific fertility rates and number of women during the projection period in reproductive ages and then multiplying them by appropriate survival ratios.

Sometimes we need projections of specific groups like urban areas, rural areas, different states, labour force, occupation literates, illiterates different religions and so on. And for that purpose a commonly used method is ratio method.

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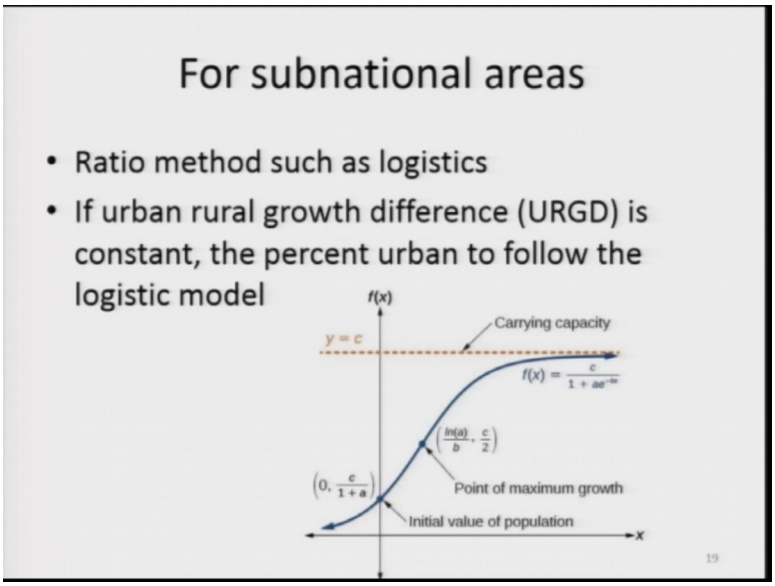

So, you calculate ratios like if you want to project urban population calculate percentage urban, then find out percentage urban from the past records and by using mathematical method or curve fitting some graphical method or some other method you can calculate, what is going to with the ratio of urban population in the future 5 years, 10 years, 15 years from now. Sometimes for this purpose logistic model is used which says that initially like percentage urban must have been close to 0 as time pass percentage urban started increasing. At some time rate of growth is quite high, then rate of growth starts declining, but the percentage urban continues to increase. At most percentage urban can be 100.

So, this logistic growth model resembles the growth of urbanization in different countries quite well. Actually logistic is a miracle method in projections of urban population is one thing, but in projections of populations of the country is also logistic method has been used. Manual aid, some of you who are interested in urban rural population projections can go through manual aid of United Nations and based on the differences between urban growth rates and rural growth rates it is called URGD Urban Rural Growth Difference population of urban area is as projected. This is only an elementary lecture.

So, you have to read manual aid for example, to understand URGD method more. The idea is that we calculate percentage or proportion or ratio of urban population in total population in the future and multiply that by the projected population and we get the

projections of urban areas. In; by using URGD when manual aid was published, we ourself projected population of urban and rural areas of Maharashtra and district population of urban and rural areas of different districts of Maharashtra that is long back. And even now, URGD method is commonly used for this purpose, ok.

Thank you very much.