Vital Statistics

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Syllabus

- **Vital Statistics, SRS, Life table**

Vital Statistics

- **Vital Statistics:** Vital Statistics as a subject deal with the data or the techniques used in the analysis of data relating to the vital events occurring in a given community.
- Vital Statistics also mean the numerical records of marriage, births, sickness, migration, divorce, and deaths by which the health and growth of a community may be studied.
- Sources of Raw Data of Vital Statistics:

    1. Census
    2. Sample Registration System (SRS)
    3. Hospital records
    4. Ad Hoc Surveys.

Census Data

- **Census Data**: A census represents a comprehensive profile of a country's population. Census data are collected at every ten years interval. The last census carried out in India was in 2011. Because of Covid19 pandemic it could not start in 2021. In a census, besidees counting the number of persons living in the country, information regarding age, sex, marital status, education level, occupation etc., are also collected.
- Census data fails to produce vital statistics for intercensal years. Moreover, the data obtained in respect of births and deaths are not complete even for the census year. Hence, the census enumeration fails to provide data suitable for vital statistics.

Sample Registration System (SRS)

- **Sample Registration System (SRS):** This is a large-scale demographic survey conducted in India for providing reliable annual estimates of birth rate, death rate and other fertility and mortality indicators at the national and sub-national levels.
- The field investigation consists of continuous enumeration of births and deaths by a resident part-time enumerator, generally a teacher followed by an independent survey every six months by an official.
- The data obtained through these operations are matched. The unmatched and partially matched events are re-verified in the field and thereafter an unduplicated count of births and deaths is obtained.
- The SRS was initiated by the Office of the Registrar General, India on a pilot basis in a few selected states in 1964-65. It became fully operational during 1969-70 covering about 3700 sample units. Thereafter the sample size has been periodically increased. The frame was recently updated based on 1991 Census data.

Hospital Records and Ad Hoc Surveys

- Beside Census and SRS, we have hospital records, or ad hoc surveys, which however fail to provide comprehensive data needed to calculate the vital rates in a community.

Rate of the Vital Event (E)

- $\boldsymbol{Rate\ of\ the\ vital\ event\ (E) =}$

$$\frac{No.\ of\ cases\ in\ which\ E\ occurs\ in\ a\ given\ region\ during\ a\ given\ period}{Total\ no.\ of\ exposers\ to\ the\ risk\ of\ E\ in\ the\ region\ during\ the\ period} \times K.$$

- According to the definition, a rate will be a proper fraction and it is usually multiplied by K (i.e., 10^3, 10^5, etc.) depending on its rarity. So it is expressed 'per thousand of population' or 'per lakh of population'.

- The rate (w/o multiplier K) can be interpreted as probability as the total number (i.e., the denominator, n) goes to infinity. So for large n, it can be interpreted as probability.

Crude Death Rate (CDR)

- **Crude Death Rate (CDR):** The simplest type of rate used in the measurement of mortality is the Crude Death Rate (CDR), which is defined as:

$$CDR = \frac{D}{P} \times 1000.$$

- where

D = Number of deaths from all causes which occurred in the population of the given region during the given period,

P = Total population size of the given region during the given period.

- CDR gives the death rate per 1000 of population.

Specific Death Rate

- **Specific Death Rate:** A Specific Death Rate (SDR) is a death rate computed for a specific segment of the population. Death rates may be made specific wrt age, sex, occupation etc. or a combination of some of these factors. The most important types of specific death rates are:

  (i) Age Specific Death Rate (ASDR)

  (ii) Sex Specific Death Rate (SSDR)

  (iii) Age and Sex Specific Death Rate

Age Specific Death Rate (ASDR)

- **Age Specific Death Rate (ASDR):** The ASDR for the age group x to x+n is

$$ {}_{n}m_{x} = \frac{{}_{n}D_{x}}{{}_{n}P_{x}} \times 1000, $$

- where ${}_{n}D_{x}$ is the number of deaths between ages x to x+n-1 last birthday (l.b.d.) in a given period in a given region, and ${}_{n}P_{x}$ is the no. of persons in the same age group in the given period in the given region.
- The Annual Age Specific Death Rate: It is defined as

$$ m_{x} = \frac{D_{x}}{P_{x}} \times 1000, $$

- where, D_{x} = number of deaths among persons aged x l.b.d. and

  P_{x} = number of persons aged x l.b.d.

- In this way we can define Sex Specific Death Rate (SSDR) for males and for females and Specific Death Rate for Age and Sex.

CDR

- If ${}_nm_x$ is the death rate at age group x to x+n-1 and ${}_nP_x$ is the population in the same age group, the total deaths will be $\sum {}_nm_x . {}_nP_x$, where the sum is over all age groups. Then the CDR is

$$m = \frac{\sum {}_nm_x \cdot {}_nP_x}{\sum {}_nP_x}.$$

- CDR cannot be used to compare mortality situations in different places unless the population of the places have identical age/sex distribution, a condition which is seldom justified. ASDR can be used to compare mortality situations of two communities here.

MMR and IMR

- **Maternal Mortality Rate (MMR):** The Maternal Mortality Rate is defined as

$$MMR = m^P = \frac{D^P}{B} \times 1000,$$

- where D^P and B are the number of deaths of mothers from puerperal causes among the female population and the number of live births occurring in the given period in the given community, respectively. (Puerperal means during the period of about six weeks after childbirth)

- **Infant Mortality Rate (IMR):** The infant mortality rate (IMR), gives the death rate for infants, i.e., the children under 1 year age. It is defined as

$$IMR = \frac{D_0}{B} \times 1000,$$

- where D_0 = Number of deaths among children of age 0 l.b.d. In other words, it is the number of infants dying before attaining the age one.
- D = Total number of live births during the same year.

Neonatal Mortality Rate (NMR)

- **Neonatal Mortality Rate (NMR):** While estimating IMR based on the data of mortality of infants by months or by weeks during the first year of life, it has been found that infant deaths during the first to fourth week of life constitute a major segment of the total infant mortality. The mortality rates during this period of life namely up to four weeks or the first month is known as Neonatal Mortality Rate.
- Symbolically, NMR is defined as:

$$NMR = \frac{D_N^Z}{B^Z} \times 1000,$$

- where D_N^Z = Number of deaths of infants during the neonatal period, i.e., 0th month in the calendar year Z., and
- B^Z = Total number of live births during the calendar year Z.

Life Table

- **Life Table:** The life table gives the probabilities of death and survival at various age groups. A life table summarizes the mortality experience of a population during the period of study and provides concise measures of the longevity of that population.
- In India, life expectancy at various broad age groups has been estimated through Sample Registration System (SRS) since 1970-75. The Sample Registration System (SRS) is a large-scale demographic sample survey based on the mechanism of dual recording system with the objective of providing reliable estimates of fertility and mortality indicators at State and National levels for rural and urban areas separately. The estimated age-specific death rates derived from the SRS provide the necessary database for undertaking construction of abridged life tables. To adjust for the sampling fluctuation and for augmenting the sample size, five-year average is compiled for estimating age-specific death rates separately for rural and urban areas, both for male and female.

Two Types of Life Table

- There are two types of life table.
- **Generation or Cohort Life Table:** Suppose we observe a certain number of persons all born at the same time. Suppose that we record in a life table the number of persons dying at the first year of age, during the second year of age, and so on, and also the survivors at the beginning of each year of age. In this way we get a life table which is called **Generation or Cohort Life Table**.
- **Current or Instantaneous Life Table:** Here we consider a hypothetical cohort of people all assumed to be born at the same time. Then we see how much a cohort would behave if they were subject to the observed rate of mortality during a given calendar period, usually a short period. Hence, this table gives us a hypothetical picture for the hypothetical cohort over the years of age. This life table is called **Current or Instantaneous Life Table**.

Description of Complete Life Table

- A typical life table has the following columns:-

Age in years (in integer)	l_x	d_x	q_x	L_x	T_x	e_x
0						
1						
2						
…	…	…	…	…	…	…
…	…	…	…	…	…	…

Various Symbols in the Life Table

- The various symbols entering the table are defined as follows:-
- x: The integral value of age in year.
- l_x: The number of persons surviving to the exact age x.
- d_x: The number of persons dying between exact age x and the next age x+1.

$$So, d_x = l_x - l_{x+1}.$$

- q_x: The probability that a person of exact age x will die before attaining age x+1. Hence,

$$q_x = \frac{d_x}{l_x}.$$

- Some tables include, beside q_x, the function $p_x = 1 - q_x$, which gives the probability that a person of age x will survive till age x+1.

Symbols in the Life Table

- L_x: The number of years lived, in the aggregate, by the cohort of l, persons between ages x and x+1. Hence,

$$L_x = \int_x^{x+1} l_t \, dt \Rightarrow L_x = \int_0^1 l_{x+t} \, dt.$$

- T_x: The total number of years lived by the cohort after attaining age x or the total future years lived by l_x persons who have attained age x. We have, then,

$$T_x = \int_0^{\infty} l_{x+t} dt = \int_0^1 l_{x+t} dt + \int_1^2 l_{x+t} dt + \cdots$$

$$= \int_0^1 l_{x+t} dt + \int_0^1 l_{\overline{x+1}+t} dt + \cdots = L_x + L_{x+1} + \cdots$$

- So that, T_x may be looked upon as a cumulative total of the L_x values, starting from L_x onwards. Observe that,

$$T_x = L_x + T_{x+1}.$$

Symbols in the Life Table

- e_x^0: The average number of years lived after age x by each of the l_x persons who have attained age x. It gives the average number of years a person of age x likely to survive under the existing mortality rate. It is called the (complete) expectation of life or life expectancy at age x and is obtained from the relation

$$e_x^0 = \frac{T_x}{l_x} = \frac{\sum_{i=0}^{\infty} L_{x+i}}{l_x}.$$

- Thus, $e_0^0 \left(= \frac{T_0}{l_0}\right)$ is the expectation of life at age 0, and is the average longevity of a person belonging to the given community.

Stationary and Stable Population

- **Stationary Population:** A population is said to be stationary if it is of constant size and constant age and sex composition over time. Suppose in a population, every year the number of births is exactly l_0 (say) and is equal to the number of deaths and these are distributed uniformly throughout the year, and the population is not affected by emigration or immigration. Under the above condition, in long run, the population will be of the same size from year to year and will have the same age distribution so that the population becomes a stationary population.
- **Stable Population:** A population is said to be stable if (i) it has a fixed age and sex distribution, (ii) it has constant mortality and fertility rates at each age, and (iii) the population is closed to emigration or immigration. Hence, for a stable population, the overall rates of births and deaths remain constant and consequently such a population increases at a constant rate, thus supporting the compound interest law of population growth.
- In a stable population, mortality and fertility rates are constant but need not be equal. In particular, in a stable population, if the constant overall birth and death rates are equal, then the population size remains fixed and, in this case, stable population becomes stationary population. A stationary population is always stable but a stable population needs to be stationary.

Abridged Life Table: 2016-20

India, 2016-20

Age Interval	Total				Male				Female			
x to x+n-1	${}_nq_x$	l_x	${}_nL_x$	e_x	${}_nq_x$	l_x	${}_nL_x$	e_x	${}_nq_x$	l_x	${}_nL_x$	e_x
0	0.03515	100000	96990	70.0	0.03426	100000	97057	68.6	0.03616	100000	96957	71.4
1-4	0.00467	96485	384836	71.5	0.00439	96574	385257	70.0	0.00490	96384	384336	73.1
5-9	0.00260	96035	479551	67.8	0.00245	96150	480162	66.3	0.00275	95911	478895	69.5
10-14	0.00260	95785	478306	63.0	0.00260	95915	478951	61.5	0.00265	95647	477604	64.7
15-19	0.00389	95537	476813	58.2	0.00394	95666	477454	56.6	0.00384	95394	476102	59.8
20-24	0.00559	95165	474554	53.4	0.00618	95289	475051	51.9	0.00494	95028	474002	55.0
25-29	0.00668	94633	471645	48.7	0.00772	94700	471750	47.2	0.00563	94558	471495	50.3
30-34	0.00881	94001	468031	44.0	0.01065	93968	467473	42.5	0.00683	94026	468578	45.6
35-39	0.01178	93173	463273	39.3	0.01485	92968	461590	37.9	0.00857	93384	465023	40.9
40-44	0.01755	92075	456573	34.8	0.02192	91588	453204	33.5	0.01292	92584	460115	36.2
45-49	0.02466	90459	447061	30.3	0.03041	89580	441455	29.2	0.01854	91388	453016	31.6
50-54	0.03836	88228	433318	26.0	0.04384	86856	425429	25.0	0.03236	89693	441828	27.2
55-59	0.06477	84844	411335	22.0	0.07543	83049	400530	21.0	0.05414	86790	422965	23.0
60-64	0.09017	79348	379773	18.3	0.10280	76784	365089	17.5	0.07696	82091	395580	19.2
65-69	0.13949	72193	337035	14.9	0.15529	68891	318873	14.2	0.12325	75774	356857	15.5
70-74	0.20678	62123	279436	11.9	0.22645	58193	258748	11.4	0.18746	66435	302201	12.4
75-79	0.28811	49277	211396	9.3	0.30815	45015	190591	8.9	0.26852	53981	234510	9.6
80-84	0.41950	35080	137919	7.0	0.43718	31144	120736	6.8	0.40252	39486	157320	7.2
85-	...	20364	107761	5.3	...	17528	90855	5.2	...	23592	127004	5.4

The Salient Features of the Life Table

- The salient features of the latest life table (SRS based Abridged Life Tables 2016-20) in India are as summarized below.

1. Expectation of life at birth for India has been estimated at 70.0 years for the period 2016-20, exhibiting an increase of 0.3 years from 2015-19. The life expectancy at birth varies from 65.1 in Chhattisgarh to 75.8 in NCT of Delhi.
2. The expectation of life at birth is 68.6 years in rural areas and 73.2 years in urban areas for 2016-20. The life expectancy has increased by 0.3 years and 0.2 years respectively for rural and urban areas as compared to 2015-19.
3. At the national level, the life expectancy at birth for males has been estimated at 68.6 years and that for females, at 71.4 years. Expectation of life at birth is highest in Delhi (74.1 years) for males and in Kerala (78.0 years) for females, whereas it is lowest in Chhattisgarh (63.5 years) for males and Uttar Pradesh (66.7 years) for females.

The Salient Features of the Life Table

4. Almost all the States/UTs have recorded a higher life expectancy at birth for females in 2016-20 both across the rural and urban areas, except for Bihar and Jharkhand. On an average, female life expectancy at birth is more than male life expectancy at birth by more than two years.

5. The gap between the rural and urban life expectancy has also narrowed down significantly from 1970-75 to 2016-20. In case of life expectancy at birth, most of the states have reported higher life expectancy in urban areas than in rural areas, except for Kerala. There is a difference of about 4.6 years in urban-rural life expectancy at birth for the country.

Crude Birth Rate

- **Crude Birth Rate**
- The crude birth rate is a measure of the number of live births per 1,000 people in a population over a specified period, usually a year. It's a simple way to track the reproductive activity of a population.
- Like its counterpart, the crude death rate, it is influenced by many factors and represents a proxy for more specific fertility measurements. It is calculated as follows

$$CBR = \frac{B}{P} \times 1000,$$

- where CBR is the crude birth rate, B is the total number of live births for a given area and time period, P is the total population at the midpoint of the time period. It is usually expressed as per thousand.

Rate of Natural Increase (RNI)

- When the crude death rate is subtracted from the crude birth rate (CBR), the result is the rate of natural increase (RNI). This is equal to the rate of population change (excluding migration).
- The average global birth rate was 17 births per 1,000 total population in 2024. The death rate was 7.9 per 1,000. The RNI was thus 0.91 percent.
- According to the World Bank India's crude birth rate was 16.15 per 1,000 people in 2023. Crude Death Rate was 6.61 per 1,000 people in the same year. Thus, the RNI was 0.95 percent which is above the all-world percent.

Birth Rate Policies

- The birth rate is an issue of concern and policy for national governments.
- Some (including those of Italy and Malaysia) seek to increase the birth rate with financial incentives or provision of support services to new mothers.
- Conversely, other countries have policies to reduce the birth rate (for example, China's one-child policy which was in effect from 1978 to 2015).
- Policies to increase the crude birth rate are known as pro-natalist policies, and policies to reduce the crude birth rate are known as anti-natalist policies.

Literacy Rate in India

- **Literacy Rate in India:**
- Literacy is a key for social-economic progress.
- The National Literacy Mission defines literacy as acquiring the skills of reading, writing and arithmetic and the ability to apply them to one's day-to-day life.
- The literacy rate is approximately 77% in India.

Thank You