Date __/__/__

Unit - 4 Vital Statistics

Vital Statistics is defined as that branch of Biometry which deals with data and the laws of human mortality, morbidity and demography.

In other words, vital statistics refers to the numerical data/techniques used in the analysis of data pertaining to vital events occuring in the given section of the popn.

- Uses of vital statistics

1) Studying of popn trend -

If BR > DR, then an ↑ing trend
If BR < DR, " a ↓ing "

Rate of natural increase per thousand - difference b/w birth rate and death rate.

2) Use in Public Administration -
for planning and evaluation of ~~envir~~ economic and social development programmes.

3) Use to operating agencies
- vaccination

4) Acturial sciences

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Date ___/___/___

- Methods of obtaining vital Statistics

1) Registration Method
2) Census Method.

- Measurement of Pop^n

$$P_t = P_0 + (B - D) + (I - E)$$

B - births I - immigrants
D - deaths E - emmigrants.

- Rates and ratios of vital events

Rate of a vital event is defined as the ratio of the total no. of occurences of the event to the total no. of persons exposed to the risk of occurence of that event.

Sex ratio = Total no. of females per 1000 males.

$$= \frac{\text{Female pop}^n}{\text{Male pop}^n} \times 1000$$

$$= \frac{fp}{mp} \times 1000.$$

Date __/__/____

Measurement of Mortality

1) Crude Death Rate (C.D.R.)

$$\text{Annual CDR} = m = \frac{\text{Annual deaths}}{\text{Annual mean pop}^n} \times k$$

where, $k = 1000$, usually.

The ~~CRt~~ CDR for any period gives the rate at which the pop^n is depleted through deaths over the course of the period.

Merits – 1) simple to understand and calculate.

2) most widely used of any v.s. rates.

3) C.D.R is a probability rate giving the probability that a person belonging to the given pop^n will die in the given period.

Demerits – 1) ignores age and sex distribution of the pop^n.

2) C.D.R is not suitable for comparing the mortality in two places or same place in two periods unless –

i) the pop^n's of the places being compared have more and less the same age and sex distribution.

ii) two periods are not too distant, since in a stable

Date __/__/__

large community, age-sex structure of the pop^n shows very little change.

2) Specific Death Rates (S.D.R.)

Death rate computed for a particular specified section of the pop^n is termed as S.D.R. for a given geographical region during a given period is defined as -

$$S.D.R. = \left[\frac{\text{Total no. of deaths in the specified section of the pop}^n \text{ in the given period}}{\text{Total pop}^n \text{ of the specified section in the same period}}\right] \times k$$

where, $k = 1000$, usually.

Usually, S.D.R is computed specific to

i) age and ii) sex

i) Age-SDR -

Let ${}_nD_x$ = No. of deaths in the age group $(x, x+n)$

${}_nP_x$ = Total pop^n of the age-group $(x, x+n)$

then, ${}_nM_x \to$ age-SDR for the age group $(x, x+n)$

Date __/__/__

$${}_nM_x = \frac{{}_nD_x}{{}_nP_x} \times 1000$$

Taking n as 1, we get the annual age-SDR as –

$${}_1M_x = \frac{{}_1D_x}{{}_1P_x} \times 1000$$

age - SDR for males is given as –

$${}_n^m m_x = \frac{{}_n^m D_x}{{}_n^m P_x} \times 1000$$

age - SDR for females is given as –

$${}_n^f m_x = \frac{{}_n^f D_x}{{}_n^f P_x} \times 1000$$

3) Infant Mortality Rate (IMR)

The IMR is defined as the chance of dying of a newly born infant within a year of its life, under the given mortality conditions.

$$IMR = i_m^z = \frac{D_0^z}{B_0^z}$$

D_0^z = no. of deaths (excluding foetal deaths) among children b/w the age 0 - 1, during year z.

B_0^z = Total no. of live births reported in the same region with the same year z.

Date ___/___/___

4) Standardised Death Rates. (STDR)

Using CDR, interms of age-SDR for two regions A and B –

$$m^a = \frac{D^a}{P^a} \times 1000$$

$$= \frac{\sum m_x^a P_x^a}{\sum P_x^a}$$

$$m^b = \frac{D^b}{P^b} \times 1000$$

$$= \frac{\sum m_x^b P_x^b}{\sum P_x^b}$$

- Methods of Standardisation

1) Direct method –

$$(STDR)_A = \frac{\sum m_x^a P_x^s}{\sum P_x^s}$$

$$(STDR)_B = \frac{\sum m_x^b P_x^s}{\sum P_x^s}$$

where, P_x^s = pop^n is some other region that is chosen as standard.

- Used to compare health conditions in 2 regions.

Page No. ___

Date __/__/__

2) Indirect method.

$$C.D.R. \times C = S.T.D.R.$$

$$\Rightarrow \frac{\sum m_x^a P_x^a}{\sum P_x^a} \times C = \frac{\sum m_x^a P_x^s}{\sum P_x^s}$$

$$\Rightarrow C = \frac{\sum m_x^a P_x^s}{\sum P_x^s} \times \frac{\sum P_x^a}{\sum m_x^a P_x^a}$$

$$\Rightarrow \hat{C} = \frac{\sum m_x^s P_x^s}{\sum P_x^s} \times \frac{\sum P_x^a}{\sum m_x^s P_x^a}$$

$$\Rightarrow (STDR)_A = (C.D.R.)_A \times \hat{C}.$$

- Mortality Table or Life Table

The life table gives the life history of a hypothetical group or cohort as it is gradually diminished by deaths.

Life tables are generally constructed for various sections of the people which have sharply different patterns of mortality.

A life table gives, for integral values of age in years (denoted by x), the values of the following functions –

(1) l_x, the no. of persons who attain (or are expected to attain) exact age x out of an

Date __/__/__

assumed no. of births l_0 (called the cohort or the radix of the life table)

(2) d_x, the no. of persons, among the l_x persons reaching age x, who die before reaching age $x+1$. Thus,

$$d_x = l_x - l_{x+1}$$

(3) q_x, the probability that a person of exact age x ~~will~~ dies before age $x+1$. Thus,

$$q_x = d_x / l_x$$

(4) L_x, the no. of years lived, in the aggregate, by the ~~ch~~ cohort of l_0 persons b/w ages x and $x+1$. Thus,

$$L_x = \int_0^1 l_{x+t}\, dt$$

an approx. value of which is given by

$$\frac{l_x + l_{x+t}}{2} = l_x - \frac{1}{2} d_x,$$

(5) T_x, the no. of years lived by the cohort after attaining the age x.

We have,

$$T_x = L_x + L_{x+1} + L_{x+2} + L_{x+3} \cdots$$

(6) $\mathring{e}_x$, the avg. no. of years lived ~~by the~~ after

age x by each of the l_x persons who attain that age. It is called the (complete) expectation of life at age x and is obtained from the relation –

$$\mathring{e}_x = \frac{T_x}{L_x}$$

$\mathring{e}_0$, the expectation of life at age 0, is the avg. age at death of the avg. longevity of a person belonging to the given community.

- Description of a life table.

Columns in a life table

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
x	l_x	d_x	q_x	p_x	m_x	μ_x	L_x	T_x	$\mathring{e}_x$	e_x

For $x = 0, 1, 2, \cdots$, we have —

1) $d_x = l_x - l_{x+1}$

2) $q_x = \frac{d_x}{l_x}$

3) $p_x = 1 - q_x$

4) $m_x = \frac{2q_x}{2 - q_x}$

5) $\mu_{x+(1/2)} = m_x$

6) $L_x = l_x - \frac{1}{2} d_x$

7) $T_x = L_x + L_{x+1} + L_{x+2} + \cdots$

$\Rightarrow T_{x+1} = T_x - L_x$

8) $\mathring{e}_x = \frac{T_x}{L_x}$

9) $e_x = \mathring{e}_x - \frac{1}{2}$

Page No.

Date __/__/__

- Uses of Life Tables

From book (PDF-page - 15)

- Fertility

Fertility is used in relation to the actual prod^n of children or occurrence of births, specially live births.

Fertility is different from fecundity, which means the capacity to bear children.

1) Crude Birth Rate - (CBR)

no. of live births to total pop^n.

$$CBR = \frac{B^t}{P^t} \times k$$

B^t = Total no. of live births in the given region during a period 't')

P^t = Total pop^n of the given region at the same time 't'.

k = 1000, usually.

CBR usually lies b/w 10 and 55 per thousand.

Date ___/___/___

2) General Fertility Rate (GFR) –

total no. of live births to the no. of females in the reproductive /child-bearing ages.

$$GFR = \frac{B^t}{\sum_{\lambda_1}^{\lambda_2} {}^t p_x} \times k$$

$\lambda_1, \lambda_2 \rightarrow$ lower and upper limits of the female child bearing age, usually 15 and 49, respectively.

$k = 1000$

3) Specific Fertility Rate (SFR) –

Fer. is affected by a no. of factors such as age, marriage, migration, state or region etc. The fertility rate computed w.r.t. any specific factor is called SFR is defined as –

$$SFR = \frac{\text{No. of births to the female pop}^n \text{ of the specified section in a given period}}{\text{Total no. of female pop}^n \text{ in the specified section.}} \times 1000$$

- Age - SFR –

$$ASFR = {}_n i_x = \frac{{}_n B_x}{{}_n^t p_x} \times k$$

$$\text{annual } ASFR = i_x = \frac{B_x}{{}^t p_x} \times k$$

Date __/__/__

4) Total Fertility Rate (TFR)

TFR is obtained on adding adding age-SFR. It is a standardised fer. rate.

$$TFR = \sum_{\lambda_1}^{\lambda_2} i_x = \sum_{\lambda_1}^{\lambda_2} \frac{B_x}{fP_x} \times k$$

Usually, $\lambda_1 = 15$, $\lambda_2 = 49$, $k = 1000$

- Measurement of Pop^n Growth

To check if pop^n has an increasing or decreasing trend or is stable.

1) ~~Cur~~ Crude Rate of Natural Increase:

$$CRNI = CBR - CDR$$

Pearl's Vital Index -

$$\frac{B^t}{D^t} \times 100$$

$$\Rightarrow \frac{CBR}{CDR} \times 100$$

$$= \frac{B^t/P^t}{D^t/P^t} \times 100.$$

2) Gross Reproduction Rate (GRR)

The GRR is the sum of age-specific fer. rates calculated from female births for each year of reproductive period.

$$GRR = \sum_{\lambda_1}^{\lambda_2} \frac{{}^{f}B_x}{{}^{f}P_x} \times k$$

3) Net Reproduction Rate (NRR)

GRR adjusted for the effects of mortality.

$$NRR = k \sum_x n \left[\frac{{}_n{}^{f}B_x}{{}_n{}^{f}P_x} \times {}_n{}^{f}\Pi_x \right]$$

where, $${}_n{}^{f}\Pi_x = \frac{{}_n{}^{f}L_x}{{}_n{}^{f}l_0}$$

$$= k \sum_x \left[n \times (\text{Female age-SFR}) \times (\text{Survival Factor}) \right]$$

Date __/__/__

Page No.