D II / Hons (Zoology.
Paper IV Group-B.

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STANDARD ERROR

Standard error is one of the test of significance of mean of a data. The test of significance of mean tells that "How accurately the mean of sample predicts about the mean of population". Theoritically the difference between mean of population and mean of obtained scores of sample should be zero but in biological expt. it is never zero.

① Standard Error of Mean :- It is denoted by SE_M. SE_M of mean is the ratio of Standard deviation of the sample divided by the square root of the total number of observations.

$$SE_M = \frac{\text{Standard deviation}}{\sqrt{N}} \quad \text{or} \quad \frac{\sigma}{\sqrt{N}}$$

SE_M - Standard Error
σ = Standard deviation
$\sqrt{N}$ = Square root of the total No. of observations

② SE_M in individual Series :- Formula is in individual series is

$\sigma = \sqrt{\frac{\Sigma x^2}{N}}$ If N is more than 30. $\sigma = \sqrt{\frac{\Sigma x^2}{N-1}}$ If N is less than 30

Ex - Haematocrit value of 5 persons were obtained 2, 5, 3, 4, 1
Find SE_M of Mean. $\bar{X} = \frac{\Sigma X}{N}$. $\bar{X} = \frac{2+5+3+4+1}{5} = \frac{15}{5} = 3$

Haematocrit value	observation - Mean $(X - \bar{X})$	Deviation x	Deviation Square x^2
2	2 - 3	- 1	1
5	5 - 3	+ 2	4
3	3 - 3	0	0
4	4 - 3	+ 1	1
1	1 - 3	- 2	4
			$\Sigma x^2 = 10$

Sum of Square is $\Sigma x^2 = 10$

$\sigma = \sqrt{\frac{\Sigma x^2}{N}}$ or $\sqrt{\frac{\Sigma x^2}{N-1}}$. $\sigma = \sqrt{\frac{10}{5-1}} = \sqrt{\frac{10}{4}} = \sqrt{2.5} = 1.5$

$SE_M = \frac{\sigma}{\sqrt{N}}$ individual series

$= \frac{1.5}{\sqrt{5}} = \frac{1.5}{2.23} = 0.67$ Ans.

Standard Error in grouped Data (Discrete & Continuous series)

For grouped data formula is $SE_M = \frac{\sigma}{\sqrt{\Sigma f}}$.

Ex— ovary wt. of 50 frogs & their frequencies were obtained Find out the SE_M.

Ovary wt. in grams $\frac{30-39}{5}, \frac{40-49}{4}, \frac{50-59}{3}, \frac{60-69}{8}, \frac{70-79}{9}, \frac{80-89}{10}$

$\frac{90-99}{4} \quad \frac{100-109}{3} \quad \frac{110-119}{2} \quad \frac{120-129}{2}$

To find SE_M first we obtain SD using formula $\sigma = \sqrt{\frac{\Sigma f.x^2}{\Sigma f}}$.

To obtain deviation, Mean of the series is calculated

$\bar{x} = \frac{\Sigma f.x}{\Sigma f} = \frac{3708.5}{50} = 74.17.$

Variable in CI	Mid Point	Frequency	fx	$x - \bar{x} = x$	x^2	fx^2
30 - 39	34.5	5	172.5	34.5 − 74.17 = 39.67	1573.70	51573.7
40 - 49	44.5	4	178.	44.5 − 74.17 = 29.67	880.30	3521.2
50 - 59	54.5	3	163	54.5 − 74.17 = 19.67	386.90	1160.7
60 - 69	64.5	8	510	64.5 − 74.17 = 9.67	93.50	7480
70 - 79	74.5	9	670.5	74.5 − 74.17 = 0.33	0.1089	1.701
80 - 89	84.5	10	845	84.5 − 74.17 = 10.33	106.70	10670
90 - 99	94.5	4	378	94.5 − 74.17 = 20.33	413.30	1653.2
100 - 109	104.5	3	313.5	104.5 − 74.17 = 30.33	919.90	2759.7
110 - 119	114.5	2	229	114.5 − 74.17 = 40.33	1626.50	3253
120 - 129	124.5	2	249	124.5 − 74.17 = 50.33	2533.10	5056.2
	Σx = 792	Σf = 50	Σfx = 3714.5			Σfx^2 = 70814.30

First step to obtain SD by $\sigma = \sqrt{\frac{\Sigma fx^2}{\Sigma f - 1}}$ grouped data.

$= \sqrt{\frac{70814.30}{50-1}} = \sqrt{\frac{70814.30}{49}} = \sqrt{1445.18} = 38.01$

Now $SE_M = \frac{\delta}{\sqrt{\Sigma f}} = \frac{38.1}{\sqrt{50}} = \frac{38.11}{7.07} = 5.37$ Ans.

Result- one can draw inference that obtained mean 74.17 is repeated 95 times out of 100 times $(\pm 1.96 \times 5.37) = \pm 10.48$. Thus observed mean differ from population mean 74.17 ± 10.48. It comes to 67.67 & 84.65. Therefore obtained mean is reliable.

Standard Error of Standard Deviation :- like mean standard deviation also varies.

$$SE\,\delta = \frac{\delta}{\sqrt{2N}}$$ (Individual series)

$SE\delta$ = standard Error
δ = S.D.
N = No of observ

Ex- Haemotocrit value of 5 persons were obtained as 2.5, 3, 4, 1 respectively. Find SEδ.

(Ungrouped data / individual series) $SE\,\delta = \frac{\delta}{\sqrt{2N}} = \frac{1.5}{\sqrt{2\times5}} = \frac{1.5}{\sqrt{10}} = \frac{1.5}{1.58} = 0.95$

Standard Error of SD in discrete & continuous series :-

① Direct method - formula is $SE\,\delta = \frac{\delta}{\sqrt{2\cdot\Sigma f}}$

Ex- Water % of 50 insects of a sps. & their frequency were obtained as

Water %: 2, 2.5, 2.7, 2.9, 3, 3.1, 3.3, 3.7, 3.9, 4, 4.6, 4.8, 4.9, 5, 5.5, 5.9, 6, 6.1, 6.7 & 6.9

Frequency: 2, 1, 1, 2, 3, 1, 3, 2, 4, 3, 2, 3, 3, 3, 2, 3, 3, 3, 3 & 3. Find SEδ.

$$\bar{X} = \frac{\Sigma f \cdot x}{\Sigma f} = \frac{229.5}{50} = 4.59.$$

Class interval	Frequency	M.P. x	frequency . x	$x-\bar{x}$	x^2	$f.x^2$
2-2.9	6	2.45	14.7	-2.14	4.5796	27.47
3-3.9	13	3.45	44.85	-1.14	1.2996	16.89
4-4.9	11	4.45	48.95	-0.14	0.0196	0.21
5-5.9	8	5.45	43.6	+0.86	0.7396	5.21
6-6.9	12	6.45	77.4	+1.86	3.4596	41.51
	$\Sigma f = 50$		$\Sigma fx = 229.5$		$\Sigma x^2 = 10.088$	$\Sigma fx^2 = 92.02$

Now $\delta = \sqrt{\frac{\Sigma f x^2}{\Sigma f}} = \sqrt{\frac{92.02}{50}} = \sqrt{1.84} = 1.35$

Now By putting its value of δ and f SEδ is obtained

$SE\,\delta = \frac{\delta}{\sqrt{2\cdot\Sigma f}}$

$$SE\sigma = \sqrt{\frac{f}{2f}}\,\sigma = \frac{1.35}{\sqrt{2\times 50}} = \frac{1.35}{\sqrt{100}} = \frac{1.35}{10} = 0.135 \text{ Ans.}$$

(2) **Short cut Method :-** SEσ is obtained from grouped data by this formula $= SE\sigma = i \times \sqrt{\frac{\Sigma f.x^2}{\Sigma f} - \left(\frac{\Sigma f.x'}{\Sigma f}\right)^2}$

Ex- From above example Deviation is obtained from assumed mean. Middle variable is considered as assumed mean & deviation is obtained by $(x - \bar{x})$ method.

C.I.	Frequency f	Mid Point	Deviation from assumed Mean x'	$f.x'$	fx'^2
2-2.9	6	2.45	-2	-12	24
3-3.9	13	3.45	-1	-13 / -25	13
4-4.9	11	4.45	0	0	0
5-5.9	8	5.45	+1	+8	8
6-6.9	12	6.45	+2	+24 / +32	48
				$\Sigma fx' = 7$	$\Sigma fx'^2 = 93$

$$\sigma = i \times \sqrt{\frac{\Sigma f.x^2}{\Sigma f} - \left[\frac{\Sigma f.x'}{\Sigma f}\right]^2} = 1 \times \sqrt{\frac{93}{50} - \left(\frac{7}{50}\right)^2}$$

$$= 1 \times \sqrt{1.86 - 0.019} = 1 \times \sqrt{1.8404} = 1 \times 1.356 = 1.356.$$

$$SE\sigma = \frac{\sigma}{\sqrt{2f}} = \frac{1.356}{\sqrt{2\times 50}} = \frac{1.356}{\sqrt{100}} = \frac{1.356}{10} = 0.1356 \text{ Ans.}$$

Merits & Demerits :-

Merit – (1) SD is rigidly defined & based on all observations

(2) The squaring of the deviations $(x-\bar{x})^2$ or dx^2 removes the drawbacks of ignoring the signs of deviations in calculating the mean deviation.

(3) Standard deviation is least affected by fluctuation of Sampling.

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