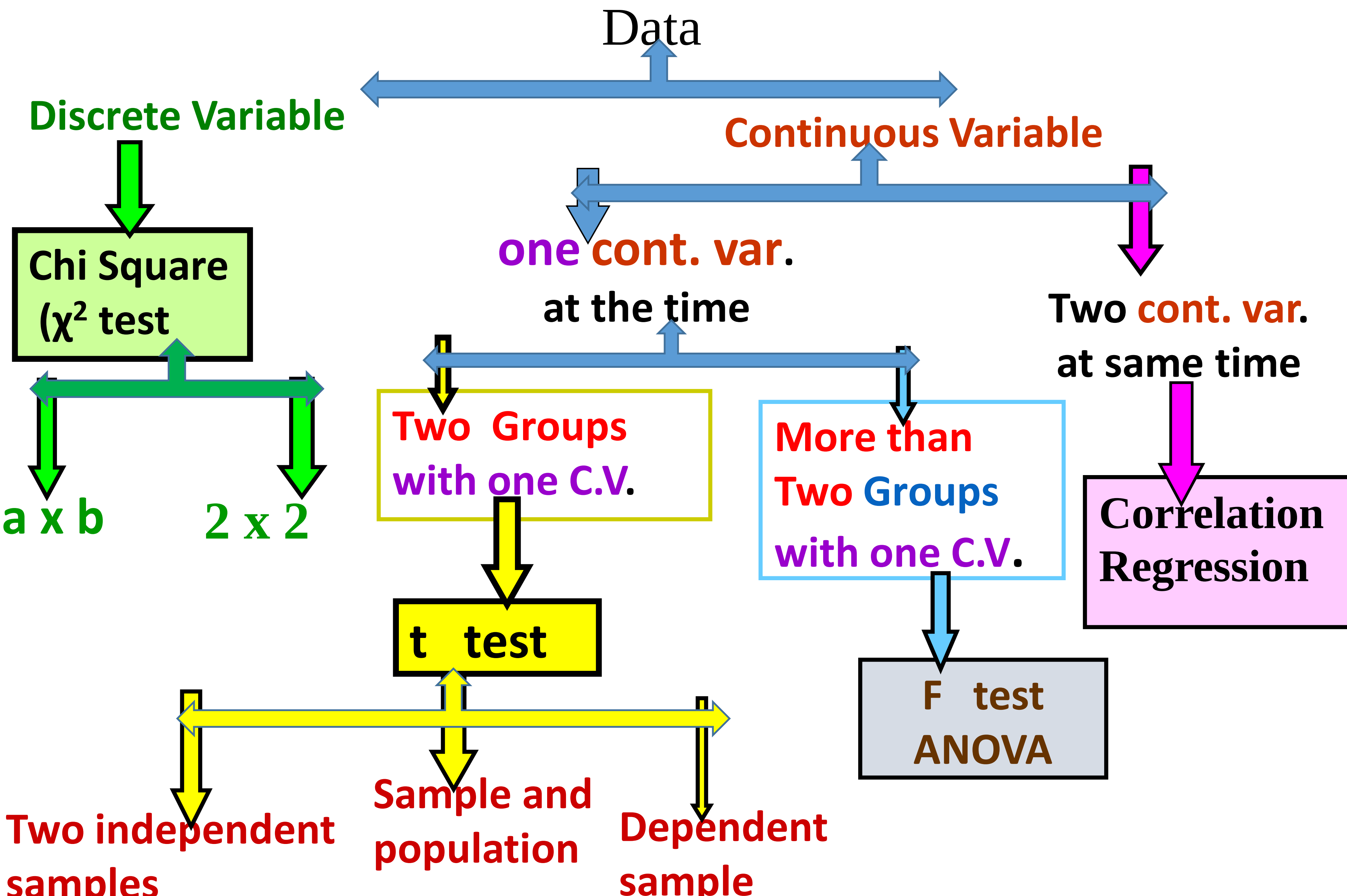
بسم الله الرحمن الرحيم

L XV

t-Tests

Part 2



An important thing is the type of the variable concerned.

It is one of the commonly test for testing Hypothesis **.**

It is used when we have quantitative data .

It is used in testing hypothesis about the difference between Means of two populations in comparing to the standard error of the difference .

to ***determine in term of probability how large the observed difference is*** :

$$t = \frac{m_1 - m_2}{S.E\ of\ \ difference}$$

Application of t test

(1) one-sample t-test;
(2) two-sample t-test; and
(3) two-sample paired t-test

(1) one-sample t-test

Application of t test

I- **Difference between sample and population Means**

t test is used to test significance of the difference between sample Mean and population mean μ , as standard mean or standard value .

Measure the distance between , μ in relation to S.E .

Example

Blood cholesterol level was **242 mg/100 ml** , sample of 81 individuals put on certain diet, their mean blood cholesterol was **200 ±45 mg/ml** **Is there a significance difference in the cholesterol level between two population?** , at level of .α 0.05

Is there any **effect of diet on cholesterol level** ?

Note, that there is a quite difference between .

Is there any effect of diet on cholesterol level ?

Note, that there is **a quite difference between** .

Sampling Error .

This difference could be either

Influencing Factor (diet) .

- The group **is equal to population mean** μ **(242 = 200),**
- but the difference is **due to unusual samples that** has been drown **(sapling error)** .

- **Or the true mean of the population of the sample is not equal to 242** . It is due to effect of **influencing factor** (diet)

- So we are **going to decide**, which **of these two** possibilities is probable or more likely . **We use t test**

Data

Data represent cholesterol level (quantitative) of 81 individuals under certain diet .

Assumption

We assume **that random sample** of 81 individuals was chosen randomly from **normal distribution** population with **equal variance** . Certain diet was given to this sample (81 individuals) to **see the effect of this diet on serum** cholesterol .

Mean blood cholesterol level of this random sample was found as 200 mg/100 ml .

Formulation of Hypothesis

Ho

HA

Ho

There **is** **no significance** **difference** in the mean cholesterol level between population mean μ (242) and population mean of the studied (81) group (sample) (200)

$$\mu = \overline{X} \qquad \mu - \overline{X} = Zero$$

$$242 = 200 \qquad 242 - 200 = Zero$$

- **And the** observed difference between μ and $\overline{X}$ is due to
  - **Sampling error .**
  - **Sampling variability .**
  - **Or Chance factor .**
- **There is no effect of diet on the cholesterol level .**

HA

* **There is a significance difference in the mean** cholesterol level between **population mean** μ and studied group $\bar{X}$.

$$\mu \neq \bar{X} \qquad\qquad \mu - \bar{X} \neq Zero$$

$$242 \neq 200 \qquad\qquad 242 - 200 \neq Zero$$

** **This difference is due to**

the effect of influencing factor .

the effect of diet on cholesterol .

*** **This difference is not due to chance factor**

level of significance

$$\alpha = 0.05 \qquad \frac{\alpha}{2} = \frac{0.05}{2} = 0.025$$

Two tails t test .
Two sided t test .

Proper test

Because This is quantitative data .

This is difference between two means

. We use

t test First application

$$t = \frac{\mu - \overline{X}}{S.E \;\; of \;\; difference}$$

$$t = \frac{242-200}{45/\sqrt{81}} = \frac{42}{45/9} = \frac{42}{5}$$

Calculated t= 8.4

Tabulated t at α 0.025

d.F= 80

df= sample size -1= (N-1)

t_{80}= 1.993

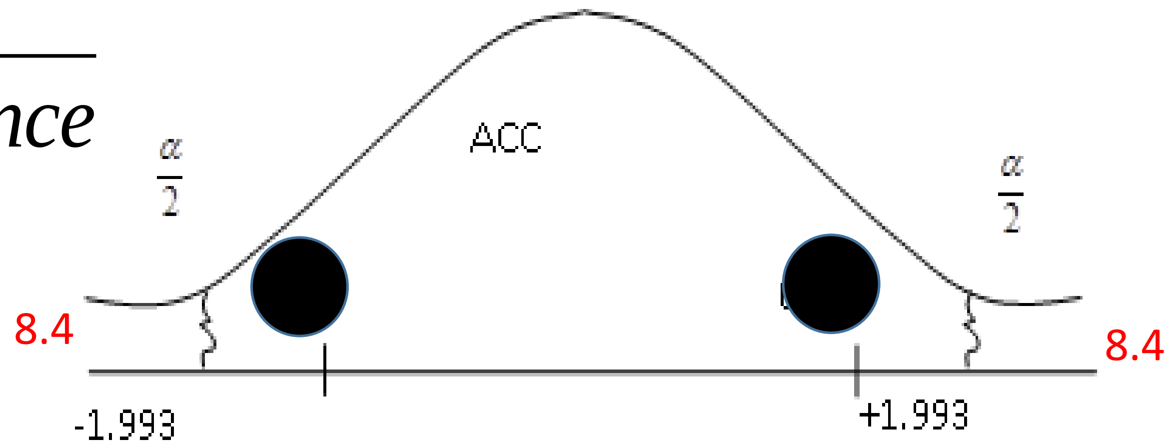
We accept that there is a significance difference ,
and the difference is due to **effect** of the diet
not due to sampling error .

This mean that calculated t fall in Rejection region .
This mean that the influencing factor is higher than 95%
This mean that the **chance** factor is **lesser than 5%** .

So, The **difference between is due to influencing factor .**

There is significance effect of diet on cholesterol level
This observed difference is not due to chance factor
$P < 0.05$.

$$t = \frac{\mu - \overline{X}}{S.E \;\; of \;\; difference}$$



Calculated t **>** **tabulated** .

So calculated t value **fall** in region of **Rejection**, so we **Reject H0** and **accept HA** .

Conclusion

There is a significance effect of diet on cholesterol level

Example

A hemoglobin level in g /dl were recorded for a sample of **20** children, who were part of a study of acute leukemia . Their **mean Hb** level was **8 .5** ± **5** g/dl. Can we conclude that hemoglobin level of children with an acute leukemia differ from normal population which is **13.5** g/dl. Let alpha =0 .05

Is there any effect of acute leukemia on Hb level ?

Note, that there is **a quite difference between** .

Sampling Error .

This difference could be either

Influencing Factor (leukemia)

- The group **is equal to population mean** μ (**13.5 = 8 .5**),
- but the difference is **due to unusual samples that** has been drown **(sapling error)** .

- **Or the true mean of the population of the sample is not** equal to 13.5 . It is **due to effect of influencing factor** (leukemia)

- So we are **going to decide**, which **of these two** possibilities is probable or more likely . **We use t test**

Data

Data represent **Hb level** (quantitative) of **20** children with acute leukemia.

Assumption

We assume that random sample of 20 children with acute leukemia, was chosen randomly from **normal distribution population** with equal variance . Hb measures was done to **see the effect of** leukemia **on** the Hb level.

Mean Hb level **of this random sample was found as 8.5 g/dl.**

Formulation of Hypothesis

Ho

HA

Ho

There **is no significance difference** in the Hb level between population mean μ (13.5) and population mean of the studied (20) group (sample) (8.5)

$\mu = \bar{X}$

$\mu = X = \text{zero}$

13.5=8.5

13.5-8.5=zero

- **And the** observed difference between μ and $\bar{X}$ is due to
- **Sampling error .**
- **Sampling variability .**
- **Or Chance factor** .
- **There is no effect of** leukemia **on the Hb level** .

HA

* **There is a significance difference in the mean** Hb level between population mean μ and studied group $\bar{X}$.

μ not= $\bar{X}$

μ not = $\bar{X}$

13.5 not= 8.5

13.5 -8.5 not = zero

** **This difference is due to**

- **the effect of influencing factor .**
- **the effect of** leukemia **on Hb level .**
- ***** This difference is not due to chance factor****

level of significance

$$\alpha = 0.05 \qquad \frac{\alpha}{2} = \frac{0.05}{2} = 0.025$$

Two tails t test .

Two sided t test .

Proper test

Because This is quantitative data .

This is difference between two means

. We use

t test **First application**

$$t = \frac{\mu - \overline{X}}{S.E \;\; of \;\; difference}$$

$$t = \frac{13.5-8.5}{5/\sqrt{20}} = \frac{5}{5/4.47} = \frac{5}{1.12}$$

Calculated t= 4.46

Tabulated t at α 0.025

d.F= 19

df= sample size -1= (N-1)

t_{80}= 2.89

We accept that there is a significance difference in Hb levels and the difference is **due to effect** of the leukemia **not due** to **sampling error** .

This mean that calculated t fall in Rejection region .

This mean that the influencing factor is higher than 95% .

This mean that the chance factor is **lesser than 5%** .

So,

The **difference in Hb levels is due to influencing factor .**

There is significance effect of leukemia on Hb level .

This observed difference is not due to chance factor .

$P < 0.05$.

t-test table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%

Example

The following are the heights in Cm of 24 two-year-old Jamaican boys with homozygous sickle cell disease (SS)

84.4	89.9	89.0	81.9	87.0	78.5	84.1	86.3
80.6	80.0	81.3	86.8	83.4	89.9	85.4	80.6
85.0	82.5	80.7	84.3	85.4	85.0	85.5	81.9

Height and weight standards for the UK give a reference height for two-year-old males of 86.5 cm .

Does the above sample suggest that two-year-old male SS children differ in height from the standards?

$\bar{X}$ = 84.1 cm .

$$t = \frac{\mu - \overline{X}}{S.E \ \ of \ \ difference}$$

SD = 3.11cm

N=24

SD/ √ N = 0.63cm

$$t = \frac{\bar{X} - 86.5}{\mathbf{SD/\sqrt{N}}} = \frac{\mathbf{84.1-86.5}}{0.63} = \frac{-2.4}{0.63} = -3.81 \ \ \text{df } 23$$

Calculated t= -3.81

Tabulated t at α 0.025

d.F= 23

df= sample size -1= (N-1)

t_{80}= 2.06

Part 3

two-sample t test pooled

If the two research samples come from two different groups (e.g., a group of men and a group of women), Student's t-testis used.

If the two samples come from the same group (e.g. pre treatment and post treatment values for the same study participants), the paired t-test is used.
In both types of Student's t-test, t is calculated by taking the observed difference between the means of the two groups (the numerator) and dividing this difference by the standard error of the difference between the means of the two groups (denominator).

$$t = \frac{M_1 - M_2}{SE}$$

Before t can be calculated, the standard error of the difference between the means **(SED)** must be determined. The basic formula for this is the square root of the sum of the respective population variances, each divided by its own sample size.

$$t = \frac{M_1 - M_2}{SE}$$

What is a t test? in two-sample t test

A t test is used to measure the difference between exactly two means.

Its focus is on the same numeric data variable rather than counts or correlations between multiple variables.

If you are taking the average of a sample of measurements t tests are the most commonly used method to evaluate that data.

For example, you might compare whether systolic blood pressure differs between a control and treated group, between men and women, or any other two groups.

This calculator uses a two-sample t test, which compares two datasets to see if their means are statistically different.

This calculator uses a two-sample t test, which compares two datasets to see if their means are statistically different.
That is different from a one sample t test, which compares the mean of your sample to some proposed theoretical value.
The most general formula for a t test is composed of two means (M1 and M2) and the overall standard error (SE) of the two samples:

Because the t-test typically is used to test a null hypothesis of no difference between two means, the assumption generally is made that there is also no difference between the variances, so a **pooled estimate of the SED (SEDP)** may be used instead

II- Difference between two sample Means (pooled t test)

Here we have two independent samples,

two different samples,

and two samples from two different populations,

we use Pooled t test .

Two independent random samples from their respective, different populations .

.

Treated group

Two groups (population)

Untreated group .

by A ♂

Two groups Two groups

by B ♀

No. of individual in each sample is not necessary be equals

we use Pooled t test .

$$Pooled\ t\ test = \frac{m_1 - m_2}{S.P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$D.F = n_1 + n_2 - 2\ or\ (n_1 - 1) + (n_2 - 1)$$

$$S.P = \sqrt{\frac{(n_1 - 1)\,S_1^2 + (n_2 - 1)\,S_2^2}{n_1 + n_2 - 2}}$$

S.P = pooled S.D .
n1 = No. in first group .
n2 = No. in second group
S1 = S.D in first group .
S2 = S.D in second group

Example

In order to evaluate the difference in Serum Na level between **15 normotensive** and **12 newly diagnosed hypertensive** patients not yet on Na controlled diet .

The mean Na level was **144±6.2 meq/L in normotensive** .

160 ± 3.9 meq/L in **hypertensive .**

Using α 0.05 level of significance can it be concluded that there is a significance difference in Na level between the two group of population ?

Data

Quantitative data of Two samples.

Sodium (Na) level in blood of two groups .

15 Normotensive with

12 Hypertensive with

Data

Quantitative data of Two samples.

Sodium (Na) level in blood of two groups .

15 Normotensive with

12 Hypertensive with

No.	X	S.D
15	144	**6.2**
12	**160**	**3.9**

Assumption

We assume that both groups were independent have been chosen randomly from normal distribution population with equal variance .

To see if there is a significance difference in the mean Sodium (Na) levels between two groups .

Formulation of Hypothesis

Ho

There is no significance difference in the mean Na level between two groups (Normotensive and Hypertensive)

m1 = m2 , m1 - m2 = zero .

The observed difference is due to Chance Factor .

Sampling Error .

Sampling Variability .

HA

There is a significance difference in the mean Na level between two groups (Normotensive and Hypertensive)

m1 ≠ m2 , m1 - m2 ≠ zero

- **This difference is due to Influencing Factor (Increases in Blood Pressure).**
- **The effect of Chance Factor is minimum .**

Using Proper test of significance

t test .

Pooled t test .

$$t = \frac{m_1 - m_2}{S.P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

Level of significance $\alpha = 0.05$ $\frac{\alpha}{2} = \frac{0.05}{2} = 0.025$

two tail t test

$$D.F = (n_1 - 1) + (n_2 - 1) = n_1 + n_2 - 2$$

$$= 15 + 12 - 2 = 25$$

$$t = \frac{m_1 - m_2}{S.P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$$

$$S.P = \sqrt{\frac{(n_1 - 1)\, S_1^2 + (n_2 - 1)\, S_2^2}{n_1 + n_2 - 2}}$$

$$S.P = \sqrt{\frac{(15-1)\ 6.2^2 + (12-1)\ 3.9^2}{15+12-2}} = \sqrt{\frac{14 \times 38.44 + 11 \times 12.96}{25}}$$

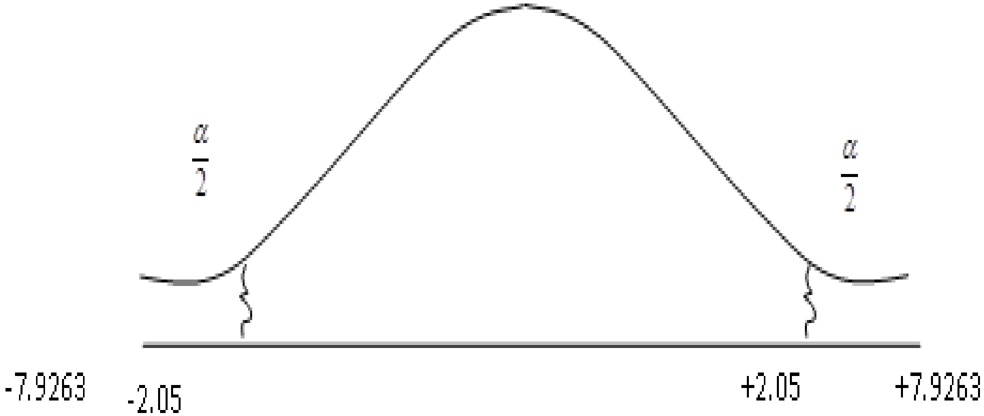
$$= \sqrt{\frac{538.16 + 142.56}{25}} = \sqrt{\frac{680.72}{25}} = \sqrt{27.2285} = 5.218$$

$$S.P = 5.218$$

$$t = \frac{m_1 - m_2}{S.P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} = \frac{160 - 144}{5.218\sqrt{0.083 + 0.066}}$$

$$t = \frac{160 - 144}{5.218\sqrt{0.1496}} = \frac{160 - 144}{5.218 \times 0.3868} = \frac{16}{2.0186}$$

$$t = 7.9263$$



$$Tabulated\ \ t_{25}^{0.025} = 2.05$$

$$d.F = 25$$

$$Calculated\ \ t = 7.9263$$

Calculated t > tabulated

Calculated t fall in area of Rejection,

so we reject Ho .

This mean that we reject that **there is no significance difference in Na level between Normotensive and Hypertensive :**

- **there is a significance difference .**

This difference is due to **influencing factor .**

This difference is **due to increase in B.P.**

- There is a significance effect of Na on B.P.

Calculated t fall in area of Rejection .

- **Calculated t fall behind the critical region, so there is an**
- increase of the influencing factor, and there is
- **a decrease in chance factor,**

Therefore **$P < 0.05$.**

t-test table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	**0.50**	**0.25**	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.001**	**0.0005**
two-tails	**1.00**	**0.50**	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.002**	**0.001**
df											
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4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
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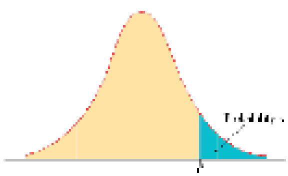
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%

t-distribution table

Areas in the upper tail are given along the top of the table. Critical t* values are given in the table.



df	0.1	0.05	0.025	0.02	0.01	0.005
1	3.078	6.314	12.706	15.895	31.821	63.657
2	1.886	2.920	4.303	4.849	6.965	9.925
3	1.638	2.353	3.182	3.482	4.541	5.841
4	1.533	2.132	2.776	2.999	3.747	4.604
5	1.476	2.015	2.571	2.757	3.365	4.032
6	1.440	1.943	2.447	2.612	3.143	3.707
7	1.415	1.895	2.365	2.517	2.998	3.499
8	1.397	1.860	2.306	2.449	2.896	3.355
9	1.383	1.833	2.262	2.398	2.821	3.250
10	1.372	1.812	2.228	2.359	2.764	3.169
11	1.363	1.796	2.201	2.328	2.718	3.106
12	1.356	1.782	2.179	2.303	2.681	3.055
13	1.350	1.771	2.160	2.282	2.650	3.012
14	1.345	1.761	2.145	2.264	2.624	2.977
15	1.341	1.753	2.131	2.249	2.602	2.947
16	1.337	1.746	2.120	2.235	2.583	2.921
17	1.333	1.740	2.110	2.224	2.567	2.898
18	1.330	1.734	2.101	2.214	2.552	2.878
19	1.328	1.729	2.093	2.205	2.539	2.861
20	1.325	1.725	2.086	2.197	2.528	2.845
21	1.323	1.721	2.080	2.189	2.518	2.831
22	1.321	1.717	2.074	2.183	2.508	2.819
23	1.319	1.714	2.069	2.177	2.500	2.807
24	1.318	1.711	2.064	2.172	2.492	2.797
25	1.316	1.708	2.060	2.167	2.485	2.787
26	1.315	1.706	2.056	2.162	2.479	2.779
27	1.314	1.703	2.052	2.158	2.473	2.771
28	1.313	1.701	2.048	2.154	2.467	2.763
29	1.311	1.699	2.045	2.150	2.462	2.756
30	1.310	1.697	2.042	2.147	2.457	2.750
31	1.309	1.696	2.040	2.144	2.453	2.744
32	1.309	1.694	2.037	2.141	2.449	2.738
33	1.308	1.692	2.035	2.138	2.445	2.733
34	1.307	1.691	2.032	2.136	2.441	2.728
35	1.306	1.690	2.030	2.133	2.438	2.724
36	1.306	1.688	2.028	2.131	2.434	2.719
37	1.305	1.687	2.026	2.129	2.431	2.715
38	1.304	1.686	2.024	2.127	2.429	2.712
39	1.304	1.685	2.023	2.125	2.426	2.708
40	1.303	1.684	2.021	2.123	2.423	2.704
41	1.303	1.683	2.020	2.121	2.421	2.701
42	1.302	1.682	2.018	2.120	2.418	2.698
43	1.302	1.681	2.017	2.118	2.416	2.695
44	1.301	1.680	2.015	2.116	2.414	2.692
45	1.301	1.679	2.014	2.115	2.412	2.690
46	1.300	1.679	2.013	2.114	2.410	2.687
47	1.300	1.678	2.012	2.112	2.408	2.685
48	1.299	1.677	2.011	2.111	2.407	2.682
49	1.299	1.677	2.010	2.110	2.405	2.680
50	1.299	1.676	2.009	2.109	2.403	2.678

df	0.1	0.05	0.025	0.02	0.01	0.005
51	1.298	1.675	2.008	2.108	2.402	2.676
52	1.298	1.675	2.007	2.107	2.400	2.674
53	1.298	1.674	2.006	2.106	2.399	2.672
54	1.297	1.674	2.005	2.105	2.397	2.670
55	1.297	1.673	2.004	2.104	2.396	2.668
56	1.297	1.673	2.003	2.103	2.395	2.667
57	1.297	1.672	2.002	2.102	2.394	2.665
58	1.296	1.672	2.002	2.101	2.392	2.663
59	1.296	1.671	2.001	2.100	2.391	2.662
60	1.296	1.671	2.000	2.099	2.390	2.660
61	1.296	1.670	2.000	2.099	2.389	2.659
62	1.295	1.670	1.999	2.098	2.388	2.657
63	1.295	1.669	1.998	2.097	2.387	2.656
64	1.295	1.669	1.998	2.096	2.386	2.655
65	1.295	1.669	1.997	2.096	2.385	2.654
66	1.295	1.668	1.997	2.095	2.384	2.652
67	1.294	1.668	1.996	2.095	2.383	2.651
68	1.294	1.668	1.995	2.094	2.382	2.650
69	1.294	1.667	1.995	2.093	2.382	2.649
70	1.294	1.667	1.994	2.093	2.381	2.648
71	1.294	1.667	1.994	2.092	2.380	2.647
72	1.293	1.666	1.993	2.092	2.379	2.646
73	1.293	1.666	1.993	2.091	2.379	2.645
74	1.293	1.666	1.993	2.091	2.378	2.644
75	1.293	1.665	1.992	2.090	2.377	2.643
76	1.293	1.665	1.992	2.090	2.376	2.642
77	1.293	1.665	1.991	2.089	2.376	2.641
78	1.292	1.665	1.991	2.089	2.375	2.640
79	1.292	1.664	1.990	2.088	2.374	2.640
80	1.292	1.664	1.990	2.088	2.374	2.639
81	1.292	1.664	1.990	2.087	2.373	2.638
82	1.292	1.664	1.989	2.087	2.373	2.637
83	1.292	1.663	1.989	2.087	2.372	2.636
84	1.292	1.663	1.989	2.086	2.372	2.636
85	1.292	1.663	1.988	2.086	2.371	2.635
86	1.291	1.663	1.988	2.085	2.370	2.634
87	1.291	1.663	1.988	2.085	2.370	2.634
88	1.291	1.662	1.987	2.085	2.369	2.633
89	1.291	1.662	1.987	2.084	2.369	2.632
90	1.291	1.662	1.987	2.084	2.368	2.632
91	1.291	1.662	1.986	2.084	2.368	2.631
92	1.291	1.662	1.986	2.083	2.368	2.630
93	1.291	1.661	1.986	2.083	2.367	2.630
94	1.291	1.661	1.986	2.083	2.367	2.629
95	1.291	1.661	1.985	2.082	2.366	2.629
96	1.290	1.661	1.985	2.082	2.366	2.628
97	1.290	1.661	1.985	2.082	2.365	2.627
98	1.290	1.661	1.984	2.081	2.365	2.627
99	1.290	1.660	1.984	2.081	2.365	2.626
100	1.290	1.660	1.984	2.081	2.364	2.626

Thank You