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Lab 1: For Ungrouped Data

Enter the following values in SPSS and calculate mean, s.d, ranges, mode, median.

Weights: 25, 35, 45, 55, 65, 75

Basic Steps for SPSS

1. Select Analyze ->Descriptive statistics ->Descriptives

2. Click the Descriptives-> Move Midvalue into Variable(s).

3. Click the Option. select Mean, s.d, ranges, mode, median

4. Click Ok

Working Expression:

1. **Mean:** Mean= Sum of all values divided by the number of values
   $$Mean= \sum x/n$$
2. **Median:** Arrange the data in ascending order.

   If n is odd: Median=Middle value

   If n is even: Median=(Middle two values sum)/2

3. **Standard Deviation:** Square root of the average of squared differences from the mean

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$$

4. **Range:** Range=Maximum value - Minimum value

Output:

Weights

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25.00	1	14.3	16.7	16.7
	35.00	1	14.3	16.7	33.3
	45.00	1	14.3	16.7	50.0
	55.00	1	14.3	16.7	66.7
	65.00	1	14.3	16.7	83.3
	75.00	1	14.3	16.7	100.0
	Total	6	85.7	100.0	
Missing	System	1	14.3		
Total		7	100.0		

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Statistics

Weights

N	Valid	6
	Missing	1
Mean		50.0000
Median		50.0000
Mode		25.00[a]
Std. Deviation		18.70829
Range		50.00

a. Multiple modes exist. The smallest value is shown

Interpretation:

1. Mean=50, mean the average value of weights is 50.
2. Median= 50, means the 50% of the wight is above 50 and 50% is below 50.
3. Mode=25, means the majority of times the weight is 25.
4. Std Deviation=18.708, means 18.708 is the average dispersion from mean.
5. Range= 50, means the difference between highest and lowest weight is 50.

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Lab 2: For Ungrouped Data

Enter the following values in SPSS and calculate mean, s.d., ranges, mode, median.

Weight	Midvalue	Frequency
20-30	25	4
30-40	35	6
40-50	45	7
50-60	55	21
60-70	65	23
70-80	75	2

Basic Steps:

1. Enter the Data Editor Window.

2. Select Data-> Weight Cases.

3. Move Frequency into Frequency Variable.

4. Click Ok. select Analyze ->Descriptive statistics-> Frequencies

5. Click the frequencies-> Move Midvalue into Variable(s)

6. Click the Statistics. select Mean.

7. Click continue. Click ok.

Working Expression:

1. **Mean:** Mean= Sum of all values divided by the number of values

   Mean= $\sum$x/n

2. **Median:** Arrange the data in ascending order.

   If n is odd: Median=Middle value

   If n is even: Median=(Middle two values sum)/2

3. **Standard Deviation**: Square root of the average of squared differences from the mean

$$\sigma = \sqrt{\frac{\sum(x_i - \mu)^2}{N}}$$

4. **Range:** Range=Maximum value - Minimum value

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midvalue

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25.00	1	16.7	16.7	16.7
	35.00	1	16.7	16.7	33.3
	45.00	1	16.7	16.7	50.0
	55.00	1	16.7	16.7	66.7
	65.00	1	16.7	16.7	83.3
	75.00	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Statistics

		midvalue	frequency
N	Valid	6	6
	Missing	0	0
Mean		50.0000	10.5000
Median		50.0000	6.5000
Mode		25.00[a]	2.00[a]
Std. Deviation		18.70829	9.09395
Range		50.00	21.00

a. Multiple modes exist. The smallest value is shown

frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	16.7	16.7	16.7
	4.00	1	16.7	16.7	33.3
	6.00	1	16.7	16.7	50.0
	7.00	1	16.7	16.7	66.7
	21.00	1	16.7	16.7	83.3
	23.00	1	16.7	16.7	100.0
	Total	6	100.0	100.0	

Interpretation.

For Mid-value.

1. Mean=50, mean the average value of weights is 50.
2. Median= 50, means the 50% of the wight is above 50 and 50% is below 50.
3. Mode=25, means the majority of times the weight is 25.
4. Std Deviation=18.708, means 18.708 is the average dispersion from mean.
5. Range= 50, means the difference between highest and lowest weight is 50.

For Frequency.

1. Mean=10.5, mean the average value of weights is 10.5.
2. Median= 6.50, means the 50% of the wight is above 6.50 and 50% is below 6.50.
3. Mode=2, means the majority of times the weight is 2.
4. Std Deviation=9.093, means 9.093 is the average dispersion from mean.
5. Range= 21, means the difference between highest and lowest weight is 21.

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Lab 3: Confidence Interval for Population Mean μ, ($σ^2$ Unknown and large n)

Enter the following values in SPSS and create a confidence intervalassuming normal distribution:

Length: 125, 120, 121, 123, 122, 130, 124, 122, 120, 122, 118, 119,

123, 124, 122, 124, 121, 122, 138, 149, 123, 128, 122, 130, 120, 122,

124, 134, 137, 128, 122, 121, 125, 120, 132, 130, 128, 130, 122, 124.

Basic Steps for SPSS

1. Enter the data.

2. Select Analyze ->Compare Means-> One sample T test.

3. Click Options-> Type % (90, 95, 99) confidence interval

4. Click on Continue and then Click OK.

Working Expression

95%

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Length	40	125.2750	6.14770	.97204

One-Sample Test

Test Value = 0

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Length	128.879	39	.000	125.27500	123.3089	127.2411

90%

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Length	40	125.2750	6.14770	.97204

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One-Sample Test

Test Value = 0

	t	df	Sig. (2-tailed)	Mean Difference	90% Confidence Interval of the Difference	
					Lower	Upper
Length	128.879	39	.000	125.27500	123.6372	126.9128

99%

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Length	40	125.2750	6.14770	.97204

One-Sample Test

Test Value = 0

	t	df	Sig. (2-tailed)	Mean Difference	99% Confidence Interval of the Difference	
					Lower	Upper
Length	128.879	39	.000	125.27500	122.6428	127.9072

Interpretation:

1. For 95% confidence level confidence interval is (123.3089, 127.2411).
2. For 90% confidence level confidence interval is (123.6372, 126.9128).
3. For 99% confidence level confidence interval is (122.6428, 127.9072).

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LAB 4: Testing of Hypothesis

The following values are the lengths of 40 steel rods selected for lab test from a factory.

Length: 125, 120, 121, 123, 122, 130, 124, 122, 120, 122, 118, 119,

123, 124, 122, 124, 121, 122, 138, 149, 123, 128, 122, 130, 120, 122,

124, 134, 137, 128, 122, 121, 125, 120, 132, 130, 128, 130, 122, 124.

Test whether this sample of size 40 has come from a population whose mean length is 125 cm.

Basic Steps in SPSS

1. Enter the data in the data editor.

2. Select Analyze ->Compare Means-> One sample T test. Type in Test Value box.

3. Click Options-> Type 95 in confidence interval percentages box.

4. Click on Continue and then Ok.

Working Expression:

We wish to test the hypothesis that the samples differ significantly from a hypothesized population mean height of 125 cm. So, we have

Step 1: Null Hypothesis(H$_0$): $\mu = 125$

i.e. There is no difference between sample mean and population mean.

Step 2: Alternate Hypothesis(H$_1$): $\mu \neq 125$

i.e. There is significant difference between sample mean and population mean.

Step3: Test statistics

Under H$_0$ Test statistics is given by,

p- value of test statistics (sig. (2-tailed)) = 0.00, compared to $\alpha = 0.05$.

Step4: Decision and Conclusion

P< α, accept H$_1$ and reject H$_0$.

Conclusion: There is significant difference between sample mean and population mean.

Output:

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Length	40	125.2750	6.14770	.97204

One-Sample Test

Test Value = 0

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Length	128.879	39	.000	125.27500	123.3089	127.2411

Interpretation: There is significant difference between sample mean and population mean.

Lab 5: Hypothesis Testing between two population Means for Matched Paired Samples

The sales of a product of a company after and before advertisement are as follows: Is advertisement effective at 5%?

Month	1	2	3	4	5	6
Before X	120	140	160	140	180	190
After Y	200	210	150	200	220	240

Basic steps in SPSS

1.Enter the data into Data Editor

2. Select Analyze-> Compare Means ->Paired- Samples T test.

3. Click Options-> Continue-> Ok.

Working expression:

Step 1: Null Hypothesis(H$_0$): μx = μy

I.e There is no difference between before and after.

Step 2: Alternate Hypothesis(H$_1$): μx < μy

I.e There is significant difference between before and after.

Step3: Test statistics

Under H$_0$ Test statistics is given by,

Tcal=0.465

p- value of test statistics (sig. (2-tailed)) = 0.00, compared to α= 0.05.

Step4: Decision and Conclusion

P< α, accept H$_1$ and reject H$_0$.

Conclusion: There is significant difference between sample mean and population mean.

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Output:

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	BeforeX	155.0000	6	26.64583	10.87811
	AfterY	203.3333	6	30.11091	12.29273

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	BeforeX & AfterY	6	.374	.465

Paired Samples Test

	Paired Differences							
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper	t	df	Sig. (2-tailed)
Pair 1 BeforeX - AfterY	-48.33333	31.88521	13.01708	-81.79481	-14.87186	-3.713	5	.014

Interpretation: There is significant difference between sample mean and population mean.

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Lab 6: Hypothesis Testing When raw data for Independent Samples is given

The monthly advertising cost of a company for two products X and Y were as follows during 6-month period:

Is there sufficient evidence to conclude that average cost on advertising on product Y is more than on product X.

Month	1	2	3	4	5	6	7
Cost I (X)	220	240	160	240	280	290	-
Cost II (Y)	100	110	150	100	120	140	145

Basic Steps for SPSS

1. Enter the data into Data editor.

2. Select Analyze ->Compare means ->Independent samples T Test

3. Move value into Test variable(s) and type into grouping variable

4. Click Define groups and type 1 and 2 into group 2

5. Click Options-> Continue ->Ok.

Working Expression:

Step 1: Null Hypothesis(H_0): $\mu 1 = \mu 2$

i.e. There is no significant difference between population mean of two group.

Step 2: Alternate Hypothesis(H_1): $\mu 1 < \mu 2$

i.e. There is significant difference between population mean of two group.

Step3: Test statistics

Under H_0 Test statistics is given by,

Tcal=5.862

Step4: Critical Value

For α=5% level of significance and (n1+n2-2) degree of freedom

Ttab= 1.796

Step4: Decision and Conclusion

Ttab<Tcal, accept H_1 and reject H_0.

Conclusion: There is significant difference between population mean of two groups.

Output:

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
cost	1.00	6	238.3333	46.65476	19.04673
	2.00	7	123.5714	21.35304	8.07069

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
cost	Equal variances assumed	1.357	.269	5.862	11	.000	114.76190	19.57600	71.67541	157.84840
	Equal variances not assumed			5.548	6.775	.001	114.76190	20.68608	65.51535	164.00846

Independent Samples Effect Sizes

		Standardizer[a]	Point Estimate	95% Confidence Interval	
				Lower	Upper
cost	Cohen's d	35.18658	3.262	1.502	4.964
	Hedges' correction	37.83666	3.033	1.396	4.617
	Glass's delta	21.35304	5.374	2.213	8.512

a. The denominator used in estimating the effect sizes.

Cohen's d uses the pooled standard deviation.

Hedges' correction uses the pooled standard deviation, plus a correction factor.

Glass's delta uses the sample standard deviation of the control group.

Interpretation: There is significant difference between population mean of two groups.

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Lab 7: Run Test

In 30 toss of a coin the following sequence of heads (H) and tail (T) is obtained. H T T H T H H H T H H H T T H T H T H H H T H T T H T H H H T H T

Test at 0.05 level of significance level whether the sequence is random.

Basic Steps for SPSS:

1.Enter the data in data editor window.

2. Analyze/ Nonparametric test / Legacy Dialogs / Runs

3. Click Options Select Descriptive and continue

4. Click OK

Working Expression:

Step 1: Null Hypothesis(H$_0$):

i.e. Sample observation is random.

Step 2: Alternate Hypothesis(H$_1$): $\mu 1 < \mu 2$

i.e. Sample observation is not random.

Step3: Test statistics:

Under H$_0$ Test statistics is given by,

Number of runs(R)=22

Number of head(n1)=14

Number of tails(n2)=16

Step 4: Critical value

For α= 0.05 level of significance, n1=16 and n2=14 tabulated value is

Rtab=(10,22)

Step 5: Decision and Conclusion

R=22$\in$ (10,22), accept H0 and reject H1.

Conclusion: Sample observation is random.

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Output:

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Runs	30	10.9333	6.32964	1.00	22.00

Runs Test

	Runs
Test Value[a]	10.50
Cases < Test Value	15
Cases >= Test Value	15
Total Cases	30
Number of Runs	2
Z	-5.017
Asymp. Sig. (2-tailed)	.000

Interpretation: Sample observation is random.

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Lab 8: Binomial Test

Test whether the coin is unbiased from following observations.

Tail Head Head Tail Head Tail Head Head Tail

Head Head Head Tail Head Head Head Head Head Head

Tail Tail Tail Tail Head Tail Tail Tail Tail Tail

Tail Tail Head Tail Tail Tail Head Tail Tail Tail

Tail Head Tail Tail Head Tail Head Tail Tail Tail

Basic Steps in SPSS

1.Enter the data in data editor window.

2. Analyze/ Nonparametric test / Legacy Dialogs / Binomial test

3. Click Options Select Descriptive and continue

4. Click OK

Working Expression:

Step 1: Null Hypothesis(H$_0$): P=1/2

i.e. Head and Tails are equally likely.

Step 2: Alternate Hypothesis(H$_1$): P $\neq$ 1/2

i.e. Head and Tails are not equally likely.

Step3: Test statistics

Under H$_0$ Test statistics is given by,

Number of Toss(n)=50

Number of head(n1)=20

Number of tails(n2)=30

Step 4: Critical value

Pvalue=0.203

Step4: Decision and Conclusion

Since Pvalue = 0.203>0.05, accept H0 and reject H1.

Conclusion: Heads and tails are equally likely.

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Output:

Binomial Test

		Category	N	Observed Prop.	Test Prop.	Exact Sig. (2-tailed)
Toss	Group 1	Tail	30	.60	.50	.203
	Group 2	Head	20	.40		
	Total		50	1.00		

Interpretation: Heads and tails are equally likely.

Lab 9: One Sample K-S Test

The number of disease infected tomato plants in 10 different plots of equal size are given below. Test whether the disease infected plants are uniformly distributed over the entire area use Kolmogorov Smirnov Test.

Plot no.	1	2	3	4	5	6	7	8	9	10
No. of infected plants	8	10	9	12	15	7	5	12	13	9

Basic Steps in SPSS

1. Start the SPSS program. In the Data editor window, type in the data.

2. Select Analyze-> Nonparametric tests-> Legacy Dialogs-> 1-Samples K-S.

3. Move X into Test Variable List. Then, Click OK.

Working Expression:

Step 1: Null Hypothesis(H$_0$): $F_e(x)=F_0(x)$

i.e. disease infected plants are uniformly distributed over the entire area.

Step 2: Alternate Hypothesis(H$_1$): $F_e(x) \neq F_0(x)$

i.e. disease infected plants are not uniformly distributed over the entire area.

Step3: Test statistics:

Under H$_0$ Test statistics is given by,

Number of Toss(n)=50

Number of head(n1)=20

Number of tails(n2)=30

Step 4: Critical value

Pvalue=0.200

Step4: Decision and Conclusion

Since Pvalue = 0.200>0.05, accept H0 and reject H1.

Conclusion: Disease infected plants are uniformly distributed over the entire area.

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Output:

One-Sample Kolmogorov-Smirnov Test

			Noofinfectedplants
N			10
Normal Parameters[a,b]	Mean		10.0000
	Std. Deviation		3.01846
Most Extreme Differences	Absolute		.146
	Positive		.130
	Negative		-.146
Test Statistic			.146
Asymp. Sig. (2-tailed)[c]			.200[d]
Monte Carlo Sig. (2-tailed)[e]	Sig.		.786
	99% Confidence Interval	Lower Bound	.775
		Upper Bound	.796

a. Test distribution is Normal.

Interpretation: Disease infected plants are uniformly distributed over the entire area.