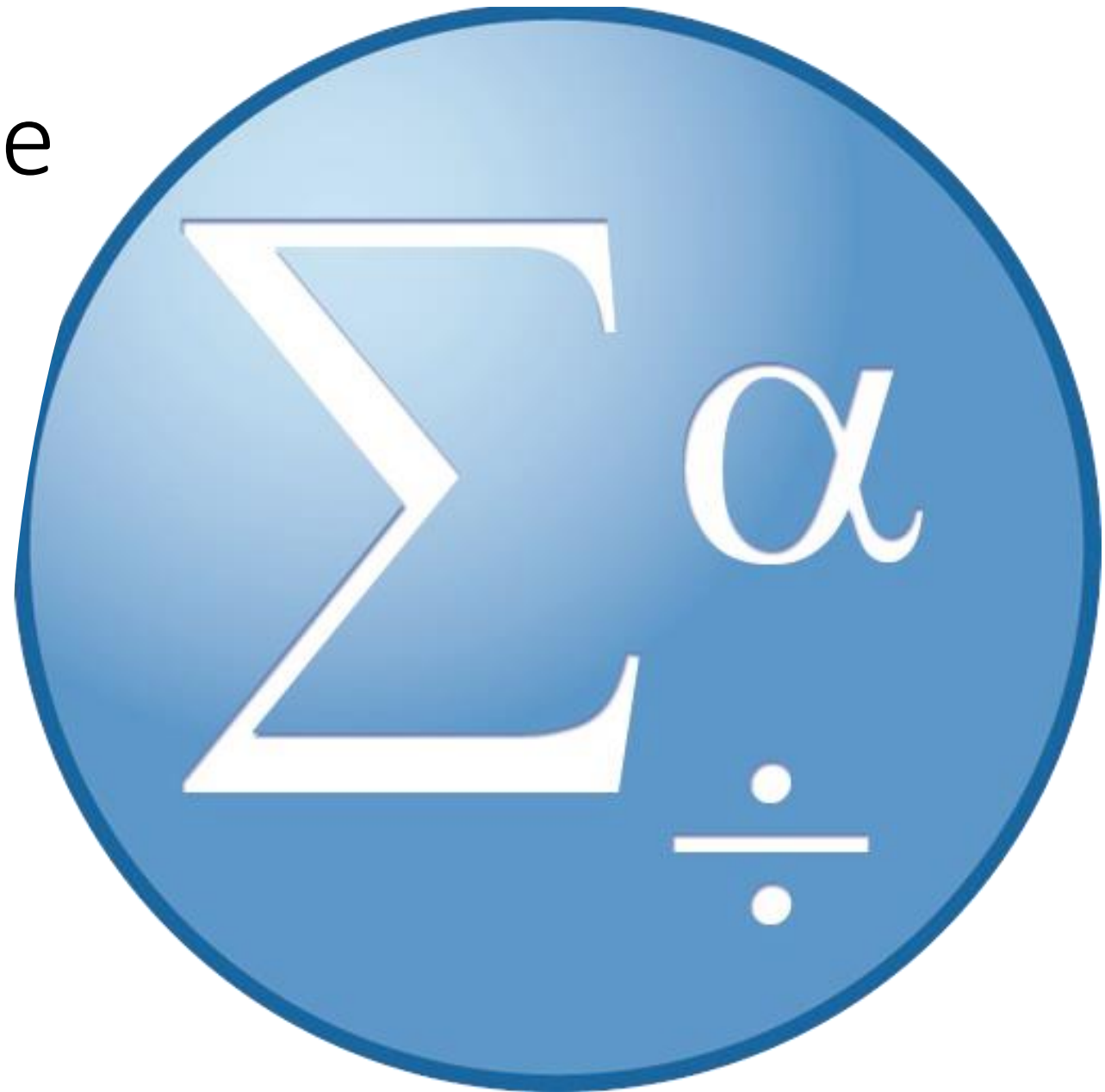


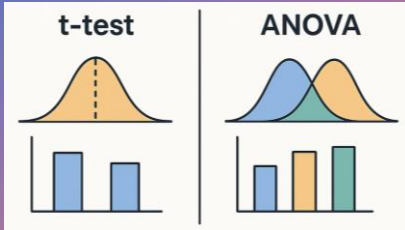
LCDB7011 Quantitative Research Methods

Week 4&5 – Basics of Statistical Analyses

(Pearson's r correlation , T-test & ANOVA)

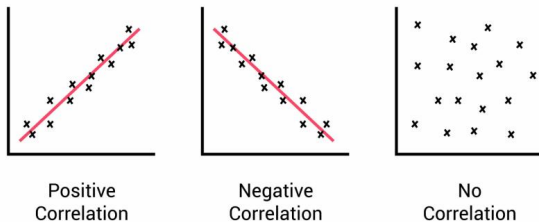


LCDB7011 Quantitative Research +Methods



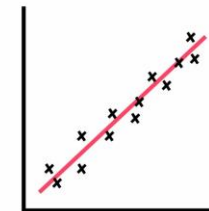
$$\sum \alpha \div$$

- Pearson's r correlation
- T-test (One sample t-test; paired sampled t-test & Independent t-test)
- ANOVA



Correlation in SPSS – Pearson's r

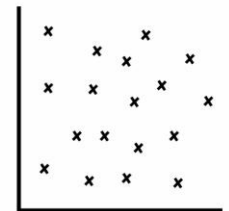
- Pearson's r measures the relationship between two variables
- Range : -1 to +1
- Correlation 0 : No relationship



Positive
Correlation



Negative
Correlation



No
Correlation

Co-workers & Job Satisfaction in SPSS

*HBAT_CFA-SEM_AMOS_ dataset_No Missing Data (8).sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

20 :

	AC3	SI3	AC4	SI4
1	1	3	1	3
2	1	4	1	4
3	1	5	2	5
4	1	3	1	4
5	2	3	2	4
6	1	3	1	3
7	3	5	3	4
8	1	4	3	2
9	3	2	1	2
10	1	3	4	3
11	4	5	5	5
12	2	4	3	4
13	2	4	3	5
14	1	2	1	3
15	2	3	4	3
16	4	3	3	3
17	5	3	4	4
18	3	5	1	5
19	1	5	2	5
20	2	3	3	2

Analyze > Correlate > Bivariate...

Bivariate Correlations

Variables:

- JS1 [JS1]
- AC1 [AC1]

Correlation Coefficients

☒ Pearson ☐ Kendall's tau-b ☐ Spearman

Test of Significance

☒ Two-tailed ☐ One-tailed

☒ Flag significant correlations ☐ Show only the lower triangle ☒ Show diagonal

OK Paste Reset Cancel Help

Correlations

→ Correlations

[DataSet2]

		Correlations	
		JS1	AC1
JS1	Pearson Correlation	1	.040
	Sig. (2-tailed)		.422
	N	400	400
AC1	Pearson Correlation	.040	1
	Sig. (2-tailed)	.422	
	N	400	400

- Sig level : $p. (0.422) > 0.5 \Rightarrow$ Weak correlation
- (Correlation co-efficient) $r = .04$

Correlations

 Bivariate Correlations

Variables:

JS5 [JS5]
AC3 [AC3]
SI3 [SI3]
AC4 [AC4]
SI4 [SI4]
C2 - Employee Type Clas...
C3 -Geographic Location ...
Age [AGE]

←

JS1 [JS1]
AC1 [AC1]
C1 - Gender Class [C1]

Options...
Style...
Bootstrap...
Confidence interv...

Correlation Coefficients

☒ Pearson ☐ Kendall's tau-b ☐ Spearman

Test of Significance

☒ Two-tailed ☐ One-tailed

☒ Flag significant correlations ☐ Show only the lower triangle ☒ Show diagonal

OK Paste Reset Cancel Help

Gender, AC and JS

Correlations

		JS1	AC1	C1 - Gender Class
JS1	Pearson Correlation	1	.040	.009
	Sig. (2-tailed)		.422	.852
	N	400	400	400
AC1	Pearson Correlation	.040	1	-.614**
	Sig. (2-tailed)	.422		<.001
	N	400	400	400
C1 - Gender Class	Pearson Correlation	.009	-.614**	1
	Sig. (2-tailed)	.852	<.001	
	N	400	400	400

** . Correlation is significant at the 0.01 level (2-tailed).

Biserial correlation between Gender and Co-worker relationship is strong

- Sig level : $p. (0.001) < .05 \Rightarrow$ Statistically significant between gender and co-worker relationship
- (Correlation co-efficient) $r = -.614$

T-test in SPSS

- One sample T-test

ta Editor

The screenshot shows the SPSS software interface. The 'Analyze' menu is open, and the 'Compare Means and Proportions' sub-menu is expanded. The 'One-Sample T Test...' option is highlighted. In the background, a data editor window is visible with a table containing numerical data.

EP2	EP3	AC1	EP4	JS2
0	5	1	6	4
0	10	2	7	4
0	10	1	7	2
				5
				4
				6
				3
				2
				5
				3
				7
				4
				4
				4
9	9	2	6	4
0	10	4	7	4
0	10	3	6	4
0	10	2	7	6
0	9	1	7	2

One-Sample T Test

Test Variable(s):

JS1 [JS1]

Options...
Bootstrap...

Test Value: 3 ☒ Estimate effect sizes

OK Paste Reset Cancel Help

EP1 [EP1]
OC3 [OC3]
OC4 [OC4]
EP2 [EP2]
EP3 [EP3]
AC1 [AC1]
EP4 [EP4]
JS2 [JS2]
JS3 [JS3]
AC2 [AC2]
SI1 [SI1]
JS4 [JS4]
SI2 [SI2]
JS5 [JS5]
AC3 [AC3]
SI3 [SI3]
AC4 [AC4]
SI4 [SI4]
C1 - Gender Class [C1]

JS vs mean value 3 (industry average)

→ T-Test

is
t
ct

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
JS1	400	4.20	1.339	.067

One-Sample Test

Test Value = 3

	t	df	Significance		Mean Difference	95% Confidence Interval of the Difference	
			One-Sided p	Two-Sided p		Lower	Upper
JS1	17.886	399	<.001	<.001	1.197	1.07	1.33

df = N (400) - 1 = 399, refer to distribution table

P value <.05 (statistically significant) ; **p <.001 (Statistically significant)**

CI does not include 0 => statistically significant. **CI = 1.07 to 1.33**

Conclusion : Our JS mean is different from the standard mean

Paired sample t-test

Within the subject measurement

Paired sample t-test

*Untitled2 [DataSet2] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

27 : SI3 3

	SI1	js4	SI2
1	4	3	4
2	5	2	4
3	5	3	5
4	5	2	4
5	5	2	5
6	5	3	4
7	5	4	5
8	3	1	4
9	3	1	3
10	4	2	4
11	5	3	5
12	4	4	4
13	5	1	5
14	3	3	3
15	4	2	5
16	5	4	5
17	5	2	5
18	5	3	5
19	5	1	5
20	4	3	4
21	5	2	4
22	5	4	5

Analyze > Compare Means and Proportions > Paired-Samples T Test...

	SI4	C1	C2	C3
3	1	0	1	4
4	1	1	1	3
5	1	1	1	4
20	1	0	1	4
3	1	1	1	4
4	1	1	1	4
5	1	0	1	3
5	1	0	1	5
2	1	1	1	4
3	1	0	1	3
5	1	1	1	5

Paired-Samples T Test

id
JS1 [JS1]
OC1 [OC1]
OC2 [OC2]
EP1 [EP1]
OC3 [OC3]
OC4 [OC4]
EP2 [EP2]
EP3 [EP3]
AC1 [AC1]
EP4 [EP4]
JS2 [JS2]
JS3 [JS3]
AC2 [AC2]
SI1 [SI1]
JS4 [js4]
SI2 [SI2]

Paired Variables:

Pair	Variable1	Variable2
1	JS1 [JS1]	AC1 [AC1]
2		

☒ Estimate effect sizes

Calculate standardizer using

- ☒ Standard deviation of the difference
- ☐ Corrected standard deviation of the difference
- ☐ Average of variances

Options...
Bootstrap...

Paired sample t-test

Paired Samples Test

		Paired Differences				Significance			
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		t	df	
					Lower	Upper			One-Sided p Two-Sided p
Pair 1	JS1 - AC1	1.438	1.893	.095	1.251	1.624	15.184	399	<.001 <.001

Paired Samples Effect Sizes

		Standardizer ^a	Point Estimate	95% Confidence Interval	
				Lower	Upper
Pair 1	JS1 - AC1	Cohen's d	1.893	.759	.648 .870
		Hedges' correction	1.897	.758	.646 .868

a. The denominator used in estimating the effect sizes.

Cohen's d uses the sample standard deviation of the mean difference.

Hedges' correction uses the sample standard deviation of the mean difference, plus a correction factor.



Independent t-test

Independent t-test

- Variables are independent of each group e.g. gender
- Two groups measure one time

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

Power Analysis >
 Meta Analysis >
 Reports >
 Descriptive Statistics >
 Bayesian Statistics >
 Tables >
Compare Means and Proportions >
 General Linear Model >
 Generalized Linear Models >
 Mixed Models >
 Correlate >
 Regression >
 Loglinear >
 Neural Networks >
 Classify >
 Dimension Reduction >
 Scale >
 Nonparametric Tests >
 Forecasting >

Means...
 One-Sample T Test...
Independent-Samples T Test...
 Paired-Samples T Test...
 One-Way ANOVA...
 One-Sample Proportions...
 Independent-Samples Proportions...
 Paired-Samples Proportions...

	EXP	JP	MeanSat	va
1	6.0	5	7.66	
2	5.8	4	10.92	
3	1.0	5	14.30	
4	7.8	5	11.15	
5	5.9	4	16.60	
6	13.0	5	12.83	
7	10.9	5	21.74	
8	11.5	3	12.98	

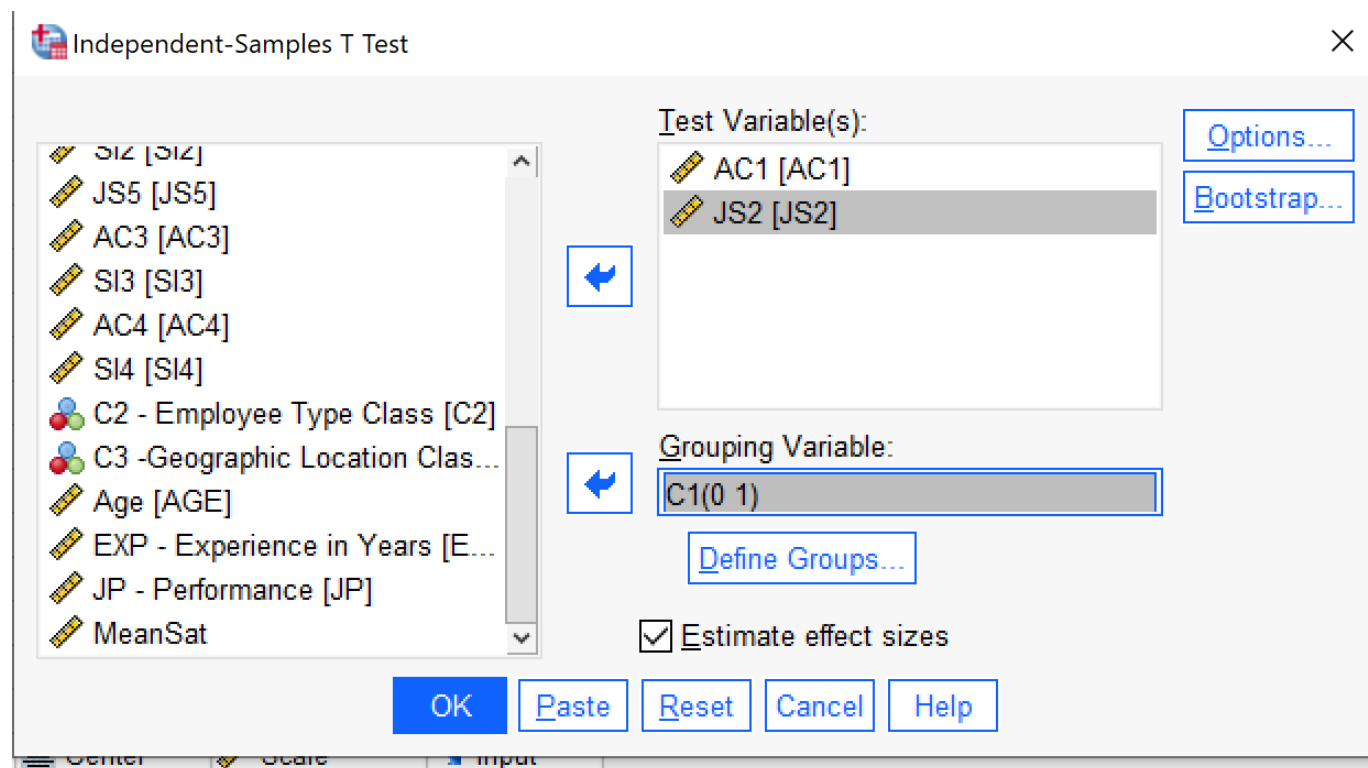
Independent-Samples T Test

Test Variable(s):
 AC1 [AC1]
 JS2 [JS2]

Grouping Variable:
 C1(? ?)

☒ Estimate effect sizes

OK Paste Reset Cancel Help



	C1 - Gender Class	N	Mean	Std. Deviation	Std. Error Mean
AC1	Male	200	3.62	1.218	.086
	Female	200	1.91	.970	.069
JS2	Male	200	4.21	1.419	.100
	Female	200	4.20	1.322	.094

Independent Samples Test

Levene's Test for Equality of Variances				t-test for Equality of Means						
				Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		
				One-Sided p	Two-Sided p			Lower	Upper	
AC1	Equal variances assumed	17.308	<.001	15.530	398	<.001	<.001	1.710	.110	1.494 1.926
	Equal variances not assumed			15.530	378.961	<.001	<.001	1.710	.110	1.493 1.927
JS2	Equal variances assumed	.067	.796	.036	398	.485	.971	.005	.137	-.265 .275
	Equal variances not assumed			.036	206.045	.485	.971	.005	.137	-.265 .275

Independent Samples Effect Sizes

				95% Confidence Interval	
Standardizer ^a			Point Estimate	Lower	Upper
AC1	Cohen's d	1.101	1.553	1.329	1.776
	Hedges' correction	1.103	1.550	1.326	1.773
	Glass's delta	.970	1.763	1.500	2.023
JS2	Cohen's d	1.371	.004	-.192	.200
	Hedges' correction	1.374	.004	-.192	.199
	Glass's delta	1.322	.004	-.192	.200

- 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 (i.e., the second) group.

One-way ANOVA

One-way ANOVA

Use MBA dataset (34)



Prifysgol Cymru
Y Drindod Dewi Sant
University of Wales
Trinity Saint David

One-Way ANOVA: Options

Statistics

- ☒ Descriptive
- ☐ Fixed and random effects
- ☒ Homogeneity of variance test
- ☐ Brown-Forsythe test
- ☒ Welch test

☒ Means plot

Missing Values

- ☒ Exclude cases analysis by analysis
- ☐ Exclude cases listwise

Confidence Intervals

Level(%):

One-Way ANOVA: Post Hoc Multiple Comparisons

Equal Variances Assumed

- ☐ LSD
- ☒ S-N-K
- ☐ Bonferroni
- ☒ Tukey
- ☐ Sidak
- ☐ Tukey's-b
- ☐ Scheffe
- ☐ Duncan
- ☐ R-E-G-W F
- ☐ Hochberg's GT2
- ☐ R-E-G-W Q
- ☐ Gabriel
- ☐ Waller-Duncan
- Type I/Type II Error Ratio:
- ☐ Dunnett
- Control Category:
- Test
 - ☒ 2-sided
 - ☐ < Control
 - ☐ > Control

Equal Variances Not Assumed

- ☐ Tamhane's T2
- ☐ Dunnett's T3
- ☒ Games-Howell
- ☐ Dunnett's C

Null Hypothesis test

- ☒ Use the same significance level [alpha] as the setting in Options
- ☐ Specify the significance level [alpha] for the post hoc test

Level:

ANOVA

Job Satisfaction

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.396	4	.849	.697	.600
Within Groups	35.339	29	1.219		
Total	38.735	33			

ANOVA Effect Sizes^{a,b}

			95% Confidence Interval	
			Lower	Upper
Job Satisfaction	Eta-squared	.088	.000	.208
	Epsilon-squared	-.038	-.138	.098
	Omega-squared Fixed-effect	-.037	-.133	.096
	Omega-squared Random-effect	-.009	-.030	.026

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.

b. Negative but less biased estimates are retained, not rounded to zero.

Homogeneous Subsets

Job Satisfaction

		Subset for alpha = 0.05 1	
	Age_cat	N	
Tukey HSD ^{a,b}	1.00	2	2.0000
	2.00	7	2.5714
	3.00	13	3.0000
	4.00	8	3.1250
	5.00	4	3.2500
	Sig.		.443

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 4.567.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Age & JS

► Oneway

Descriptives

Job Satisfaction								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
1.00	2	2.0000	.00000	.00000	2.0000	2.0000	2.00	2.00
2.00	7	2.5714	1.13389	.42857	1.5228	3.6201	1.00	4.00
3.00	13	3.0000	.91287	.25318	2.4484	3.5516	1.00	4.00
4.00	8	3.1250	1.24642	.44068	2.0830	4.1670	1.00	5.00
5.00	4	3.2500	1.50000	.75000	.8632	5.6368	2.00	5.00
Total	34	2.9118	1.08342	.18580	2.5337	3.2898	1.00	5.00

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Job Satisfaction	Based on Mean	1.747	4	29	.167
	Based on Median	1.192	4	29	.335
	Based on Median and with adjusted df	1.192	4	25.054	.339
	Based on trimmed mean	1.750	4	29	.166

ANOVA

Job Satisfaction					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.396	4	.849	.697	.600
Within Groups	35.339	29	1.219		
Total	38.735	33			

Levine test for homogeneous variance
Between subjects

Age & JS

ANOVA Effect Sizes^{a,b}

			95% Confidence Interval	
			Lower	Upper
Job Satisfaction	Eta-squared	.088	.000	.208
	Epsilon-squared	-.038	-.138	.098
	Omega-squared Fixed-effect	-.037	-.133	.096
	Omega-squared Random-effect	-.009	-.030	.026

a. Eta-squared and Epsilon-squared are estimated based on the fixed-effect model.

b. Negative but less biased estimates are retained, not rounded to zero.

Levine test for homogeneous variance

Between subjects

ANOVA					
Job Satisfaction					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.396	4	.849	.697	.600
Within Groups	35.339	29	1.219		
Total	38.735	33			

- $df(4,29) = .697, P > .05, n$
- Remarks : n = effect size

Sig level $p < .05$ =
significantly different

Findings revealed that
all age group have no
significant difference
towards JS

Multiple Comparisons

Dependent Variable: Job Satisfaction

	(I) Age_cat	(J) Age_cat	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	-.57143	.88509	.966	-3.1442	2.0014
		3.00	-1.00000	.83847	.755	-3.4373	1.4373
		4.00	-1.12500	.87271	.700	-3.6618	1.4118
		5.00	-1.25000	.95601	.689	-4.0289	1.5289
	2.00	1.00	.57143	.88509	.966	-2.0014	3.1442
		3.00	-.42857	.51752	.920	-1.9329	1.0758
		4.00	-.55357	.57132	.867	-2.2143	1.1072
		5.00	-.67857	.69191	.862	-2.6898	1.3327
	3.00	1.00	1.00000	.83847	.755	-1.4373	3.4373
		2.00	.42857	.51752	.920	-1.0758	1.9329
		4.00	-.12500	.49605	.999	-1.5669	1.3169
		5.00	-.25000	.63118	.995	-2.0847	1.5847
	4.00	1.00	1.12500	.87271	.700	-1.4118	3.6618
		2.00	.55357	.57132	.867	-1.1072	2.2143
		3.00	.12500	.49605	.999	-1.3169	1.5669
		5.00	-.12500	.67600	1.000	-2.0900	1.8400
	5.00	1.00	1.25000	.95601	.689	-1.5289	4.0289
		2.00	.67857	.69191	.862	-1.3327	2.6898
		3.00	.25000	.63118	.995	-1.5847	2.0847
		4.00	.12500	.67600	1.000	-1.8400	2.0900

The same results will be reflected in Homo. subsets
All subset for Alpha is in the same direction.

Homogeneous Subsets

Job Satisfaction			Subset for alpha = 0.05
	Age_cat	N	1
Tukey HSD ^a	1.00	2	2.0000
	2.00	7	2.5714
	3.00	13	3.0000
	4.00	8	3.1250
	5.00	4	3.2500
	Sig.		.443

Means for groups in homogeneous subsets are displayed.

- a. Uses Harmonic Mean Sample Size = 4.567.
- b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

The same results will be reflected in Homo. Subsets

If they are different, they will be in different direction

Homogeneous Subsets

Complaints about wicked witches

Location where witches live		Subset for alpha = 0.05	
		1	2
Tukey HSD ^a	North Region	5	1.00
	South Region	5	1.40
	East Region	5	3.60
	West Region	5	4.20
	Sig.		.937

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 5.000.

These two (North & South) belong in one group. They are the same.

Activity

- i. Please create ONE hypothesis
- ii. Based upon your hypothesis, please select the appropriate tool for hypothesis testing.
(t-test, ANOVA and Pearson correlation Test)

