Week 4 Key Notes — Comparing Groups

The Three Types of t-Tests

1. One-Sample t-Test

- Compares a sample mean to a known/reference value (e.g. μ = 66kg)
- Example: Is the average weight of this group different from 66kg?

2. Independent Samples t-Test

- Compares means between **two unrelated groups** (e.g. men vs women)
- Example: Do men and women weigh the same?

3. Paired Samples t-Test

- Compares means between two measurements of the same group (e.g. before vs after)
- Example: Did people lose weight after the program?

When to Use Each t-Test

Test Type	Use when
One-Sample	Comparing sample mean to a known value
Independent Samples	Comparing two separate/unrelated groups
Paired Samples	Comparing before/after or matched pair values

Assumptions for t-Tests

- Your data should be symmetrical or bell-shaped (normal distribution)
- Observations are independent
- No extreme outliers (especially in small samples)

\nearrow The Three Types of Chi-Square (χ^2) Tests

1. One-Sample χ²-Test

- Compares observed proportions with expected ones
- Example: Is the gender split in the sample equal (50%-50%)?

2. Pearson's χ^2 -Test (Independent Groups)

- Compares proportions between two separate groups
- Example: Do men and women differ in their exercise habits?

3. McNemar's χ²-Test (Paired Groups)

- Compares proportions between before and after or paired categories
- Example: Did more people exercise after the programme?

Assumptions for Chi-Square Tests

- No more than 20% of cells with expected frequencies < 5
- Minimum expected frequency = 1
- Data must be **categorical** and **independent** (except McNemar's)

What the rule means:

☑ Rule 1: No more than 20% of the cells should have expected counts < 5

- Expected count = what SPSS would expect if the null hypothesis were true.
- If too many cells have very low expected counts (e.g. 2 or 3), the chi-square test becomes unreliable.
- This rule ensures that the test has **enough data to detect real differences**.

Rule 2: The smallest expected frequency must be at least 1

- No cell should have expected count less than 1.
- If any expected value is below 1, the math behind the test breaks it becomes statistically invalid.

6 How to Interpret It:

Message SPSS Gives	What It Means
✓ Only 10% of cells < 5	Assumption is met – you're good to go!
⚠ 25% of cells < 5	Assumption is violated – be cautious
X Minimum expected count < 1	Assumption not met – results are invalid

SPSS: Essential Commands

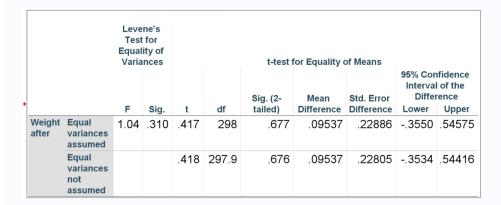
Test Type	SPSS Menu Path
One-Sample t-Test	Analyze > Compare Means > One-Sample T-Test
Independent t-Test	Analyze > Compare Means > Independent-Samples T-Test
Paired t-Test	Analyze > Compare Means > Paired-Samples T-Test
One-Sample χ^2	Analyze > Nonparametric Tests > Legacy Dialogs > Chi-Square
Pearson's χ²	Analyze > Descriptive Stats > Crosstabs > Statistics: Chi-Square
McNemar's χ²	Analyze > Nonparametric Tests > 2 Related Samples

Decision Rule (for all tests)

p-value What to do		What it means		
≤ 0.05 Reject H₀		There is a statistically significant difference		
> 0.05 Do not reject H₀		Not enough evidence to say there's a difference		

Quiz:

Based on the output, the correct interpretation for the difference in 'weight after' across males and females, is:



Select one:

- a. Non significant (F=1.04, df=297.9, p=0.676)
- b. Non significant (t=0.418, df=297.9, p=0.676)
- c. Non significant (t=0.417, df=298, p=0.677)
- d. Non significant (F=1.04, df=298, p=0.677) ×

Your answer is incorrect.

Check Levenes test under the null hypothesis H0: Variances are equal

As the p-value is >0.05 we fail to reject the null hypothesis and conclude that we are assuming equal variance.

From the top line of the output we get a non significant result as the p-value is > 0.05 (t=0.417, df=298, p=0.677) and we can conclude that there is no statistically significance difference in weight (kg) after in the two gender groups.

The correct answer is: Non significant (t=0.417, df=298, p=0.677)

▼ t-test for Equality of Means (Top row)

- t = **0.417**
- df = 298
- p = .677
- CI = $[-0.3550, 0.54575] \rightarrow Includes 0 \rightarrow Not significant$

X Why Option D is Wrong

Option D says:

"Non significant (F=1.04, df=298, p=0.677)"

- ♦ This mixes two different tests:
 - F = 1.04 is from **Levene's test** (for variance)
 - df = 298 and p = .677 are from the t-test
- So it's mismatching stats from two different tests.
- Note: The F value from Levene's test is not used for interpretation.

The F-statistic is used to calculate the p-value, but it's not important for your decision in SPSS output.

Types of t-tests

- 1. One-sample t-test: compares mean to known value
- 2. Independent samples t-test: compares means between 2 groups
- 3. Paired samples t-test: compares means in matched pairs

Types of chi-square tests

- 1. One-sample chi-square: test observed % vs expected %
- 2. Pearson's chi-square: compare proportions across independent groups
- 3. McNemar chi-square: compare proportions across matched groups

Assumptions for t-tests

- Approximately normal distribution (bell-shaped)
- Independent observations
- No extreme outliers

Assumptions for chi-square tests

- Expected frequency in each cell > 1
- No more than 20% of cells < 5
- Random and independent observations

SPSS: One-Sample t-test

Analyze > Compare Means > One-Sample T-Test

- -> Add variable to Test Variable
- -> Enter test value
- -> Click OK

SPSS: Independent Samples t-test

Analyze > Compare Means > Independent-Samples T-Test

- -> Test Variable: your measurement
- -> Grouping Variable: your two groups
- -> Define groups -> OK

SPSS: Paired Samples t-test

Analyze > Compare Means > Paired-Samples T-Test

- -> Pair: before and after (e.g. weight1, weight2)
- -> Click OK

SPSS: One-Sample Chi-Square

Analyze > Nonparametric Tests > Legacy Dialogs > Chi-Square

-> Add variable -> Choose 'All categories equal' or enter expected values

SPSS: Pearson's Chi-Square

Analyze > Descriptive Statistics > Crosstabs

- -> Add row + column variable
- -> Click Statistics > Chi-Square
- -> Cells > column % -> OK

SPSS: McNemar's Chi-Square

Analyze > Nonparametric Tests > Legacy Dialogs > 2 Related Samples

-> Use McNemar for paired categorical variables (e.g. before vs after)

Institute of Psychiatry, Psychology and Neuroscience



Module Title: Introduction to Statistics

Session Title: Lecture Knowledge Quiz 4 - Solutions

Topic title: Comparing groups I (parametric methods)

Lecture Progress Quiz 4

Welcome to the Topic 4 Knowledge Quiz

This quiz is made up of 5 multiple choice questions and a bonus question.

You have are given 10 mins to complete the quiz. The quiz is timed and you will not be able to answer a question after the time has ended.

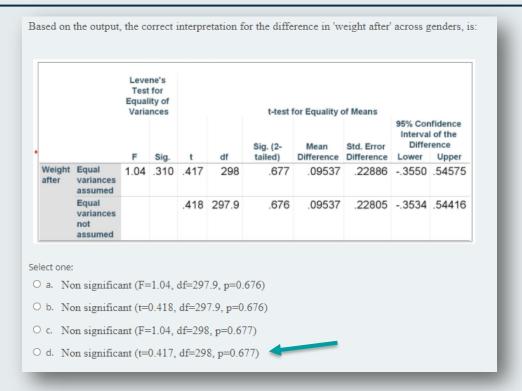
The quiz has free navigation and you can move between the questions using the navigation pane to your left.

A researcher wants to study the difference in 'weight' (in kg), across genders. Which is the appropriate test to use?

Select one:

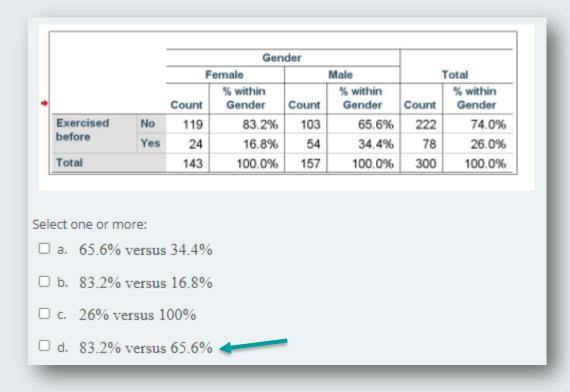
- One sample t-test
- b. Independent samples t-test
- O c. McNemar test
- O d. Paired samples t-test

As the weight (kg) is a numerical continuous variable, and we are comparing two independent groups (male and female) the only suitable test among the listed ones is the independent samples t-test, provided that the assumptions of the test are satisfied.



We first check the Levene's test under the null hypothesis of the group variances being equal. As the p-value is >0.05 we do not reject the null hypothesis and allow to assume equal variances.

From the top line of the output we get a non significant result (t=0.417, df=298, p=0.677) and we can conclude that there is no statistically significant difference in the mean weight (kg) between these two gender groups.



The % have been computed by column (they add up to 100% by column) and we need to compare by row (as we never compare % that add to 100%). The only correct response is 83.2% versus 65.6%.

Based on the output for the association between exercise 'before' and 'after', the correct interpretation is:

	Exercised after						
		No		Yes		Total	
		Count % of Total		Count	% of Total	Count	% of Total
Exercised before	No	119	39.7%	103	34.3%	222	74.0%
	Yes	48	16.0%	30	10.0%	78	26.0%
Total		167	55.7%	133	44.3%	300	100.0%

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	1.473 ^a	1	.225		
Continuity Correction ^b	1.169	1	.280		
Likelihood Ratio	1.484	1	.223		
Fisher's Exact Test				.236	.140
Linear-by-Linear Association	1.468	1	.226		
McNemar Test				.000°	
N of Valid Cases	300				

- a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 34.58.
- b. Computed only for a 2x2 table
- c. Binomial distribution used.

Select one:

- O a. The percentage of those exercising 'before' is different than that of those exercising 'after' (26% vs 44.3%, Pearson Chi Squared=1.473, df=1, p=0.226)
- O b. The percentage of those exercising 'before' is different than that of those exercising 'after' (26% vs 44.3%, McNemar p<0.001)
- Oc. The percentage of those exercising 'before' is not different than that of those exercising 'after' (39.7% vs 16%, Pearson Chi Squared=1.473, df=1, p=0.226)
- $^{\circ}$ d. The percentage of those exercising 'before' is not different than that of those exercising 'after' (16.0% vs 34.3% , Fisher's exact p=0.236)

We are comparing paired categorical data (before and after), with the assumption of discordant cells <25 not violated.

The percentage of those exercising 'before' is different than that of those exercising 'after' (26% vs 44.3%, McNemar p<0.001)

Based on the output for the association between 'ethnicity' and 'gender', the correct interpretation is:

Ethnicity * Gender Crosstabulation

		Gender						
		Female		N	Male		Total	
		Count	% within Ethnicity	% within Count Ethnicity		Count	% within Ethnicity	
Ethnicity	White	53	42.7%	71	57.3%	124	100.0%	
	Black	44	49.4%	45	50.6%	89	100.0%	
	Asian	46	58.2%	33	41.8%	79	100.0%	
	Other	0	0.0%	8	100.0%	8	100.0%	
Total		143	47.7%	157	52.3%	300	100.0%	

Chi-Square Tests

		Value	df	Asymptotic Significance (2-sided)
	Pearson Chi-Square	12.136 ^a	3	.007
•	Likelihood Ratio	15.219	3	.002
	Linear-by-Linear Association	.801	1	.371
	N of Valid Cases	300		

a. 2 cells (25.0%) have expected count less than 5. The minimum expected count is 3.81.

Select one:

- a. All of the above
- O b. Among women, those who classified themselves as Asian had significantly highest percentage (58.2%; Pearson chi-squared=12.136, df=3, p=0.007)
- $^{\circ}$ c. Among Asian people, the percentage of women was significantly higher than men (58.2% vs 41.8%, Pearson chi-squared=12.136, df=3, p=0.007)
- O d. None of the above

Option c would have been a correct interpretation but we see under the table that the Pearson chi-squared assumptions are violated and therefore none of the options is correct (we will learn in the next topic that a different test is suitable for such cases).