Inputs for Power Analysis: Literature Review

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Learning Objectives

Identify the inputs for power or sample size analysis.

Describe how to search the literature for inputs.

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UNDERSTAND KEY INPUTS

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To design a study, specify four types of information

1. Design
2. Statistical test
3. Criterion
4. Five key inputs for power or sample size analysis

Kreidler et al., 2013
Munjal et al, 2013

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Some inputs for power analysis are derived from the experimental setup

1. Design
2. Statistical test
3. Criterion
4. Five key inputs for power or sample size analysis

Kreidler et al., 2013
Munjal et al, 2013

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Other inputs for power analysis are collected from external sources

1. Design
2. Statistical test
3. Criterion
4. Five key inputs for power or sample size analysis

Kreidler et al., 2013
Munjal et al, 2013

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To perform calculations, specify the design, test, criterion, and inputs

Design describes the experiment.

Power, and thus sample size, depends on the choice of statistical test.

Criterion can be power or sample size.

Inputs provide information about the expected results of the experiment.

Kreidler et. al., 2013
Munjal et. al, 2013

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Study design involves five inputs

1. Clustering
2. Predictors
3. Covariates
4. Repeated measures
5. Response

Kreidler et al., 2013
Munjal et al, 2013

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Depending on the planned analysis, there are multiple statistical tests

Multivariate approach to repeated measures tests

1. Hotelling-Lawley Trace
2. Pillai-Bartlett Trace
3. Wilks' Lambda
4. Roy's largest root

Univariate approach to repeated measures tests

5. Uncorrected
6. Box
7. Geisser-Greenhouse
8. Huynh-Feldt

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An analyst needs to specify a computational target

GLIMMPSE supports a computational target of power or sample size.

Choosing a specific sample size allows computing power.

Choosing a specific power allows computing a sample size.

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Specifying the smallest group size implies the total sample size

Examples:

In a 1:1 randomization, if the smallest group size is 10, then the total sample size is 20.

In a 2:1 randomization design, if the smallest group size is 10, then the total sample size is 30.

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Five key inputs are needed for power or sample size analysis

1. Predictors in model
2. Hypothesis
3. Hypothesized means and slopes (may suffice to specify only the differences)
4. Hypothesized standard deviations and correlations among measurements
5. Desired Type I error

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The last three inputs are numeric

1. Predictors in model Hypothesis
2. Hypothesis
3. Hypothesized means and slopes (may suffice to specify only the differences)
4. Standard deviations and correlation between measurements
5. Desired type I error

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In this lecture we will focus on reviewing the literature review to find values for the key numeric inputs of means, standard deviations, and correlations

Literature review is the systematic collection and examination of past research studies relevant to the present scientific goal.

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UNDERSTAND HOW TO SEARCH LITERATURE FOR NUMERIC INPUTS

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Literature review can help estimate unknown key numeric inputs for power and sample size calculation

Frequently unknown numeric inputs:

- Standard deviations
- Correlations between measurements
- Scientifically meaningful detectable difference

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Literature review can also reveal standards for desired power

Standards may vary by field of study.

Power values of 0.80 are common.

We usually recommend 0.90 or 0.95.

The choice depends on ethical and scientific considerations.

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Literature review can also reveal standards for Type I error

Standards may vary by field of study.

Type I error is often set to 0.05.

Sometimes, Type I error is set to 0.01.

Bonferroni corrected Type I errors may be much smaller.

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Plan your literature review and document your progress

Identify questions of interest, such as unknown correlations or standards of design in a given field.

Be careful to not reuse an inappropriate design or analysis, such as ignoring clustering.

Identify search terms.

Example: field of study + study design

Search for selected terms.

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Carefully document the results of your search

You may choose to estimate inputs based on a group of studies in your field of research or one highly representative study.

Study	Author	Title	Field of study	Study design	Standard deviation	Correlation between measurements		
						3 months apart	6 months apart	12 months apart
1	Logan *et al.*	...	Pain recall	Longitudinal	0.98		Slightly higher than 0.4	0.4
2	...	...	Pain recall	Longitudinal	0.87	...	...	...
3	...	...	Pain recall	Longitudinal	1.02	...	...	...

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We show an example literature review summary for numeric inputs

Vignette

Researchers propose a randomized controlled trial to compare pattern of weight gain over pregnancy for two treatment groups. The trial will enroll pregnant women at risk of gestational diabetes.

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Vignette

The women will be randomized to either a dietary intervention designed to prevent excess weight gain, or to the standard of care. Weight will be measured at 6 time points during pregnancy.

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Vignette

Analysis plan: repeated measures analysis of variance

Null: No difference in pattern of weight gain for two groups.

Planned test: Hotelling-Lawley test

Type I error rate: 0.05

Covariate: pre-pregnant BMI

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After finding relevant studies, summarize key inputs found in each

Study	Trt. Group ($\bar{X}$, SE in kg)	Control Group ($\bar{X}$, SE in kg)	N (treat/ control)	Treatment
Quinlivan *et al.* (2007)	7 (0.65)	13.8 (0.67)	63/61	Continuity of care + weight tracking + 5 min diet counseling + mental health assessment
Wolff *et al.* (2008)	6.6 (1.1)	13.3 (1.4)	23/27	10 (1hr) diet consults throughout pregnancy
Thornton *et al.* (2007)	5.0 (0.6)	14.06 (0.7)	116/116	1 visit with RD + daily food log throughout pregnancy

Note: Standard error, not standard deviation. Always determine which you have.

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Summarize unpublished data from one of your own similar studies

The unpublished study provided an estimate of correlations between measurements.

Correlations are rarely published, which makes estimating correlations for power analysis difficult.

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Summarize unpublished data from one of your own similar studies

	HS obese women Mean (SD)
Pre-pregnant weight (kg)	95.23 (16.76)
Last weight (kg)	105.05 (17.65)
Correlation	0.87
Predicted weight for 39 weeks (kg)	106.22 (17.50)
Correlation	0.89

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Notice that there are multiple means and standard deviations in the table

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To account for uncertainty in the power and sample size calculation, a researcher may:

Use a power curve.

Consider many different values of mean differences close to the expected difference.

Consider different values of standard deviation.

Use the experimental situation to guide the choice of a conservative or liberal estimate.

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The next several images show how to incorporate uncertainty from estimates in power curves

One can draw several curves, one for each variance estimate.

For a given power, one can look at the range of mean differences one could detect for difference variance estimates.

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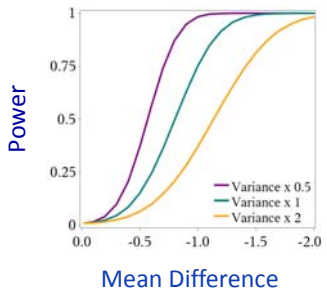
Accounting for uncertainty



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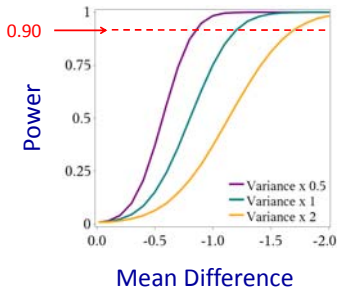
Accounting for uncertainty



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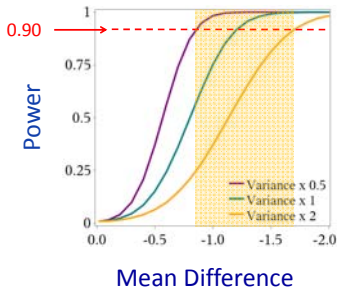
Accounting for uncertainty



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Be careful about using published numbers

One previous table included standard errors, and one included standard deviations.

Standard errors are smaller, standard deviations are larger.

Power analysis will be wrong if one mistakes standard errors for standard deviations, or vice versa.

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Review Summary

- The literature review can help estimate unknown key numeric inputs for power and sample size calculation
- Plan your literature review and document your progress
- Make sure to account for uncertainty of the estimates you find for the power and sample size calculation

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