

This document contains screenshots for the power analysis for Homework 1.

- Click the “New Study” button to start a new power and sample size analysis.
- or
- Click the “Upload” button to upload a json file with a previous study design that you have saved.

◆ GLIMMPSE

General Linear Mixed Model Power and Sample Size

Design a Study

Welcome to GLIMMPSE. The GLIMMPSE software calculates power and sample size for study designs with normally distributed outcomes. Select one of the options below to begin a power or sample size calculation.

New Study

Start a new design.

Upload

You have previously used GLIMMPSE and wish to work on a saved design.

For a new study: Add title here

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module1: Study title

Progress  Help  Save  Home 

Please pick a concise title for the study:

module1



Click the “Power” or “Sample Size” button depending on what you want to solve for. In this case, we are solving for power.

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module1: Solve for

Progress  Help  Save  Home 

Please indicate whether you would like to solve for power or total sample size.

If you have a rough idea of the number of research participants you will be able to recruit, then solve for power.

If you have few restrictions on recruitment then you may wish to solve for sample size.

Power

Sample Size



We now move to select the hypothesis test of interest. Thus, we click the Hotelling-Lawley trace.

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module1: Statistical tests

Progress  Help  Save  Home 

Please choose one or more statistical tests. If you are unsure which to pick, we recommend the Hotelling Lawley Trace test due to its equivalence to a mixed model test.

- Hotelling Lawley Trace
- Pillai-Bartlett Trace
- Wilks Likelihood Ratio
- Box Corrected
- Geisser-Greenhouse Corrected
- Huynh-Feldt Corrected
- Uncorrected



Now we choose the Type I error rate. Type in 0.05.

Then, we click the plus sign to add this value to the design.

A Type I error occurs when a scientist declares a difference when none is present in the population. The Type I error rate is the probability of that kind of error, a false positive, and is often referred to as α (alpha). A Type I error rate can range from 0 to 1. Although the most commonly used value is 0.05, we recommend 0.01.



Type I Error Rate

remove

0.05



Enter outcome variables here.

Then, click the plus sign to add the outcome entered to the design.

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module1: Outcomes

Progress  Help  Save  Home 

Enter the name of each outcome variable one at a time in the underlined space below. For example, in a study investigating cholesterol-lowering medication, the outcome variables could be HDL, LDL, and total cholesterol.

Note that repeated measurement information will be addressed on the next screen.

Please name the one or more outcomes.



Outcome

remove

Post-treatment drinking



Click the “Levels” button to add the levels of the design.

Here, the workplace is the independent sampling unit, or cluster.

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module1: Clustering

Progress  Help  Save  Home 

What term would you like to use for the independent sampling unit in the study? (For example, school.)

All levels of clustering are nested within the independent sampling unit.

workplace

Cancel Next: Levels

For this example, the worker is the study participant.

There are 15 workers per cluster.
Remember to click the plus sign to add the value entered

Name each level of clustering within the independent sampling unit, and specify the number of elements each level (e.g. level 1 class has 5 members; level 2 student has 22 members):

The sample size in this study is **N** workplace(s).

Clustering level name:

Number of elements:

worker

15



Elements must be an integer between 2 and 10000 (inclusive)

Click on the pen icon to
"Remove/Edit" as needed.

| Level Name | No. Elements | Remove/Edit |
|------------|-------------------------|-------------|
| workplace | N workplace(s) in study | |

Cancel Back Update clustering

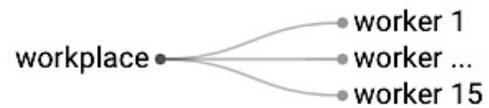
This screen shows the structure and levels of clustering.

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module1: Clustering

Progress  Help  Save  Home 



Levels of clustering within independent sampling unit workplace:

| Level Name | No. Elements |
|------------|--------------------------------|
| workplace | N workplace(s) in study |
| worker | 15 worker(s) in each workplace |

Remove Clustering

Edit Clustering

Enter the predictor and then define the data type.

The predictor name is treatment.

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module1: Fixed predictors

Progress  Help  Save  Home 

Please name the predictor:

treat

Cancel Next: Data Type

2

1

After defining the type of data, click the “Groups” button to add the groups considered in the study.

module1: Fixed predictors

Progress  Help  Save  Home 

What type of data is treat?

Nominal

Continuous

Cancel

Back: Data Type

Next: Groups

This screen shows the groups in the study.
Here, treatment has two levels: Workplace Training Program and Control Group.

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module1: Fixed predictors

Progress  Help  Save  Home 

Please name at least two groups: 

Groups:

 treat_group

 control

Cancel

Back: Type

Update predictor

This screen shows the predictors, type of data, and groups.

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module1: Fixed predictors

Progress  Help  Save  Home 

Each independent sampling unit has one or more observations which are statistically independent from observations from any other unit.

GLIMMPSE allows you to define fixed predictors which divide the independent sampling unit into groups. One common example of a fixed predictor is treatment, with values placebo and drug, for which the independent sampling unit is randomized to a placebo group or a drug group. Another is gender, with values male or female.

If the design has no fixed predictors, do not define any here.

Define Fixed Predictor

Fixed Predictors

| Name | Type | Units | Groups | Remove | Edit |
|-------|---------|-------|------------------------------|---|---|
| treat | NOMINAL | | ["treat_group", "control"] |  |  |

Select the option "No Gaussian Covariate" for this example.

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module1: Variability due to the gaussian covariate

Progress  Help  Save  Home 

A common experimental design is an analysis of covariance, which includes one or more fixed predictors and one or more continuous control variables, the "covariates." For example, one might run an experiment with 10 males and 10 females, with an indicator variable for gender as a fixed predictor and age as a covariate.

A common special case uses a series of repeated measurements on a continuous outcome. The first measurement, observed prior to treatment, is used as a baseline covariate. The other repeated measurements are outcomes in the general linear multivariate model.

GLIMMPSE can calculate power for hypotheses concerning the fixed predictors, optionally controlling for a single normally distributed covariate. If you plan to include a single normally distributed covariate in your model, use the switch below.

At present, the GLIMMPSE software does not calculate power for multiple normally distributed covariates nor non-normally distributed covariates.

No Gaussian Covariate

Gaussian Covariate

Select the option “Main Effect” for this example because we are interested in the main effect of treatment.

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module1: Hypothesis choice

Progress  Help  Save  Home 

Each power or sample size calculation is based on selecting a specific study hypothesis. The options below show the hypotheses which are available for the current study design. Specify the hypothesis that represents your scientific question.

GLIMMPSE chooses sensible contrast matrices based on cell means coding. Should you wish to define your own contrast matrices, pick the highest order interaction and choose from the advanced options in the hypothesis components.

Select a hypothesis from the list.

| | Effects Available for Consideration | Nature of Variation |
|----------------------------------|-------------------------------------|---------------------|
| <input checked="" type="radio"/> | treat: Main Effect | Between |
| <input type="radio"/> | Grand Mean | Between |

Specify means for:

Factors in Hypothesis All Factors

In this example, “All mean differences zero” was selected to indicate the type of contrast desired.

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module1: Between hypothesis

Progress  Help  Save  Home 

What type of contrast do you wish among the levels of the between predictors?

All mean differences zero

A parameter is a characteristic of a population. The parameters of interest are the group means.

The null hypothesis is that all pairwise differences between group means are the same.

Show Advanced Options



This screen gives you the option to select a value different than zero for the contrast comparison constant.

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module1: Theta 0

Progress  Help  Save  Home 



A hypothesis compares parameters to a constant, the contrast comparison constant, θ_0 . This is almost always zero. If you choose a value other than zero, be sure that you understand that the hypothesis you define is scientifically meaningful. Also note that the description and interpretation of your hypothesis given when choosing your contrasts will be affected.



Add smallest group size here.

We enter 20 to indicate that there are 20 workplaces randomized to treatment, and 20 randomized to control. There are a total of 40 workplaces in the study.

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module1: Smallest group size

Progress  Help  Save  Home 

Enter the number of independent sampling units in the smallest group in the study. You may enter multiple values for the smallest group size in order to consider a range of total sample sizes.

If you wish to consider fractional group sizes, specify an appropriate integer here and use fractional relative group size values.

Would you like to add another smallest group size?



Smallest Group Size

remove

20



Add the ratio between groups here.

There are two randomization groups, each of equal size.

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module1: Group size ratios

Progress  Help  Save  Home 

For equal group sizes, input a "1" in the block next to each group. This is the default study design.

For unequal group sizes, specify the ratio of the group sizes. For example, consider a design with an active drug group and a placebo group. If twice as many study participants receive the placebo, a value of "2" would be selected for the placebo group, and a value of "1" would be selected for the active drug group.

Group size ratios

| | | |
|-------|-------------|---|
| treat | treat_group | 1 |
| | control | 1 |



Add the mean values per group here.

We enter the means for the workplace training program and the control group separately.

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module1: Marginal means

Progress  Help  Save  Home 

The table below shows the mean values for outcome **Post-treatment drinking** within each group in the study. Each group is represented by a row in the table.

Enter the mean values you expect to observe for outcome **Post-treatment drinking** within each group. The table should contain at least one value that is non-zero. Also, at least two groups should have means which differ by a scientifically meaningful amount.

Expected mean values, per group, for *Post-treatment drinking*

| | |
|-------------|------|
| treat_group | 0.73 |
| control | 1.24 |

Set blank values to value



We could enter scale factors for means to consider other options for mean differences on this screen. Since we have the values from the literature, we are fairly confident, and put in 1 here.

In power analysis, it is not possible to know the exact values of means before the experiment is observed. Scale factors allow you to consider alternative values for the means by scaling the values entered on the previous screen. For example, entering the scale factors 0.5, 1, and 2 would compute power for the mean values divided by 2, the mean values as entered, and the mean values multiplied by 2.



Enter a scale factor:



Scale Factor

remove



Here, we enter the within-participant standard deviation as 1.1.

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module1: Variability across outcomes

Progress  Help  Save  Home 

Enter the standard deviation you expect to observe for each outcome.

| Outcome | Standard Deviation |
|-------------------------|--------------------|
| Post-treatment drinking | 1.1 |



Enter the intra-class correlation here.

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module1: Intra-class correlation

Progress  Help  Save  Home 

Define the intra class correlation for cluster workplace

The correlation within level **worker** must be a number between $-0.071 < r < 1$



Given our literature review, we are fairly confident, and decide to do the power calculation with the numbers we have. Thus, we enter 1.

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module1: Scale factor variance

Progress  Help  Save  Home 

Changes in variability can dramatically affect power and sample size results. It is not possible to know the variability until the experiment is observed. Scale factors allow you to consider alternative values for variability by scaling the calculated covariance matrix. For example, entering the scale factors 0.5, 1, and 2 would compute power for the covariance matrix divided by 2, the covariance matrix as entered, and the covariance matrix multiplied by 2.

You may add up to 10 scale factors.

Choose a number greater than zero



Scale Factor

remove

1



For this example, we don't need to specify the confidence intervals.

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module 1: Confidence intervals

Progress  Help  Save  Home 



If the means (\mathbf{B}) or the error covariance (Σ_e) are sample estimates, then the power values produced from these matrices will be random quantities. To account for this randomness, GLIMMPSE can calculate confidence intervals for power values using the techniques described by Taylor and Muller (1995), Gribbin et al. (2013), and Park (2007).



Include Confidence Intervals

When we hit the "Calculate" button, the results are shown in the power results table.

Calculate

Download result

Results Matrices Design

| | |
|-------------------------|---|
| Design | ✓ |
| Hypothesis | ✓ |
| Design Dimensions | ✓ |
| Parameters | ✓ |
| Optional Specifications | ✓ |

Clicking the "Matrices" tab gives the matrices used for the calculation.

We can save results and study design inputs by using the “Save” button. The file labeled Homework1.json contains the design, which you can upload using the upload button if you want to reproduce the power analysis.

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module 1: Calculate

Progress

Help ?

Save ↓

Home 🏠

Calculate

Download result

Results

Matrices

Design

| Power | Total Sample Size | Means Scale Factor | Variability Scale Factor | Test | Power Method | Type I Error Rate |
|-------|-------------------|--------------------|--------------------------|------------------------|--------------|-------------------|
| 0.909 | 40 | 1 | 1 | Hotelling Lawley Trace | conditional | 0.05 |

In case you are interested, here are the matrices used for the calculation.

$$Es(\mathbf{X}) = \begin{bmatrix} 1.00 & 0.00 \\ 0.00 & 1.00 \end{bmatrix}$$

$$\mathbf{B} = \begin{bmatrix} 0.730 \\ 1.24 \end{bmatrix}$$

$$\mathbf{C} = [1.00 \quad -1.00]$$

$$\mathbf{U} = [1.00]$$

$$\begin{aligned} \Sigma_* &= (\mathbf{U}'_o \Sigma_o \mathbf{U}_o) \otimes (\mathbf{U}'_r \Sigma_r \mathbf{U}_r) \otimes (\mathbf{U}'_c \Sigma_c \mathbf{U}_c) \\ &= [1.21] \otimes [1.00] \otimes [0.188] = [0.227] \end{aligned}$$

$$\Theta_0 = [0.00]$$

$$\alpha = 0.05$$

$$\Theta = [-0.510]$$

$$\mathbf{M} = [2.00]$$

$$\nu_e = 38$$

No. of replicated rows in design matrix: 20

$$Es(\Delta) = [0.130]$$

For notation details, please see

1. Glueck DH, Muller KE. Adjusting power for a baseline covariate in linear models. *Statistics in Medicine*. 2003;22:2535-2551.
2. Muller KE, Stewart PW. *Linear Model Theory: Univariate, Multivariate, and Mixed Models*. Hoboken, NJ: Wiley; 2006.