Sample Size Determination with Examples using Sample Size Calculator (web)

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Outlines

- Introduction
- General health research:
  - One sample (mean, proportion)
  - Two independent samples (means, proportions) and paired (means, proportions)
  - Correlation, regressions (linear, binary logistic)
- Validation:
  - Exploratory and Confirmatory Factor Analyses
  - Structural Equation Modeling
  - Reliability: Cronbach's alpha
  - Agreement: Intraclass-correlation and Kappa coefficients
  - Sensitivity & Specificity

Software used

- Sample Size Calculator (web)

  https://wnarifin.github.io/ssc_web.html

Introduction

Why calculate?

- An important part of a research design & plan
- Determines:
  - ✓ Number of participants
  - ✓ Funding
  - ✓ Feasibility
  - ✓ Validity

Steps toward calculation

(1) Define the research **objective**

(2) Decide on the suitable **statistical analysis**

(3) Determine the **sample size**

Define objective

- Clearly define objective
- Outcome (dependent variables)?
- Predictors (independent variables)?
- Measurable

Statistical analysis

- Choose suitable statistical analysis based on:
  - objective itself – compare, estimate, correlate, validate ...
  - the scale of outcome & predictors
  - sample – independent / dependent
- Examples:
  - Independent *t*-test for ...
  - Chi-squared test for ...
  - Linear regression for ...
  - Logistic regression for ...

Sample size formula

- Choose suitable sample size formula / method
- Based on objective & chosen statistical analysis
- Estimation vs Hypothesis Testing
- Examples:
  - Confidence interval – estimation
  - Comparison of means – hypothesis testing

General

One mean

(1) Objective:

- Estimate mean of numerical outcome in a population e.g. BMI, weight etc
- "This study aims to estimate mean BMI among UiTM students."

One mean

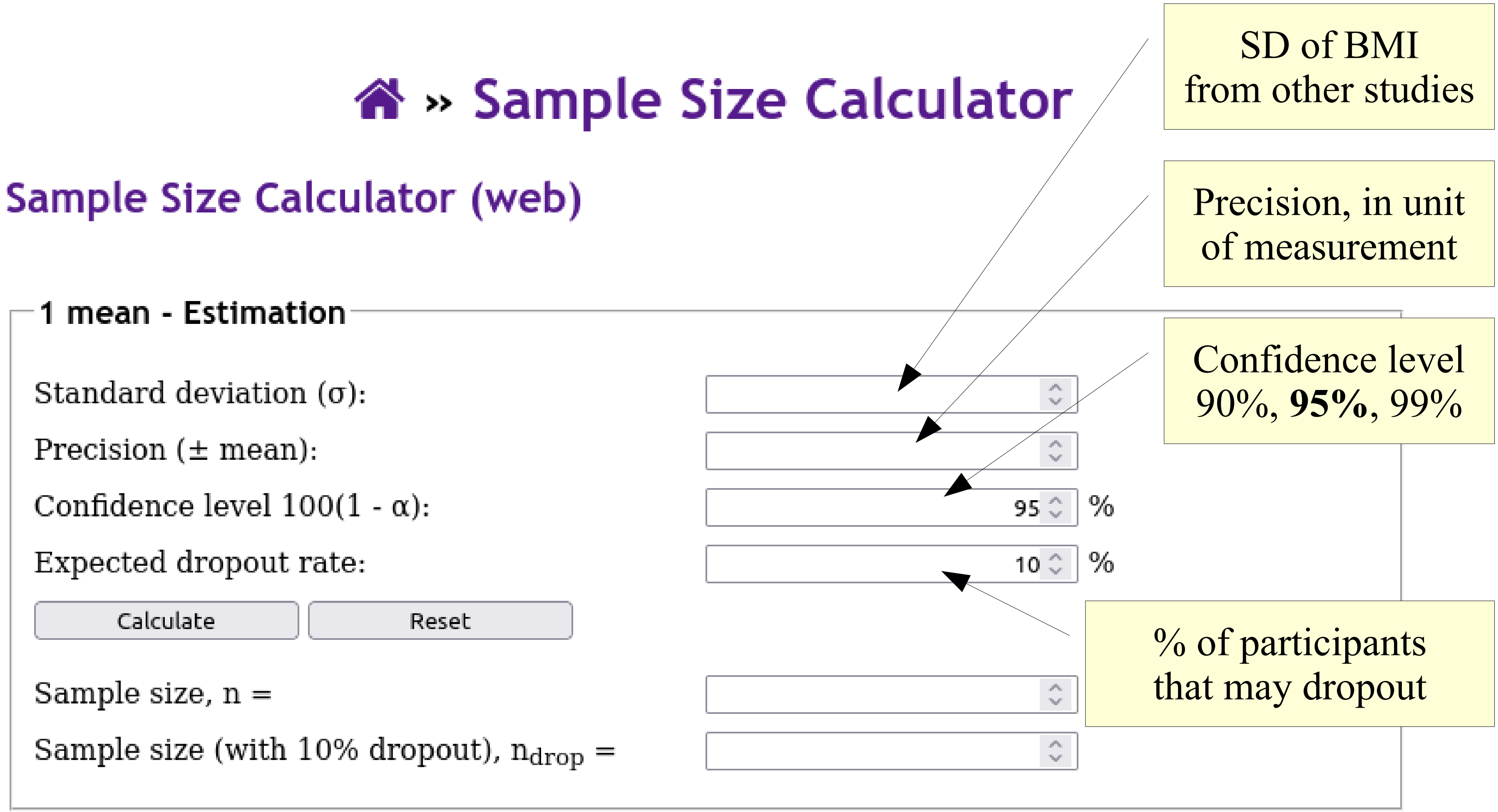
(2) Statistical analysis:

- Mean, 95% Confidence Interval (CI)

(3) Sample size method:

- Single mean – Estimation

1. Means → Single Mean → 1 mean – Estimation



One mean

- Let say:
  - SD of BMI = 7.5kg/m^2
  - Precision = 1kg/m^2
  - 95% Confidence level
  - 20% dropout
- How many UiTM students should we sample?

One mean

Sample Size Calculator

Sample Size Calculator (web)

1 mean - Estimation

Standard deviation (σ):	7.5
Precision ($\pm$ mean):	1
Confidence level $100(1 - \alpha)$:	95 %
Expected dropout rate:	20 %

Calculate | Reset

Sample size, n =	217
Sample size (with 20% dropout), n_{drop} =	272

One mean

- We have to sample 272 students to estimate mean BMI among UiTM students, with mean BMI ± $1kg/m^2$, taking into account a 20% dropout rate.

One proportion

(1) Objective:

- Estimate % or proportion of categorical outcome in a population e.g. obesity, diabetes etc
- "This study aims to estimate prevalence of obesity among UiTM students."

One proportion

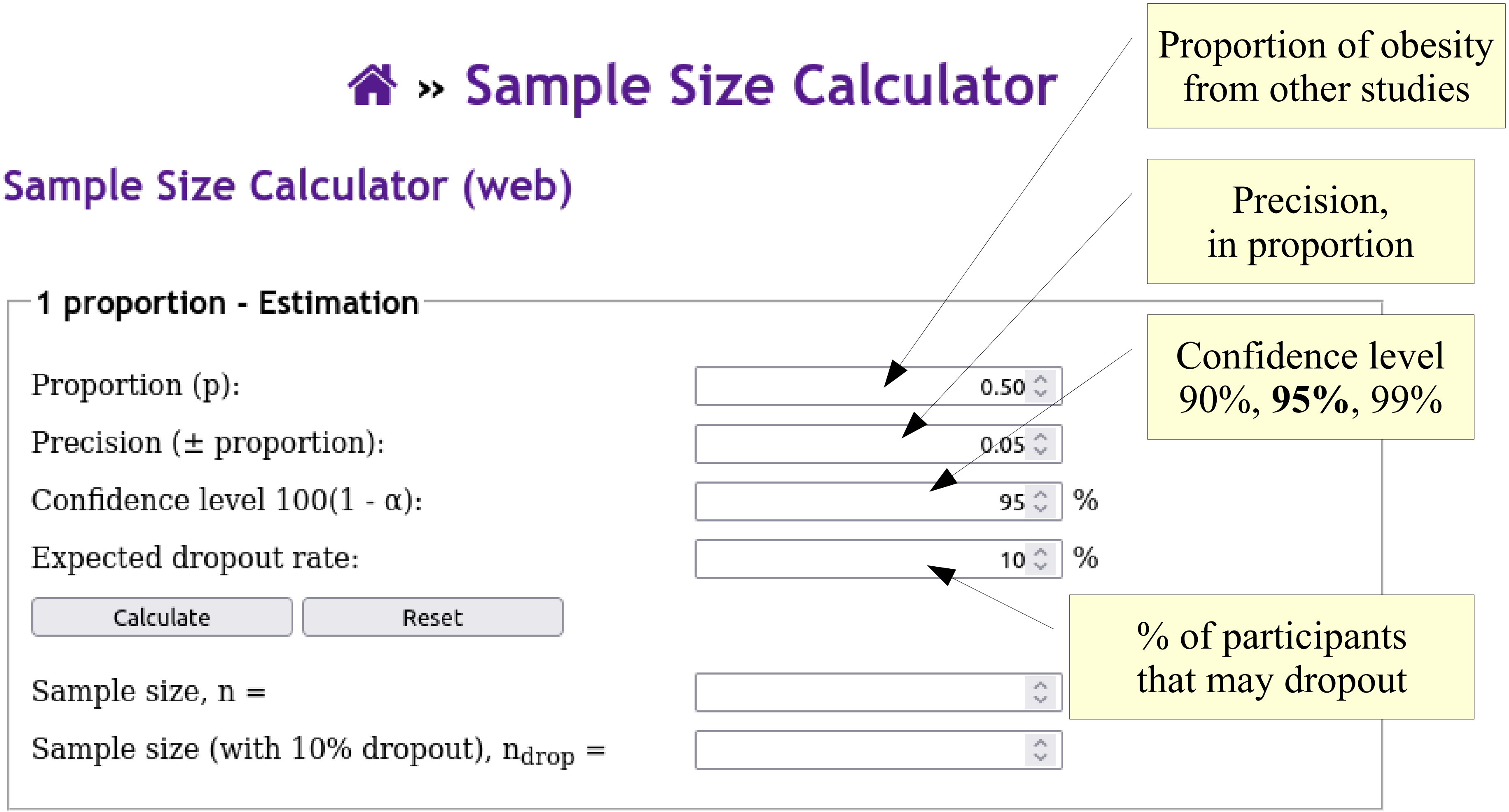
(2) Statistical analysis:

- Proportion, 95% Confidence Interval (CI)

(3) Sample size method:

- Single proportion – Estimation

2. Proportions → Single proportion → 1 proportion – Estimation



One proportion

- Let say:
  - Prevalence of obesity = 25% = 0.25 (in proportion).
  - Precision = ±5% = 0.05 (in proportion).
  - 95% Confidence level.
  - 10% dropout (i.e. those who won't let you measure their weight and height).
- How many UiTM students should we sample?

One proportion

» Sample Size Calculator

Sample Size Calculator (web)

1 proportion - Estimation

Proportion (p):	0.25
Precision (± proportion):	0.05
Confidence level 100(1 - α):	95 %
Expected dropout rate:	10 %

Calculate | Reset

Sample size, n =	289
Sample size (with 10% dropout), n_{drop} =	322

One proportion

- We have to sample 322 students to estimate prevalence of obesity among UiTM students, with % of obesity ± 5%, taking into account a 10% dropout rate.

Two means

(1) Objective:

- Compare means of a numerical outcome in two populations e.g. BMI, weight etc
- "This study aims to compare mean BMI between 1st and final year students."

Two means

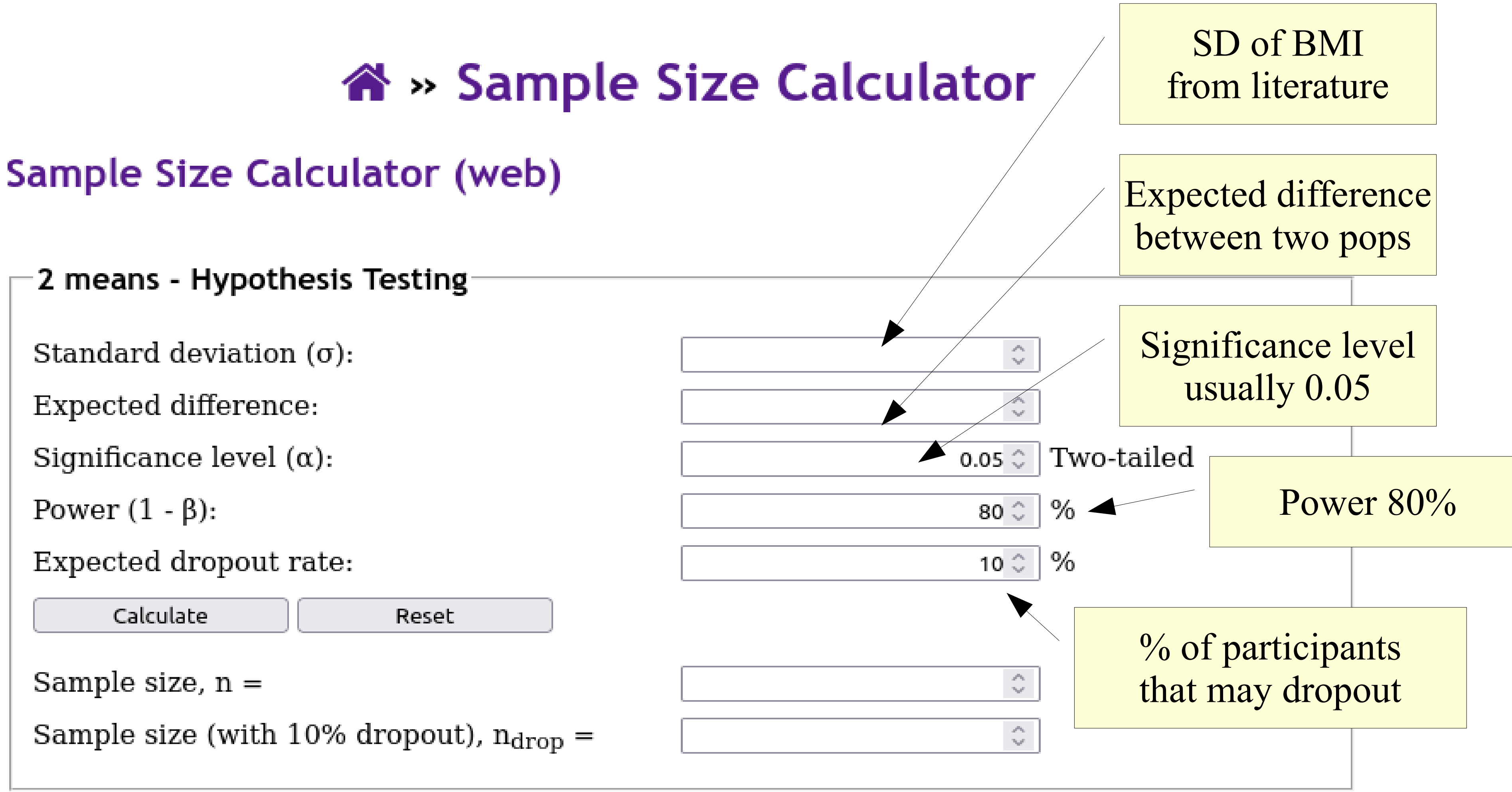
(2) Statistical analysis:

- Independent t-test

(3) Sample size method:

- Two means – Hypothesis testing

1. Means → Two-mean comparison (independent) → 2 means – Hypothesis Testing



Two means

- Let say:
  - Largest SD you could find from literature = 1.5
  - Expected Difference = 1 unit.
  - Significance level = 5% (0.05)
  - Leave Power = 80% – default value.
  - 30% dropout (i.e. as some weight themselves while only one foot was on the scale).
- How many students per group should we sample?

Two means

» Sample Size Calculator

Sample Size Calculator (web)

2 means - Hypothesis Testing

Standard deviation (σ):	1.5	
Expected difference:	1	
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	30	%

Calculate Reset

Sample size, n =	36
Sample size (with 30% dropout), n_{drop} =	52

Two means

- We have to sample 52 1st year students and 52 final year students to make the comparison, expecting a difference of 1 unit BMI between the two, taking into account a 30% dropout rate.

Two proportions

(1) Objective:

- Compare % or proportion of categorical outcome in two populations e.g. obesity, diabetes etc
- "This study aims to compare prevalence of obesity between 1st and final year students."

Two proportions

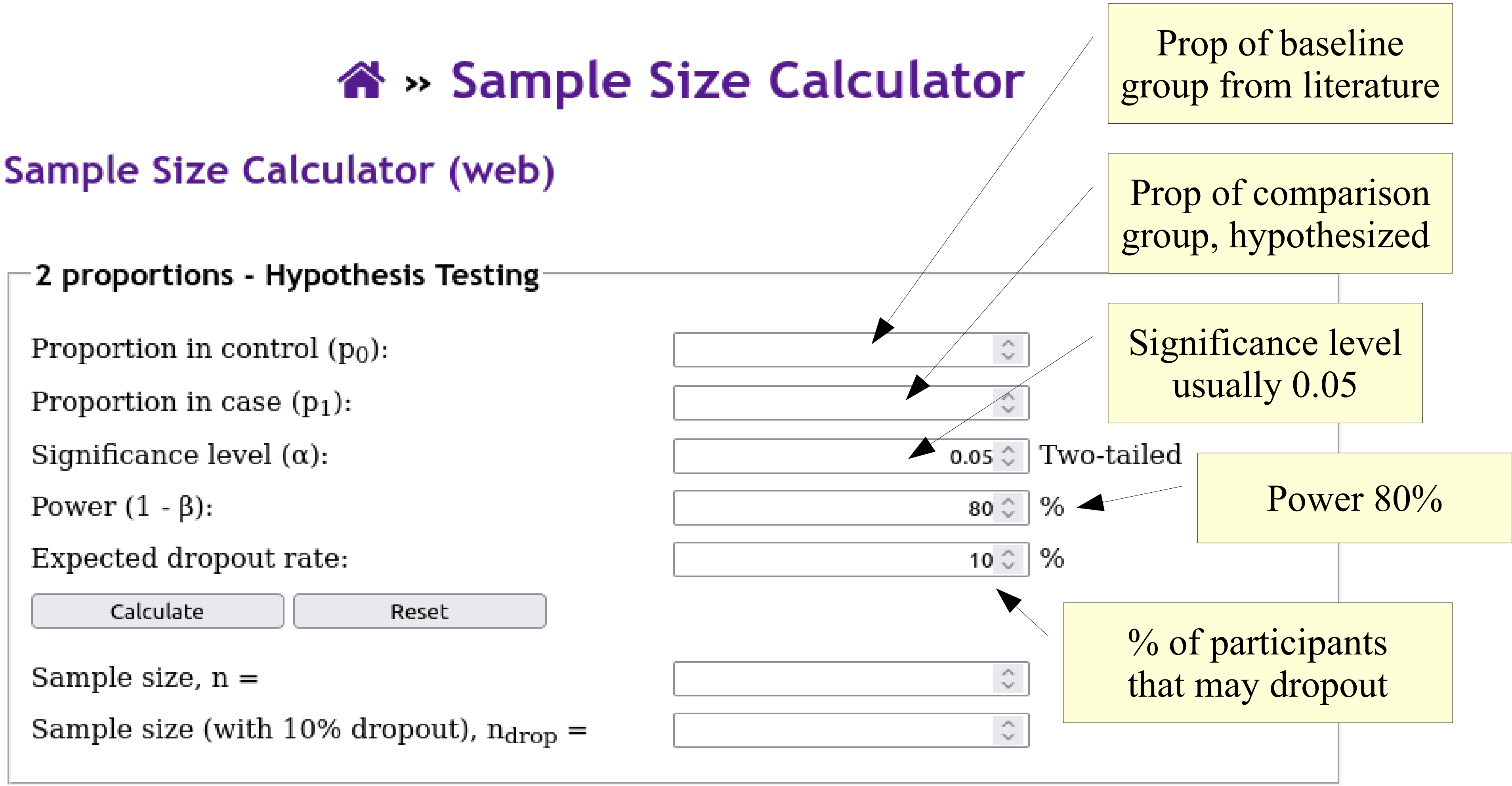
(2) Statistical analysis:

- Chi-squared test

(3) Sample size method:

- Two proportions – Hypothesis testing

2. Proportions → Two-proportion comparison (independent) → 2 proportions – Hypothesis Testing



Two proportions

- Let's say:
  - p_0 = 35% = 0.35 (in proportion) → 1st year students as control.
  - p_1 = 50% = 0.5 (in proportion) → Hypothesized % for final year students.
  - Significance level = 5% (0.05)
  - Power = 80%
  - 10% dropout
- How many students per group should we sample?

Two proportions

» Sample Size Calculator

Sample Size Calculator (web)

2 proportions - Hypothesis Testing

Proportion in control (p_0):	0.35	
Proportion in case (p_1):	0.5	
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Expected dropout rate:	10	%

Calculate | Reset

Sample size, n =	170
Sample size (with 10% dropout), n_{drop} =	189

Two proportions

- We have to sample 189 1st year students and 189 final year students to make the comparison, expecting a difference of 15% for % of obesity between the two, taking into account a 10% dropout rate.

Two means (paired)

(1) Objective:

- Compare means of a numerical outcome in a population, pre-post design e.g. weight before and after intervention
- "This study aims to compare mean weight before and after a weight loss program among students."

Two means (paired)

(2) Statistical analysis:

- Paired t-test

(3) Sample size method:

- Two means (paired) – Hypothesis testing

1. Means → Two-mean comparison (paired) → 2 means (paired) – Hypothesis Testing

Sample Size Calculator (web)

SD difference in weight from literature

Expected difference between pre-post

Significance level usually 0.05

Power 80%

% of participants that may dropout

2 means (paired) - Hypothesis Testing[1,2]

Standard deviation of difference (σ_d)*:

If σ_d not available in literature, use **Standard deviation of difference** calculator below to get an approximate value of σ_d.

Expected difference:

Significance level (α): 0.05 Two-tailed

Power ($1 - \beta$): 80 %

Expected dropout rate: 10 %

Calculate | Reset

Sample size, n =

Sample size (with 10% dropout), n_{drop} =

Two means (paired)

- Let say:
  - SD of difference from literature = 2.5kg
  - Expected Difference = 5kg (post – pre weight)
  - Significance level = 5% (0.05)
  - Power = 80%
  - 20% dropout
- How many students should we sample?

Two means (paired)

» Sample Size Calculator

Sample Size Calculator (web)

2 means (paired) - Hypothesis Testing[1,2]

Standard deviation of difference (σ_d)*:	7.5	
If σ_d not available in literature, use **Standard deviation of difference** calculator below to get an approximate value of σ_d.		
Expected difference:	5	
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	20	%

Calculate | Reset

Sample size, n =	18
Sample size (with 20% dropout), n_{drop} =	23

Two means (paired)

- We have to sample 23 students to make the comparison, expecting 5kg change following the weight reduction program, taking into account a 20% dropout rate.

Two proportions (paired)

(1) Objective:

- Compare % or proportion of a categorical outcome in a population, pre-post design e.g. % vaccine uptake after before and after health promotion
- "This study aims to compare percentage of vaccine uptake among villagers before and after a vaccine awareness campaign."

Two proportions (paired)

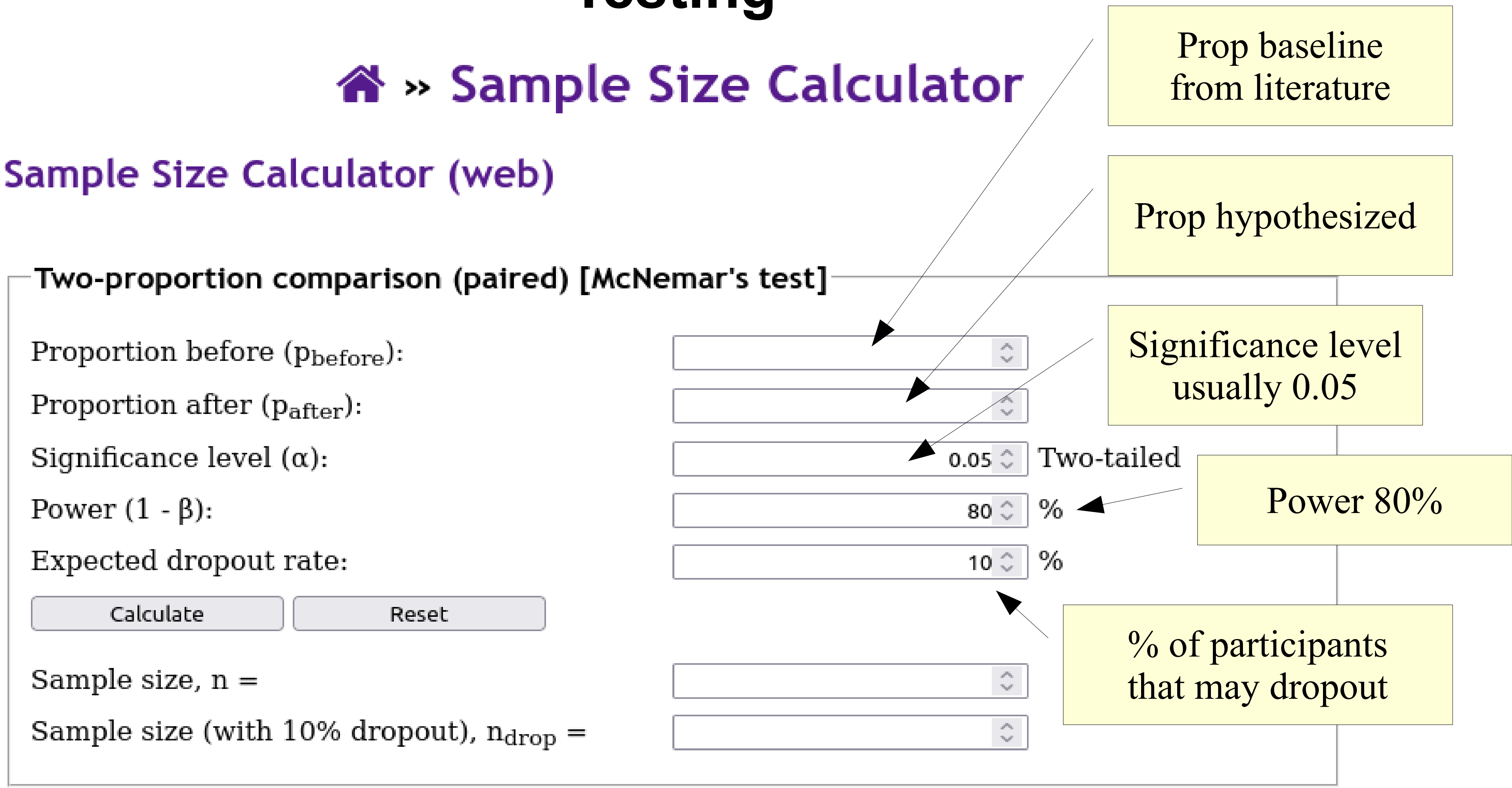
(2) Statistical analysis:

- McNemar's test

(3) Sample size method:

- Two proportions (paired) – Hypothesis testing

2. Proportions → Two-proportion comparison (paired) → 2 proportions (paired) – Hypothesis Testing



Two proportions (paired)

- Let's say:
  - p_{before} = 50% = 0.5 (in proportion) → before campaign
  - p_{after} = 80% = 0.8 (in proportion) → after campaign
  - Significance level = 5% (0.05)
  - Power = 80% (0.8)
  - 10% dropout
- How many villagers should we sample?

Two proportions (paired)

» Sample Size Calculator

Sample Size Calculator (web)

Two-proportion comparison (paired) [McNemar's test]

Proportion before (p_{before}):	0.5	
Proportion after (p_{after}):	0.8	
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Expected dropout rate:	10	%

Calculate Reset

Sample size, n =	42
Sample size (with 10% dropout), n_{drop} =	47

Two proportions (paired)

- We have to sample 47 villagers to make the comparison, expecting 30% change in vaccine uptake following the vaccine awareness campaign, taking into account a 10% dropout rate.

Correlation

(1) Objective:

- Determine correlation between two numerical outcomes e.g. between age and cholesterol level etc
- "This study aims to determine the correlation between age and cholesterol level among lecturers."

Correlation

(2) Statistical analysis:

- Pearson's correlation coefficient

(3) Sample size method:

- Pearson's correlation – Hypothesis testing (H_0: $r = 0$)

3. Pearson's correlation → Hypothesis Testing

» Sample Size Calculator

Sample Size Calculator (web)

Pearson's Correlation - Hypothesis Testing[1]

Expected correlation (r):	0.3	
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Expected dropout rate:	10	%

Calculate | Reset

Sample size, n =	
Sample size (with 10% dropout), n_{drop} =	

Expected r, can be estimated from literature

Significance level usually 0.05

Power 80%

% of participants that may dropout

Correlation

- Let say:
  - Correlation r that you expect, educated guess from literature = 0.55
  - Significance level = 5% (0.05)
  - Power = 80%
  - 30% dropout
- How many lecturers should we sample?

Correlation

» Sample Size Calculator

Sample Size Calculator (web)

Pearson's Correlation - Hypothesis Testing[1]

Expected correlation (*r*):	0.55	
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	30	%

Calculate Reset

Sample size, n =	23
Sample size (with 30% dropout), n_{drop} =	33

Correlation

- We have to sample 33 lecturers to determine the correlation between age and cholesterol level, taking into account a 30% dropout rate.

Multivariable, numerical outcome

(1) Objective:

- Determine associated factors of a numerical outcome, e.g. predictors of cholesterol level etc
- "This study aims to determine the associated factors of cholesterol level among lecturers."

Multivariable, numerical outcome

(2) Statistical analysis:

- Multiple linear regression

(3) Sample size method:

- Rule-of-thumb – 10 subjects per independent variable*
  - n = k x 10

*Norman, G. R., & Streiner, D. L. (2008). Biostatistics: the bare essentials. Ontario, Canada: BC Decker Inc.

Multivariable, numerical outcome

- Let's say:
  - 1 numerical outcome (cholesterol)
  - 3 numerical independent variables:
    - Age in years, BMI in kg/m^2, weekly physical activity in hours
  - 3 categorical independent variables:
    - Male = yes, no (binary)
    - Smoking = yes, no (binary)
    - Race = Malay, Chinese, Indian (3 levels)
  - 20% dropout
- How many lecturers should we sample?

Multivariable, numerical outcome

Independent Variables, k	Count
Age (numerical)	1
BMI (numerical)	1
Weekly physical activity (numerical)	1
Male (binary categorical)	1
Smoking (binary categorical)	1
Race (categorical, 3 levels → 2 dummy variables)	2
Total	7

Formula:

$$n = k \times 10$$

Independent variable count, k = 7

Sample size, n?

$n = k \times 10 = 7 \times 10 = 70$

n + 20% dropout?

$n_{drop} = n / (1 – \text{dropout proportion})$

$= n / (1 – 0.2)$

$= 70 / 0.8 = 87.5$

Sample size is 88 (rounded up).

Multivariable, numerical outcome

- We have to sample 88 lecturers to investigate the associated factors of cholesterol level among lecturers, taking into account a 20% dropout rate.

Multivariable, binary outcome

(1) Objective:

- Determine associated factors of a binary outcome, e.g. predictors of hypertension (HPT)
- "This study aims to determine the associated factors of HPT among workers in ABC office."

Multivariable, binary outcome

(2) Statistical analysis:

- Multiple logistic regression

(3) Sample size method:

- Rule-of-thumb – 10 events-per-parameter*
  - Event, n_1 = number with outcome e.g. CAD = yes
  - Parameters = Indep. Variables + (Intercept + Interaction Terms)
  - Sample size, $n = n_1 + n_0$ (w/out outcome) $= n_1 / p$ (prevalence)

*Hosmer, D., Lemeshow, S., & Sturdivant, R. (2013). Applied logistic regression (3rd ed.). Hoboken, New Jersey: John Wiley & Sons Inc

Multivariable, binary outcome

- Let's say:
  - 1 binary outcome (HPT)
  - Prevalence of HPT, $p = 0.3$
  - 3 numerical independent variables:
    - Age in years, BMI in kg/m^2, weekly physical activity in hours
  - 3 categorical independent variables:
    - Male = yes, no (binary)
    - Smoking = yes, no (binary)
    - Race = Malay, Chinese, Indian (3 levels)
  - 30% dropout
- How many workers should we sample?

Multivariable, binary outcome

Independent Variables, k	Count
Age (numerical)	1
BMI (numerical)	1
Weekly physical activity (numerical)	1
Male (binary categorical)	1
Smoking (binary categorical)	1
Race (categorical, 3 levels → 2 dummy variables)	2
Total	7

Formula:

$$n_1 = \text{parameters} \times 10$$

$$n_1 = (k + 1) \times 10$$

$$n = n_1 / p$$

1 intercept
0 interaction

Events, n_1?

$n_1 = (k + 1) \times 10 = (7 + 1) \times 10 = 80$

Sample size, n?

$n = n_1 / p = 80 / 0.3 = 266.7 \approx 267$

$n_{drop} = n / (1 – \text{dropout proportion})$
$= n / (1 – 0.3)$
$= 267 / 0.7 = 381.4 \approx 382$

Sample size is 382.

Multivariable, binary outcome

- We have to sample 334 workers to investigate the associated factors of hypertension among workers in ABC office, taking into account a 20% dropout rate.

Validation

Exploratory factor analysis

(1) Objective:

- Explore internal structure validity / construct validity of a psychometric tool / questionnaire
- "This study aims to explore the internal structure validity of ABC-Q among students."

Exploratory factor analysis

(2) Statistical analysis:

- EFA

(3) Sample size method:

- Rule-of-thumb – 5 respondents / item*

*Costello, A. B., & Osborne, J. W. (2005). Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis. Practical Assessment Research & Evaluation, 10(7).

Exploratory factor analysis

- Let's say a researcher wants to validate a questionnaire with:
  - 40 items (variables)
  - 30% dropout
- How many respondents should he sample?

Formula:

$$n = k \times 5$$

$n = k \times 5 = 40 \times 5 = 200$

$n_{drop} = n / (1 – \text{dropout proportion}) = 200 / (1 – 0.3) = 287.7 \approx 288$

Sample size is 288.

Exploratory factor analysis

- We have to sample 288 students to explore the internal structure validity of ABC-Q among the students, taking into account a 30% dropout rate.

Confirmatory factor analysis

(1) Objective:

- Confirm internal structure validity / construct validity of a psychometric tool / questionnaire
- "This study aims to confirm the internal structure validity of ABC-Q among students."

Confirmatory factor analysis

(2) Statistical analysis:

- CFA

(3) Sample size methods:

- Rule-of-thumb – at least 200 respondents*
- RMSEA, CFI model fit indices – Hypothesis testing

*Kline, R. B. (2016). Principles and practice of structural equation modeling. 4th ed. New York: Guilford Publications.

5. Structural Equation Modeling → RMSEA

» Sample Size Calculator

Sample Size Calculator (web)

Structural Equation Modeling - Root Mean Squared Error of Aproximation (RMSEA)

Expected RMSEA:	0.05	
Number of items:		
Number of factors:		
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	10	%

Reset

Please input number of item.
Please input number of factor.

Usually aim < 0.05
Can expect based
on literature

Total number of items.
Can be unequal per
factor.

Confirmatory factor analysis

- Let's say a researcher wants to validate a questionnaire with:
  - 2 factors
  - Factor 1: 8 items, Factor 2: 4 items
  - Acceptable RMSEA is set < 0.05.
  - 10% dropout
- How many respondents should he sample?

Confirmatory factor analysis

Structural Equation Modeling - Root Mean Squared Error of Aproximation (RMSEA)

Expected RMSEA:	0.05	
Number of items:	12	8 + 4 items
Number of factors:	2	2 factors
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	10	%

Reset

Degree of freedom, df =	53
Sample size, n =	235
Sample size (with 10% dropout), n_{drop} =	262

Confirmatory factor analysis

- We have to sample 262 students to confirm the internal structure validity of ABC-Q among the students, taking into account a 10% dropout rate.

5. Structural Equation Modeling → CFI

Requires equal number of items per factor

» Sample Size Calculator

Sample Size Calculator (web)

Usually aim > 0.95
Can expect based
on literature

Structural Equation Modeling - Comparative Fit Index (CFI)

Expected CFI:	0.95	
Number of items:		
Number of factors:		
Average factor loading:	0.6	
Average factor correlation:	0.3	
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	10	%

Reset

Please input number of item.
Please input number of factor.

Total number of items.
MUST be equal per
factor.

Confirmatory factor analysis

- Let's say a researcher wants to validate a questionnaire with:
  - 2 factors, 6 items each
  - Based on literature, average factor loading is around 0.7
  - Average factor-factor correlation around 0.3
  - Acceptable CFI > 0.95
  - 10% dropout
- How many respondents should he sample?

Confirmatory factor analysis

Structural Equation Modeling - Comparative Fit Index (CFI)

Expected CFI:	0.95	
Number of items:	12	
Number of factors:	2	
Average factor loading:	0.7	
Average factor correlation:	0.3	
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	10	%

Reset

Degree of freedom, df_{model} =	53
Degree of freedom, $df_{baseline}$ =	66
Sample size, n =	160
Sample size (with 10% dropout), n_{drop} =	178

6 items x 2 factors MUST be equal

2 factors

Av. factor loadings & correlation

Confirmatory factor analysis

- We have to sample 178 students to confirm the internal structure validity of ABC-Q among the students, taking into account a 10% dropout rate.

5. Structural Equation Modeling → CFI (advanced)

Allows unequal number of items per factor

» Sample Size Calculator

Sample Size Calculator (web)

Usually aim > 0.95
Can expect based
on literature

Structural Equation Modeling - Comparative Fit Index (CFI)

Expected CFI:	0.95
Number of items per factor (separated by comma ","):	
Average factor loading:	0.6
Average factor correlation:	0.3
Significance level (α):	0.05 Two-tailed
Power (1 - β):	80 %
Expected dropout rate:	10 %

Allows setting unequal number of item per factor

Reset

Enter valid format.

Confirmatory factor analysis

- Let's say a researcher wants to validate a questionnaire with:
  - 3 factors
  - Factor 1: 8 items, Factor 2: 4 items, Factor 3: 6 items
  - Based on literature, average factor loadings around 0.7
  - Average factor-factor correlation around 0.3
  - Acceptable CFI > 0.95
  - 10% dropout
- How many respondents should he sample?

Confirmatory factor analysis

Structural Equation Modeling - Comparative Fit Index (CFI)

Expected CFI:	0.95	
Number of items per factor (separated by comma ","):	8, 4, 6	
Average factor loading:	0.7	
Average factor correlation:	0.3	
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	10	%

Reset

Degree of freedom, df_{model} =	132
Degree of freedom, $df_{baseline}$ =	153
Sample size, n =	162
Sample size (with 10% dropout), n_{drop} =	180

Factor 1: 8 items
Factor 2: 4 items
Factor 3: 6 items

Av. factor loadings & correlation

Confirmatory factor analysis

- We have to sample 180 students to confirm the internal structure validity of ABC-Q among the students, taking into account a 10% dropout rate.

Structural Equation Modeling

(1) Objective:

- Test a hypothesized structural model for theory ABC
- "This study aims to test the hypothesized ABC model among students by SEM."
- "This study aims to examine/test the hypothesized structural relationships between X, Y, and Z among students."

Structural Equation Modeling

(2) Statistical analysis:

- SEM

(3) Sample size methods:

- Rule-of-thumb – at least 200 respondents*
- RMSEA model fit index – Hypothesis testing

*Kline, R. B. (2016). Principles and practice of structural equation modeling. 4th ed. New York: Guilford Publications.

5. Structural Equation Modeling → RMSEA

» Sample Size Calculator

Sample Size Calculator (web)

Usually aim < 0.05
Can expect based on literature

Structural Equation Modeling - Root Mean Squared Error of Aproximation (RMSEA)

Expected RMSEA:	0.05	
Degrees of freedom:		
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Expected dropout rate:	10	%

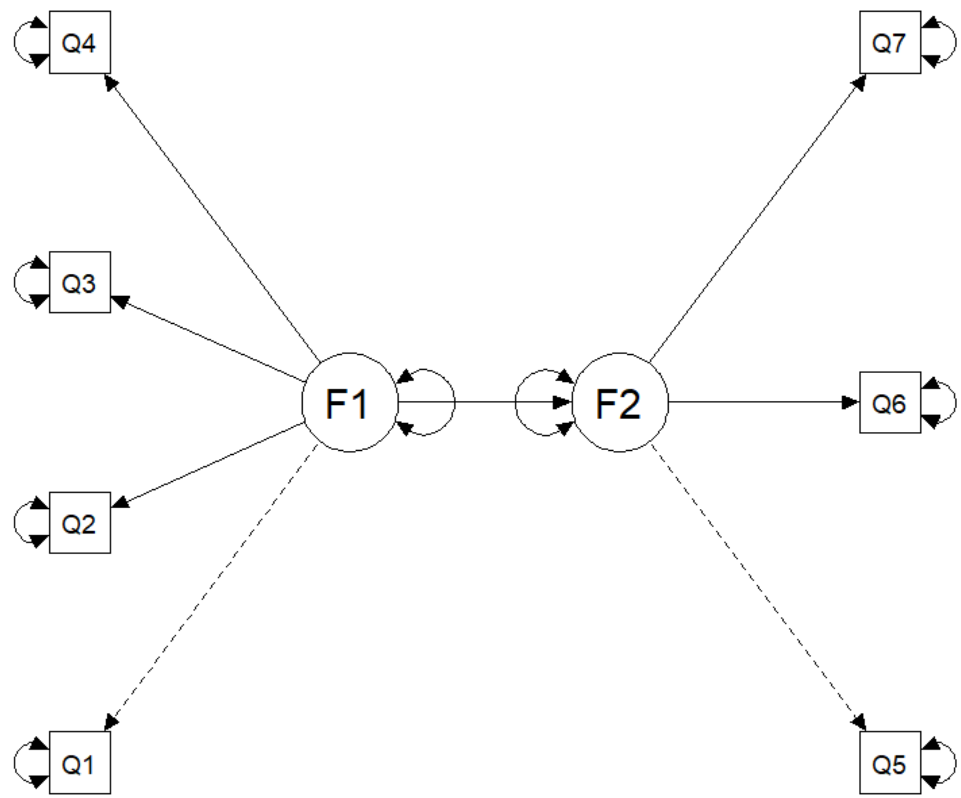
Calculate | Reset

Sample size, n =	
Sample size (with 10% dropout), n_{drop} =	

df, must calculate for SEM model

Structural Equation Modeling

- Let's say a researcher wants to validate a the provided structural model with:
  - Acceptable RMSEA is set < 0.05
  - 10% dropout
- How many respondents should he sample?



Structural Equation Modeling

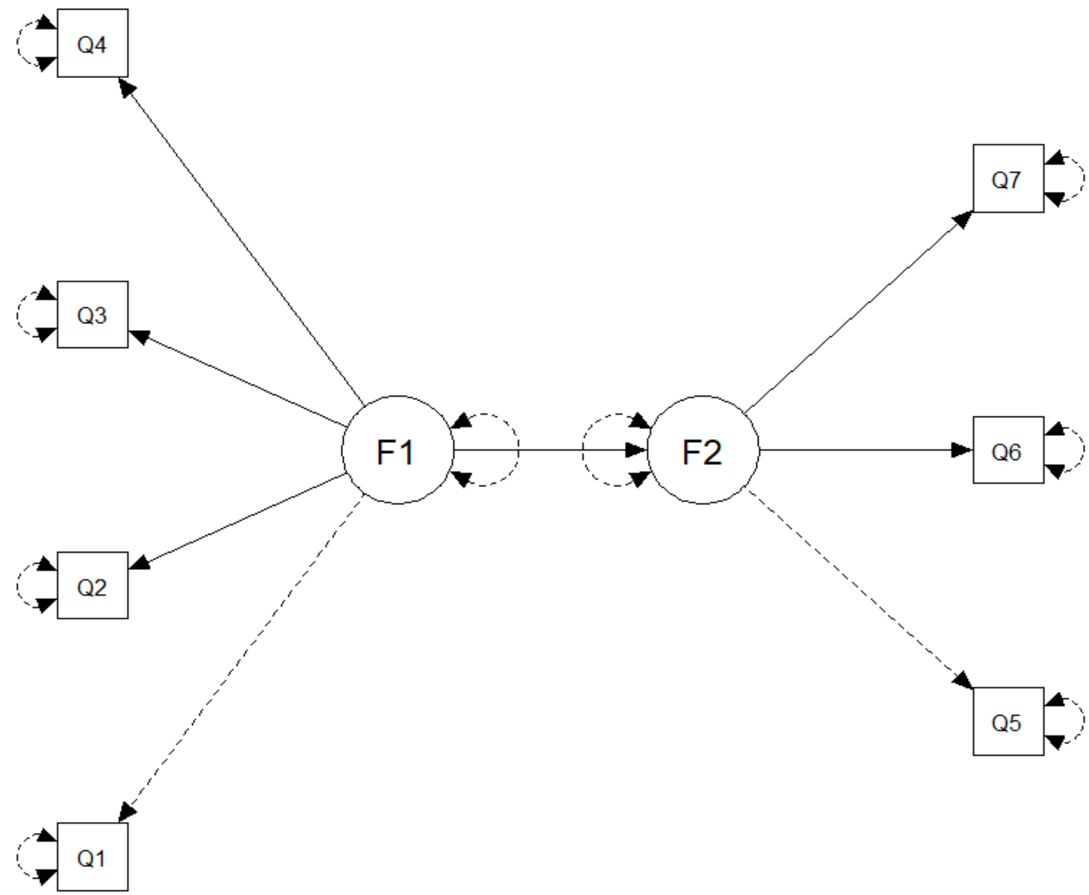
Calculate *df* manually:

Estimated parameters	Count
Factor loadings	5
Error variances	8
Factor variances	1
Factor covariances	0
Regressions	1
Total (a)	15

a = number of estimated parameters

p = number of items
b = p(p + 1)/2 = 7(7 + 1)/2 = 28

df = b – a = 28 – 15 = 13



Structural Equation Modeling

Calculate *df* in R:

R code

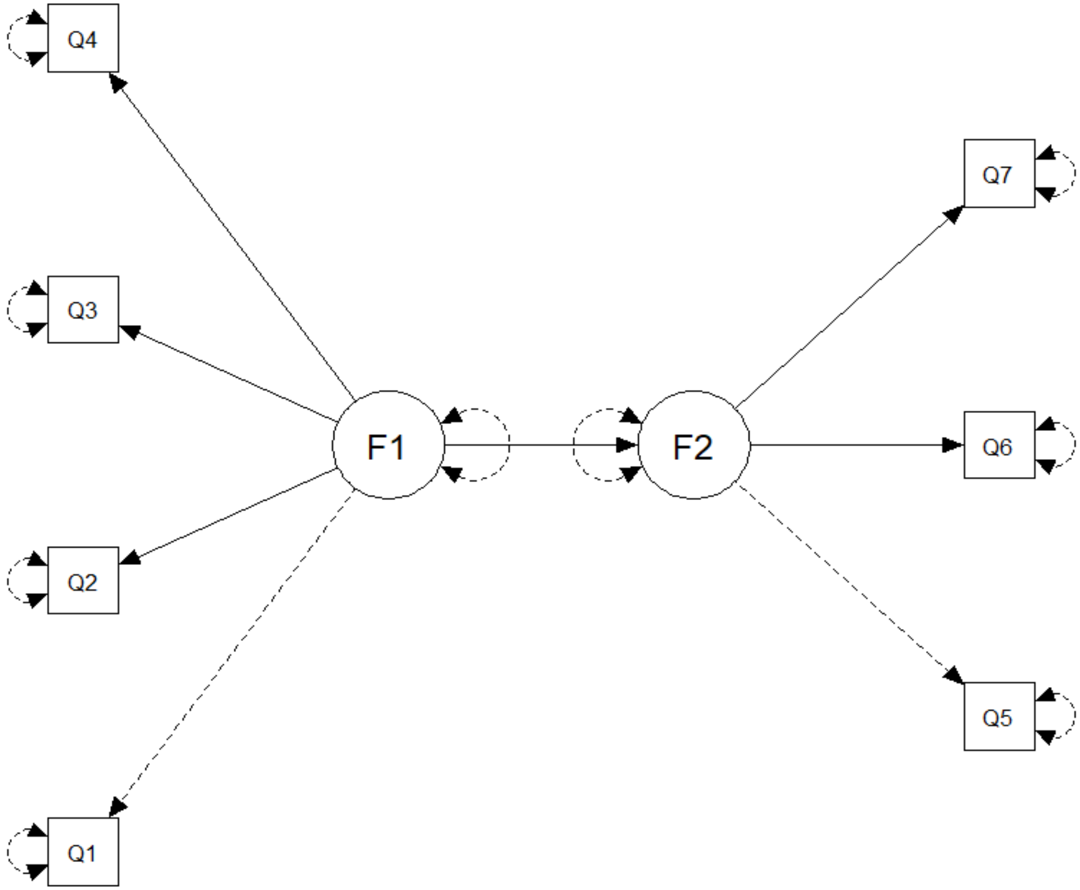
```
library(lavaan)
library(semPlot)

model1 = "
F1 =~ 1*Q1 + Q2 + Q3 + Q4
F2 =~ 1*Q5 + Q6 + Q7
F2 ~ F1
"
data = simulateData(model1)
fit.model1 = sem(model1, data = data)
fitmeasures(fit.model1)["df"]
```

R output

```
df
13
```

R plot

```
semPaths(lavaanify(model1), what="path",
         whatLabels="name",
         edge.color = "black",
         layout = "tree2", rotation = 2)
```



Structural Equation Modeling

Structural Equation Modeling - Root Mean Squared Error of Aproximation (RMSEA)

Expected RMSEA:	0.05	
Degrees of freedom:	13	Calculated df
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Expected dropout rate:	10	%

Calculate Reset

Sample size, n =	551
Sample size (with 10% dropout), n_{drop} =	613

Structural Equation Modeling

- We have to sample 613 students to confirm the proposed structural model among the students, taking into account a 10% dropout rate.

Cronbach's alpha

(1) Objective:

- Determine reliability of a psychometric tool / questionnaire
- "This study aims to determine the reliability of ABC-Q among students."

Cronbach's alpha

(2) Statistical analysis:

- Cronbach's alpha coefficient

(3) Sample size method:

- Cronbach's alpha coefficient – Hypothesis testing

4. Reliability → Cronbach's alpha coefficient

» Sample Size Calculator

Sample Size Calculator (web)

Cronbach's alpha - Hypothesis Testing

Minimum acceptable Cronbach's alpha (H_0):	0.65	
Expected Cronbach's alpha (H_1):		
Significance level (α):	0.05	Two-tailed
Power (1 - β):	80	%
Number of items (k):		
Expected dropout rate:	10	%

Calculate | Reset

Sample size, n =	
Sample size (with 10% dropout), n_{drop} =	

Usually 0.65, 0.7

Expected, can be estimated from literature

Cronbach's alpha

- Let's say a researcher wants to determine reliability of a questionnaire with:
  - Minimum acceptable Cronbach's alpha = 0.7
  - Expected Cronbach's alpha = 0.85
  - 2 factors
  - Factor 1: 8 items, Factor 2: 6 items
  - 20% dropout
- How many respondents should he sample?
  - Calculate for each factor, and take the largest.

Cronbach's alpha

» Sample Size Calculator

Sample Size Calculator (web)

Cronbach's alpha - Hypothesis Testing

Minimum acceptable Cronbach's alpha (H_0):	0.7	
Expected Cronbach's alpha (H_1):	0.85	Expected, can be from literature
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Number of items (k):	8	8 items from Factor 1
Expected dropout rate:	20	%

Calculate | Reset

Sample size, n =	40
Sample size (with 20% dropout), n_{drop} =	50

Cronbach's alpha

» Sample Size Calculator

Sample Size Calculator (web)

Cronbach's alpha - Hypothesis Testing

Minimum acceptable Cronbach's alpha (H_0):	0.7	
Expected Cronbach's alpha (H_1):	0.85	Expected, can be from literature
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Number of items (k):	6	6 items from Factor 2
Expected dropout rate:	20	%

Calculate | Reset

Sample size, n =	42
Sample size (with 20% dropout), n_{drop} =	53

Cronbach's alpha

- We have to sample 53 students to determine the reliability of ABC-Q among the students, taking into account a 20% dropout rate.

Intraclass correlation

(1) Objective:

- Determine test-retest reliability / interrater reliability of a numerical measure, i.e. consistency / agreement.
- "This study aims to determine the test-retest reliability of ABC-Q among students."
- "This study aims to determine the interrater reliability of new doctors in measuring blood pressure."

Intraclass correlation

(2) Statistical analysis:

- Intraclass correlation coefficient (ICC)

(3) Sample size method:

- Intraclass Correlation Coefficient (ICC) - Hypothesis Testing

4. Reliability → Intraclass correlation coefficient (ICC) → ICC - Hypothesis Testing

» Sample Size Calculator

Sample Size Calculator (web)

Intraclass Correlation Coefficient (ICC) - Hypothesis Testing[1]

Minimum acceptable reliability (ICC) (ρ_0):	0.60	
Expected reliability (ICC) (ρ_1):		
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Number of raters/repetitions per subject (k):	2	
Expected dropout rate:	10	%

Calculate Reset

Sample size, n =	
Sample size (with 10% dropout), n_{drop} =	

Between 0.6 to 0.74

Expected, can be estimated from literature

Test-retest = 2 / Any number of raters

Intraclass correlation - test-retest

- Let's say for test-retest reliability:
  - Minimum acceptable ICC = 0.7
  - Expected ICC = 0.85
  - Two occasions
  - 10% dropout
- How many respondents should he sample?

Intraclass correlation

» Sample Size Calculator

Sample Size Calculator (web)

Intraclass Correlation Coefficient (ICC) - Hypothesis Testing[1]

Minimum acceptable reliability (ICC) (ρ_0):	0.7	
Expected reliability (ICC) (ρ_1):	0.85	Expected, can be from literature
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Number of raters/repetitions per subject (k):	2	2 repetitions for test-retest
Expected dropout rate:	10	%

Calculate | Reset

Sample size, n =	53
Sample size (with 10% dropout), n_{drop} =	59

Intraclass correlation

- We have to sample 59 students to determine the test-retest reliability of ABC-Q among the students, taking into account a 10% dropout rate.

Intraclass correlation - interrater

- Let's say for interrater reliability:
  - Minimum acceptable ICC = 0.8 (set higher, measuring blood pressure correctly is a serious matter)
  - Expected ICC = 0.9
  - 5 doctors
  - 10% dropout
- How many doctors should he sample?

Intraclass correlation

» Sample Size Calculator

Sample Size Calculator (web)

Intraclass Correlation Coefficient (ICC) - Hypothesis Testing[1]

Set higher at 0.8

Minimum acceptable reliability (ICC) (ρ_0):	0.8	
Expected reliability (ICC) (ρ_1):	0.9	
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Number of raters/repetitions per subject (k):	5	
Expected dropout rate:	10	%

Expected, can be from literature

5 doctors

Calculate | Reset

Sample size, n =	33
Sample size (with 10% dropout), n_{drop} =	37

Intraclass correlation

- We have to sample 37 **patients** to determine the interrater reliability of 5 **doctors** in measuring blood pressure, taking into account a 10% dropout rate.

Kappa agreement

(1) Objective:

- Determine interrater reliability of a categorical measure, i.e. consistency / agreement.
- "This study aims to determine the interrater reliability of two radiologists in rating X-ray films for the presence of pneumonia among patients with shortness of breath."
- Rater = human rater / diagnostic test

Kappa agreement

(2) Statistical analysis:

- Kappa coefficient

(3) Sample size method:

- Kappa (2 raters) – Hypothesis testing

4. Reliability → Kappa coefficient → Kappa (2 raters) - Hypothesis Testing

» Sample Size Calculator

Sample Size Calculator (web)

Usually 0.6, Moderate agreement

Expected, can be estimated from literature

Kappa (2 raters) - Hypothesis Testing[1]

Minimum acceptable kappa (κ_0):	0.6	
Expected kappa (κ_1):		
Proportion of outcome (p), e.g. *p* of heart disease:	0.5	
Significance level (α):	0.05	Two-tailed
Power ($1 - \beta$):	80	%
Expected dropout rate:	10	%

Calculate | Reset

Sample size, n =	
Sample size (with 10% dropout), n_{drop} =	

Kappa agreement

- Let's say a researcher wants to determine the agreement between two radiologists:
  - Minimum acceptable kappa = 0.6
  - Expected kappa = 0.9
  - Presence of pneumonia among patients with shortness of breath is 30% ($p = 0.3$)
  - 30% dropout
- How many patients should be sampled?

Kappa agreement

» Sample Size Calculator

Sample Size Calculator (web)

Kappa (2 raters) - Hypothesis Testing[1]

Minimum acceptable kappa (κ_0):	0.6
Expected kappa (κ_1):	0.9
Proportion of outcome (p), e.g. *p* of heart disease:	0.3
Significance level (α):	0.05 Two-tailed
Power ($1 - \beta$):	80 %
Expected dropout rate:	30 %

Calculate   Reset

Sample size, n =	66
Sample size (with 30% dropout), n_{drop} =	95

Expected, can be from literature

30% presence of pneumonia
$p = 0.3$

Kappa agreement

- We have to sample 95 X-ray films of patients with shortness of breath to determine the interrater reliability of two radiologists in rating X-ray films for the presence of pneumonia, taking into account a 30% dropout rate.

Sensitivity & Specificity

(1) Objective:

- Estimate sensitivity and specificity of a diagnostic test, e.g. RTK-Ag for COVID-19
- "This study aims to determine sensitivity and specificity of a new COVID-19 self-test kit among exposed adults."

Sensitivity & Specificity

(2) Statistical analysis:

- Proportion, 95% Confidence Interval (CI)

(3) Sample size method:

- Sensitivity/Specificity – Estimation

2. Proportions → Sensitivity and specificity → Sensitivity/Specificity - Estimation

» Sample Size Calculator

Sample Size Calculator (web)

Sensitivity/Specificity - Estimation

Expected sensitivity:	0.90	
Expected specificity:	0.85	
Prevalence of disease (p):	0.20	
Precision (± expected):	0.10	
Confidence level 100(1 - α):	95	%
Expected dropout rate:	10	%

Calculate | Reset

Sample size for sensitivity, n_{sen} =	
Sample size for specificity, n_{spec} =	
Final sample size (largest), n =	
Final sample size (with 10% dropout), n_{drop} =	

Expected sensitivity, can be from literature

Expected specificity, can be from literature

Prevalence of disease

Precision, in proportion

Confidence level 90%, **95%**, 99%

% of participants that may dropout

Sensitivity & Specificity

- Let say:
  - Expected Sensitivity = 0.9
  - Expected Specificity = 0.7
  - Prevalence of COVID-19* = 5% = 0.05 (in proportion)
  - Precision = ±5% = 0.05 (in proportion)
  - 95% Confidence level
  - 10% dropout
- How many exposed adults should we sample?

*based on positivity rate

Sensitivity & Specificity

» Sample Size Calculator

Sample Size Calculator (web)

Sensitivity/Specificity - Estimation

Expected sensitivity:	0.90	
Expected specificity:	0.7	
Prevalence of disease (p):	0.05	
Precision (± expected):	0.05	
Confidence level 100(1 - α):	95	%
Expected dropout rate:	10	%

Calculate | Reset

Sample size for sensitivity, n_{sen} =	2766
Sample size for specificity, n_{spec} =	340
Final sample size (largest), n =	2766
Final sample size (with 10% dropout), n_{drop} =	3074

Take the largest of the two

Sensitivity & Specificity

- We have to sample 3075 patients to estimate both sensitivity and specificity of the new test kit among exposed adults, taking into account a 10% dropout rate.

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