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How Many Subjects Do I Need? A Crash Course in Sample Size Calculations

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Learning Objectives

After this session, participants will be able to:

1. Define what is a Type I error.
2. State the formula for power.
3. Calculate the required sample size for three common research scenarios.
4. List four ways to decrease the required sample size.

Scenario 1

- A primary care provider working in long-term care wants to estimate the prevalence of a recent (in the past year) major depressive episode in adults aged 65+ years.

- She will take a random sample and, after obtaining informed consent, the subjects will be evaluated.

- She will report the prevalence along with a 95% confidence interval.

Review of Hypothesis Testing

- Null hypothesis (H_0) and alternative hypothesis (H_A).
- H_0 is usually the *hypothesis of no difference.*
- The null hypothesis is the straw man.

Review of Hypothesis Testing (continued)

H_0: RR = 1

H_A: RR ≠ 1

Type I and II Errors

- α is the probability of committing a Type I error.

- β is the probability of committing a Type II error.

- $\alpha = 0.05$.
- $\beta = 0.20$.

A Quick Note on Beta

- The Greek letter beta in statistics has different meanings in various contexts.

Power

- Power = 1 – β.
- The ability to detect an association if one exists.
- Power of a test is the probability of rejecting the null hypothesis if it is false.
- Power usually set at 80%. What is the β then?

False Positive and False Negative

- α is the probability of committing a Type I error: *False positive*.

- β is the probability of committing a Type II error: *False negative*.

Result: You Reject the Null Hypothesis

- Made correct decision.

or

- Committed a Type I error if the null is true.

Result: Fail to Reject the Null Hypothesis

- Made correct decision.

or

- Committed a Type II error if the null is false.

Form of the dependent & independent variables

↓

Statistical test or model that will be used

↓

Appropriate sample size formula

Scenario 1: Additional Details

- Based on her review of the literature, the primary care provider believes the prevalence of a recent major depressive episode is 10% in her long-term care home.

- What is an appropriate sample size?

Formula for a Confidence Interval for One Proportion

- Refer to an introductory statistics textbook such as Daniel WW. *Biostatistics: A Foundation for Analysis in the Health Sciences Fifth Edition*. New York: John Wiley & Sons, Inc.; 1991.

Formula for a Confidence Interval for One Proportion (continued)

$$n = \frac{(z^2)\ (p)\ (q)}{d^2}$$

Daniel 1991

A Note on Expressing Probability

- 10% can be expressed as 0.10.
- 50% can be expressed as 0.50.

Scenario 1 (continued)

- Assume she will report the prevalence along with a 95% confidence interval.

- Desired precision: 3 percentage points. Precision is also known as the margin of error (see PASS Sample Size Software Chapter 116 cited at the end of this slideshow).

- Assume random sampling from an infinite population.

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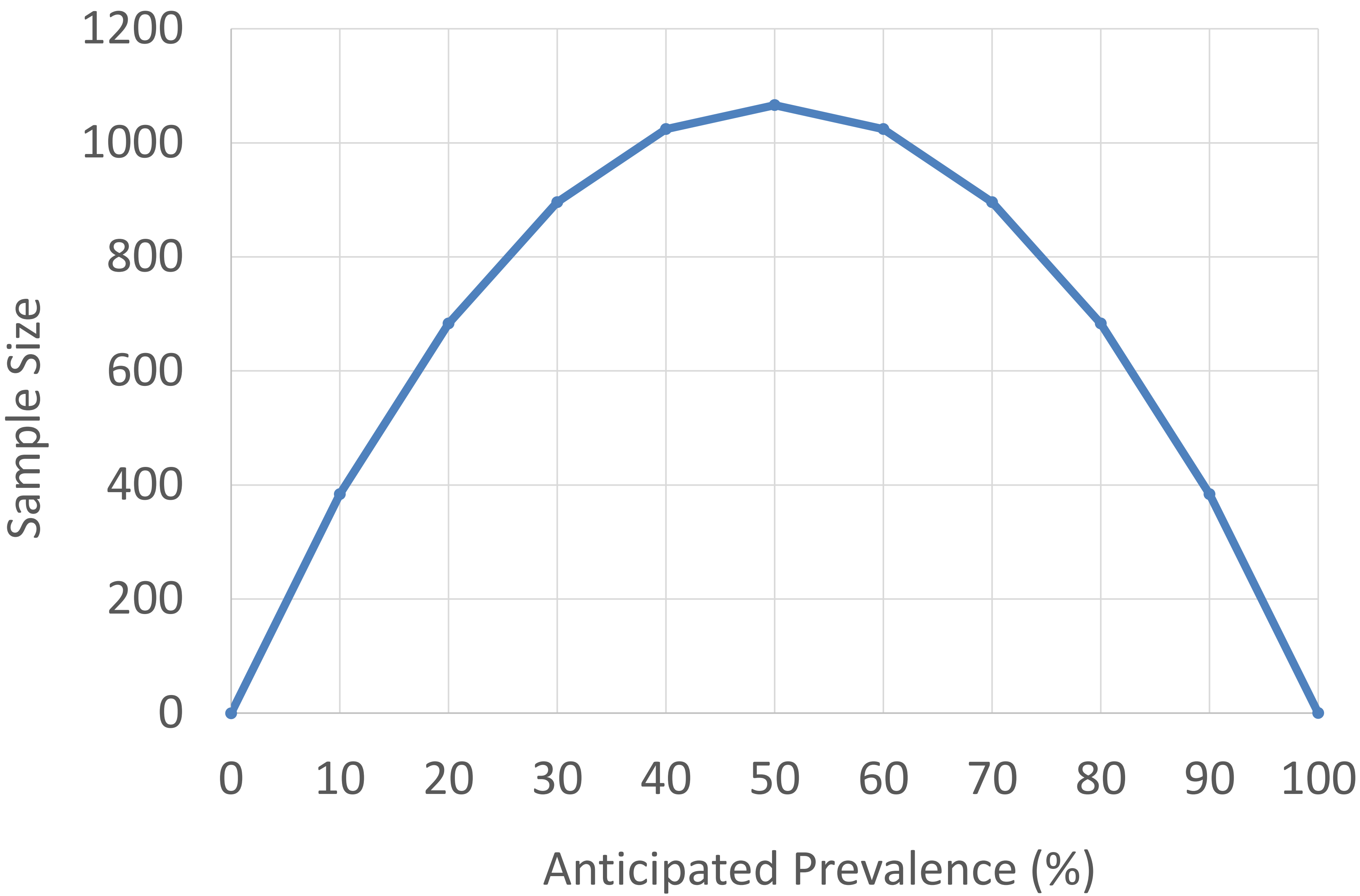
Estimated Prevalence (%)	I Want to Estimate the Prevalence to within ± ____ Percentage Points of the True Prevalence	Required Sample Size for a 95% Confidence Interval
10	3	384
10	5	139
50	3	1066
50	5	384

Max *N* at 50% (at 0.50)



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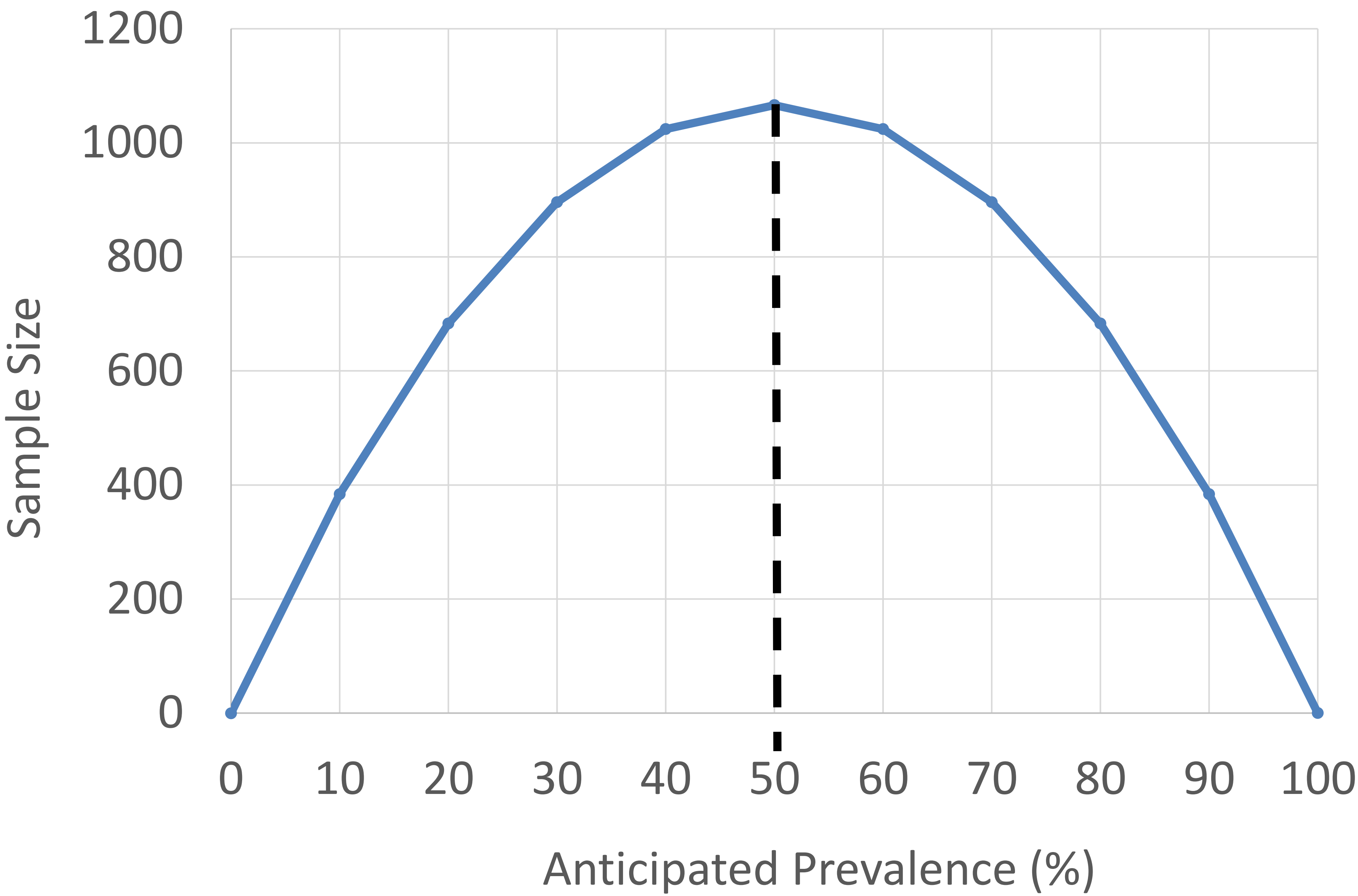


Scenario 4

- Case-control study of periodontal disease as a risk factor for preeclampsia.
- Exposure: Periodontal disease (present vs. absent).
- Cases: Women with preeclampsia.
- Controls: Women free of preeclampsia.

Odds Ratio (OR)

	Cases	Controls
Exposed	A	B
Not exposed	C	D

$$OR = AD / BC$$

CDC
Hennekens 1987

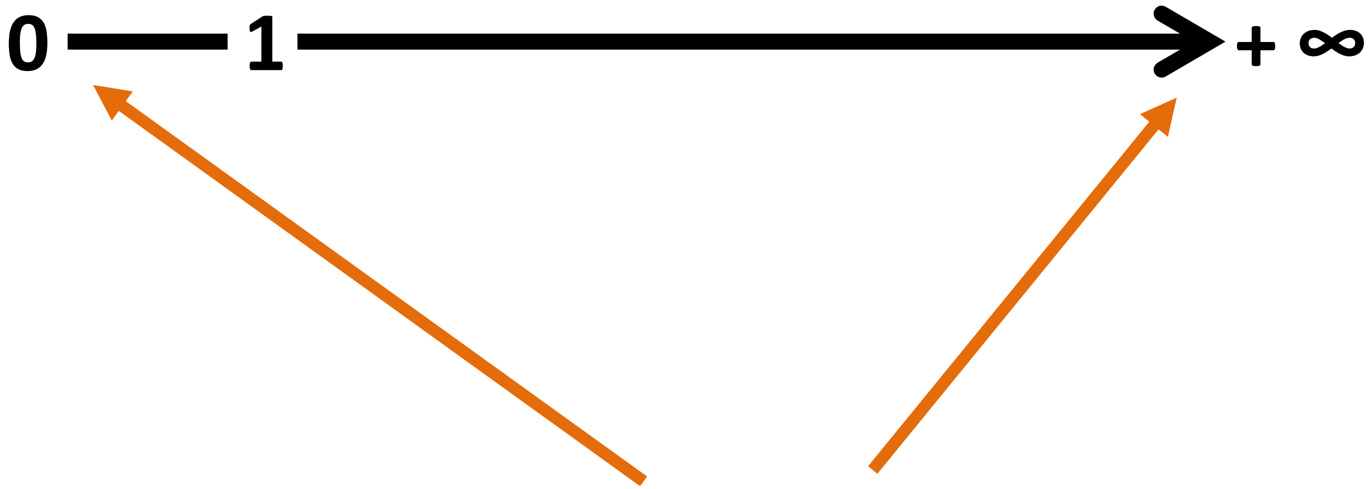
Odds Ratio (OR) (continued)

	Cases	**Controls**
Exposed	A	B
Not exposed	C	D

OR = AD / BC

CDC

Review of the OR



Extreme values compared to those around the null value of 1

Review of OR (continued)

- Statistically-significant ORs around the null value of 1 (say, 0.97 or 1.02) represent weak associations compared to ORs that are far away from 1.

- ORs around the null value of 1 (say, 0.97 or 1.02) will require a larger sample size to detect than ORs that are far away from 1 such as 0.16 or 3.52.

Methods to Reduce the Required Sample Size

- Increase α.
- Increase β (decrease power).
- Switch to one-tailed testing (if indicated).
- Increase the magnitude of the difference between the two groups (i.e., design a study to look for a larger effect).

Methods to Reduce the Required Sample Size (continued)

- Increase α.
- Increase β (decrease power).
- Switch to one-tailed testing (if indicated).
- Increase the magnitude of the difference between the two groups (i.e., design a study to look for a larger effect).

Realities of Research

- If the required sample size is too large, then

1. Increase the accrual rate (get more study sites and/or increase time needed for study).

2. Relax scientific requirements (α, β, etc.).

3. Abandon the study.

Abandon the Study

- Lack of funds is no excuse for conducting an underpowered study.

Abandon the Study (continued)

- "…if a trial will be too small to detect realistic and clinically relevant differences then one should avoid inconveniencing patients, and wasting funds and effort on an experiment which is scientifically inadequate."

Pocock 1983

Conclusions

- Sample size calculations are just estimates and are only as good as your "inputs."
- The formulae get more complicated when dealing with confounding and other issues (see next slide for SAS code for a proposed multiple logistic regression analysis).
- Details on sample size tests for log rank test, matched case-control studies, multiple logistic regression, etc., are found elsewhere.

```
proc power;
    logistic
        vardist("Sex") = binomial(0.5, 1)
        vardist("Income") = binomial(0.2, 1)
        testpredictor = "Income"
        covariates = "Sex"
        responseprob = 0.30 0.50
        testoddsratio = 1.8
        covoddsratios = 1.2
         corr=0.10
        alpha = 0.05
        power = 0.8
        ntotal = .;
run;
```

Cited References

- CDC (Centers for Disease Control and Prevention). Lesson 3: Measures of Risk. Section 5: Measures of Association. In: *Principles of Epidemiology in Public Health Practice, Third Edition. An Introduction to Applied Epidemiology and Biostatistics*. Available at: https://www.cdc.gov/csels/dsepd/ss1978/lesson3/section5.html

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- Daniel WW. *Biostatistics: A Foundation for Analysis in the Health Sciences Fifth Edition*. New York: John Wiley & Sons, Inc.; 1991.

- Hennekens CH, Buring JE. *Epidemiology in Medicine*. Boston: Little, Brown and Company; 1987.

Cited References (continued)

- PASS Sample Size Software, Confidence Intervals for One Proportion from a Finite Population. Chapter 116, page 116-5: https://ncss-wpengine.netdna-ssl.com/wp-content/themes/ncss/pdf/Procedures/PASS/Confidence_Intervals_for_One_Proportion_from_a_Finite_Population.pdf

- Pocock SJ. *Clinical Trials: A Practical Approach*. Chichester, United Kingdom: John Wiley & Sons; 1983.

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