Medical Statistician Presentation

NTNU Interview Case

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Research Problem

Vi skal genomföre en klinisk studie på nydiagnostiserte pasienter med myelomatose hvor vi ska sammenlign standardbehandling med en ny kombinasjon av experimentella medikamenter.

Fra tidigare studier kan forvente:

- Standard: 50% minimal residual disease (MRD)

Forskargruppe tror att vi kan oppnå en klinisk signifikant bedring om:

- Experimentell: 70% minimal residual disease (MRD)

Med andre ord, jo mindre kreft, desto bedre.

Statistical Analys

Head of the Research team thinks: Data costs money,

Hvor mange patienter trenger studien vår, med 80% power og signifikansnivå på 5 %?

Resultat beroende data (paired/dependent data)

Beste fall: total 98 patienter, 49 vardera gruppe
Verste fall: 102

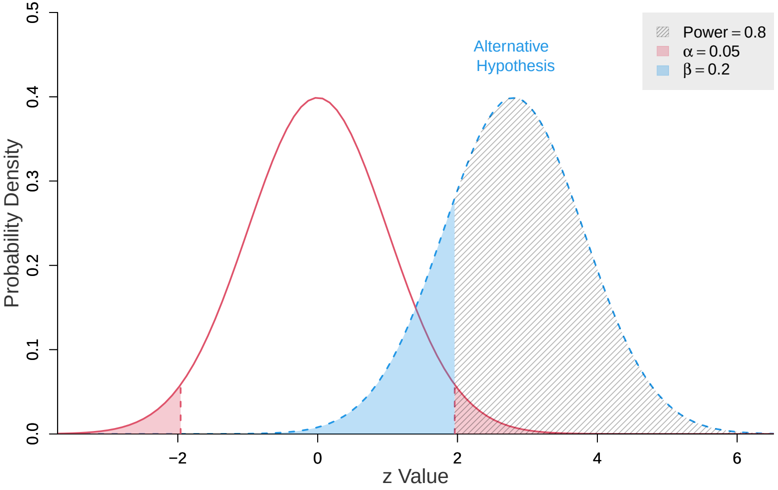
Test	Same	Assumptions
Two Sample T	$49 + 49$	Approx. Normal, iid
Wilcoxon signed-rank Test	$51 + 51$	Non-parametric, iid, effect size ≈ 0.41

Resultat oberoende data (independent data)

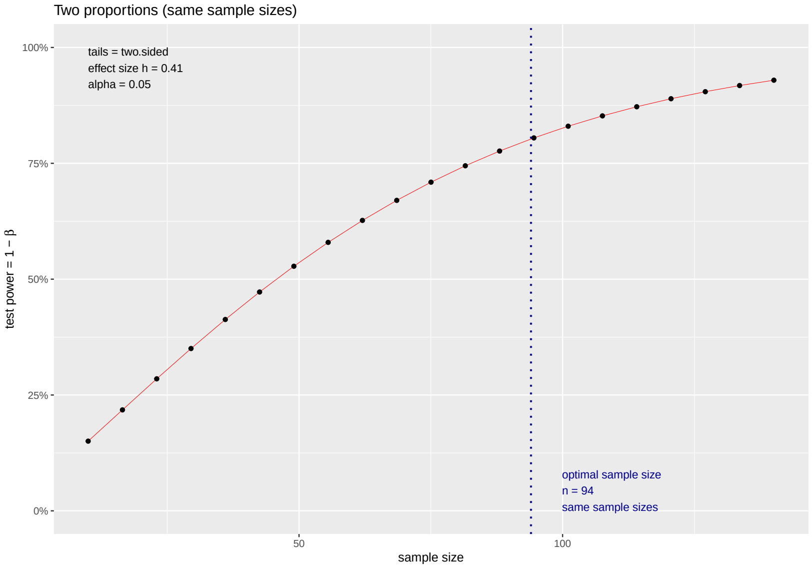
Beste fall: total 182 patienter, 91 vardera gruppe
Verste fall: 231

Test	Same	Different	Assumptions
Two Sample Z	$91 + 91$	-	Normality, iid
Two Sample T	$93 + 93$	$180 + 63$	Approx. Normal, iid
Mann-Whitney U	$99 + 99$	-	Non-parametric, iid, effect size $\approx$ 0.41
Chi^2 ($df = 90$)	231	-	Z scores for df

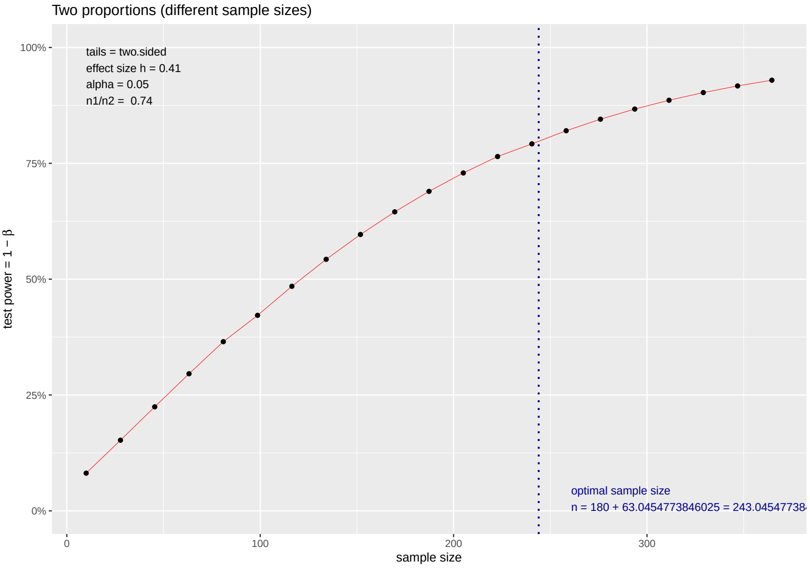
Graphical Results Z Test



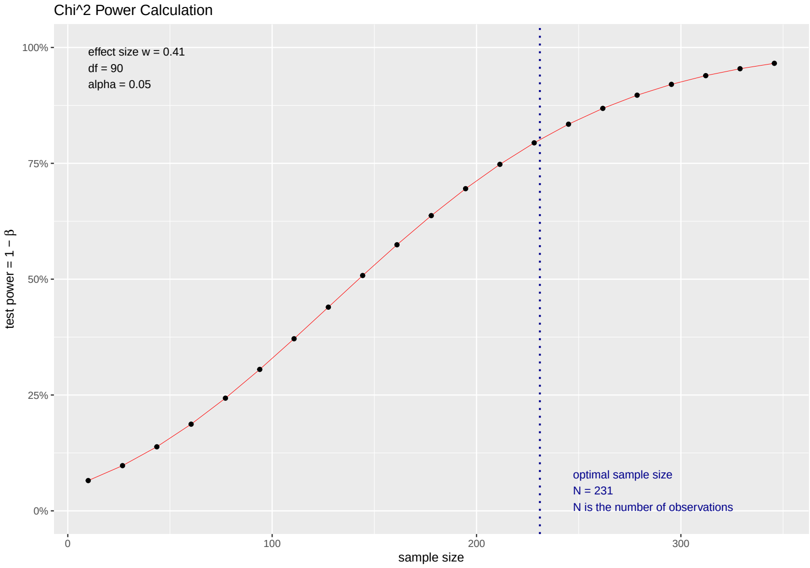
Graphical Results Student t-test



Graphical Results Student t-test



Graphical Results Chi^2



Code

Github link

Analytical Calculation: Z-tests

$$H_0 : p_1 = p_2$$

$$H_1 : p_1 \neq p_2$$

To determine the sample size needed for a study comparing two proportions use two-sample proportion test. The formula is:

$$Z = \frac{(p_1 - p_2)}{\sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}}$$

Simplified to, given $n_1 = n_2 = n$:

$$n = \frac{(p_1(1 - p_1) + p_2(1 - p_2))(Z_\alpha + Z_\beta)^2}{(p_1 - p_2)^2}$$

Analytical Calculation: Z-tests

p_1 is the reduction in MRD for Drug A (50%, or 0.5).
p_2 is the targeted reduction in MRD for Drug B (70%, or 0.7).
Z_α is the Z-score for a 5% significance level (approximately 1.96).
Z_β is the Z-score for an 80% power (approximately 0.84).

Analytical Calculation: Z-tests

Substitute these values into the formula to calculate n:

$$n = \frac{(0.5 \times 0.5 + 0.7 \times 0.3)(1.96 + 0.84)^2}{(0.5 - 0.7)^2}$$

Now, calculate the result.

$$n = \frac{(0.25 + 0.21)(2.8)^2}{0.04}$$

$$n = \frac{0.46 \times 7.84}{0.04}$$

$$n = \frac{3.6064}{0.04}$$

$$n = 90.16$$

$$n \approx 91$$

Analytical Calculation: Student t-test

Start with the formula for the t-statistic in the two-sample proportion t-test:

$$t = \frac{(\hat{p}_1 - \hat{p}_2)}{\sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}}$$

For the t-test, the formula is:

$$n = \frac{(t_{\alpha/2,df} + t_\beta)^2 \times (p_1(1-p_1) + p_2(1-p_2))}{(p_1 - p_2)^2}$$

$\hat{p}_1$ and $\hat{p}_2$ are the sample proportions for Group 1 and Group 2,
$\hat{p}_1 = 0.5$ (for Drug A),
$\hat{p}_2 = 0.7$ (for Drug B),
Degrees of freedom (df) for the t-distribution: $df = 2n - 2$,
$t_{\alpha/2,df}$ and t_β from the t-distribution tables.

Analytical Calculation: Student t-test

$$n = \frac{(1.97 + 0.85)^2 \times (0.5(1 - 0.5) + 0.7(1 - 0.7))}{(0.5 - 0.7)^2}$$

$$n \approx \frac{(2.82)^2 \times (0.25 + 0.21)}{0.04}$$

$$n \approx \frac{(7.9524) \times (0.46)}{0.04}$$

$$n \approx \frac{3.656704}{0.04}$$

$$n \approx 91.42$$

$$n \approx 92$$