Chapter 8
Sample Size

Continuous Data, Power 50%

An essential part of clinical studies is the question, how many subjects need to be studied in order to answer the studies' objectives. As an example, we will use an intended study that has an expected mean effect of 5, and a standard deviation (SD) of 15.

What required sample size do we need to obtain a significant result, or, in other words, a p-value of at least 0.05.

A. 16,
B. 36,
C. 64,
D. 100.

A suitable equation to assess this question can be constructed as follows.

With a study's t-value of 2.0 SEM-units, a significant p-value of 0.05 will be obtained. This should not be difficult for you to understand when you think of the 95% confidence interval of study being between – and + 2 SEM-units (Chap. 5).

We assume

$$\begin{aligned} \text{t-value} &= 2 \text{ SEMs} \\ &= (\text{mean study result}) / (\text{standard error}) \\ &= (\text{mean study result}) / (\text{standard deviation} / \sqrt{n}) \end{aligned}$$

(n = study's sample size)

T.J. Cleophas and A.H. Zwinderman, *Statistical Analysis of Clinical Data on a Pocket Calculator: Statistics on a Pocket Calculator*, DOI 10.1007/978-94-007-1211-9_8,

From the above equation it can be derived that

$$\sqrt{n} = 2 \times \text{standard deviation (SD)} / (\text{mean study result})$$
$$n = \text{required sample size}$$
$$= 4 \times (\text{SD} / (\text{mean study result}))^2$$
$$= 4 \times (15/5)^2 = 36$$

Answer B is correct.

You are testing here whether a result of 5 is significantly different from a result of 0. Often two groups of data are compared and the standard deviations of the two groups have to be pooled (see page 25). As stated above, with a t-value of 2.0 SEMs a significant result of $p = 0.05$ is obtained. However, the power of this study is only 50%, indicating that you will have 50% chance of an insignificant result the next time you perform a similar study.

Continuous Data, Power 80%

What is the required sample size of a study with an expected mean result of 5, and SD of 15, and that should have a p-value of at least 0.05 and a power of at least 80% (power index $= (z_\alpha + z_\beta)^2 = 7.8$).

A. 140,
B. 70,
C. 280,
D. 420.

An adequate equation is the following.

$$\text{Required sample size} = \text{power index} \times (\text{SD} / \text{mean})^2$$
$$= 7.8 \times (15/5)^2 = 70$$

If you wish to have a power in your study of 80% instead of 50%, you will need a larger sample size. With a power of only 50% your required sample size was only 36.

Continuous Data, Power 80%, 2 Groups

What is the required sample size of a study with two groups and a mean difference of 5 and SDs of 15 per Group, and that will have a p-value of at least 0.05 and a power of at least 80%. (Power index $= (z_\alpha + z_\beta)^2 = 7.8$).

A. 140,
B. 70,
C. 280,
D. 420.

The suitable equation is given underneath.

$$\text{Required sample size} = \text{power index} \times (\text{pooled SD})^2 / (\text{mean difference})^2$$
$$(\text{pooled SD})^2 = SD_1{}^2 + SD_2{}^2$$
$$\text{Required sample size} = 7.8 \times (15^2 + 15^2) / 5^2 = 140.$$

The required sample size is 140 patients per group. And so, with two groups you will need considerably larger samples than you do with 1 group.

Binary Data, Power 80%

What is the required sample size of a study in which you expect an event in 10% of the patients and wish to have a power of 80%.

10% events means a proportion of events of 0.1.

The standard deviation (SD) of this proportion is defined by the equation

$$\sqrt{[\text{proportion} \times (1 - \text{proportion})]} = \sqrt{(0.1 \times 0.9)}.$$

The suitable formula is given.

$$\text{Required sample size} = \text{power index} \times SD^2 / \text{proportie}^2$$
$$= 7.8 \times (0.1 \times 0.9) / 0.1^2$$
$$= 7.8 \times 9 = 71.$$

We conclude that with 10% events you will need about 71 patients in order to obtain a significant number of events for a power of 80% in your study.

Binary Data, Power 80%, 2 Groups

What is the required sample size of a study of two groups in which you expect.

A difference in events between the two groups of 10%, and in which you wish to have a power of 80%.

10% difference in events means a difference in proportions of events of 0.10.

Let us assume that in Group one 10% will have an event and in Group two 20%. The standard deviations per group can be calculated.

$$\text{For group 1: SD} = \sqrt{[\text{proportion} \times (1 - \text{proportion})]} = \sqrt{(0.1 \times 0.9)} = 0.3.$$

$$\text{For group 2: SD} = \sqrt{[\text{proportion} \times (1 - \text{proportion})]} = \sqrt{(0.2 \times 0.8)} = 0.4$$

$$\text{The pooled standard deviation of both groups} = \sqrt{(SD_1{}^2 + SD_2{}^2)} = \sqrt{(0.3^2 + 0.4^2)} = \sqrt{0.25} = 0.5$$

The adequate equation is underneath.

$$\text{Required sample size} = \text{power index} \times (\text{pooled SD})^2 / (\text{difference in proportions})^2 = 7.8 \times 0.5^2 / 0.1^2 = 7.8 \times 25 = 195.$$

Obviously, with a difference of 10% events between two groups we will need about 195 patients per group in order to demonstrate a significant difference with a power of 80%.