Sample Size Guidelines

1. "**How many subjects do I need?**" is linked to the question, "**how many can I afford to get**?"
    - Sample size must be considered BEFORE collecting data, early in the design phase of the study, when major changes are still possible
    - Final decision must pay attention to the various constraints on recruitment, (i.e., affordability and feasibility)
    - Where the number of available patients is a known limiting factor, **sample size calculations should still be provided**, to indicate either
        - The power which the study will have to detect the desired difference of clinical importance, or
        - The difference which will be detected when the desired power is applied.

2. Justify your choice of **smallest effect**
    - Sample size is sensitive to the value of the smallest effect
    - Dividing in half the smallest effect will quadruple the sample size
    - Best to be conservative and assume smallest effect
    - Standardized effect size (Cohen's d) defaults:
        i. Difference in means (2 groups): 0.20
        ii. Difference in means (2+ groups): 0.10
        iii. Change in mean (matched samples): 0.30
        iv. Difference in proportion or prevalence: 10% or 0.10
        v. Correlation: 0.10
        vi. Relative risks, hazard or odds ratio:
            - 0.9 for a decrease, 1/0.9=1.11 for an increase

3. You may justify your sample size based on **similar published studies** that produced **clear outcomes.** You can pilot study data, data from other studies, expertise of those in the field and generic effect sizes.
    - Remember that effects are clear often because they are substantial
    - If yours turns out to be smaller, you may need a larger sample
    - You can use the sample size, effect size, p-value or CI from a similar **published crossover or controlled study** to estimate your sample size
    - Where prior information on standard deviations is unavailable, sample size calculations can be given in very general terms, i.e. by giving the size of difference that may be detected in terms of a number of standard deviations
    - Provide simulations!

4. Check the **assumptions and justifications** in published studies
    - Be skeptical about the justifications you see in the Methods
    - Most authors either do not mention the smallest important effect, or make some other serious mistake with the calculation

6. Optimum sample size/power depends on **study design**
    - Ways to optimize your sample size as you develop your study design
    - **Use continuous variables** – there is more information from continuous variables; so you get bigger power for given sample size or a smaller sample size for a given power
    - **Use paired measurements** – this reduces the between-subject part of the variability of the outcome variable
    - **Use more precise variables**, perhaps by taking duplicate measurements or refining the measurement tool
    - **Use unequal group sizes**, if it is easier to recruit in one group than another (e.g. case-control)
    - **Use a more common outcome** (versus rare outcome), i.e., one with a frequency closer to 50% rather than one close to 0% or 100%

7. **Descriptive studies often lead to comparative studies**
    - Rarely is a study aiming only to establish an estimate of a prevalence or an average value or a single pairwise correlation between two variables
    - Post-hoc analysis often involves informal inference and model-building to examine relationships and associations among variables
    - Estimation should also take this into account and sample size should be sufficiently large for analysis of future questions.
    - **Rule of thumb** for model-building: number of observations or cases must be 10x the number of independent variables in any model!
    - **Factor analysis**: use above rule of thumb with the added constraint that we have at least 100 subjects in total in order to do the job properly!

8. **For rank tests** (e.g. Mann-Whitney, Wilcoxon, Kruskal-Wallis):
    - Determine the sample size from the equivalent parametric test
    - You don't lose any power with these tests and when the data are not normal, they are more powerful than their parametric equivalent

9. **For equivalence studies**:
    - To show that two groups are "not different", that is, they are equivalent, requires setting power higher (say .90 or .95) and the effect size smaller, small enough so as not to be clinically significant
    - With bigger power and smaller effect sizes, equivalence studies require larger sample sizes!

10. Keep in mind that the calculated sample size may also need to be adjusted for any **potential losses** (e.g. loss to follow-up, non-compliance). Include an allowance for **losses to follow-up**:
    - Calculated sample size is the minimum number of cases needed for analysis
    - Inflate by 10-30% if potential attrition is expected
    - Might need to be set as high as 33% if elderly or very ill patients are the subjects

Online Calculators

There are some dedicated programs on the web. It is highly recommended to confirm with a statistician, after you determine a sample size.

1. Dr. Rollin Brant's sample size calculators (*University of British Columbia*)
   https://www.stat.ubc.ca/~rollin/stats/ssize/

2. Statulator
   http://statulator.com/SampleSize/ss1P.html

3. Sample size and confidence intervals calculators (*UK Consulting*)
   https://select-statistics.co.uk

4. Sample size, effect size, CI's: clinical trials, ORs, survival, clustered sampling (*UCSF*)
   http://www.sample-size.net/

5. Power and Sample Size (Over 30 calculators: ORs, survival, inferiority studies)
   http://powerandsamplesize.com/Calculators/

6. Vanderbilt University software for power and sample size: regression, survival
   http://biostat.mc.vanderbilt.edu/wiki/Main/PowerSampleSize

7. Calculator for power, effect size and other statistical tools
   https://www.danielsoper.com/statcalc/

8. Harvard University calculator for epidemiological applications
   http://hedwig.mgh.harvard.edu/sample_size/size.html

9. Qualtrics sample size calculator for surveys
   https://www.qualtrics.com/experience-management/research/determine-sample-size/

10. G*Power software
    - Download software:
      https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower.html

    - Tutorials: https://stats.idre.ucla.edu/other/gpower/