***Helping you to use: Statistics for Healthcare Professionals,2e* by Scott, *and* Mazhindu*: with brief guides to using* SPSS and Excel**

Contents

Introduction

The guide is intended to be used in conjunction with the book, S*tatistics for health care professionals,* second edition (which will be henceforth referred to in this document as "the book").

The book is written as an introduction to statistics and is designed to allow the reader to develop a firm base upon which to build. For many people studying healthcare statistics can often be an intimidating subject. When using this book we encourage you to practice as you go. In each chapter you will find exercises both within boxes and at the end of the text; please try to find time to undertake these tasks. We have attached the data files belonging to the hypothetical studies that we use, so you will be able to complete many of the exercises using the computer packages described below. The data for the study on sexual health can be found in file named **Questdata**, whilst that for the hypothetical experiment in **Symphdata** both these files are in *Microsoft* Excel format. You will also find on the site guides for using *Microsoft Excel* and *SPSS* with the statistics described in this book.

Chapters 1 & 2

Chapters 1 & 2 provide a background to the use of statistics within healthcare and explain how the scientific approach is intrinsically linked to statistical analysis. The chapters look at what is meant by evidence based practice and how statistics are used within the context of this modern health care mantra. Chapter 2 includes a discussion concerning taking a critical approach to looking at research; whilst this chapter may seem rather early we feel it is an important element because many students will become consumers of research before they are producers of it. Useful exercises to accompany these chapters are to: question the belief associated with the quantitative paradigm and to examine what constitutes evidence in the context of evidence based practice. You may like to compare your views of evidence with those of health agencies such as the National Institute for Clinical Excellence (www.nice.org.uk); or the Medical and health care products regulatory agency (http://www.mhra.gov.uk).

Chapter 3

Chapter 3 provides an introduction to notion of error and the measurement of error. It discusses in particular measurement error, design errors and sampling error. Useful discussion that can be had here are around what makes a good design. This of course, links back to chapter 2, which is concerned with the nature of evidence. Students tend to be able to grasp the concept of measurement error well particularly when it is demonstrated, in practical sessions. With respect to design error, it is a good idea to discuss common design issues such as sampling methods and how representative the sample is. These are key factors that often let research papers down. It is worth noting that researchers work in the real world and therefore there is a theory practice gap; most papers are not perfect, but do they make fair and reasonable conclusions? The social research methods website (http://www.socialresearchmethods.net/kb/sampstat.php) provides good additional background and detail to this topic.

Chapter 4

Strictly speaking, this chapter on questionnaire design belongs in a book on research methods, however we included this chapter because so many healthcare students start their research careers by conducting questionnaires. In addition, many healthcare workers are involved in responding to the outcomes of surveys based on questionnaires (e.g. patient satisfaction surveys). Thus we thought that including a brief chapter on questionnaire design and data to analyse would provide a useful back ground as well as allowing fruitful reflection of the potential errors and issues generated by this much used research tool.

Many questionnaires are available from web sites (e.g. http://www.outcomes-trust.org/instruments.htm). These questionnaires have been tested, explored and evaluated. You can also analyse the questionnaire for leading questions. Exploring the ability to lead participant's answers can be a very interesting activity; this can be done either by trying to spot such questions in existing questionnaires or by asking students to write their own leading questions. Students can be asked to investigate the outcomes of using different questions to explore a particular phenomenon. The results from these investigations can be analysed statistically at a later date. Debates over which scale to use and how many options to use rattle on and this blog gives a useful overview of some of these discussions http://www.surveygizmo.com/survey-blog/question-scale-length beware it is a blog so look for the evidence to back-up what people are saying.

Chapter 5

This chapter gives details of the two hypothetical studies that are referred to throughout the book. You should use them to both practice using statistics, as well as for critical analysis. The studies are not perfect and students should be encouraged to evaluate their design and discuss sources of error. The data 'generated' from these studies can be found in the files Syphmdata and Questdata.

Chapters 6 and 7

In chapter 6 and 7 we look at descriptive statistics and displaying data. These are important chapters because the vast majority of the statistics which, health care professionals encounter are descriptive in nature, and often they are displayed in the form of graphs and tables. So, do take time to master the content of these chapters before moving on. The concepts of measures of central tendency can be explored using commonly quoted statistics, for example, comparisons of national mean, median and mode wage levels often yields fruitful discussion and can be linked to the notion of dispersal as well. A good source of 'real data' to work with can be found at http://www.statistics.gov.uk/ . These data sources can also be used to practice displaying data. The more 'real' the data the higher the level of engagement with the activity will be.

When presenting data graphically there is a tendency for some to focus on the aesthetics of the graph and to lose site of what we are trying achieve. The purpose of the graph is to convey information to the reader as efficiently and as clearly as possible; not to look pretty. The website, '*Gallery of Data Visualization: The Best and Worst of Statistical Graphics*' located at http://www.datavis.ca/gallery/ provides some excellent examples of the good, the bad and the confusing from the world of data presentation.

Chapter 8

Chapter 8 provides an interlude between descriptive and inferential statistics. For most of us, the most common type of statistic we see and hear are descriptive statistics. In this chapter we look at the ways in which data are gathered and presented can give rise to some strange and often erroneous conclusions. This chapter therefore has lessons on how to avoid making these such conclusion but also in how to look beyond the data presented. So as with all research, when reading statistical data the message is caveate emptor – buyer beware; if you do not want to be misled by statistics you need to understand them. ***.*** ***An amusing video that takes a sideways look at the statistics can be found at*** *http://www.ted.com/talks/lies_damned_lies_and_statistics_about_tedtalks.html* ***.*** Some more serious case are discussed can be found at http://www.badscience.net/

Chapter 9

In this chapter, the nature of the hypothesis and its relationship with statistical testing is discussed. The concept of chance is also introduced. We raise the issue of the difference between clinical and statistical significance. The distinction between independent and dependent variables is discussed, as is the idea of testing for significant difference or association. Understanding the content of chapter 9 is essential to a full appreciation of the chapters that follow. Students will often struggle with the notion of the experimental hypothesis, and find this concept difficult to distinguish from that of a theory or paradigm. It is thus a good idea to establish clear definitions. Similarly students will be helped if a clear link is made between statistical hypotheses developed and their associated experimental hypothesis. This web site http://stattrek.com/hypothesis-test/hypothesis-testing.aspx?tutorial=ap is good for revision and provides some an overview of the basics.

Distinguishing between investigations that look for either relationships/associations can normally be improved by reference to a range of different published studies. For example selecting a range of titles of recently published journal (quantitative) articles and then imaging the types of study that were undertaken can produce informative discussion.

The notion between of the difference between the independent and dependent variable tends to be easily grasped particularly when dealing with correlation and regression. Thinking about which variable is causing the effect tends to sort out most problems. Do be aware that particularly with regression analysis the distinction is not always clear (This phenomenon is discussed in Chapter 17).

Chapter 10

This chapter, as with the previous one, provides detail of concepts vital to understanding of the rest of the book. Its focus is probability and its use in statistics. There are four areas to the chapter: probability; probability and its link to statistics; the normal distribution curve and other distributions. It is important that a good understanding of the first two areas (at least) is established before progressing with the rest of the book.

Probability is an area of maths, which many people struggle with; so, if you find difficulties with this section you will not be alone. Probability is a concept that most health professionals will deal with every day although it is normally referred to as risk. When we consider what the risk of an event is we are really say what is the probability of this event occurring. To improve skill in the use of probability the best tactic is to practice (e.g. trying to make predictions of events such as pulling two 'hearts' from a pack of cards). If you struggle with probability try having a look at this site prepared by the BBC http://www.bbc.co.uk/bitesize/ks3/maths/handling_data/probability/revision/1/ and if you like football http://plus.maths.org/content/understanding-uncertainty-football-crazy this site may help you when it comes to predicting the outcomes of matches.

The link between probability and statistics for beginners tends to centres on the notion of the significance level. The understanding of this phenomenon tends to improve with practice (try performing and analysing mini experiments); as well as through reading journals and going over what the statistical tests used actually mean.

Chapter 11

Chapter 11 shows how distribution curves (and their associated probability functions) can be used to make predictions. The chapter provides a firm link between chapters 8 & 9 and the use of statistics to make inferences or predictions. As we say at the start of this chapter, the best way to improve is to practice. Exploring the use of z scores in your practice area or home life can be informative – they can be used to make predictions about any phenomenon where the data collected are more or less normally distributed. We think one of the best ways to practice is in groups. Study groups provide mutual support and help.

Chapter 12

This chapter forms one of two that look at statistical test for differences between samples. We would encourage you to attempt at least one statistical test using hand calculations. We appreciate that this does take time but also feel that with the advent of calculators people have become less and less familiar with the use of numbers and looking at how they interact. We have included details of the mathematics involved in many of the tests, along with worked examples. If you are going to use a computer all of the time, these will be of less interest to you, although working through the examples will help you become familiar with the language of statistics particularly that used with more advanced tests. I tend to introduce many statistical test by running mini-experiments; for example I ask students to measure their pulse rate before and after a light (five minutes walking) bout of exercise; I will often perform the analysis live (using Excel); we can then discuss the results and their presentation. You can see a video of someone going through this here http://www.youtube.com/watch?v=JlfLnx8sh-o Exercises like these can also be used to discuss other statistical phenomenon such as sampling and error. Do make sure that any activity you might use is ethical, and safe for the participants. The social methods web site gives more examples of teh application of t-test and the theory behind the t-test http://www.socialresearchmethods.net/kb/stat_t.php.

Chapter 13

Here the notion of ANOVA is introduced. Sometimes it is difficult to get the importance of Type I and Type II errors over. Thinking of examples of what could happen in clinical practice if they weren't considered often brings home this point. (see http://the-brain-box.blogspot.co.uk/2013/04/statistical-power-is-truth-power.html) This chapter on ANOVA follows the style of that used in Chapter 11, and again we would encourage you to practice. We include in this chapter an explanation of the repeat measure design. Repeat measures designs are frequently used in clinical studies, however their statistical analysis is quite complex; we have provided references for those who wish to pursue these designs at this stage. This gentle little video talks through ANOVA http://www.youtube.com/watch?v=-yQb_ZJnFXw

Chapter 14

The statistical tests described in the previous chapters rely on the data being distributed normally. In this chapter, we look at test that can be used to determine if samples do deviate significantly from normality, and what to do if they are not normally distributed. If you look in published literature you will often find that the authors do not state whether or not they checked their data's distribution before applying statistical tests; this can lead to errors particularly when the tests assume a specific distribution type (i.e. parametric tests). We encourage you to look at how different phenomena are distributed (e.g. physical measurements, measures of IQ, disease distributions), and to explore how these can be transformed into a normal distribution.

Chapter 15

This chapter concerns non-parametric tests and follows from the previous discussion on transformation. If you find that your samples cannot be transformed; you will need to use a non-parametric tests. We practice you will automatically know when non-parametric tests are going to be the better option. As a rule of thumb, data collected on an ordinal scale tends to be difficult to transform, and unless your set of data is large, non-parametric tests are probably going to be the better option. A wide range of tests are described in this chapter and we suggest that you work through at least one by hand.

Many of the tests rely on ranking the data; and working through this process will give you a fell for what the test actually does.

Chapter 16

The previous chapters looked at statistical tests that can be used to investigate if there is a significant difference between samples; chapters 15 and 16 describe tests that can be used to look for significant associations between variables. Chapter 16 looks at chi-square tests whilst chapter 16 addresses regression and correlation.

Chi-square calculations are quite easy to perform by hand. With more involved contingency tables using an Excel spreadsheet is useful. The interpretation of one-way and tests for homogeneity causes few problems. These tests tend to be used for nominal or ordinal type data. They are sometimes used in relation to Likert scales although when used here it is highly likely that the assumption of independence is broken. You can practice using chi-square tests using naturally occurring nominal phenomena (e.g. eye colour) or non-natural classifications (e.g. individuals' geographic origins). You may want to discuss how we classify cases into their particular nominal group; it is not always as straightforward as it seems. When interpreting contingency tables it is possible to identifying which cell are contributing most to the significance of the chi-square statistic. These are the cells where the difference between the observed and the expected result is greatest.

Chapter 17

Correlation is a very widely used statistical test. The correlation test is straightforward, however, its interpretation often leads to problems. This is because it is very easy to believe that correlation implies cause and effect; unfortunately, it doesn't. Correlation implies only that there is a relationship. When you find a correlation, it is always worth thinking about what might be causing the relationship. A good exercise is to try to devise your own spurious correlations; is there a relationship between the amount of jam consumed and the number of fatal road traffic accidents? There is a whole on-line journal http://www.jspurc.org/news2.htm devoted to exposing spurious correlations.

The second part of this chapter concerns bivariate linear regression. The use of bivariate linear regression should be confined to situations where you want to know the equation that defines the relationship between the variables of interest. This web site http://www.le.ac.uk/bl/gat/virtualfc/Stats/regression/regrcorr.html has a view on the difference between correlation and regression.

Chapter 18

Chapter 17 concerns tools to help when making clinical decisions where there are a range of potential therapies available, each of which may have been independently assessed. The two tools are Numbers Needed to Treat and L'abbe plots, both these techniques allow the risks associated with a particular approach to be set in a clinical context. Many examples of these approaches can be found in the on-line evidence based health practice journal Bandolier. It is a good idea when using these techniques to results from studies that have been published in systematic reviews. In such reviews, the authors assess the quality of the material used. To make sure that the inclusion criteria used by the systematic review matches your expectations. Examples of systematic reviews can be found in the Cochran Library (http://www.nelh.nhs.uk/cochrane.asp) access to which is available free to many students studying health care.

Chapter 19

Probably the most common questions students undertaking research ask is: 'How big does my sample need to be?' This chapter starts to answer this complex question, which has practical as well as philosophical considerations. There are web sites that will help you calculate your sample size needs bur beware these often assume a particular test type. A better option, for the serious researcher may be to obtain specific software for this purpose such as

PASS. This paper provides a good discussion of sample size determination in clinical studies http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3409926/

Chapter 20

This flow chart will help you to select the type of statistical test that you need. If you are stuck read the review chapter.

Guides to computer programmes for statistics

There are two guides attached to this file. They look at two computer packages that can be used to perform statistical analysis; the first section will look at Microsoft Excel® the Second SPSS® (Statistical Package for Social Science). Both Excel® and SPSS® computer programmes are widely available they are, however, very different particularly with respect to their ease of use, accessibility, cost and the range of statistics that they can perform.

This guide assumes that you are able to use a personal computer (PC) and are familiar with programmes that use things such as windows and icons. It assumes that you can: open and close files and programmes, that you can save work and that you have at least used a computer for word processing. This guide is not a meant as a comprehensive manual to the packages described but as a brief introduction to get you started. As with most computer packages, as you explore them you will learn more our advice is to be brave, try new things and if possible keep the manual handy.

Using a statistical package when calculating statistics tends to produce less errors; this is because in general computers are extremely good at performing calculations, so tend not to make mathematical mistakes. You can also use computer packages to help but your data in a convenient form for storage and for any subsequent manipulation (e.g. expressing data measured in grams as kilograms). If you have a number of statistical calculations to perform you will find computer packages a great help. You do need to remember that learning a new computer package will take time; however think of this time as an investment, the next time you need to use the package it will be much easier.