

Ian Scott and Debbie Mazhindu

STATISTICS

for Healthcare Professionals

An Introduction

SECOND EDITION



Los Angeles | London | New Delhi
Singapore | Washington DC

2

The statistical approach: when should it be applied?

Areas of learning covered in this chapter

- What are the major concepts in statistical analysis?
- What types of studies use statistical analyses?
- Where do statistics fit within the research framework?

In our first chapter we discussed how an understanding of statistics is essential if professionals are to engage with the development of professional knowledge and practice. But what are statistics? Why use the statistical approach and when should it be applied? How do we know if the right test has been used when reading and evaluating research?

What are statistics?

Statistics is a term that derives from the Latin *status*, meaning state, and historically statistics referred to the display of facts and figures relating to the demography of states or countries (Bhattacharyya and Johnson 1977). In French, the term *recherche* (research) means to go and look for something. The statistical approach involves defining phenomena in terms of numbers and then using these numbers to either imply or deduce cause and effect. Statistics are a key research tool for quantitative researchers.

Box 2.1 Reviewing

Take a brief look at some quantitative studies. Make a list of (a) the descriptive statistics used and (b) the inferential statistics used. You will find web addresses to articles you can access in many of this book's chapters.

Today statistics are used in a whole variety of studies and investigations. Statistics are used to summarize and describe the data from studies where the data is collected in the form of numbers. Statistics are used to look for patterns and to ascertain the probability of observations having occurred by chance. Statistics are thus a vital tool that underpin all quantitative (number-based) research.

The scientific method

The process of collecting facts in a systematic manner is valued as the basis for the concept of evidence-based practice. This is because, predominately, knowledge for practice is predicated upon the belief that the world and its inhabitants can be viewed objectively, and predictions about things can be proved or disproved. Having a view about how knowledge is created and tested that is shared generally with other people in the world is called a 'world-view' or **paradigm**.

Some beliefs associated with statistics from the quantitative paradigm:

1. Observation and reason are the basis of knowledge.
2. Observations can be numbered, coded, ranked, organized and analysed.
3. Measurements are best made using numbers, as they are unlikely to be tainted by feelings or emotions.
4. Numbers are the best basis for analysing research as they are unlikely to be tainted by feelings or emotions.
5. Individuals are observers of the physical world set on discovering laws that can be used to govern the world and its inhabitants. The rules of the physical world can be represented as universal laws, by which predictions can be made and efforts made to control environments (e.g. the laws of thermodynamics).
6. Individuals of the world respond mechanically to their environment by obeying predetermined universal rules (e.g. touching a hot plate will produce the same reaction in individuals across the world).
7. Reality is not internal to each individual but external to the individual and has an objective nature that can be observed.
8. Events in the world all have causes, which can be discovered through the process of hypothesizing and theory testing.
9. Knowledge exists independently of the individual and is something that can be transmitted and tested for.

Box 2.2 Where do you stand?

Take time to reflect on points 1–9 above; which do you agree with? Are they interconnected? Can you logically agree with some but not all of them?

An alternative view

Whilst this book has a clear focus on statistics and quantitative techniques within research it is worth noting that other forms of data exist. Researchers who use these techniques tend to see the world as socially and individually constructed, with individuals' perceptions and interpretations being the basis of reality. This paradigm is quite different from the quantitative paradigm and has distinctive features.

Researchers who use qualitative data-collection methods view participants as collaborative partners in the research process, who will bring to bear all their biases, variability and individual prejudgements to the data. Qualitative researchers acknowledge this and also acknowledge their own effect on data creation and recognize their 'effect' upon the research co-participants.

Qualitative researchers tend to inform participants in advance of data collection, tell participants what it is they are researching and believe that by being open, honest and reflective about their research the data collected will therefore be more representative of the topic or phenomenon being researched. Qualitative researchers acknowledge and analyse the effect the researcher has had upon the data-gathering process and of working with numerous uncontrollable variables.

Qualitative research design is very elastic and flexible enough to pay attention to the multiple sources of participants, of data and potential biases that will inevitably influence the data, once enough evidence has been gathered and analysed to support the case being presented. Qualitative researchers often use techniques such as questionnaires, interviews, focus groups, narratives, historical and contemporary document analysis.

Researchers who gather quantitative data, on the other hand, take steps to eliminate biases and attempt to control as many variables as possible, to try to ensure that data is 'uncontaminated' or unbiased. Some researchers combine qualitative and quantitative data-collection methods; such studies are often referred to as mixed method designs.

The characteristics of research methods that use statistics

Given that quantitative studies tend to have a universal philosophy, they also tend to follow a universal method; this method is commonly known as the scientific method, although it is worth noting that the idea of the scientific method is not confined to quantitative research.

These methods have a number of distinctive qualities, although not all of these will be seen in every study. Studies based on statistics will generally attempt to control the influence of factors (variables) that are not important to the actual study although they could bias the results. All statistical studies rely on evidence derived from observation or experiment as the basis for any new knowledge generated; such information is given the term 'empirical'. An important aspect of empirically based evidence is that it is itself verifiable or provable by observation, experiment and/or replication.

The majority of studies using statistical methods seek to test hypotheses (an idea or theory); by test we mean to disprove (Popper 1959). Thus the studies based on statistics tend to involve the collection of empirical evidence in order to disprove a hypothesis. In general, when using statistics we try to produce results that are generalizable; that is the results from a sample are applicable to the overall population of individuals we are interested in. The link between the sample and the population is the focus of many statistical tests.

Within research the statistical approach is used to:

- describe variables and their relationships;
- help explore the nature of relationships amongst variables;
- help explore the differences between samples and populations;
- help investigate the role of chance in giving rise to measurements;
- help explain relationships between sets of data;
- predict the causes of relationships amongst phenomena;
- control (take account of) variables.

When we examine or establish research using statistics the method used should, more or less, follow the form described below. As it is not the purpose of this book to detail all the research methods, we will not go into the detail of the different aspects of all the methods but focus on indicating where within the research approach adopted statistical analysis lies.

It is possible, for example, to be both analysing data and collecting it at the same time. Indeed, the whole research process should be seen as very dynamic.

Box 2.3 Using studies

Ram Patel works as a nurse in a neurological out-patient department. He is concerned that the level of immediate post-consultation care may be inadequate, particularly in light of the fact that many patients receive disturbing prognoses following their consultations. He decides to embark on a study to assess the impact of the consultation on his patients' immediate health; he intends to use the results to help make a case to increase the allocation of staff to post-consultation care. Ram is aware that he needs to take measures pre- and post-consultation.

1. What quantitative aspects of health could Ram measure?
2. How could Ram use his data as part of an argument to justify more resources?
3. What types of data do you think health care managers prefer to use and why?

Basic parts of the research method

Forming the question(s)

Identify the problem or phenomenon of interest. Decide on the outline of the study, population to be studied and questions that will be investigated. Through searching the literature and drawing on your own thoughts decide on which methods will be used to gather data. At this stage a small pilot study may be conducted that will allow potential problems to be highlighted and obviously if any do come to light there will be a need to revisit the questions being addressed.

The literature review

A vast body of literature that exists concerning many areas of health care; it is essential that any new work is set in the context of any previous or concurrent work. It is also essential that the literature is reviewed so that we can learn from this work before we move on. The literature review will probably start from the moment a research idea is conceived, and it will continue throughout the study.

Conceptual and theoretical frameworks

There are different ways of viewing problems. Many areas of investigation have distinct frameworks and concepts on which the evolution of new knowledge is based. It is important to be aware of these for the particular type of study you are working on. It is likely that a biologist and a sociologist will use different concepts and attribute varying levels of importance to different types of data. Despite having different lenses through which to view the world both these academic disciplines use statistics a great deal.

Hypotheses and variables

In many studies there is a hypothesis; this is a prediction or series of predictions that are under test. Normally the hypothesis originates from a theory. We test hypotheses by measuring relevant variables and investigating how they relate to each other and the populations from which they originate. A variable is a phenomenon (thing) that varies. Not all studies have hypotheses, for example descriptive or exploratory studies.

The research design

The design provides guidelines with which you conduct the research. The design directs the sampling technique and how the data collected is to be analysed. The principal aim of the research design is to minimize all the potential sources of error. It should also strive to ensure that any hypotheses that are under test are actually tested, i.e. the research design should allow the aims of the research to be met. At this stage you must also consider the ethical implications of your work.

Population and sample

The population is composed of all those individuals or objects that you could potentially take measurements from; the sample represents those individuals or objects (given the constraints and resources) that you were able to measure from. Normally we plan to take a sample that is representative of the population being studied. This is subject to the research design being approved by an appropriate ethics committee. You can use statistical techniques to help you to determine the sample size

Data collection

You collect the data, using the method or tool most appropriate.

Data analysis

Here the data are described and summarized, and statistical tests performed. Today, there are many computer-based statistical packages available to help.

Results and conclusions

Having analysed the data you now need to decide what the results are suggesting. You need to decide whether or not any hypothesis under test has been confirmed or rejected. The results need to be related to those from previous studies, and the work needs to be related to an existing body of theory. You should also consider whether you have an ethical duty to communicate the findings of the study.

How do we know if the statistical analysis is any good? Analysing statistics critically

The major concepts involved and the statistical language will become more comprehensible as you go on to practise and undertake the exercises at the end of each chapter.

As you become more familiar with statistics you will be in a position to make up your own mind whether you feel a research report that uses statistical analyses is of value. The process to use in making up your mind is the process of getting critical. Getting critical takes a long time, lots of practice and reading of research reports. Do not worry if this seems insurmountable at this stage. Getting critical requires practice and an understanding of statistical concepts.

The process of becoming critical is ongoing and developmental. Once you have tackled an analysis of a research report, your skills will develop and refine. Reading from a wide variety of sources enhances the development of skills for becoming critical. Health care professionals should be encouraged to carry out and critically evaluate research in order to secure the best evidence base for care.

As you go through this book and work through the exercises we hope you will become more critical of how you view statistics. That is to say, we hope you will view all statistics with which you are presented with a healthy degree of suspicion and that your skills and knowledge (enhanced and honed through using this book) will enable you to evaluate if the statistics have been applied appropriately and correctly.

A critical analysis should be considered a balanced evaluation, that is, you need to be aware that a practice theory gap exists even in the field of statistical analysis, which means that sometimes we need to make compromises.

Before starting an evaluation you will need to remind yourself of the steps in the research process and refer to the appropriate chapters in this book. A very important point to remember when carrying out an evaluation is that just because research is published it does not guarantee

that the results of an investigation are either valid or reliable. This is ever more so given the large amount of information published on the web.

In Appendix 1 we present a framework that can help you evaluate the statistical components of research and other reports; do bear in mind that there may be other aspects of the research as well as the statistics that you might like to focus on. When evaluating statistical aspects of research reflect on why statistics are used (see above). You can use Appendix 1 to help you practise to become critical; we suggest that you start using Appendix 1 once you feel you have become more familiar and content with the basic concepts of statistical analysis.

Having read this chapter and completed the exercises, you should be familiar with the following ideas and words:

- statistics;
- the 'beliefs' of quantitative research;
- the research method;
- the components of the statistical approach;
- the basis of analysing statistics appropriately.

Select three research papers that report quantitative research.

1. Identify where the steps in the scientific method lie within the paper.
2. Decide whether the papers follow the 'beliefs' outlined in the list of beliefs above.
3. At this stage, how do you feel about the conclusions that the authors reach and the implications for practice? What would you require before implementing a change?