Ian Scott and Debbie Mazhindu

STATISTICS for Healthcare Professionals

An Introduction

SECOND EDITION

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SAGE Publications Ltd
1 Oliver's Yard
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About the Authors

Ian Scott is Associated Dean for Student Experience in the Faculty of Health and Life Science at Oxford Brookes University. He has worked in higher education for over 20 years and in 2011 was awarded a National Teaching Fellowship. Ian's main research area is learning in non-classroom environments. He has published in areas such as experiential learning in professional education, the recognition of prior learning and the role of fieldwork in environmental education. Ian's love of statistics developed through his first degree which is in Applied Biology. Ian lives with his family in Great Malvern, UK and in his spare time enjoys sailing and cycling.

Debbie Mazhindu is Reader in Clinical Practice Innovation in the Faculty of Society and Health, Buckinghamshire New University (BNU) and Imperial Healthcare NHS Trust. Debbie has over 24 years teaching experience and has worked in senior management and strategic levels within six different universities in the UK and abroad. Debbie is a qualified Nurse (Adult), Nurse Tutor and Registered Practice Educator (NMC), and has over 16 years clinical experience in: Intensive Therapy and Coronary Care, Accident & Emergency, Medical and Surgical and Care of Older People.

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Additional Online Material

Additional online material focuses on use of well know computer programmes that are currently used to analyse statistics. The material guides users in how to undertake, the various statistical tests described in the textbook using statistical software. It will give access to the data sets of the hypothetical studies outlined in Chapter 5. Through using the resources you will become more practiced and adept at analysing data with statistics.

Visit www.sagepub.co.uk/scott2e for access to the following materials which accompany the book:

Guide to using Microsoft Excel
Guide to using SPSS
Datasets

1

Statistics for health care research

Areas of learning covered in this chapter

- How can you use this book and use statistics to enhance practice?
- What is evidence-based practice (EBP)?
- How are statistics used to enhance evidence-based health care?
- How can statistics help you to evaluate professional knowledge and professional values as the evidence base for practice?

Scope of the book

This book aims to expand health care students' and professionals' knowledge and understanding of statistics within health care practice. We hope that through reading and using this book you will be encouraged to evaluate statistical analysis as a technique and its relationship to evidence-based practice, and develop a practical understanding of basic statistics. There are many different approaches to investigating questions in health care practice. We deal with quantitative approaches to investigating problems in health care, which require an understanding of some of the rules and principles of statistics. Understanding research in health care requires appreciating both qualitative and quantitative approaches to analysing data. Students of health care professions, both medical and non-medical, can expect to encounter a range of research approaches, which use particular statistical techniques to derive answers to particular patient problems. To this end, health care practice involves understanding of a range of research techniques within health-related subjects, including the use of statistics.

Glossary When you see a term in **bold** you may want to look it up in the glossary of terms at the end of the book. This will explain terms used and help you to remember key words.

For many students and practitioners of health care, statistics is a subject that can often appear incomprehensible, daunting and, worse still, far removed from the real issues and problems encountered when caring for people. Within the book we try to demystify some of the more commonly used statistical tests and help readers understand the language of research that uses statistics, which both novice and advanced researchers find very off-putting to read. Undertaking the exercises within and at the end of each chapter will encourage you to think critically and reflectively about the research that you encounter, both in terms of the statistical process and the dynamic health care context in which studies are executed. The book can be used as a basis for taught courses on statistics at both pre-registration and post-registration level and as a reference guide for those using statistics in health care settings. The book is an introduction and aims to take you from novice to advanced beginner. Statistics is a vast subject which many people find difficult. We hope to make the learning process easier, but we can't promise an effort-free process.

The book is divided into twenty chapters. Each contains explanations of its terms and use for reference. A glossary has been provided and every time you encounter a word in **bold** print you can look up a short definition in the glossary. At the end of each chapter you will find questions and exercises. Using these exercises will allow you to practise, become more proficient and develop your understanding.

The book takes a 'how to' approach, which explains how specific statistical tests can be performed. We have included details of how to calculate many of the statistics by hand, because doing at least some of the statistics by hand will help you to get a feel for the processes. As the statistical techniques become more advanced, readers are directed towards suitable computer packages and other literature. Understanding statistics can sometimes be difficult for students of health care, as statistics often appear far removed from immediacy of patient problems. Examples of statistical techniques commonly used will be explored and the results of a hypothetical questionnaire on sexual health and a clinical trial are used to encourage you to practise and explore statistics. We encourage you to try calculating statistics by hand, at least at first as this will help you to develop a feel for what is going on. Computers with statistical packages are now more readily available in some health care settings, particularly in the more industrialized parts of the world. As tests become more advanced and you feel more confident, do try to use the statistical computer packages that are available. (A short guide to using SPSS and Excel can be found at www.sagepub.co.uk/scott2e.)

The use of clinical and community-based studies will form a central thread to allow data analysis to be explored from the perspective of differing subject areas. As well as analysing data from the studies provided we encourage you to analyse your own data, collected in response to some sample questions.

We encourage you to think critically about data analysis and research design and how appropriate research design impacts upon evidence-based practice, because an understanding of statistics is essential if the numerous reports and documents issued within the health industries are to be scrutinized and considered in a critical manner.

Box 1.1 Reflective exercise

Take a few moments to think about the decisions made in health care today.

- How do we make decisions about what is the best care for patients and clients?
- How do you make decisions about what is best for you?
- How do you feel about making decisions that may affect another person's life?
- How do you feel about people's health?
- How do you feel about circumstances which may affect a person's ability to: give birth, father or mother children, recover from cancer, cope with devastating trauma, cope with loss or grief, help someone integrate back into society after mental illness?

How do we as health care providers analyse such problems and then come to reach decisions that have an impact on many people's lives? The answers to these questions lie in the basis we use for our professional knowledge, the power we have to implement changes in practice and what constitutes our evidence base for our practice.

After reading this book, we hope that your skills of critical analysis will have become more refined. We anticipate that you will have a better understanding of the process of research and the use of statistics and all that is involved in getting answers to problems. We hope that you will be able to understand the importance of carefully reading and reviewing research reports in order to come to conclusions about their relevance to your area of practice. It is also hoped that you will begin to feel comfortable talking the language of quantitative research, which can assist you when presenting a case for changing or improving an area of practice.

The use of statistics in health care research

There has been an increase in the development of research-based and evidence-based practice (EBP) in health care over the last two decades. For students undertaking professional health care education and those practising as professionals in health care, understanding the statistical terms used in research is of paramount importance when evaluating research studies.

One of the key aims of this text is to enable the development of a greater understanding of the process and practice of using statistics in order to find answers to complex health problems. After the initial preparation to practise health care, qualified practitioners are charged with a duty to care for patients and clients in the best manner possible. This means: taking account of patients' and clients' family life and their involvement with others, the knowledge and skills attributed to practice, medical orders and the role of the allied health professions (AHPs). Understanding statistical terms and analysis helps practitioners to make sense of the many research studies that underpin EBP, takes account of professional values as service providers to the public and enables practitioners to undertake studies themselves.

What are the goals of health care research?

The primary goal of health care research is to aid patient and client care by developing a scientifically based body of knowledge, which can be used to help us with decision making, to develop new practice and promote the professional role. The degree to which a body of people such as health care professionals can be judged as professional resides to a large extent on the body of specialist knowledge that they can draw on for practice. Developing a specialist knowledge base by a process of scientific enquiry can aid the professional standing of a professional health care provider. The ultimate aim of health care providers is the delivery of safe, effective care for patients and clients. This is an essential prerequisite in all health care professionals' codes of conduct.

Understanding statistics is just one way of ensuring that professional practice is based on the best available evidence to date by which to treat and help the wider community. Health care research shares many of the qualities of practice interventions, as they are both practical and intellectual activities, which have a defined language to learn. Good practice and good research do not spring from *ad hoc* or sloppy practice. Health care practice and health care research both use processes which when applied rigorously can improve patient care. Health care practice that is ritualized, not research-based and not assessed, not planned and (more importantly) not evaluated to see if it makes a difference to patient care can kill people, as it leads to unsafe practice. Evidence of this is to be found in the various catalogues of disciplinary hearings concerned with the safe conduct of health care providers of all disciplines.

Box 1.2 Professional values

Take a look at this set of values, which are common to most health care professions; how do you think a knowledge of statistical analysis could help you to maintain these values?

- To practise within the various codes of conduct, which regulate your chosen health care discipline.
- Be aware of cause and effect of health and ill health.
- Track progression and regression of health states and disease.
- Serve society by implementing the best practice based on available evidence.
- Teach new generations of health care professionals by using up-to-date research findings.
- To be self-governing and self-regulating in order to protect and serve the public.

Randomized control trials (RCTs)

Currently in health care practice, the 'gold standard' type of research is the randomized control trial (RCT) but even this kind of research has its critics and is not immune from accusations concerning its truthfulness and the way RCTs are conducted. For example, there are disagreements about how many RCTs should be undertaken before the outcomes can be used as

evidence, how big the samples are to be legitimized as '**representative**' and how 'international' a range of samples are before data is acceptable as 'significant'**.** An RCT is a highly specialized research undertaking as usually the patients are carefully selected prior to randomization; usually they are younger and healthier than the people who will actually be taking the drug, and the people in the sample selected will only usually have one thing wrong with them and only be taking that one drug. Conversely, people in the 'real world' will be older and very likely have two or three conditions for which they are also taking five or more drugs making comparisons difficult if not impossible. RCTs do, however, remain the 'gold standard' form of research in health care.

The fact remains that research, from whichever perspective, that is not rigorous, systematic, ethical and well designed can have devastating effects on people's lives. The thalidomide drug research is a case in point. Maynard (2003) suggested that medication errors occurring in health care in the United States kill twice the number of people per year than those who died in the terrorist attack on the World Trade Center on 11 September 2001. The prevalence of Methicillin-resistant *Staphylococcus aureus* (MRSA) and other resistant microbes causes great concern across the globe. In France, four times more antibiotics are consumed *per capita* than among Dutch patients, with higher levels of antibiotic resistance as a result (ibid.). Understanding statistics in health care research, then, is every professional health care provider's business.

Professional knowledge and evidence-based practice

Currently, many hospitals in the UK gather systematic and routine statistical data (often called metrics) from patient care settings, in order to determine the effectiveness of the service provided and to determine the prevalence and incidence of iatrogenesis[1] such as: the number and incidence/prevalence of patient falls, health care induced infections (especially catheter acquired urinary tract infection), pressure ulcers, patient complaints, drug administration errors or cases of inadequate nutrition. It is essential that health care providers are able to interpret and act appropriately upon these data.

The demand of EBP today for implementing practice based upon statistical evidence is still problematic (Raleigh and Foot 2010). The difficulties can be attributed to a large extent to the lack of understanding of statistics, lack of understanding about effective training of data gatherers, sample size, sampling techniques, timeframes and methods of data collection and, lastly, the lack of engagement of health care providers in the process of change (Maynard 2003). Instituting change in health care relies on an understanding of statistics. Understanding the language of statistics gives all health care providers a common language despite the differences between the professions. The difficult question remains of gaining consensus in deciding what exactly constitutes evidence.

[1] An iatrogenic disorder is a condition that is caused by health: treatment, care, personnel or through exposure to the environment of a health care facility.

Box 1.3

Take ten minutes to write down possible sources of evidence you have seen routinely gathered in the clinical area you are working in; this could relate to, for example, staffing levels, sickness absence, patient complaints, bed occupancy, staff vacancies, incidences of MRSA, admissions, deaths and discharges.

- Can you identify when and at what time this data is collected?
- Does the time this data is collected (e.g. midnight) represent a fair and accurate representation of incidence/prevalence of the evidence?

If we examine the credibility of evidence-based practice (EBP) in health care through exploration of its philosophical origins, there are several key features that emerge as important considerations. First, we need to evaluate critically the declared purposes and strengths of what exactly constitutes the evidence base for practice in health care. Second, we require an analysis of the implicit reasons for implementation of EBP. Third, we require a critical discussion of the strengths and limitations of EBP within the context of modern health care. An example of this is the data collection for metrics used in many UK hospitals. Following the publication of the recent Francis (2013) report which identified cases of poor quality care and lack of compassion that have subsequently become the focus of much media attention in the UK, now more than ever health care workers and their leaders need to identify the way statistical evidence and measurement can be used to best effect (Royal College of Nursing (RCN) 2009) and to demonstrate good patient outcomes (NHS Outcomes Framework 2012/2013). Measuring the quality of care is central to providing in good patient care (NHS IC 2010) that is more transparent, accountable and focused on improvement (Maben et al. 2012). The brief outline below attempts to articulate in terms of numerical measures 'quality of nursing care', illustrating some of the issues surrounding the wider use of EBP but also how understanding what phenomena to measure and how they can be measured is so important for health care practitioners and managers of health care services.

A report by Maben et al. (2012), for example, draws together information about a wide range of UK initiatives and international developments in the measurement of nursing quality and describes:

- current knowledge and issues about use of nursing metrics;
- types of nursing metrics that are currently being used in the English National Health Service (NHS);
- national and international trends in measurement of nursing;
- the feasibility of a national set of key indicators of high-quality nursing;
- design and implementation of an infrastructure that enables national consistency and benchmarking between organizations.

It remains unclear, however, the extent to which all of these variables are sensitive to variations in nursing quality as there are numerous other contextual variables that impact upon the quality of patient care, which can be regarded as wider structural indicators and therefore beyond

the realm of nursing to effect any measurable difference (ibid.), and these normally fall to the responsibility of senior management, such as:

- workforce, e.g. staffing levels, skill mix, sickness absence, recruitment and retention;
- staff experiences, e.g. perception of the practice environment, ongoing education training and continuing professional and personal development (CPPD);
- systems, e.g. admissions, discharge, handover, medically led health care administration.

The collection and use of statistical data in care quality metrics, if developed and used in the right way, has the potential to support and improve all areas of care delivered through the NHS in England (Mabon et al. 2012). For example, indicators and metrics included in *Imperial College Healthcare NHS Trust Quality Improvement Framework* (Gage et al. 2012) are:

1. Nurse sensitive outcome indicators: care bundle compliance (falls prevention, pressure ulcer prevention, food and nutrition, pain and failure to rescue), incidence and prevalence data relating to falls, pressure ulcers and catheter-acquired urinary tract infections.
2. Infection prevention and control: hand hygiene compliance, invasive devices care bundle compliance, cleaning scores, incidence data for trust acquired MRSA and *C. diff* cases, MRSA screening rates.
3. Workforce: band and agency usage, sickness, vacancy and appraisal rates.
4. Patient experience: commissioning for quality and innovation scores, complaints.

Whilst in the UK many NHS trusts[2] are measuring some or all of these indicators in a structured way at a local level (see North West Transparency Project UK), including the use of 'quality dashboards' (Royal College of Nursing (RCN) 2011), there is still considerable overlap between approaches to quality measurement but, as yet, lack of standardization of key quality indicators (Maben et al. 2012). This means that in the UK many current systems of measurement do not permit effective benchmarking between organizations and at the ward or unit level (ibid.). Whilst there appears to be some degree of standardization around specific nursing quality indicators for patient safety, including measures for falls and pressure sores (the NHS Safety Thermometer, and through the North West Transparency Project), there is a dearth of good risk adjustment for measures such as falls and pressure ulcers to ensure valid comparisons between organizations within the UK (ibid.). Very few UK metrics systems appear to have achieved the advanced metrics systems represented by the United States and Canada (ibid.).

It is questionable whether EPB is flawed, a borrowed or unique concept, but whichever the view, it is better than doing nothing to ensure better safer patient care. What is clear is the need for staff undertaking EBP to understand the basics of statistics in order to understand metrics. Whatever considerations and issues are raised with EBP, there can be no doubt about the impact of statistics upon the prevailing views of professional health care practice. The implications of ensuing debate on statistical concepts for health care providers are numerous and have

[2] Publicly owned organizations that provide and organize health care in the UK under the NHS are known as NHS trusts.

significant implications for the future of the professions, because these range from immediate curriculum development and delivery of professional practice in health care education and training to a multi-professional and multicultural perspective, including the role and preparation of educators, clinicians and students. The **quantitative paradigm** has had a massive impact on the knowledge base for the practice of health care professionals. Some authors (Colyer and Kamath 1999) maintain that, philosophically, EBP is fundamentally utilitarian. If that is the case, an understanding of statistics is essential for EBP.

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

- using this book to develop your understanding of statistics;
- evidence-based practice;
- the relationship between quantitative research and evidence-based practice;
- how quantitative research contributes to the development of professional knowledge and professional values;
- the importance of statistics in health care practice.

EXERCISES

1. When considering introducing change to your practice, what type of evidence do you require to support that change?
2. Consider the last time change was introduced to your practice. What evidence was it based on? What role did you play in the decision? Did the change have a statistical basis?

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 uncontainable 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 becomes 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.

EXERCISES

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?

3

Measuring, sampling and error

Areas of learning covered in this chapter

- What are populations, samples, variables and measures?
- What types of measurement scale and error are there?
- How do scales of measurement influence how I handle my data?

Whilst this book is not about research design it is impossible to learn about statistics without at least knowing something about samples and populations. This chapter will take a look at the concept of the sample and the population.

Population

A population is made up of all the individuals or objects or phenomena that you could potentially measure/count as part of your study. If, for example, you were studying the reasons why nurses in the UK left the profession early your population would be made up of all the nurses in the UK who had left the profession early.

If, on the other hand, you were studying the reasons why nurses in a particular hospital left the profession early your population would be those nurses who left early in that particular hospital.

It is also important to note that the population that we are interested in may not be exactly the same as the one we end up sampling from. This is because some of the individuals within the population of interest may refuse to take part in our study. Thus there may be a distinction between the target population and the actual population.

Sample

In most cases it is unlikely that you would be able to gather information from all the population: you probably would not have the resources. So instead we must take a sample. A sample is made up of a proportion of individuals or objects from the total population available. Many of the statistics described in this book concern establishing how good the sample is at representing the population and whether or not different samples come from the same population. When you read research articles or review numerical data always consider whether the sample is representative of the population being studied. In Chapter 8 we discuss several ways in which poor sampling can mislead people.

There is a great deal of literature that is concerned with how to ensure that a sample is representative; however, as this book is primarily about statistics we will not discuss them here, but we strongly advise that you read around this topic before embarking on any research. A useful chapter to read is Chapter 6 of Blaikie (2003).

Cases

Every sample is made up of the individuals or objects under study. These individuals or objects may be referred to by a variety of names, such as sampling units. For each individual or object we will measure some variable or variables; these variables may be physical (e.g. blood pressure), represent thoughts or feelings (e.g. anxiety) or represent events in the individual's life (e.g. number of visits to a health clinic). The important thing about these variables is that they are measurable. If a variable isn't measurable it can't be dealt with statistically. Each individual or object from which we take a measurement is termed a **case**.

Box 3.1 Measurements and samples

Go to a library or the internet and find five articles. For each decide on:

1. the measurement;
2. the variable being measured;
3. the population;
4. the sample;
5. the sampling unit.

For each case the measurement may referred to as a value. A collection of values is called data.

For every case we should be able to state: the measurement, the variable being measured, the sampling unit, the actual sample and the population being studied.

(Continued)