CHAPTER 6

Constructing Hypotheses

In this chapter you will learn about:

- The definition of a hypothesis
- The functions of a hypothesis in your research
- How hypotheses are tested
- How to formulate a hypothesis
- Different types of hypotheses and their applications
- How errors in the testing of a hypothesis can occur
- The use of hypotheses in qualitative research

Keywords: *alternate hypotheses, hunch, hypothesis, hypothesis of point-prevalence, null hypothesis, operationalisable, research hypothesis, Type I error, Type II error, unidimensional, valid.*

> Almost every great step [in the history of science] has been made by the 'anticipation of nature', that is, by the invention of hypotheses which, though verifiable, often had very little foundation to start with. (T. H. Huxley cited in Cohen & Nagel 1966: 197)

The definition of a hypothesis

The second important consideration in the formulation of a research problem in quantitative research is the construction of a **hypothesis**. Hypotheses bring clarity, specificity and focus to a research problem, but are not essential for a study. You can conduct a valid investigation without constructing a single formal hypothesis. On the other hand, within the context of a research study, you can construct as many hypotheses as you consider to be appropriate. Some believe that one must formulate a hypothesis to undertake an investigation; however, the author does not hold this opinion. Hypotheses primarily arise from a set of 'hunches' that are tested through a study and one can conduct a perfectly valid study without having these hunches or speculations. However, in epidemiological studies, to narrow the field of investigation, it is important to formulate hypotheses.

The importance of hypotheses lies in their ability to bring direction, specificity and focus to a

research study. They tell a researcher what specific information to collect, and thereby provide greater focus.

Let us imagine you are at the races and you place a bet. You bet on a hunch that a particular horse will win. You will only know if your hunch was right after the race. Take another example. Suppose you have a hunch that there are more smokers than non-smokers in your class. To test your hunch, you ask either all or just some of the class if they are smokers. You can then conclude whether your hunch was right or wrong.

Now let us take a slightly different example. Suppose you work in the area of public health. Your clinical impression is that a higher rate of a particular condition prevails among people coming from a specific population subgroup. You want to find out the probable cause of this condition. There could be many causes. To explore every conceivable possibility would require an enormous amount of time and resources. Hence, to narrow the choice, based on your knowledge of the field, you could identify what you assume to be the most probable cause. You could then design a study to collect the information needed to verify your hunch. If on verification you were able to conclude that the assumed cause was the real cause of the condition, your assumption would have been right.

In these examples, you started with a superficial hunch or assumption. In one case (horse racing) you waited for the event to take place and in the other two instances you designed a study to assess the validity of your assumption, and only after careful investigation did you arrive at a conclusion about the validity of your assumptions.

Hypotheses are based upon similar logic. As a researcher you *do not know* about a phenomenon, a situation, the prevalence of a condition in a population or about the outcome of a programme, but you *do have a hunch* to form the basis of certain *assumptions or guesses*. You test these, mostly one by one, by collecting information that will enable you to conclude if your hunch was right. The verification process can have one of three outcomes. Your hunch may prove to be: right, partially right or wrong. Without this process of verification, you cannot conclude anything about the validity of your assumption.

Hence, a hypothesis is a hunch, assumption, suspicion, assertion or an idea about a phenomenon, relationship or situation, the reality or truth of which you do not know. A researcher calls these assumptions, assertions, statements or hunches hypotheses and they become the basis of an enquiry. In most studies the hypothesis will be based upon either previous studies or your own or someone else's observations.

There are many definitions of a hypothesis. According to Kerlinger, 'A hypothesis is a conjectural statement of the relationship between two or more variables' (1986: 17). *Webster's Third New International Dictionary* (1976) defines a hypothesis as:

> a proposition, condition, or principle which is assumed, perhaps without belief, in order to draw out its logical consequences and by this method to test its accord with facts which are known or may be determined.

Black and Champion define a hypothesis as 'a tentative statement about something, the validity of which is usually unknown' (1976: 126). In another definition, Bailey defines a hypothesis as:

> a proposition that is stated in a testable form and that predicts a particular relationship between two (or more) variables. In other words, if we think that a relationship exists, we first state it as a hypothesis and then test the hypothesis in the field. (1978: 35)

According to Grinnell:

A hypothesis is written in such a way that it can be proven or disproven by valid and reliable data – it is in order to obtain these data that we perform our study. (1988: 200)

From the above definitions it is apparent that a hypothesis has certain characteristics:

1. It is a tentative proposition.
2. Its validity is unknown.
3. In most cases, it specifies a relationship between two or more variables.

The functions of a hypothesis

While some researchers believe that to conduct a study requires a hypothesis, having a hypothesis is not essential as already mentioned. However, a hypothesis is important in terms of bringing clarity to the research problem. Specifically, a hypothesis serves the following functions:

- The formulation of a hypothesis provides a study with focus. It tells you what specific aspects of a research problem to investigate.
- A hypothesis tells you what data to collect and what not to collect, thereby providing focus to the study.
- As it provides a focus, the construction of a hypothesis enhances objectivity in a study.
- A hypothesis may enable you to add to the formulation of theory. It enables you to conclude specifically what is true or what is false.

The testing of a hypothesis

To test a hypothesis you need to go through a process that comprises three phases: (1) constructing a hypothesis; (2) gathering appropriate evidence; and (3) analysing evidence to draw conclusions as to its validity. Figure 6.1 shows this process diagrammatically. It is only after analysing the evidence that you can conclude whether your hunch or hypothesis was true or false. When concluding about a hypothesis, conventionally, you specifically make a statement about the correctness or otherwise of a hypothesis in the form of ‘the hypothesis is true’ or ‘the hypothesis is false’. It is therefore imperative that you formulate your hypotheses clearly, precisely and in a form that is testable. In arriving at a conclusion about the validity of your hypothesis, the way you collect your evidence is of central importance and it is therefore essential that your study design, sample, data collection method(s), data analysis and conclusions, and communication of the conclusions be valid, appropriate and free from any bias.

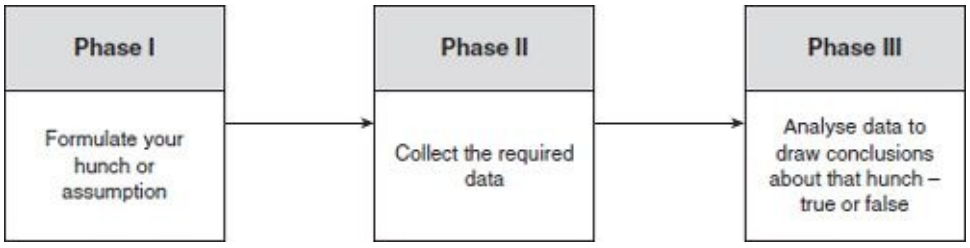

FIGURE 6.1 *The process of testing a hypothesis*

The characteristics of a hypothesis

There are a number of considerations to keep in mind when constructing a hypothesis, as they are important for valid verification. The wording of a hypothesis therefore must have certain attributes that make it easier for you to ascertain its validity. These attributes are:

A hypothesis should be simple, specific and conceptually clear. There is no place for ambiguity in the construction of a hypothesis, as ambiguity will make the verification of your hypothesis almost impossible. It should be 'unidimensional' – that is, it should test only one relationship or hunch at a time. To be able to develop a good hypothesis you must be familiar with the subject area (the literature review is of immense help). The more insight you have into a problem, the easier it is to construct a hypothesis. For example:

> The average age of the male students in this class is higher than that of the female students.

The above hypothesis is clear, specific and easy to test. It tells you what you are attempting to compare (average age of this class), which population groups are being compared (female and male students), and what you want to establish (higher average age of the male students).

Let us take another example:

> Suicide rates vary inversely with social cohesion. (Black & Champion 1976: 126)

This hypothesis is clear and specific, but a lot more difficult to test. There are three aspects of this hypothesis: 'suicide rates'; 'vary inversely', which stipulates the direction of the relationship; and 'social cohesion'. To find out the suicide rates and to establish whether the relationship is inverse or otherwise are comparatively easy, but to ascertain social cohesion is a lot more difficult. What determines social cohesion? How can it be measured? This problem makes it more difficult to test this hypothesis.

A hypothesis should be capable of verification. Methods and techniques must be available for data collection and analysis. There is no point in formulating a hypothesis if it cannot be subjected to verification because there are no techniques to verify it. However, this does not necessarily mean that you should not formulate a hypothesis for which there are no methods of verification. You might, in the process of doing your research, develop new techniques to verify it.

A hypothesis should be related to the existing body of knowledge. It is important that your hypothesis emerges from the existing body of knowledge, and that it adds to it, as this is an important function of research. This can only be achieved if the hypothesis has its roots in the existing body of knowledge.

A hypothesis should be operationalisable. This means that it can be expressed in terms that can be measured. If it cannot be measured, it cannot be tested and, hence, no conclusions can be drawn.

Types of hypothesis

Theoretically there should be only one type of hypothesis, that is the research hypothesis – the basis of your investigation. However, because of the conventions in scientific enquiries and because of the wording used in the construction of a hypothesis, hypotheses can be classified into several types.

Broadly, there are two categories of hypothesis:

1. research hypotheses;
2. alternate hypotheses.

The formulation of an **alternate hypothesis** is a convention in scientific circles. Its main function is to explicitly specify the relationship that will be considered as true in case the research hypothesis proves to be wrong. In a way, an alternate hypothesis is the opposite of the research hypothesis. Conventionally, a null hypothesis, or hypothesis of no difference, is formulated as an alternate hypothesis.

Let us take an example. Suppose you want to test the effect that different combinations of maternal and child health services (MCH) and nutritional supplements (NS) have on the infant mortality rate. To test this, a two-by-two factorial experimental design is adopted (see Figure 6.2).

There are several ways of formulating a hypothesis. For example:

1. There will be no difference in the level of infant mortality among the different treatment modalities.
2. The MCH and NS treatment groups will register a greater decline in infant mortality than the only MCH treatment group, the only NS treatment group or the control group.
3. Infant mortality in the MCH treatment group will reach a level of 30/1000 over five years.
4. Decline in the infant mortality rate will be three times greater in the MCH treatment group than in the NS group only over five years.

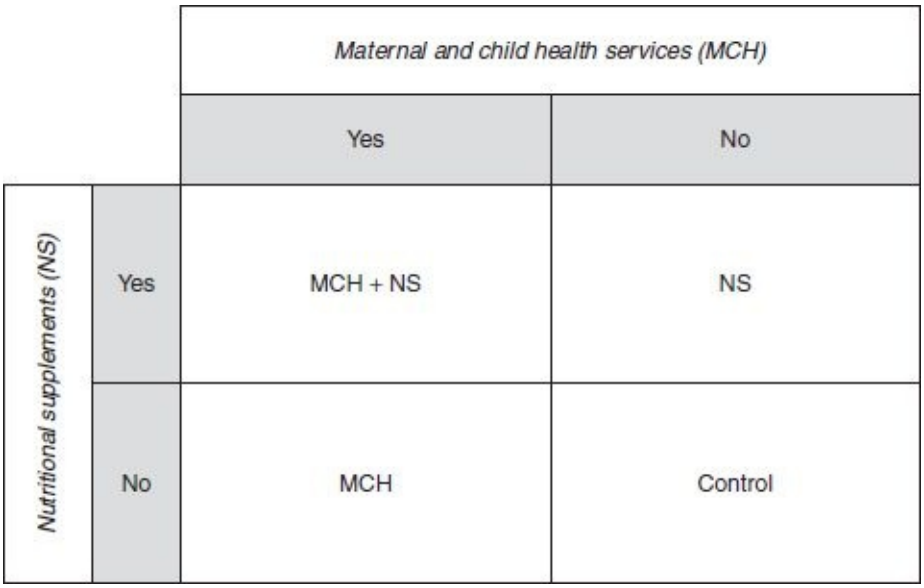

FIGURE 6.2 *Two-by-two factorial experiment to study the relationship between MCH, NS and infant mortality*

Let us take another example. Suppose you want to study the smoking pattern in a community in relation to gender differentials. The following hypotheses could be constructed:

1. There is no significant difference in the proportion of male and female smokers in the study population.

2. A greater proportion of females than males are smokers in the study population.
3. A total of 60 per cent of females and 30 per cent of males in the study population are smokers.
4. There are twice as many female smokers as male smokers in the study population.

In both sets of examples, the way the first hypothesis has been formulated indicates that there is no difference either in the extent of the impact of different treatment modalities on the infant mortality rate or in the proportion of male and female smokers. When you construct a hypothesis stipulating that there is no difference between two situations, groups, outcomes, or the prevalence of a condition or phenomenon, this is called a **null hypothesis** and is usually written as H0.

The second hypothesis in each example implies that there is a difference either in the extent of the impact of different treatment modalities on infant mortality or in the proportion of male and female smokers among the population, though the extent of the difference is not specified. A hypothesis in which a researcher stipulates that there will be a difference but does not specify its magnitude is called a **hypothesis of difference**.

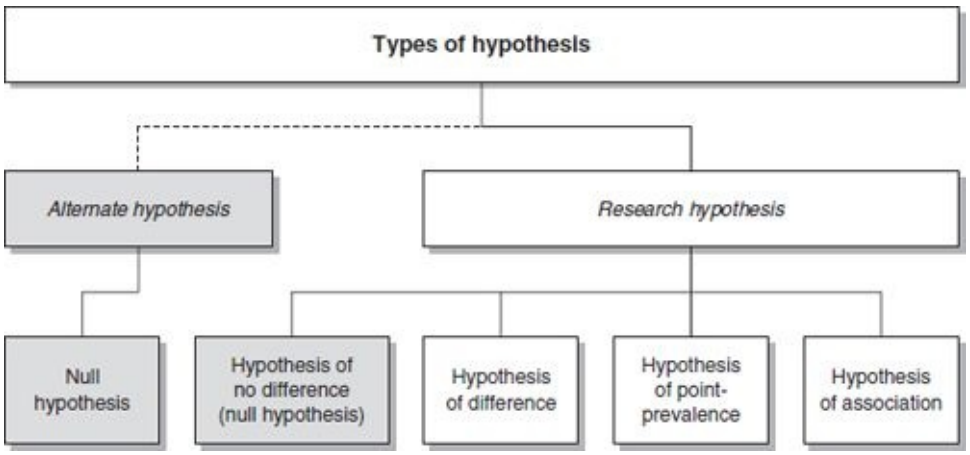

FIGURE 6.3 *Types of hypothesis*

A researcher may have enough knowledge about the smoking behaviour of the community or the treatment programme and its likely outcomes to speculate almost the exact prevalence of the situation or the outcome of a treatment programme in quantitative units. Examine the third hypothesis in both sets of examples: the level of infant mortality is 30/1000 and the proportion of female and male smokers is 60 and 30 per cent respectively. This type of hypothesis is known as a **hypothesis of point-prevalence**.

The fourth hypothesis in both sets of examples speculates a relationship between the impact of different combinations of MCH and NS programmes on the dependent variable (infant mortality) or the relationship between the prevalence of a phenomenon (smoking) among different populations (male and female). This type of hypothesis stipulates the extent of the relationship in terms of the effect of different treatment groups on the dependent variable (‘three times greater in the MCH treatment group than in the NS group only over five years’) or the prevalence of a phenomenon in different population groups (‘twice as many female as male smokers’). This type of hypothesis is called a **hypothesis of association**.

Note that in Figure 6.3 the null hypothesis is also classified as a hypothesis of no difference under ‘Research hypothesis’. Any type of hypothesis, including a null hypothesis, can become the basis of an enquiry. When a null hypothesis becomes the basis of an investigation, it becomes a research hypothesis.

Errors in testing a hypothesis

As already mentioned, a hypothesis is an assumption that may prove to be either correct or incorrect. It is possible to arrive at an incorrect conclusion about a hypothesis for a variety of reasons. Incorrect conclusions about the validity of a hypothesis may be drawn if:

- the study design selected is faulty;
- the sampling procedure adopted is faulty;
- the method of data collection is inaccurate;
- the analysis is wrong;
- the statistical procedures applied are inappropriate; or
- the conclusions drawn are incorrect.

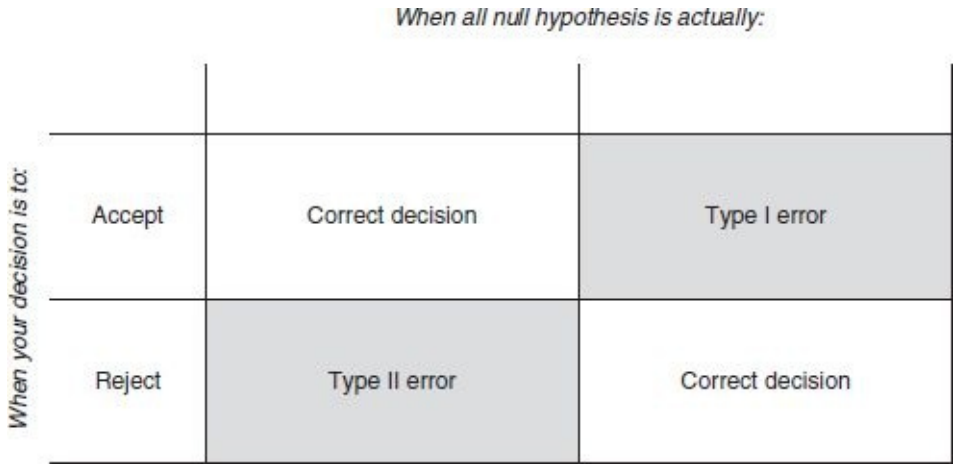

FIGURE 6.4 *Type I and Type II errors in testing a hypothesis*

Any, some or all of these aspects of the research process could be responsible for the inadvertent introduction of error in your study, making conclusions misleading. Hence, in the testing of a hypothesis there is always the possibility of errors attributable to the reasons identified above. Figure 6.4 shows the types of error that can result in the testing of a hypothesis.

Hence, in drawing conclusions about a hypothesis, two types of error can occur:

- *Rejection* of a null hypothesis when it is true. This is known as a **Type I error**.
- *Acceptance* of a null hypothesis when it is false. This is known as a **Type II error**.

Hypotheses in qualitative research

One of the differences in qualitative and quantitative research is around the importance attached to and the extent of use of hypotheses when undertaking a study. As qualitative studies are characterised by an emphasis on describing, understanding and exploring phenomena using categorical and subjective measurement procedures, construction of hypotheses is neither advocated nor practised. In addition, as the degree of specificity needed to test a hypothesis is deliberately not adhered to in qualitative research, the testing of a hypothesis becomes difficult and meaningless. This does not mean that you cannot construct hypotheses in qualitative research; the non-specificity of the problem as well as methods and

procedures make the convention of hypotheses formulation far less practicable and advisable. Even within quantitative studies the importance attached to and the practice of formulating hypotheses vary markedly from one academic discipline to another. Fro example, hypotheses are most prevalent in epidemiological research and research relating to the establishment of causality of a phenomenon, where it becomes important to narrow the list of probable causes so that a specific cause-and-effect relationship can be studied. In the social sciences formulation of hypotheses is mostly dependent on the researcher and the academic discipline, whereas within an academic discipline it varies markedly between the quantitative and qualitative research paradigms.

Summary

Hypotheses, though important, are not essential for a study. A perfectly valid study can be conducted without constructing a single hypothesis. Hypotheses are important for bringing clarity, specificity and focus to a research study.

A hypothesis is a speculative statement that is subjected to verification through a research study. In formulating a hypothesis it is important to ensure that it is simple, specific and conceptually clear; able to be verified; rooted in an existing body of knowledge; and able to be operationalised.

There are two broad types of hypothesis: a research hypothesis and an alternate hypothesis. A research hypothesis can be further classified, based upon the way it is formulated, as a null hypothesis, a hypothesis of difference, a hypothesis of point-prevalence and a hypothesis of association.

One of the main differences in qualitative and quantitative research is the extent to which hypotheses are used and the importance attached to them. In qualitative research, because of the purpose of an investigation and methods used to obtain information, hypotheses are not used and almost no importance is given to them. However, in quantitative research, their use is far more prevalent though it varies markedly from one academic discipline to another and from researcher to researcher. On the whole it can be said that if the aim of a study is to explore where very little is known, hypotheses are usually not formulated; however, if a study aims to test an assertion by way of causality or association, validate the prevalence of something or establish its existence, hypotheses can be constructed.

The testing of a hypothesis becomes meaningless if any one of the aspects of your study – design, sampling procedure, method of data collection, analysis of data, statistical procedures applied or conclusions drawn – is faulty or inappropriate. This can result in erroneous verification of a hypothesis: Type I error occurs where you reject a null hypothesis when it is true and should not have been rejected; and Type II error is introduced where you accept a null hypothesis when it is false and should not have been accepted.

For You to Think About

- *Refamiliarise yourself with the keywords listed at the beginning of this chapter and if you are uncertain about the meaning or application of any of them revisit these in the chapter before moving on.*
- *To what extent do you think that the use of hypotheses is relevant to social research?*
- *Formulate two or three hypotheses that relate to your own areas of interest and consider the factors that might affect their validity.*