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2nd Edition



Research Methodology for Health Professionals

Including Proposal, Thesis & Article Writing, Research Funding and Plagiarism

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Forewords
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4
CHAPTER

Formulation of Objectives, Research Question, and Hypothesis

RESEARCH OBJECTIVES

Objectives are closely related to the statement of the problem. They can be divided into *general objectives* (the essence of the study is worded in declarative form which gives general direction of the enquiry) and *specific objectives* (general objective are divided into smaller, logically connected parts).

In a *quantitative study*, a worded statement of objective identifies the key study variables and their interrelationship as well as nature of the population of interest, e.g., to examine the relationship between high blood pressure and body mass index (BMI) in executives.

In a *qualitative study*, the statement of objective indicates the nature of inquiry, the key concept/phenomenon under investigation, and the group, community, or setting under study, e.g., to describe end-of-life care in intensive care unit as perceived by critical caregivers who have been taken care of dying patients.

Specific objectives explain *what*, *where*, and *for what purpose*.

The formulation of objectives will help to *Focus* on the study (narrowing it down to essentials), *Avoid* unnecessary collection of data, and *Organize* the study in clearly defined parts or phases.

The objectives should cover the different aspects of the problem and its contributing factors in a *coherent* way and in a *logical sequence*, *clearly phrased* in *operational terms*, *realistic* considering local conditions, and use *action verbs* that are specific enough to be evaluated.

Examples of action verbs are: to determine, to compare, to verify, to calculate, to describe, to establish, to demonstrate, to prove, etc. *Avoid* the use of vague nonaction verbs such as: to appreciate, to understand, to discover, to develop, or to study.

Keep in mind that when any project is evaluated, the results are compared to the objectives. If the objectives have not been spelled out clearly, the project cannot be evaluated.

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RESEARCH QUESTIONS

Research question may be sometimes direct rewording of the general objectives, which is phrased interrogatively rather than declaratively.

Example 1: General objective—to examine the relationship between high blood pressure and BMI in executives.

Research question: What is the relationship between high blood pressure and BMI in executives?

Example 2: General objective—to compare the perceived levels of stress, social support, and immune responses between healthy and asthmatic adolescents.

Research question: Are there group differences in the perceived levels of stress, social support, and immune responses between healthy and asthmatic adolescents?

Other examples of research questions:

- Do rural and urban community home-based care (CHBC) projects differ with respect to the adequacy, quality, affordability, and sustainability of home-based care (HBC) provided?
- How satisfied are AIDS (acquired immunodeficiency syndrome) patients, relatives, and service providers with the care provided? Are there differences in perceptions between those groups?
- Does the stigma attached to being HIV+ (human immunodeficiency virus) hold the same strength for women as for men? Or are there gender differences in stigma?
- What impact does the care provided to AIDS patients have on the economy of the homestead? Is there competition with other basic needs (e.g., schooling of children, purchases of food)?

HYPOTHESES

The hypothesis consists of two words, i.e., hypo and thesis. "Hypo" means tentative or subject to the verification and "thesis" means statement about a solution to a problem.

Hypothesis is a specific version of the research question that summarizes the main elements of the study—the sample, and the predictor and the outcome variables—in a form that establishes the basis for the tests of statistical significance.

It is a tentative proposition which is subject to verification through subsequent investigation. It may also be seen as a guide to the researcher in that it depicts and describes the method to be followed in studying the problem. In many cases, hypotheses are hunches that the researcher has about the relationship between variables (Verma and Beard, 1981).

"All advances in scientific understanding ... begin with a speculative adventure, an imaginative preconception of what might be true ... It is the invention of a world [that is] ... exposed to criticism to find out whether or not that imagined

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world is anything like the real one. Scientific reasoning is therefore at all levels an interaction between two episodes of thought-a dialogue between two voices, the one imaginative and the other critical; a dialogue, if you like between the possible and the actual, … between what might be true and what is fact the case." (Medawar, 1972)

According to McGuigan (1990), "a testable statement of a potential relationship between two or more variables, i.e., advance as potential solution to the problem."

Kerlinger (1973) defined "a hypothesis is a conjectural statement of the relation between two or more variables."

A *hypothesis* is a tentative prediction of a relationship between one or more factors/variables and the problem under study that can be tested. Hypothesis is applied to majority of the observational (accept descriptive) and experimental studies. If any of the following terms appears in the research question, then the study is not simply descriptive and hypothesis should be formulated: greater than, less than, causes, leads to, compared with, more likely than, associated with, related to, similar to, correlated with, and different from.

Generally, the terms assumption, postulate, and hypothesis are frequently encountered in the research literature. These terms are also seen as synonyms but they are actually not the same.

- *Assumption*: It means taking things for granted so that the situation is simplified for a logical procedure.
- *Postulate*: It is the working belief of most scientific activity. A postulate is a statement assumed to be true without the need of proof of any kind.
- *Hypothesis*: It is different from both of these. It is the presumptive statement of a proposition which the investigator seeks to prove.

Functions of Hypothesis

Some of the functions are enumerated below:

- Research is focused.
- Testing of the theories
- The investigation activities are carried out.
- It serves as a guide for the study to be conducted.
- It explains social–cultural phenomena.
- It acts as bridge between the theory and the investigation.
- It prevents the review of irrelevant literature and the collection of useful or excess data.
- It provides the most efficient instrument for exploring and explaining the unknown facts.
- It provides data collection techniques and new insight.
- It provides opportunity to understand better research design and technique of analysis.
- It helps in achieving the relevant outcome.
- Each hypothesis may lead to formulate another hypothesis.
- It simulates the investigator for further research studies.

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- It translates the research question into a prediction of expected outcome.
- It forces researcher to think logically.
- It exercises critical judgment.
- It ties together earlier study findings.

Characteristics of a Good Hypothesis

A hypothesis should:

- Be simple and easily understandable
- Not be formulated in the form of a question
- Be written in present tense
- Be empirically testable, irrespective of right or wrong
- Be specific and precise
- Not be contradictory or ambiguous
- State the expected relationship between the independent and dependent variables
- Specify all variables related to study
- Make sure that available tools and techniques are used for the purpose of verification of the facts and explanation thereof.

Types of Hypothesis

- *Simple hypothesis*: A simple hypothesis contains one predictor (independent) and one outcome (dependent) variable.
  Example: Lower level of exercise (predictor variable) during postpartum will be associated with greater weight retention (outcome variable).
- *Complex hypothesis*: It contains more than one (multiple) predictor or outcome variable.
  Example of complex hypothesis with multiple predictor variables: A sedentary lifestyle and alcohol consumption (predictor variables) are associated with an increased risk of proteinuria and neuropathy (outcome variables) in patients with diabetes.
- *Specific hypothesis*: Any hypothesis should not leave any ambiguity about the subjects and variables. It uses concise operational definitions that summarize the nature and source of subject and how variable will be measured.
  Example: Use of tricyclic antidepressant medications, assessed with pharmacy record, is more common in patients hospitalized with an admission diagnosis of myocardial infarction in civil hospital in the past year than in controls hospitalized for the asthma.
  This is a long sentence but it communicates the nature of the study; all variables are to be measured.
- *In-advance and after-the-effect hypothesis*: The hypothesis should be stated in advance (at the beginning of the study); this will keep the research focused. Hypothesis made during or end of the analysis of data can lead to overinterpretation and hence be avoided (post hoc hypothesis).
- *Primary and secondary hypotheses*: *Primary hypothesis* is a hypothesis around which the study has been designed but sometimes especially in

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TABLE 1 Examples of various hypotheses.

Nature of the statements	Type of hypothesis
Lower level of exercise postpartum is associated with greater weight retention	Directional/one-sided
There is a relationship between level of exercise postpartum and weight retention	Nondirectional/two-sided
There is no association between level of exercise postpartum and weight retention	Null hypothesis
Young people like junk food more than the traditional food	Directional
There is no association between drinking well water and coronary heart diseases	Null hypothesis
Patients with pancreatic cancer will have a higher rate of coffee drinking than control patients	Directional/one-sided
Patients with pancreatic cancer will have a different rate of coffee drinking—either higher or lower—than control patients	Directional/two-sided

randomized trials, more than one hypothesis may be needed (secondary hypothesis). This secondary hypothesis should be written in advance to increase the credibility of the results.

- *Statistical hypothesis*: This hypothesis is an assumption about statistical populations which may be rejected or accepted. The null hypothesis and alternative hypothesis together are called statistical hypothesis.
- *Null hypothesis (statistical hypothesis) (Ho)*: It states that there is no relationship/association between predictor and outcome variables in the population. The null hypothesis is the formal basis for testing statistical significance **(Table 1)**.
- *Alternative hypothesis (Ha)*: It proposes that there is an association between predictor and outcome variables. Statistical tests attempt to reject the null hypothesis of no association in favor of alternative hypothesis. These hypotheses could be one-sided or two-sided **(Table 1)**.
- *Directional hypothesis (one-sided or one-tailed)*: It specifies the expected direction of the relationship between variables, i.e., surety about the relationship between independent (predictor) and dependent (outcome) variables **(Table 1)**. Generally, on the basis of previous experiences and published articles. *For example*: There is a definite association between high blood lipids and myocardial infarction.
- *Nondirectional hypothesis (two-sided or two-tailed)*: This form of hypothesis is used in studies where there is no sufficient past research on which to base a prediction. Do not lay down the direction of the relationship. *For example*: There is an association between diabetes mellitus and vegetarian diet **(Table 1)**.
- *Associative hypothesis*: This hypothesis proposes relationships between variables; when one variable changes, the other changes. Do not indicate cause and effect.

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- *Causal hypothesis*: This hypothesis suggests a cause and effect interaction between two or more variables. The dependent (outcome) variable is based on the influence of the independent variable.

There is a difference between research hypothesis and null hypothesis. *Research hypothesis* (substantive, declarative, or scientific hypothesis) is a statement of an expected relationship between two variables. It is often directional hypothesis, usually one-sided.

Testing the Hypothesis

Hypothesis testing is concerned with testing whether the value of a population parameter is equal to some specific value. Null hypothesis states that any observed differences are entirely due to chance/sampling errors.

In hypothesis testing, null hypothesis is either rejected or accepted depending on whether the *p* value is above or below the predetermined cutoff point, known as significance level of test.

The investigator, based on data collected, uses statistical tests to determine whether there is sufficient evidence to reject the hypothesis in favor of alternative hypothesis that there is an association in the population. The standard for these tests is known as the *level of statistical significance*.

If the *p* value is less than the cutoff point, the null hypothesis is rejected. If the *p* value is more than or equal to the cutoff point, the null hypothesis is accepted. It is usual to choose either 0.05 (5%) or 0.01(1%) as the level of significance, for testing the null hypothesis.

- *Type I (α) error*: It occurs if an investigator rejects a null hypothesis that is actually true in the population. It is the error of falsely stating that two drug effects are significantly different when they are actually equivalent. The probability of making α error is called level of significance **(Table 2)**.
- *Type II (β) error*: It occurs if the investigator fails to reject a null hypothesis that is actually false in the population. It is the error of falsely stating that two drug effects are equivalent when they are actually different **(Table 2)**.
- *Power (1-β)*: It is the probability that the test will correctly identify a significant difference/effect/association in the sample, should one exist in the population or correctly reject the null hypothesis **(Table 2)**.

TABLE 2 **Truth in the population versus the results in the sample: The four possibilities.**

	Truth in the population	
Results in study population	**Association between predictor and outcome variables**	**No association between predictor and outcome variables**
Positive (reject null hypothesis)	Correct (1-β) True positive	α (type I error) False positive
Negative (accept null hypothesis)	β (type II error) False negative	Correct True negative

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- This book comprises a variety of topics, such as identification and prioritization of Research Problems, Literature Search, Formulation of Research Questions, Objectives and Hypotheses, Study Design Options, Research on Diagnostic Tests, Determination of Sample Size, Data Collection Methods and Techniques, Analysis of Quantitative and Qualitative Data, Designing Research Questionnaire, Ethical Issues, etc., with special inclusion of Writing a Research Proposal, Steps in Thesis Writing and Writing an Article for Publication which will help readers in designing and conducting research studies
- Added four new chapters on Systematic Reviews and Meta-analysis, Quality Hospital Performance Indicators, Research Funding, and Plagiarism and revised four chapters, namely Formulation of Objectives, Research Questions and Hypothesis, Experimental Study Design under study designs, Ethical Issues on Health Research, and Designing the Research Instruments. Two chapters were revised and renamed, namely Writing and Publishing a Scientific Article and Critical Review and Evaluation of Scientific Research Publications
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