HEALTH RESEARCH

A COMMUNITY-BASED APPROACH

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PREFACE

Dear Reader,
This book grew out of a sense of need that we felt after spending two years in India developing a cadre of people who could carry out research at the applied level. During the project, which was sponsored by the Government of India and the World Health Organization, we worked with masters students at the Raj Kumari Amrit Kaur College of Nursing, Ministry of Health, the Directors of Nursing of major hospitals in New Delhi, and public health supervisors from scattered parts of India. These experiences led us to realize that sources of help in the form of articles and a good basic text were simply unavailable—a situation unacceptable for researchers who rely heavily on reference materials. Out of this realization, we published a series of articles on research which were critiqued by the readers and from these frank reactions emerged the starting point for this book.

The text is designed to introduce the research process to health professionals conducting research in rural village areas. We relied heavily on our experiences and those of our students and colleagues who have spent years involved in a variety of research efforts. Thus, the examples used in the text are taken from the village setting, rather than from the usual, and often foreign, tests and measurement paradigms. The book is designed to assist you in systematically observing and recording data, as well as in analysis, interpretation, and reporting findings, Methods of handling the delicate task of obtaining villagers' cooperation, the use of letter writing, and the ethical considerations you must observe, have been included. We realize the uniqueness of the local settings in many countries and the many levels of development in research methods among health workers. Thus, we have presented many examples of situations using actual instances where we and/or our colleagues have had experience. Also included are computational and statistical techniques, and a section on the use of hand-calculators and computer facilities. The writing of a clear and complete report is delineated with emphasis placed on the essential contents required for accurate and full reporting.

Examples and terms used are not country-or-profession-specific, so that many levels of health personnel will find the materials applicable to their own settings. Thus, this book can be used by post-basic and graduate students, health workers engaged in field studies, and individuals who wish to attempt research in rural village areas. The focus of the book is the reader: the learner who has little background in the research process and/or statistical methods—the reader who must engage in research, but who has questions such as the hundreds which have been asked of us throughout our experiences.

The theme of the book is applied research in primary health care settings in rural villages. The text is intended to convey a give-and-take discussion approach in the form of a letter which we are writing to you, the reader. We have included your hypothetical comments, distinguished by quotation marks, these comments are those we have been asked most frequently. We believe that by raising these questions we have legitimized your concerns and fears which, we find frequently inhibit or block progress. We have found that beginning researchers have burning questions that appear at odd times in a discussion, but are the ones that press for a response. By answering these questions, we hope you will have your immediate problems addressed. Further, we hope that you will see that others too, have the very questions you think are "silly".

To write a book such as this required students and workshop participants who asked questions, and who demanded as clear responses from us as we expected of their research. To these students we are indeed grateful. In addition to masters students at the RAK College of Nursing in New Delhi, India, four consultants read and critiqued our materials. They are: Mr. Rudolph L.Swann, WHO Nurse Educator, Bangalore, India, Dr. G.P.Mehrotra, Reader of Education, University of Delhi, Ms. Evelyn Vellegas, Nurse Educator, Jakarta, Indonesia, and Mr. Paul Hedrick, WHO statistician, SEARO, New Delhi, India. Mr. Hedrick also lent much assistance during the main draft revisions. Our thanks are extended to them for their help, patience, support and most useful comments.

We are also grateful to those whose foresight and sensitivity to the need and place of research in health made our work possible. To Dr. Amelia Maglacas, Nurse Scientist, Geneva, Switzerland, we extend sincere thanks. We also acknowledge the support of Ms. Barbara Vail, Ms. Janet Erickson and Ms. Saiyud Niyomviphat Regional Advisers in Nursing, WHO, New Delhi, India, for their sustained administrative and personal support. The help of the following people is also appreciated: Dr. S. Krishnan, Principal, RAK College of Nursing, New Delhi, Ms. R.K. Sood, Ms. P.K. Karthyani, Nursing Advisers, Directorate of Health Services, Government of India and Dr. V.T.H. Gunaratne, the Regional Director, WHO, SEARO, New Delhi, India. Finally, to our colleagues and families who encouraged, cajoled, threatened, supported and pushed us toward this effort—our heartfelt thanks.

Marie Farrell

Aparna Bhaduri

New Delhi, India
15 December 1979

INTRODUCTION

Recently a renewal of the need for research has found expression. The willingness to approach client problems in a systematic way, the availability of funds for research activities, and the number of workshops and meetings devoted to the discussion of the need for research activities—all have increased in the past years. But, in fact, much of health delivery and development remains largely imitative and intuitive rather than innovative, creative or empirical in nature. Further, research and the mode of thinking used by researchers is still believed to be a special body of esoteric knowledge applied by highly trained professionals. Yet every student of education, nursing, sociology, anthropology, management, medicine, and nutrition has been educated in that very process. And the professional activities on which their respective practices are based have evolved from a knowledge predicated upon the findings of research. Further, if a profession is to remain viable, that is, if it has any plans to continue to provide or render its services, then research must be an inextricable component of the professional's everyday activity. In short, no health care provider can continue to provide quality care exclusive of research and the contribution of research findings to his/her practice. Thus, it behooves health care providers, at all levels, to become at least familiar enough with the process, as a consumer, and as a participant.

There is no lack of technology, no dearth of intelligence, no dearth of capable people to carry out research. Just like other aspects of health care, research is manageable and can be conducted in some form, in any place, at some level. To be successful is not to produce the perfect research question, nor to use computers, nor to calculate complex inferential statistical techniques. Nor is relevant research that which involves teams of experts from outside the local area. Effective research assumes that one has done one's homework, that the situation has been studied carefully, and that the problems as seen by the villager and community have been examined.

Effective research implies a sensitivity and responsiveness to the worries and priorities of the people and the governments whose *raison d'etre* is the community it serves. Finally, effective research builds on what has gone before, gently examines what is, and carefully and thoughtfully suggests what could or may be.

Thus, the strategies developed to deliver basic services are similar to those necessary to the carrying out of research activities. That is, like other health workers, research must begin to view the process as part of the business of health delivery.

The key elements are the same: (1) community participation; (2) consideration of the people; (3) use of local support; (4) building on existing information; (5) training of local workers; and, (6) commitment on the part of the government. As health professionals, it is quite seductive to suggest an approach to a problem we have found to be effective in another situation. And it is very tempting to plan programmes because some funding source is interested in some particular aspect of development this year, or because someone's extra funds must be spent. But we must not waste money, time, and talent on publishing or creating proposals which have no basis or substance, and we must refuse to enter into a modality of "programme planning" for which not a shred of sound evidence has been collected. Further, we cannot stop our questioning just because of a solution of "doing a study" seems to have been discovered. What is needed? Astute observation. Penetrating questions. Thorough review of the literature. Precise planning. Comprehensive instruments. Accurate data collection. Well-trained data collectors. Careful, thoughtful analysis. Well-documented research reports—That is what's needed—Then and only then can programme planning begin.

LETTER 1

"AT THIS POINT AN OVERVIEW WOULD BE APPRECIATED"

Overview of the Research Process

Dear Reader,

Before we get into the details of how to identify and define the problems or methods of doing research, we would like to give an overall picture of the research process. In this letter, we will not attempt to describe, in depth, all steps involved in the research process but will merely present an overview of the steps which will be elaborated upon in subsequent chapters.

"At this point, I would appreciate such an overview."

Well, there are three basic, distinct stages involved in conducting research: planning, implementing and writing the research report. These three stages can be further broken down into a number of steps so that periodic reviews of each stage can be made to assure conciseness and accuracy. Although one's thinking is not always logical, one should attempt to carry out research systematically, with an eye to the constant review of progress made. The need for a peer review and sharing one's progress with one's colleagues cannot be overemphasized as a method for assuring such a checking system. A model for reviewing the steps of the progress, as it relates to the three stages, is illustrated in Figure 1:1.*

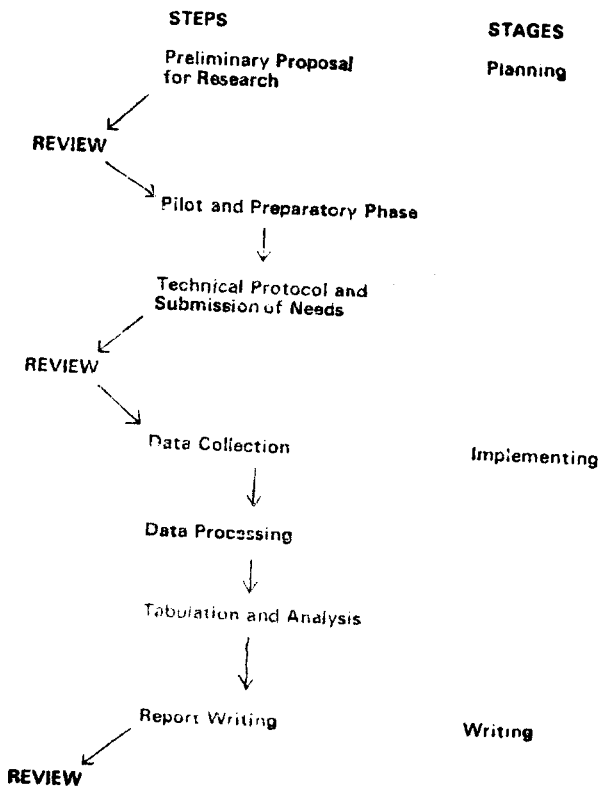

Fig. 1.1: Steps in Research Process

*Credit for the ideas expressed concerning the above model is extended to by Mr. Paul Hedrick, WHO Statistician, Jakarta, Indonesia, Nov. 28, 1977.

The Planning Stage

"Shouldn't we first find out the problem that is to be investigated?"

Exactly. So that is the first task in the planning stage. Ways of helping you in identifying the problem will be discussed in our next letter. To formulate or **identify a researchable problem** and to state it adequately is not only the most essential factor but is also the most difficult part of research. But yes, the first step is to identify a problem you wish to study.

"But how do I know what constitutes a problem? I am interested in many things—do I simply pick one?"

That is a very important question and one that is frequently raised by beginning researchers. The "things" the researcher decides to study arises from his/her perception of trends, patterns and changes which occur on a daily basis. As the health worker goes about the work of the day, he/she observes the behaviour of patients and groups of patients with keen sensitivity. If the client's action tends to occur over and over, the worker begins to ask questions, such as, "under which circumstances does this behaviour seem to occur? Are these patterns related to such behaviour?" And this is the beginning of a research question. In research, we look at very specific questions either in the form of **questions and/or hypotheses** but we address one question at a time, or we test one hypothesis at a time. And this is the difficulty: to narrow down several vague ideas into one or more concrete specific statements. In order to clarify the problem, it is essential to **define all terms** so that the evidence of behaviour to be collected is observable and measurable.

"Can you give me an example?"

Yes. Let us use one real, simple research example, one which was conducted by a Government of India/WHO Team. The researchers identified a general area of concern which had to do with the low rate of completion of immunization schedules of children. They knew that this was a problem area requiring investigation so that this did not need to be established. They also found, through working with the villagers, that some fathers would often scold their wives for not bringing the children for their injections. The researchers wondered, "What if fathers were taught about immunizations, what would be the rate of return of their children for immunization?" Here, a general concern about poor completion of immunizations became refined into an experimental design which hypothesized that "infants (between birth and one year of age) of fathers who have been through a formalized training programme would have a higher completion rate than infants whose fathers had not been through such a programme."

"That is a lot more specific than just saying 'what about immunizations' in babies?"

Right. We have specified things or "**variables**" (infants, fathers, programme). This is what we mean by stating terms specifically. Also note that the thing or "variable" to be measured, "completion of rate of immunization", is something that is observable and measurable.

The details of **research** questions may only be in the form of objectives or research questions. For example, J.Y. Peng has done considerable work and has written several articles on the use of traditional birth attendants, particularly in Malaysia. [1] The questions he and his team raised are good examples of exploratory questions used in beginning research in a previously unexplored field. The questions they raised were:

(1) What functions should the TBA be asked to perform in family planning activities? (2) What system should be used for gathering information on initial acceptors and on continuers of family planning?

(3) How should the TBAs be recruited and trained? (4) What should be the target used to measure optimum performance? (5) How should TBAs be compensated? (6) How should the performance of TBAs be assessed as a basis for effecting appropriate changes in the programme? and (7) How should the success of the project be evaluated?[2]

"Are research questions the same as hypotheses?"

Hypotheses are always in a statement form, and they either generally or specifically relate "variables" to research. Hypotheses carry clear implications for testing the stated relations.[3] These "variables" are the phenomena or "things" we wish to study. For example, if we were studying the "variables" of education and wanted to know how it affected another "variable"—the kind of care given in rural areas—we could "hypothesize" that: a baccalaureate degree programme produces a more proficient rural practitioner than a basic diploma programme.

This problem could be stated in the form of a question. A problem is an interrogative sentence of a statement that asks: what relations exist between two or more "variables"?[4] For the example just given, the question would read, "Does a baccalaureate degree programme produce a more proficient rural practitioner than a basic diploma programme?" Either form is acceptable.

Before we select the research method in order to test the formulated hypotheses, it is necessary to do a **study of related literature:** The review of non-research literature helps us develop a better insight into the problem, whereas, the review of research literature helps us to find out what related aspects of the selected problem have been so far investigated, what areas remain to be studied and what methods and techniques were used by previous researchers for investigating similar problems.

"Is it not difficult to cover all aspects of the problem in a single research study?"

Yes, your fears are understandable. There may be areas or aspects of the problems which we cannot include because of limited time, finance, facilities or other reasons. The term **"delimitation"** or **"limitation"** is used to indicate the cut off points beyond which the research does not intend to probe."In the limitations, the researcher notes those uncontrollable elements which limit the certainty with which he advances his findings and the boundaries which encircle the findings....."[5] To go back to our immunization example, we have limited ourselves not only to infants, but to those between birth and six months of age. We could not possibly study all age groups.

"And it is further confined to a comparison of those infants whose fathers have been through a special course for immunization with a group which has not been through such a course. The research seems like an experiment. Are all research studies experiments?"

No. There are three major types of research **approaches.** They are the **survey approach**, the **historical approach** and the **experimental approach**. In a brief summary it can be said that historical research deals with past events. This type of research attempts to convey an impression of an earlier period in health development. The researcher's task becomes one of documentation of evidence and evaluation of the authenticity of the material.

"I don't mean to sound unappreciative, but of what real value can this type of research be to a health worker practising in a rural health centre?"

That's a good question, and one that is often raised. Like any other historical document, a piece of research often assists in that it can serve to clarify today's problems; it helps us to explain the present. For example, knowing the historical place of women in a society and the rate of progress made towards equality has tremendous potential for providing direction and prediction of future changes and ways of implementing change in such a society.

The survey or descriptive study assesses the existing patterns or focuses on events which are currently taking place. Actual examples include: current child rearing practices in Bihar, nutritional status of school age children in Bangladesh, achievement scores of medical students on a state board examination in Bangkok.

Experimental research involves creating a new situation and seeing whether it gives the expected results.

"So, experimental research looks to the future!"

Right. Experimental or "explanatory methods" manipulate the situation in some way to test a hypothesis. Certain "things" or "variables" are held the same or "kept constant" and an independent "thing" or "variable" is manipulated. Usually, at least one experimental and one control group is used in this type of research. In short, the purpose is to see why something happens, evaluate the effectiveness of something (programme, drug, treatment, educational experience, kind of nursing care, social services) and, finally, to see whether a predicted result occurs. A more lengthy discussion of research designs is elaborated upon in a later letter.

We mentioned above that the basic terms used in research need to be defined clearly so that the evidence of behaviour that we want to collect is not only observable but also measurable. This brings us to the next step of planning, that is to decide how to collect the data. There are three basic **ways of collecting data:** by raising questions about the behaviour, by observing the behaviour and by measuring the **behaviour** through reliable instruments. The type of data we expect to gather also determines the plan of analysis or treatment which may be in the form of descriptive statistics or in terms of inferential statistics. Descriptive statistics would give only an overall summary of data in terms of frequency, percentage or averages, whereas inferential statistics would help us to see whether our hunches are correct or indicate the nature of relationship between identified factors (such as relationship between intelligence and health educators' performance).

"From whom do we collect this data?"

Well, it is necessary for the researcher to define who would be the best provider of the information sought. This group becomes [illegible]er **population,** out of which he selects a small group or **sample** to question. When the research design is planned, it is often put to a pre-test, through a pilot study, in order to find out the effectiveness of the design setting, instruments, and methodology as a whole. This helps in modifying the research plan.

Implementing Phase

The implementing phase involves mainly the **collection of data** and **analysis of the data,** through descriptive or inferential statistics, and the interpretation of the results. In research, the investigator analyzes the data objectively, so that the presentation of findings does not include his or her opinion or point of view. This point cannot be overemphasized. The researcher is not a politician, nor a policy maker. He/she must present the findings in as objective a way as possible. The results can be presented to administrators or politicians who can decide to fund and/or lend support to projects. Further, a researcher must not begin a research study with political motives in mind; nor should a study be undertaken to "prove" the desirability of one programme, method or approaches over another.

Writing the Research Report

The last step of the research process is to write the research report in order to document the research findings and to share the results with other interested groups.* The written reports should include the process of designing the research, the actual method of data collection, and the conclusions based on the analysis of data. The report should also include the researcher's logical views on the implication of the findings for education, service or care. Further, the role the research findings can play in overall plans at the administrative and/or policy level can be suggested.

"Where can we find these reports?"

Well, two essential tasks of the researcher are to communicate the research findings and apply the results to health practices. Depending on the academic nature of the study and the nature and importance of the findings, reports may be published in professional journals, newspapers, magazines, in a separate report form or presented to a professional group for discussion and criticism.

Often a health professional conducts a study, but does not write up the efforts, for fear that "it is not good **enough**". However, an urgent need for documentation (even imperfect documentation) is sorely needed. Your work can, in some way, add to the body of knowledge that others can build on. If you do not communicate your findings then all is lost. The goal is not perfect research. There is no such thing. But you can present what you thought, what you did, and what you found. You can explain the shortcomings or limitations to the reader, and you can qualify your report of findings so that your findings are not misleading. A fellow researcher will understand that position. And he/she will do the same qualifying when the next study is undertaken. The essential quality is not perfection, but honesty.

To summarize: in this letter we have written an overview of the research process which involves:
(1) planning a research design, including definition or problem, statement of objective and/or hypotheses, review of related literature, selection of research approach, tool and sample and plan of data analysis;
(2) implementing the design including collection and analysis of data; and
(3) writing of the research report, in an accepted form, in order to communicate the result and plan implementation of the research findings.

"That's some process! Am I really capable of doing all that?"

With guidance and support, you certainly are. Although the steps are given in an orderly way, the process in real life can be quite unsystematic, even chaotic. We know that and we realize that learning and integrating these steps into your thinking is a slow process requiring all of us to repeat, review, and explain many times, using many different examples. In our next letters we will take each of these steps and explain them in greater detail. In the meantime, what problems do you see that need researching?

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*See Letter 17.

LETTER 2

"WHAT DOES THEORY HAVE TO DO WITH RESEARCH?"

Use of Theory in Research

In our first letter we discussed the need for developing nursing knowledge through research in nursing. Let us now examine the means by which one further develops and adds to our existing knowledge about health and health care. In a later chapter we will go into the details of developing or isolating health-related principles.

Knowledge Building

One of the oldest and most established means of solving problems is the transmission of knowledge through **authority.** We use this method under certain circumstances, such as, when we accept the church as the authority for religious knowledge. We often defer to other authorities as well, such as, the clergy, the college professor, the economist, the banker, the physician.

"What about an expert in nutrition—is she an authentic source of knowledge?"

Yes, a specialist in any field of practice, is considered an authority.

"Sometimes, one who has had rich personal experiences also becomes an expert."

This is right. Often such knowledge is of great value in learning cultural habits and customs of people living in tribal or remote areas. But one should also guard against making what we call a "subjective estimation". That is, one may establish belief on insufficient evidence or fail to observe significant factors. Or, one may omit evidence that does not agree with his/her opinion.

Knowledge is also gained through **deductive and inductive** reasoning. You may begin your questioning by observing particular instances, say, relationship patterns between infants, mothers and grand mothers. And when you have made the particular observation several times, you begin to establish general conclusions about the whole class to which these instances belong. This is called inductive reasoning.

"Can you illustrate this with another example?"

Well, let us say that you observe that in several instances children of working mothers show comparatively slower social development than the children of non-working mothers. This may lead you to say that there is a relationship between maternal deprivation and social development of children. This is an example of inductive reasoning.

"What is deductive reasoning?"

In deductive reasoning, you go from the general to the specific. If an investigator arrives at general conclusions through induction, he may use them for deductive inferences. This is a scientific method of acquiring knowledge as there is a quality of self-correction based on objective evidence. For example, from the general proposition that the contamination of a drinking water source by *Entamoeba histolytica* will bring dysentery to those drinking the water, we can deduce the particular proposition that the people of Gurnka Village risk dysentery because their water has become infected with this organism.

"What is objective evidence?"

Evidence is objective when it is observable and measurable, e.g., one can see and measure a rise in pulse, blood pressure, and change of facial expression, but one cannot measure "anger", or "worry". If you need objective evidence of anger, then you need to define the concept in observable and measurable terms. This is what is called an **operational definition.**

Facts, Principles, Concepts and Theories

The body of health knowledge consisting of facts, principles, concepts and theories depends on physical, biological, social and medical sciences.

"What's the difference between fact and concept?"

Facts are observable and measurable events. e.g., name, sex, age, number of children, measure of body temperature, and fracture of a limb seen on X-ray—all are facts about a person or client. A **Concept** is a generalized idea of some group of objects or several facts perceived in a meaningful way by the users.

"Is a concept the same as an impression?"

No. A Concept is not an impression but involves higher mental ability such as interpreting language, finding relationship etc. A Concept includes both a **concrete** form, such as the concept of "Kidney", or it may be ideational, such as the "concept of liberty". Let us examine the following example: A **10-year old boy** has a large **wound** on his body. He develops a **high temperature - 40°C [105°F]** and a rapid **pulse and respiratory rates - 120/28.** His painful wound shows a **pus** discharge. The health worker thinks of "infection" as she studies the relationship between vital signs and the abnormal discharge of wound. She gives cold drinks, a cold head compress to reduce temperature and sends the pus sample to the laboratory for a bacteriological test. The words emphasized are facts—that is, the events that are observable. "Infection" is a concept as several events occuring together form a concept. The application of cold compresses and the giving of cold drinks is related to the loss of body temperature through conduction which is a **principle** of heat transfer.

"Do you mean that the principle is a general rule that can be applied to different situations?"

Right, there are several therapeutic procedures of cold, local and general applications where the principles of heat transfer can be explained. Thus, principles are derived from the results of scientific investigations that describe a particular phenomenon.

"What is a theory then? Isn't a theory the same thing as a law?"

In some ways, yes—both theory and laws describe relationships between facts that may be used to explain phenomena or a series of events on the basis of observed facts; but a theory lacks absolute or direct proof whereas a law states that when conditions are the same, the particular phenomenon would always occur.

"Can you explain this theory with an example?"

In the previous example, the theory explains the relationship of fever to the reaction of the body against bacteria and also it explains the reason for the selection of cold therapy to reduce the temperature.

A theory consists partly of events that are of known dimensions (fact, law), and events that are of assumed dimensions (e.g. assumptions, hypotheses, propositions). It may also include events of unknown dimensions for which adequate explanations are not available.[6] Research aims at shifting the events from unknown to assumed dimensions, and assumed dimensions to the known dimensions. Kerlinger[7] explains the functions of theory as description, prediction and explanation; e.g. it describes what the variables are and how they are related; it predicts relationships between variables, suggests new things, or it attempts to explain sets of events, i.e. in analyzing the occurrence of events.

"So many forms to know! It is confusing."

Well, it is a complex idea and it takes hard thinking to conceptualize relationships that are not so concrete or right in front of you. Let us look into the following diagram of spread and control of a gastrointestinal infection. This model is a diagram (See Fig. 2.1). It shows in picture form how the ideas relate to each other. If you did not have a picture available, you could write down your ideas and describe the model and your theoretical framework.

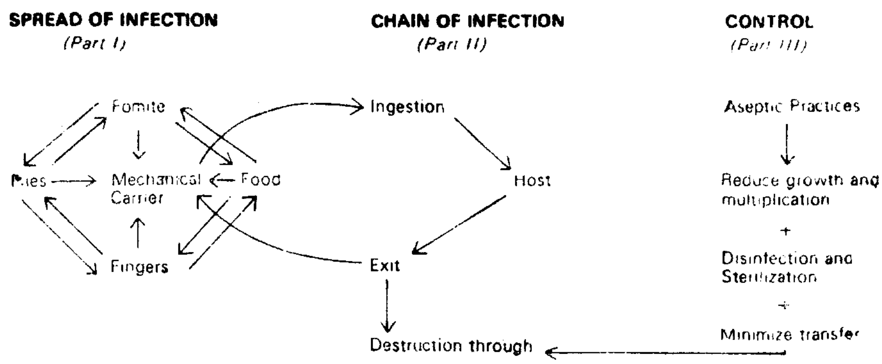

Figure 2.1: Conceptual Model on Spread and Control of Gastro-intestinal Infection.

This picture describes a model of the spread of infection (Part I), the infection in the human being (Part II), and the methods of controlling or preventing the infection (Part III). The model also shows relationships among the variables, i.e. mechanical carriers with infection and infection with control. If we set up a research study in relation to this model we would also be able to predict occurrence of infection or control of infection on the findings related to the chain of infection.

"That's better—it is getting clearer. It means that the model represents some theoretical concepts and this concept is represented as a form of reality using symbols and signs?"

Right. And a theoretical framework is intended to identify the related theory and law which remain behind the model structure.

For your interest we have included another model in Figure 2.2

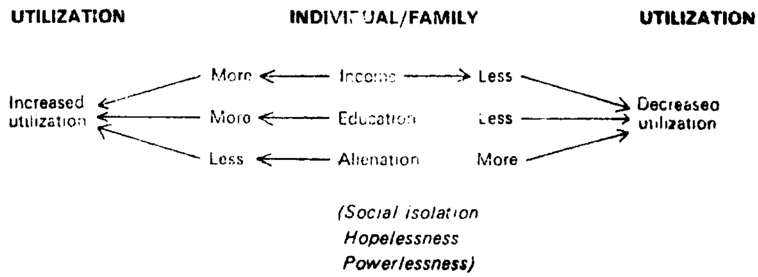

Figure 2.2: Conceptual Model on Utilization of Preventive Health Services [8]

Do you find any relationships between utilization of Preventive Health Services and individual or family background? Can you identify the nature of the relationships that are direct or inverse?

To summarize, we have discussed how theory building occurs through the acquisition of knowledge and through the use of scientific methods. Theory also develops when relationships among variables are examined in order to predict newer relationships.

LETTER 3

"WHAT KINDS OF RESEARCH CAN I DO?"

Three Approaches to Research

Dear Reader:

When deciding what type of research to conduct, you may want to consider three broad types of approaches to research. These are: (1) historical research; (2) survey research; and (3) experimental research. Now, which one you choose depends on the objectives and framework of your study, the kind of data sought and the nature of the problems to be solved. Further, your own skills, background, academic preparation and areas of competence will certainly influence your selection of the type of research you conduct.

Let us take a look at three broad examples. Let us say you wish to study the status of rural community health services from the beginning of 1900 to 1970 in Africa, Indonesia, and India.

"That sound like a historical approach to me."

That's right, and that is exactly what it is called. And historical research has some assumptions and specific approaches that are unique to the approach which we shall examine shortly.

"What other approaches are there?"

Well, let us say we are interested in an analysis of the perceived health needs of expectant mothers in villages served by the local health centre.

"You mean surveying their opinions about their own views of what they need?"

Yes, and a survey approach is what it is called, in fact. The survey approach focuses primarily on the present whereas historical research looks to the past. But more about these essential differences in a minute.

The final approach can be illustrated by an example where we wish to test the effects of information gained through two organized pre-natal health teaching programmes, one in the home and one in the health centre setting.

"Sounds like an experiment to me."

That's right, that's exactly what it is formally called, the experimental approach. Here the time focus is the future, where the researcher says, "if I manipulate the teaching setting, I predict I will get certain results."

The Appropriate Fit

"Well, how do I know which category my research fits into, and further, is it important for me to classify my research according to approach?"

The Availability of Data

Those are excellent questions. First, it is indeed important for you to identify what type research you are conducting. As we pointed out, the type of data you wish to collect and the purpose of your research dictate your approach. You may say you'd like to do an experiment, but if you are in no position to manipulate the independent variables then an experimental design is out of the question. But, if you have access to library facilities or historical documents, then historical research will be open to you. If you have access to a sample or access to records then survey approaches will be possibilities.

"In addition to the issue of time what other factors must be considered in the selection process of research approaches?"

Well, the first which we alluded to is the availability of the data. In historical research, as we said, you will use old records, historical documents and/or information from individuals who were living or practising at the time under study.

"For the survey data, the material is current, right?"

Right. For example, data concerning the current child rearing practices of Balinese island families could be collected through the survey method. But in the experimental method we must create a situation to obtain the data sought. Here, we expose one group to some sort of unique experience or to "X" the special treatment. This group is referred to as the experimental group. The other group is the group which does not receive "X"; this is the "O" group or the control group. Sometimes, you have several groups receiving variations of the treatment. These groups are often receiving X, X^a, X^b—etc. For example, you may wish to see what factors will effect a change in completion of immunization schedules as part of the EPI (Expanded Programme for Immunization) effort. So for one of the groups you provide the injections. For a second group you provide the injections plus teaching. For a third group you provide the injection, plus teaching, plus a monetary incentive. (Because of the nature of this study, that is providing essential immunizations, the use of a control group which receives no immunizations would raise ethical questions.) What you are asking in the experimental approach is: does the unique treatment make a difference? Then, you measure the effectiveness of the unique approach against some set criterion or some pre-determined outcome.

Researcher's Control Over the Data

"So, it's the researcher who decides what factors will be manipulated."

Exactly, and the control that the researcher has over the data makes this approach the most desirable one.

"In the historical method I can see no opportunity for the researcher to manipulate the data. The nature and amount of data is really not under the researcher's control, is it?"

No, it isn't. The researcher must accept what written or verbal documentation is available. However, we must recognize that any author has his/her own biases and necessarily writes from that biased perspective. No true objective of reality, historical or not, really exists. But in the survey approach the researcher has a great deal of latitude. Here, he/she has the choice of structuring the kind and amount of the data to be collected. (This is not to say that they will always get the answer to the questions they pose). The data exists somewhere. The researcher has to make a judicial choice of the setting in which to observe the data.

"But what about sampling? In historical research, some communities may have kept no records, whereas others may have kept extensive records. This will certainly present sampling problems, won't it? I mean the data will not be 'representative'."

The Perspective of the Researcher

In historical research, the investigator will make every effort to get every piece of information available on the topic. Further, he/she will look into all relevant social, economic and political forces that were then present to influence the changing events related to the topic. But it is true that the data available may reflect different periods of time as well as isolated facts which bear little relationship to the overall focus of the research. And, the political/social and philosophical orientation of the researcher will, in turn, affect the perspective of the research. The writer must be aware of his own bias for it influences the very factors he studies and reports.

"In the survey method though, the researcher is on more solid ground, isn't he/she?"

Certainly. If you want to survey expectant mothers in the Chawla Health Centre in Delhi, you can take ten per cent of the population of 6,000 from the total of six villages; here sampling is essential to assure that all types of mothers are represented. It is equally important in the experiment but in these two approaches the sample is more under the control of the researcher.

"But I would guess that in relation to data collection there can be no standardized method for all three approaches."

What do you mean?

"Well, in the historical method you cannot say one method will be used—you must use what you have."

Oh, that's true, and in the survey and experimental approaches, consistency is really a must. With our expectant mothers, we must interview all mothers and not only those who cannot read and write, and in our experiment, the gathering of data should be the same for both groups so that the only difference is the exposure to the unique teaching approach, and not the added dimension of inconsistency in gathering of data on the two groups.

Investigator's Role

A final area which must be considered is that of the investigator. In the survey and experimental approaches the data stand on their own; the personal judgement of the investigator has no place in interpretation. Comparative analysis of health interests and health needs can only be made on the basis of data as obtained from the mothers or whoever is interviewed. The relative effectiveness of the unique teaching approach can only be interpreted on the basis of the experimental findings. The reader is informed of the data obtained and the researcher's educated guess as to the reasons which may have contributed to the results obtained.

"Now that I know the advantages and disadvantages of each type of research, I have many questions in mind. To begin with, where do I get the data for the historical method?"

Historical Method

You will find your answer as we tell you more about the historical approach. Let us look at our previous example: "A Study of the Status of Rural Community Health Services from the Beginning of 1900 to 1970 in Africa." Here we need to find the observations of the people who had lived during the early 1900s, to ascertain their perceptions of the issues. We can either find written documents, verbal accounts of people who are still alive, or we can look at "things" and/or institutions or programmes, that were used or available for health services. The data you obtain through written documents or verbal accounts of another person become a **secondary source** as you do not directly observe them. Whereas the data that you gather by looking at things of that era, such as, drugs, herbs, the building used for a clinic, the incinerator used, are called **primary sources.** The secondary source data are valuable but they are subject to another person's interpretation which may be biased or incomplete. To a large extent, the historical approach depends upon data observed by others. Here your task is to find accuracy, authenticity, and objectivity of the records of observation. When you look at the "things" of that era or when you write your first hand observations, the data then are collected from primary sources. The difference between the two sources of data is that one is your personal recording (primary) and the other is obtained from other's recording (secondary). The researcher always prefers primary source data, as then the bias is limited to the researcher's own interpretation. "How do I know that the recorded events by others are authentic?" One has to validate the authenticity of the document and this is called "external criticism". This is a rigorous procedure of check and cross-check. You collect the number of documents, as many as you can, then verify the information finding the common references, the source of data referred to by the authors etc. Even when the source is primary, your task here is to find out whether the relic is authentic. (You may have a piece of junk in your hands!)

There is no question of sampling here; you collect as much as you can. Also for this research topic you would consider other research literature written during the same time period related to health, community living, health statistics etc. Once the researcher determines the authenticity of the data, the next task is to determine whether the data are accurate and relevant. This is called "internal criticism".

"Are the research steps same as in other research methods?"

Yes. here the review of literature is extensive and intensive. The secondary source of data is obtained with the researcher taking special note of motives, biases, and limitations of the author. While interpreting the data, the researcher considers all other interpretations that have preceded his/her study. Because the data represent less empirical evidence, the presentation must be based on a sound, logical rationale.

Let us now take a look at the survey approach.

Survey Method

"Yes, I had a question about the survey. In your example of needs of expectant mothers, could you relate the needs with the mother's level of education?"

In the survey approach, one can describe, in a systematic way, the facts and characteristics of the population, say, rural expectant mothers. This type of research is called **a descriptive survey**. Let us take another example: "A public opinion survey to assess eligible couples' attitude towards family planning practices". This is an example of a community survey to establish the needs for a health education programme. So in the descriptive survey, the purpose is to collect data-based information or to identify problems. This type of survey does not necessarily seek to explain relationships, compare groups, test hypotheses or make predictions. It is essentially exploratory in nature. An exploratory study can also explore relationships between variables. This type of descriptive research is called a **correlational survey.** In a correlational survey the researcher investigates the extent to which variations in one variable (e.g. educational level) corresponds with variations in another variable (e.g. perceived needs) based on correlation coefficients. The data are collected on more than one variable from the same group of respondents and the magnitude of relationships between variables are estimated.

"Can I compare the second trimester nutritional needs of rural expectant mothers with that of urban expectant mothers?"

Yes, here you attempt to find similarities, and dissimilarities, but there should be a pre-existing criterion, against which the groups are compared. This type of study is called a **comparative survey.** The important issue here is that the study is based on a particular problem and the results of data will be significant only for that particular problem.

There is another type of survey method appropriate for studying the effectiveness of a particular method; this is where the researcher attempts to assess whether or not the method used meets the criteria stated in the purpose of the original project. In this case also we need pre-existing criteria against which the existing condition is to be evaluated. The method is called an **evaluative survey.**

"Is it possible to investigate a pattern of living where one can study sequences?"

Sure, growth and development can be studied as a sequence type of problem. And you can study this problem in two ways. One, you can follow a group of new born infants from, say, their birth to five years of age to assess selected aspects of their growth or developmental patterns. This is called a **longitudinal survey.** The second method is a **cross-sectional survey** where you take representative samples from the age groups of: birth-three months, four-six months, seven-nine months, etc. Both methods have certain advantages and disadvantages.

"Are these called developmental studies?"

Yes, longitudinal and cross-sectional surveys are two examples of **developmental research.** Researchers may also like to investigate possible cause and effect relationships by observing some existing consequences and looking through the data from the past for plausible causal factors. This is different from the experimental approach where data is collected in a controlled situation. Let us give an example. Say you wish to identify factors characterizing persons having either high or low accident rates. Here the investigator collects data of all the events of interest occurring in certain subjects having high and low accident rates. Here he/she examines the data by going back through time seeking out course, relationships and their meanings.

"Does it mean the data are collected after all the events of interest have occurred?"

Yes. This is a causal-comparative approach which is "*ex post facto*" in nature; that is, data are collected by looking to past events. In social or behavioural studies, it is difficult to find a cause for an effect because there are many variables or factors that influence behaviour or the occurrence of events. It is almost an impossible task for any researcher to include all variables for one study. Hence, often cause-and-effect survey studies become, in a true sense, relationship studies.

"Is there any other way of studying cause-and-effect relationships?"

Experimental Method

Yes, by using the experimental method. We have already said earlier that in an experimental approach the investigator studies possible cause-and-effect relationships by exposing an experimental group to a "treatment" (e.g. drug, teaching, conditions, etc.). Then he/she compares the results with the findings of the control group which was not exposed to the "treatment". The number of experimental groups and number of treatments can number more than one. One of the simplest true experimental designs is called the **pre-test—post-test control group design** as explained in Fig. 3.1.

Groups	**Pre-test**	**Treatment**	**Post-test**
Experimental	0	(X)	0
Control	0	—	0

Fig. 3.1: Pre-test—Post-test Control Group Design

You select the subjects at random from the population and assign them randomly to either the experimental or control groups. You then pre-test both groups, expose the experimental group to the "treatment" and then post-test both groups. All conditions except the "treatment" should be the same for both groups. You can find the difference of the measures for both groups and compare the groups on the selected variable. (We will discuss the details of hypotheses testing in a later chapter.) Now let's look at a concrete example. Forty village fathers are randomly selected for a study to measure the effectiveness of a teaching-learning experience of knowledge of immunization principles. They are randomly assigned to the experimental and control groups. Both groups are first tested on their knowledge of immunization principles. The experimental group is exposed to a structured teaching programme on immunization. Then, both groups are given the post-test on knowledge of immunization.

"Isn't it possible that a control group father can come to know about immunization concepts from an experimental group father?"

Yes, it is possible. So the researcher keeps in mind that the experimental group does not "contaminate" the control group. In this instance you could locate the groups in separate areas so this contamination will not occur. Yes, you need to control the conditions of the experimental variables (treatment) so that contamination does not occur. There are several ways to design experimental studies, and further details as to how to go about doing so can be found in Campbell, Kerlinger, and Van Dalen[9].

"Well, it seems that I will need some time to think about these ideas a bit more. Each type of research has its advantages and disadvantages which I must consider carefully."

Think about them. In the meantime, we look forward to our next discussion.

LETTER 4

"IF ONLY I HAD A PROBLEM..."

Statement of the Problem

Dear Reader:

In our last letter we presented an overview of the research process. We also touched on the issue of identifying a problem you could research, and the need for communicating your findings to others.

"Yes, and I've been thinking about it ever since we last met. I have talked with a lot of people, have done considerable reading, and have reviewed studies that others have conducted. Yet I find, after doing this, that to narrow down a topic is quite difficult. Right now I am convinced that if only I knew what my problem was, I would know how to do the rest. Why don't you just give me a list of problems and I'll select one."

It's a tempting thought. We have heard these and other similar laments from new researchers so many times. But you must be careful about taking on a research topic selected by others. Abdellah and Levine correctly point out that "dictated research" weakens an important characteristic of research considered to be essential—intellectual curiosity. [10] That's not to say, however, that you ignore the experience and wisdom of professionals who have spent many years in the particular field of your interest. On the contrary, these experts are the people you see at the outset—people from whom the state-of-the-art can be summarized in perhaps a very short meeting.

Choosing Your Subject Area

Some believe that choosing one's own topic is not as credible as it sounds. David Drucker, a social scientist, notes: "it has been my experience—to find that students are expected, even required to choose their own 'research topics'. I believe that the primary responsibility for identifying 'research topics' belongs to the profession in general and practitioners in particular. It is the practitioners in their daily work who are faced with questions that require answers."[11]

Justification of the Project

But the research you conduct must be something in which you can put your full interest; someone else's vested interest will not produce this effect. Further, the real need for the study is perhaps the most essential criteria for taking on a project. The justification is based on your experiences, the experiences of others, and the accumulated data already existing in the literature. And just think, for the first time in your life, you are actually looking for a problem. Well, you are not alone; and it is not often possible to have a concise and pinpointed problem identified. It may take days or weeks before you can make a clear statement of the problem. However, this step is crucial and will influence all following steps in the process.

"How is that?"

Defining the Problem

Well, at every step of the process you refer back to the statement of your problem. You ask yourself over and over, "now what was it I needed to know about my topic?" And the clearer you can be about the statement of your problem area the easier will be the following steps in the process.

"How does this 'clarity of thinking' evolve? I mean I just can't say 'now I will think clearly' and it happens. I don't really think so clearly: maybe I'd do better to explore some general topic to start the research when I have more 'background' as they say."

We understand that you feel very uncomfortable. But, you must begin somewhere, and even though you feel that coming to identify a problem is difficult, it is essential that you do just that. Next month or next year, with 'more background' the difficulty will still exist. The process necessarily includes the first step of identifying the problem area. Some researchers feel that one "has no need to, and actually should not, specify a highly defined research problem until some reading has been done within the problem area and, that the researcher's thinking has developed as the result of this contact with the literature."[12] As a matter of fact, the way many important research ideas begin is with a general idea, or to put it differently, one designs with "a vague unrest about observed and unobserved phenomena, a curiosity as to why something is as it is."[13]

And the first step is to be aware of that sense of incongruity, that uneasy feeling. The idea is to try to put into words the nature of the observed inconsistency. As Dewey says, one senses, "a troubled, perplexed, trying situation, where the difficulty is, as it were, spread throughout the entire situation, infecting it as a whole.'[14] And this 'trying situation' begins to bother the researcher until he/she can put the problem into a general statement.

"Well, I know the kinds of things I am interested in: in general, I know the problems that exist in my area of practice."

That's a good start. This knowledge on your part shows that you are aware of the problems in the speciality area where you work. One reason people often have difficulty identifying a research problem is that they have little clinical experience upon which to draw. We think nurses, social workers, nutritionists, midwives, medical anthropologists and other health workers have an advantage because of the amount and kind of clinical "hands on" experience they have daily.

"Anyway, what comes after this initial general statement of the problem?"

Review of the Literature

Well, then you need to see what has been done in your subject area. For example, say, you are interested in urban and rural differences in growth patterns of children. You will want to know what are the basic considerations made by researchers in this field, what is their frame of reference, where will research like yours fit in? You are interested in making a contribution to research literature. Well, what has been learned already, and what gaps are there to be filled? You are not interested in doing an isolated bit of work which cannot be used by others. Further, you do not wish to repeat a type of study that has been done. It is known that the newborn has a certain height, weight, head circumference, etc. You are not interested in establishing these facts all over again. In addition, by reviewing others' research you learn about their success and failures, the instruments they found helpful, and the kinds of situations you may wish to avoid. In the growth and development example, one review of the literature revealed that the arm measurement using the arm bangle was one simple way of assessing growth and nutritional status. As you read others work, you begin sorting out what has been done, what is needed, and what is possible or what is yet to be done.

"So, you begin a sort of process of elimination."

That's right. And, so you begin to narrow down your search, your problem becomes more and more specific. The review of the literature will assist you in further outlining a tentative problem.

"What do you mean by 'tentative'?"

Well, after an initial review, you will begin to ask, now that I have my problem, where will I get my answers?

"From the subjects or people of the study?"

Right! You will begin to think about the people or the population about whom data or information will be sought. Unless you have a population, you have little to research. Then additional questions will come in mind concerning the literature review you previously did. You will be more aware that you have more definitive questions to ask, and this prompts the second, more precise, review of the literature. For example, during the second review of the literature in the authors' growth and development study, we begin asking: what kind of scales did the researchers use? What simple methods did they use to collect data in rural areas? Are there any instruments we could adapt? And how did they present their findings? What recommendations for future research did they make? How much did the research effort cost, etc.?

"So, the second review should help you get down to specifics about costs, feasibility, and value of the research."

Yes. And by this time, if you still want to carry out your study, you are convinced about these things. Your hunches become more clear—you are more sure of the questions you feel must be asked. And further, you now ask "Is it possible? Can this study be done?"

"You mean you must be sure that the study is feasible, valuable, and economically sound?"

Study Feasibility

Well, those considerations are essential; feasibility takes into account the time, money and the availability of the methodology to do the study. The needs of the organization, regional area, community and residents must be considered. And these considerations must be evaluated very carefully particularly in developing areas; any project must have the community's approval as well as the approval and support of the government. Part of the government's rationale in giving approval will have to do with the potential use of the data, that is, how important will the results be to the intended users. Transportation problems, extremes of temperature, language barriers, local customs, cost of materials—all are factors of utmost importance. In our growth and development example (a real one), collecting the data meant that a nurse had to drive from village to village during very hot weather. She needed transport and money to do this. Each visit took at least 30 minutes and each visit had to be carried out after the nurse's usual working hours, so that time became a crucial consideration. In short, you must ask, is the study practical? Is it a common sense approach to our problem? These are factors which contribute to rendering a study "feasible" or not.

"You almost have to sit down with a map and a calendar to work out the geography of the situation and the whole time frame."

That is a must; and that exercise is one part of your overall plan. Then you must ask, is the project worth the time, money and effort? What effect will the findings have on the ultimate health of the people? We must also ask ourselves, "if I find something out about this group of people, does it hold true for a larger group of people?" That is, can I generalize my findings to other settings?

For example, say, I conduct a short course for mothers within a ten km. radius of a health centre, teaching them about immunization of their infants; and then I observe the number who bring their children in for immunization. That is, are my findings "generalizable". Can my results apply to all rural mothers? Of course not. The proximity to the health centre might be a factor partly responsible for what we could call the high rate of compliance. If I use ten mothers out of a population of 2,000, I can hardly generalize my findings. What is true for ten is not necessarily what is true for 2,000. It is too small a sample.

We also need to see how far the result of the study is actually feasible. Suppose we used sophisticated audio-visual aids as part of our teaching strategy and we found that more mothers brought their children for immunization. But, in the practical setting, is it possible to use such sophisticated methods? We may find that in reality this is an expensive item, and completely beyond the budgetary allowances for rural health programmes.

"Well, with all these constraints I am not sure I am even competent to carry out an involved study."

Well, that is also an essential factor with which to deal. But, you may want to consider the assets you do have. You know, health personnel have been trained to observe systematically. They are aware of physiological instruments of measurement such as thermometer, blood pressure apparatus, and other mechanical devices, they have an acute awareness of their own presence and impact on the patient; and they have been painstaking in their development of recording communication skills. These are the very skills needed by the researcher. But health personnel have been doing these things for years; the very skills you have been taught are the ones taught to the students of research. These students do not know anything magical or special which makes their training unique.

But, we should also note, that the researcher must be able to observe, hypothesize (make educated guesses), experiment, analyze, record and communicate one's findings. You could not possibly possess all the detailed skills or knowledge required in each of these areas. But if the health worker cannot interpret the findings in the intensive care nursery, say, a paediatrician is called in. So too in research. If a problem calls for a statistical approach with which the researcher is not familiar, a statistician is called. No one can be expected to have all the specialized skills in neonatology or in statistical analysis. If an infant is ill, specialized laboratory tests are carried out by skilled laboratory technicians. If complex analyses require the work of a computer, a specialist is called in to complete this part of the process. In both instances, the health worker must: (1) recognize what is needed; (2) use the appropriate resources; and (3) be able to utilize the findings of the specialist who has assisted him/her.

"From all we've said, it seems that it might be a good idea to identify some resource people at the problem definition stage of the process."

That's an excellent point. The statistician and content experts must have early and ongoing input into your research problem. This approach avoids many problems at later stages of the process, and it provides for a much more stimulating and comprehensive research project.

"Well, may be because it's all so new to me, I find most things we've discussed difficult."

We're sure you do. And what makes the picture more trying is that research, at the applied level, is complicated because it is carried out on people in live situations which are constantly changing. It is not pure like the laboratory test-tube environment.

Therefore, we pointed out that a clear specific statement, at the outset, was not necessary or desirable.

"I do feel better about that, I must admit. You also indicated the kinds of things one should review about the project—sort of criteria one should use to decide whether or not the project should be carried out."

Yes, and we think you can now see the reason for the second literature review as well as the need for on-going help from experts.

"I do, and at this point. I feel comforted that I can use them to bounce off some of the ideas going through my head."

Oh, sounds like some ideas are beginning to form—that should make our next session interesting—think you can hold them?

"I'll try."

LETTER 5

"HOW MANY DO I NEED FOR MY SAMPLE?"

Sampling

Dear Reader:

If you remember in our last letter we discussed three different research approaches. You may also remember that in the historical method, the researchers' "sample" was whatever was available to him, through records, historical documents and interviews. But in the survey or experiment the researcher has more control over the exact composition and size of his/her sample.

Several questions typically asked by beginning researchers are "who will comprise the sample?" and "why do I need to do sampling?"

"Those were the questions I was about to ask—and I had another one, too—how do I select the sample?"

Let us take one question at a time.

The Sample Versus Population

This question can best be answered with an example. Let us suppose you want to study the health status of mothers from selected African villages.

The general group of village mothers, or category to which the mothers belong, is called the **population.** Here each single mother of the village would be a **population element.** In this case the population described are human beings but depending on the problem, it could also include animals, plants or inanimate objects. This is a statistical population.

"But there are thousands of 'elements' in the rural villages of Africa. I have neither the time nor the money to study all the rural mothers."

That's right. When we study some of the elements with the intention of finding out something about the population from which they come, we say that we have selected a sample.

"Then, could I say that a sample is a small proportion of a population?"

Yes, and the population is also a part of the larger group called the universe, all the entities relevant for study. There is only one completely relevant universe but any number of populations to study.

"If it's only part of the population shouldn't the sample be **representative** of the population?"

Right! The sample should represent the population of those critical characteristics you plan to study. Then you can say that what I have found out about the sample is true of the population. And you can do this, provided your sample really represents the population and is not a select or favoured group. That is, samples are not selected haphazardly, but deliberately so that every element in the population has an equal chance of being selected for the study. If these conditions are met then what you say about the sample can also be said about the population. For example, you were studying villagers' attitudes toward mental illness. If the villages selected were located near an active psychiatric outpatient department, it is doubtful that you would truly have representation. Or, if you were to study a nuclear family in a village where the unit was the joint family, you would not represent that village, at least where family structure is concerned.

"Why can't I just study all the people in the village?"

If that is your target population, and if it is manageable enough, then go ahead. You can study all the villagers (elements) as subjects and that's the best choice in making inference on that particular group. But this is not often the case.

If you take all health workers who are employed in a government health centre located in a district as your population, you will perhaps study one whole population. Whereas if you define your population as all health workers of your country—one cannot usually study the whole group! Even if you can, it's a waste of money and time. The process of selecting a fraction of the **sampling units** of your target population for inclusion in your study is **sampling.**

"What's the difference between sampling elements and sampling units?

The population "element" consists of the attributes or phenomenon of the subjects or objects that we want to study. A true representative sample consists of similar elements; these are called the sampling elements. Each sampling unit contains a number of sampling elements. For example, in a village if the lists of Hindu, Muslim and Christian mothers are available from which you can select your sample, then each group becomes a sampling unit. In each such unit, a number of sampling elements, mothers in this case are present. Sampling technique will then involve getting representatives from each unit.

Need for Sampling

"But what if I see sampling bias in some data?"

Then you do not accept a generalization to the intended population. All you can say is that the findings are limited to that sample. And, this is an essential point to note when you need a researcher's description of the problem and sample. What are the critical characteristics for this problem for which you should have achieved representativeness? When you have identified these, then you can make the decision whether or not the researcher has addressed the issue, and whether or not he has convinced you that his sample can be considered representative.

"Can I make this decision at this point in my research career?"

Certainly—and you should. You know that villages located near health centres can be very different in a variety of ways from villages which are not. This is a judgement you can make as well as any researcher—and probably better.

"It seems what you are trying to say is that the primary function of a sample is to help researchers draw valid generalizations regarding the population. Right?"

Right. At this point we are introducing two new terms which will be discussed later in chapters of analyses. The population value such as average or range is called a **parameter** whereas the measured value of the sample is termed **statistic.** We infer the parameter from the statistic when we know that the sample is a true representative of population.

Figure 5.1 diagramatically explains the purpose of a sample.

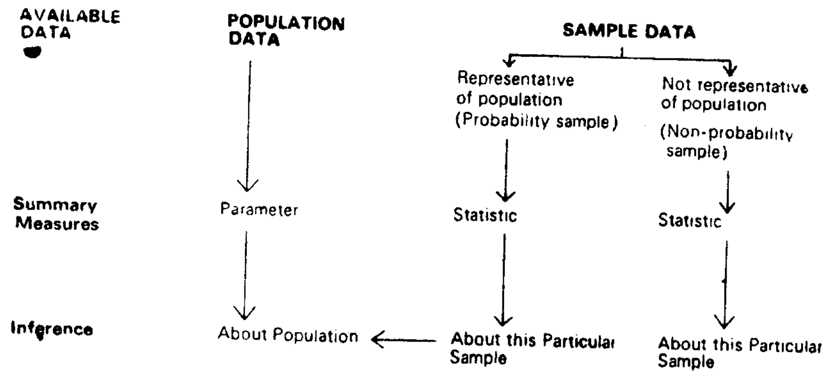

Fig. 5.1: Statistical Inference Process in Sampling

Kinds of Samples

Probability Sampling

Simple Random Sample

"How do I get samples which are unbiased?"

That is a good question. There are various methods of selecting items (or elements) for statistical samples. One of the simplest procedures is **simple random sampling.** In this case each element in the population has an equal chance of being selected and that each choice is independent of another. One of the techniques of random sampling is to use a table of random numbers as the basis of selection. We have included one below; it consists of columns of digits in random order. (You will find these tables in standard statistics books. See Table 5.1).

"How do I use the table —it looks rather complicated!"

Not at all. Let us say you have 95 villages and you wanted to select 10 of them. You would number the villages from 1 to 95—the villages can appear in any order. This provides a method for assigning a number to each element(village) of the population. Since we have 95 villages, a two-digit number is required. Thus we need two columns in the table.

"How do I decide which column to use?"

You blindly stick a pin in the Table of Random Numbers and use the number on which the pin lands.

"All right. I picked columns 11 and 12."

Well, the first number in column 11 is a zero and the first number in column 12 is a three, making your two-digit number 03. So, village three is the first village selected. Our second village would be—?

"Sixty-nine"

TABLE 5.1: Table of Random Numbers (Hypothetical)

COLUMN NUMBER															
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
2	1	6	9	4	1	1	4	6	2	0	3	8	6	4	1
8	3	9	7	4	3	8	1	8	2	6	9	4	3	2	0
4	9	4	0	2	9	2	4	9	0	2	0	3	1	5	4
6	4	1	2	4	9	9	1	3	2	6	9	8	9	8	7
3	6	3	4	4	3	0	3	0	4	6	0	2	4	1	2
5	9	3	5	1	6	0	5	4	9	0	2	3	1	1	4
8	6	8	3	6	6	2	3	8	2	6	5	7	7	2	9
0	3	2	8	3	0	4	3	1	9	4	3	3	8	0	7
6	9	4	1	3	3	8	2	4	9	2	0	2	4	5	3
4	4	2	4	1	6	3	1	8	2	3	5	4	9	0	2

Right. You continue your selection until you reach the total of ten villages previously determined. These would include villages: 3, 69, 20, 69, 60, 2, 65, 43, 20 and 35.

"I find number 69 is selected twice; what can I do now?"

You ignore the second 69 and take the next number.

"This seems a lot of work. Is it worth the effort?"

It is, especially if you are concerned about the bias of the researcher. Your critics cannot say that you got the results you wanted because you hand-picked the sample. You know that every element in the population had an equal probability of being selected. A second very important consideration is that in order to use many kinds of statistics you must have a bias-free sample.

"Do I have to tell the reader of my research that I stuck in a pin, and used a table of random numbers?"

No. If you inform the reader that you used a table of random numbers to select the simple random sample, he/she will understand what you mean. And also, when you read others' research you must question whether or not the author, considering his problem, should have used a bias-free selection procedure. If you think he/she should have and did not, then you should read on for an explanation as to why random selection was not utilized.

Can't I just use a lottery? Close my eyes and pick up numbers from a bag?"

Yes, you can. Each time you pick a number, record the number, and return it to the pile to give a chance of equal probability of being chosen. If you don't, the chance of being one in 95 changes. For example, when you pick the first number, each number has the probability of being chosen, in a ratio of 1:95 (95 refers to the total number of villages in the population) if you put the first number aside, then the second number has the probability of being chosen in the ratio of 1:94 and so on.

Systematic Sampling

"I understand this, but, can't I just take every 9th subject, like 9,18,27,36,45,54,63,72,81,90?"

This method is not statistically sound although simple to do. You may choose the first number randomly (between 1 to 9) and then take every 9th number. But after you have chosen the first number the rest of the numbers lose the property of having equal chance of getting selected. This is also called **sampling by regular intervals or systematic sampling.**

"According to the examples shown in sampling through the simple random method, each item in the population is to be numbered systematically; it seems to me that if I want to truly represent the population then the question of proportion has to be considered."

Go on, can you give me an example.

"Well, let's see, to continue with the example of village mothers, supposing I wanted to study the relationship between health and religious practices by villagers. I know that 60 per cent of the villagers in the population are Muslim, 20 per cent are Hindu, and 20 per cent Christian. Then would I not have to assure that these aspects exist in the same proportion of the sample as in the population?"

Stratified Sampling

Absolutely, if religion is one factor which you wish to control. By doing this, you are addressing the process of stratification. Here the population (rural villages) is divided into subgroups or **strata** on the basis of the characteristic (religious affiliation) for which you seek representativeness. You, then randomly select proportionate villagers from each of the three strata in order to learn the effects the three religions have on selected health practices.

Thus, you would include three-fifths of the sample from the Muslim community and one-fifth each from Hindu and Christian religious groups. (See Table below.)

TABLE 5.2: Villagers Categorized by Religious Affiliations

Religious Affiliation	Proportionate Sampling	Constant Stratified Sampling
60% Muslim	[illegible]	50
20% Hindu	30	50
20% Christian	30	50
(N = 150)		

This means that to study 150 village mothers unequally distributed among three religious groups, you would need to have some knowledge of population. In this case, the knowledge needed is composition of the population according to religious distribution and is called stratification by **optimal allocation.**

For other types of stratification, we would keep the number of village mothers constant, that is, we would select 50 Muslim mothers, 50 Hindu and 50 Christian. This process, where you select a constant from each stratum, is called **constant stratified sampling.** Table 5.2 shows that you want to study the religious orientation which is one characteristic of the population.

"So, let me see if I have this concept. I would stratify when I want to be sure that the characteristics I am studying are proportionately represented in the sample as they occur in the population. But, supposing I had nine or ten variables, that would get so cumbersome, I would not be able to manage it."

So, you stratify according to two or three essential characteristics, which is usually the way it is done in most research. Moreover, for stratification, you need to have the knowledge of proportions of each stratum in the population.

Cluster Sampling

"I feel it is going to be really difficult to find out the proportion if I do not have the information at hand. Morever, what do I do if I do not have the list of members in the population?"

The appropriate method of choice is **cluster or area sampling.** A cluster sample is a simple random sample in which each sampling unit is a collection or cluster, of elements. For example, a provincial medical officer might fear an outbreak of a disease among infants in his province. He wants to study 500 infants for immediate medical examination. It is really not practical to list all the infants in the province and then draw a random sample from them. It is much easier, from a working point of view, to have the infants groups in units such as sub-districts, villages or census blocks and then draw a sample from these units. However, there is one major danger which must be avoided. An important principle of random sampling is that every infant must have an equal chance of selection. Villages may vary in size from under 100 to up to 10,000. It is clearly not valid to equate a very small village with one of maximum size as the infant in the small village would have a greater opportunity of selection than in the largest village. This problem is overcome by breaking the villages into units of equal size such as census blocks or by a system of weighting.

It is possible to go a step further and sample in stages. **A two-stage cluster sample** is obtained by first selecting a simple random sample of clusters and then selecting a simple random sample of elements from each sampled cluster. The investigator may be interested in the pregnancy histories of women admitted for spontaneous abortions to hospitals within a region. He/she first makes a list of all the relevant hospitals in the region and categorizes them according to size. A random sample selection is then made of the hospitals. Lists of patients treated for spontaneous abortions are then drawn up and a further sample selection made from these lists.

It is possible to have multi-stage sampling, but it must be remembered that cluster sampling and multi-stage sampling also extends the range of the sampling error as it brings mere possible causes of variability to the final results.*

"So the smaller the cluster the better it is?"

Yes, more numbers of smaller clusters spread over large areas is better than having few, larger clusters covering small areas. In the above example, it is better to have 20 women from each of the 50 hospitals than to have 100 women from each of the 10 hospitals; this is so because a larger number of clusters reduces statistical measures of spread or variability. On the other hand, field work is much easier if you have a fewer number of clusters. Hence, the investigator has to compare the advantages of this readier access to the selected sample population against the increased error.

*For measures of variability see chapter on data analysis.

"Can't I just use the available samples?"

Non-probability Sampling

Convenience Sampling

Well, so far we have been discussing probability sampling where the sample is considered a true representative of the population. This allows making probable an estimation of parameter, thereby, drawing inference about the population. If you just take the available sample, which is also called a **convenience sample**, your technique is **non-probability sampling.**

"Doesn't the non-probability sampling consider the chance of every item being included in the sample?"

You are correct. For example, if you stood in a village and questioned all the villagers who were first in line for a clinic visit, you would have a sample of villagers. This type is one example of a non-probability sample. A non-probability sample tells you that you have no way of estimating the chance that each person or element has of being included in the sample. When you take the first cases that fall to hand and continue until the sample reaches a designated size that is called convenience sampling or spot sampling. You have no way of evaluating bias—you can only hope that you are not being too grossly misled. The "man-on-the street" interviews are often of this nature.

Purposive Sampling

"I see. So, my approach, although simple, does not give a fair chance to everyone, and can produce data which is not truly representative."

That's right. It is really the weakest form of sampling, but is usually the most frequently observed. Avoid accidental samples unless you can get no other—and if you do have to use them, use extreme caution in analyzing and interpreting the data. It may be noted that statistical inference which is biased on probability cannot be applied for non-probability sampling. Some elementary descriptive statistics may be used but even that cannot be interpreted with confidence because the sampling elements are biased. It is only valuable for making a rough estimate as a preparation for planning a larger research study.

"If convenience sampling is to be avoided, are there any other options?"

Yes. Another is **purposive sampling** where you attempt to identify typical cases of whatever you are studying. For example, if you are studying Tibetan villagers, finding the "typical Tibetan villager" would be one approach (if there is such a person). Or, if you were interested in the play patterns of four-year old village boys, studying a small sample of "typical" four-year olds would comprise your sample. Obviously, this approach is not often a very dependable one, for what is "typical" is often a very subjective opinion. Kerlinger notes, "Purposive sampling, ... is characterised by the use of judgement and a deliberative effort to obtain representative samples by including presumably typical areas or groups in the sample."[15] For example, if you want to study the dietary supplement for goitre cases, you will probably select areas where goitre is prevalent, say, Guatemala in Central America. Here you deliberately choose that region for study.

"In this case, can I generalize to the population?"

You can surely generalize to the population you have studied but remember you have drawn your sample from a restricted population from that region. The same method of dietary supplement treatment may not be appropriate for the population in another region.

Advantage of Probability Sampling

"What is the use of probability sampling?"

The main issue of probability sampling is that you can make population estimates from the sample. This is possible because of random selection. In other words, the great advantage of random sampling is that by selecting the units randomly, you are preparing a model of the total population with the same characteristics as the population. This model is subject to sampling errors, but the extent of these errors can be calculated and allowances made for them.

Thus, the use of a random sample has obvious benefits for the research investigator who is operating with limited resources of staff, budget and supplies. Instead of having to cover the total population, sufficiently accurate results might be obtained, if he/she only confers with a small sample of the population.

Sampling Errors

The sample statistics is not identical to population estimates but it deviates due to chance variations in drawing few items (sample) from many possible items (population). This is called a **sampling error.** When we generalizé on the population from the sample statistics we estimate the size of the sampling error. When we find the error to be small, we conclude that the difference between the sample mean and population mean is due to chance and we say that the sample is representative of the population.*

"When the sampling error is large can we generalize on the population?"

No. We then conclude that the sample is not a true representative of the population.

"Can you explain this with an example?"

Look at Table 5.3 . In a hypothetical case, 100 samples each of 5 persons, 100 samples each of 10 persons, 100 samples each of 20 persons and a final 100 samples of 50 persons each were studied for colds. Table 5.3 gives the summary of the mean, standard deviation and total number of observations in each case. The hundred samples in each of these sample sizes gave different mean values which are listed in column 1 and the frequencies of obtaining these values are listed in column 2, 3, 4 and 5.

Let us assume that we know that the population average is 4.50 (class interval 4.25-4.75) colds with a standard deviation of 2.87. If our 400 samples were perfect, then, the mean of each samples would lie between 4.25 and 4.75. Thus the measurements of the mean show that 39 per cent of the samples of five lie between 3.75-4.75, 58 per cent of the samples of 10, 77 per cent of the samples of 20, and 91 per cent of the samples of 50 lie within this range. What do you see here?

*Refer to letter 13 for test of significance.

TABLE 5.3: Mean Number of Colds per Person in Samples of Different Sizes

Value of Mean in sample	Frequency occurrence with values as shown in Column (1)			
	samples of 5	samples of 10	Samples of 20	Samples of 50
(1) (1)	(2)	(3)	(4)	(5)
0.75	1	-	-	-
1.25	1	-	-	-
1.75	4	1	-	-
2.25	2	2	-	-
2.75	12	5	2	1
3.25	15	8	9	5
3.75	12	16	24	22
4.25	10 } 39	26 } 58	31 } 77	45 } 91
4.75	17	16	22	24
5.25	8	15	10	3
5.75	6	8	2	-
6.25	7	3	-	-
6.75	4	-	-	-
7.25--7.75	1	-	-	-
Total Number of Means	100	100	100	100
Total Observations	500	1000	2000	5000
Grand Means	4.43	4.61	4.50	4.48
Stand.Deviation of each 100 Means	1.36	0.91	0.61	0.44

"I find that as the sample number increases, the sample means are more similar to the population."

Right, you can also see that the standard deviation also gets smaller as the size increases.

"But in a normal situation we do not take 100 samples to study! How are we to find if the standard deviation of sample mean is small?"

That's right. This is done mathematically; standard deviation of means of samples is equal to the standard deviation of the sample divided by the root of the number included in the sample.* This is also called **the standard error of the mean**. With samples of varying sizes, the question will always arise: how much sampling error is there likely to be? You can see in Table 5.3 that the smaller the sample, the larger the error and conversely, the larger the sample, the smaller the error. You want to give the principle of randomness a chance to be operative. The larger the group, the less chance of error. Therefore, the size of the sample will depend upon the problem precision aimed at, the design of the study, and the availability of subjects.

The large sample does not only give a smaller error but also increases the power of a statistical test applied to the data. It also increases reliability of the study. But at the same time, a small sample is economical, makes the study more feasible, and acceptable reliability can be estimated statistically.

In behavioural research a small sample is necessary for an in-depth study such as a case study.

If you are doing a pilot study, a size of 10 is a good number. But a size of 30 or above is a good small size sample for applying statistical methods. Whereas if you want to standardize a treatment or certain drug dosage the sample could be as large as 5,000.

Try to be reasonable when deciding about your sampling procedure and sample size. You may gain by a large sample but find the numbers too unwieldy to manage, which may jeopardize your whole plan.

"I can see that the generalizations I make in my study have a good deal to do with the choice of sample—so I had better select carefully."

You've got the right idea—we will keep coming back to this issue throughout the design, implementation, and analysis of our problem.

*Standard error of the mean $= \dfrac{\text{Standard deviation of the sample}}{\sqrt{\text{Number included in the sample}}}$

LETTER 6

"I KNOW WHAT I WANT TO STUDY BUT HOW DO I MEASURE IT?"

Data Collection Instruments

Dear Reader,

When we have decided on the problem, the conceptual framework, the research approach and the sample for our study, we are faced with the task of systematically collecting observable and measurable evidence upon which we base our findings.

"If we want to know the opinion of 100 sample mothers related to infant feeding, how do we begin?"

Well, the data in this case is opinion-related to infant feeding. This compilation of mothers' responses is known as **Data Collection**. And, in this case, the method by which the opinion responses are collected is called **questioning**. We may either **interview** the mothers and collect data by asking questions or ask them to answer a list of written questions presented to them in the form of a questionnaire. Both interviewing and using questionnaires are included in the questioning method of data collection.

"Can't we also see how mothers are actually feeding the infants?"

Sure, in that case the method of data collection is called **observation;** that is, the information needed is observed, measured and recorded by the researcher or trained observer.

The third method of data collection is called **measurement** where standardized tools are used to collect observable, measureable facts. For example, if the researcher wants to calculate the nutrient value of rural infants' feeds, she may actually measure each feed that the sample infants take per day. In this case the method of collection of data will involve physical measurement of food in mililitres or grams. Standardized psychological tests to measure intelligence (I.Q.), or personality inventory measures to assess personality characteristics are also examples of measurement tools.

To summarize what we have said so far, in general, there are three methods of data collection: (1) observation, (2) questioning, and (3) measurement. The purpose of collecting the data are related to the objectives of the study, and the data collected is the basis for description, inference, or prediction.

"Would you tell me in more detail about these methods so that I know when to use them, how to use them and what the advantages and disadvantages are."

Let's answer these questions by describing each method separately.

Questioning

Let us refer to the example of mother's opinion on infant feeding. Here, you are looking for the mother's verbal responses rather than their actual behaviour. The data relates to what they say and not to what they actually do. This means that this kind of data is one step removed from raw observation. In this respect, it is somewhat artificial and the researcher must assume the honesty of their responses. But remember, if the questions are seeking answers at the sub-surface level, such as opinion on likes and dislikes or satisfaction and dissatisfaction, the data could be false. In order to obtain information of a deeply personal nature, the questions are to be convert in nature. Thus questions seeking depth-level data (reactions, feelings, judgements) are often subjected to multiple interpretation.

"Shouldn't that complicate the data analysis process?"

Yes, the analysis of data having multiple interpretations presents more a complex problem but it provides rich data as well.

"What's the purpose of the questioning method?"

One of the purposes, is to collect data for research findings as we have already mentioned; another purpose is to use this method in order to establish the need for the research. Sometimes, we also use this method when we want to probe further into a matter. For example, you observe that the mothers use certain practices during childbirth; you want to know why do they use them. So you question them.

Questionnaire

There are various techniques of collecting data through questioning methods. One such technique is the questionnaire which is a "paper and pencil technique".

Types of questions:

A **questionnaire** can be structured, semi-structured, or unstructured. Structured questions seek definite answers and are more like objective test items whereas an unstructured questionnaire has open-ended questions encouraging participants in a free response. Often the open-ended questionnaire is used at the instrument development stage before forming the structured questionnaire.

"Can you explain the structured and unstructured items with an example?"

Let us look at the examples given below:

This is a sample of a question from a questionnaire used in a national survey of hilots or Traditional Birth Attendants (TBAs) in the Philippines.[17]

Ex.1: "37 Have you ever advised women to space or limit pregnancies?
(Check only one)

☐ 1. Yes
☐ 2. No
☐ 3. May be
☐ 4. Don't Remember

37.1: If yes, under what circumstances did you advise them?

☐ 1. Difficult Pregnancy	☐ 5. Marital Conflict
☐ 2. Difficulty Labor	☐ 6. Conserve Mother's Health
☐ 3. Poverty	☐ 7. For Children's Sake
☐ 4. Ill Health of Patient	☐ 8.____________________"

Ex.2: This is a sample of a question from a questionnaire used for an enquiry among women clients of TBAs, in a rural area of Mexico [18].

"9. In general, what do you think people feel about SSA* services? ____________________

____

____

you will notice that item 37 of example 1 is structured. There are four alternative answers and the respondent has to check one of them.

"I see that the respondent has to fit her/his answer within the researcher's choice of answer."

Yes. The question is highly structured. But see the item 37.1: here there are eight alternative choices out of which the eighth choice is left open. This allows the respondent to write her own answer if he/she does not agree with any of the seven answers listed. Analysis of item 37 is easy as you know it will be one of the four choices, whereas analysis of item 37.1 will be more complex as there can be several alternative answers coming out of the open-ended blank.

"But I think analysis will be still more complex from data obtained from the second example."

You are absolutely right. The length of the respondents' answer may vary from one word to several sentences, although you may get more free responses and in-depth answers. However, categorizing them for analysis will be a more laborious task since you will then have to read each response and decide into what predetermined category it fits.

Highly structured questionnaires seek very specific juggement and are mainly used for information-seeking purposes or getting at interpersonal interactions.

Advantages and disadvantages:

In spite of these limitations, some of the greatest advantages of this technique is that information can be obtained from large masses of people and, is a relatively economical method.

When the questionnaires are administered personally, the researcher can explain the purposes of the study and make sure all items are answered. But this is not always possible. Mostly, the questionnaires are mailed which decreases the travel cost, although you need to spend money for postage. The mailed questionnaire is one of the most frequently used research instruments; but one of the practical difficulties the researcher may be taced with is the non-response of questionnaires. One has to make sure that the respondent is well conversant with the language and that the questionnaire is not too long. A 48 per cent return on a questionnaire is considered average for a mailed response requested.

*government health centres.

Construction of a questionnaire

The process of selecting or developing measuring devices and methods is called **Instrumentation.**

The first step in the construction of a questionnaire is to state the reason for the questionnaire. You ask yourself, "Why do I want to use this technique? What information do I want as data? What's my plan of data analysis?"

"Should I first go through my objectives of research?"

Of course. The items in the questionnaire should be directly related to what you want to identify or determine as your answer to a research question. And, one of the best ways of developing a good objective questionnaire is to ask open-ended questions to a small group similar to your sample and get an idea for possible alternative answers to your question.

"Can I use questionnaires written by others?"

Yes, you can use them as they are or modify them to suit your purpose but acknowledge the source and request permission from the authors if necessary. After you have made a preliminary draft of your questionnaire, try it out among your friends, classmates or students. When you do this, you may find that some items are ambiguous, or the language is not clear, they may have no idea of what you are talking about; you may also find that you have given them clues for the right answers. After you have edited your questionnaire, try it out again on a similar sample (whom you will not include in final study). This is called the **pre-testing** of the instrument and is done to find out whether the instrument is workable.

Reliability and Validity:

"How do I know that the questionnaire will measure what it intends to measure and that it will measure the necessary factors accurately?"

That's a good question. You are actually talking about Validity and Reliability. If you ask "is my instrument valid?" It means, does the instrument measure what it claims to measure.

"How do I determine the validity of the instrument?"

The term "validity" refers to the quality of the instrument that asks "to what extent does the instrument measure what it purports to measure".

There are different types of validity. One of the most common requirements is to have the **content validity**. For example, while constructing a knowledge/achievement test for the primary school children on dental hygiene, the researcher would like to see whether the content relates to the knowledge level of children in the primary school programme. The usual method is to logically conclude whether or not the test content contains an adequate definition of what it claims to measure Often the course outline literature or experts are consulted for this purpose. Another way to validate a questionnaire (specially if it is a paper/pencil test) is to administer it to carefully selected pupils or subjects similar to the sample subjects; then the scores are compared (correlated) with other data such as school marks, grade placements, or scores on other instruments. The resulting statements or quantifications which indicate the extent to which the test scores agree or correlate, indicate the extent to which the test is measuring—the extent to which the test is functioning. In other words the validity of the tool is indicated.

"What is reliability?"

Reliability means, is it an accurate, consistent and stable measuring instrument? If I ask the village panchayat some questions about his village sanitation on Monday, then ask him the same questions on Tuesday, I should get about the same answer.

"How would you find out whether the test is consistent and is a stable measuring instrument?"

There are different techniques that are followed to obtain the reliability. A few are discussed. In the pre-testing stage the test could be administered twice to a group similar to the sample of the study with a difference of 2-3 days. The extent of agreement between the two successive measurements with the same test could be obtained by statistical computation. This is called a **test-retest** method. Statistical value is called the reliability coefficient. The higher the coefficient value the more is the test reliability (see for details letter 12 on measures of relationship). The coefficient is a decimal number. It varies in size between $r = 0$ which indicates no relationship at all, to $r = 100$, the maximum, which indicates a full and complete relationship. A minus sign indicates that the relationships are in reverse order. For example if $r = .88$ between the two scores on test administerd on 2nd December and 5th December, we say that the two scores have a high positive relationship indicating higher reliability of the test. Usually you use the formula for Pearson Product-Moment Coefficient of Correlation or Rank-order Coefficient of Correlation. Another method of finding coefficient of internal consistency is the **split-half** technique where the test items are divided into two equivalent halves. The most commonly practised method is to divide odd items as one half and the even items as the second half. The Spearman-Brown formula is applied to estimate the reliability.[20] One can also use the alternate forms which involves successive administration of two parallel forms of the same test. Here the two tests include two different representative samples of items and hence are considered the most desirable index of test reliability.

Interview

The second questioning technique involves the **face to face** interview. Here the researcher asks the respondent questions and records the mother's verbal responses. More depth-level questioning could be done by this method. Like the questionnaire, the interview schedule may be structured or unstructured. The same procedure, as in the questionnaire technique, is involved in constructing an interview schedule and finding the validity and reliability of the tool.

Use

The technique can be used as an exploratory device, for example, to identify variables or suggest hypotheses; as the main instrument of research for measuring variables, and/or, as a supplement to other methods, for example, to follow up unexpected results or to validate other methods.

"To interview 100 mothers, I would require near about 100 hours of just interviewing times. Isn't that time consuming?"

Advantages and Disadvantages

Yes, it is time consuming, if you allow one hour per mother, and more expensive when compared to the questioning technique. But you are sure to have 100 per cent responses, and the technique permits greater depth of questioning and probing for data. Also, in countries where the literacy rate is low, this method is useful when respondents cannot read or write. It is also a convenient technique when the sample includes children. The researcher has to guard against personal bias as the technique may introduce the problem of subjectivity. Recording the data is one of the problems faced by several researchers. If you attempt to write as the respondents speak, they may get suspicious; at the same time, if you do not record as you go along, some data may get lost because of selective memory. The use of a tape recorder also has its advantage and disadvantage. We may get all the data recorded in tape but the use of a tape recorder may create a barrier between interviewer and interviewee.

Another disadvantage stated by Mathews[21] is that we may often get incorrect information from the respondents as he observed that the results obtained from the census and the sample survey often differed considerably, for example no village leader was able to list all the ceremonies and festivals observed and many leaders had only a vague idea of the proportions of the different castes in the village.

"Will the villagers sit down to answer my list of questions? They may say they are too busy."

On the whole we have found that patients like to talk or the villagers are helpful and friendly people. Mathews also found this in his study that in the early stages cooperation was excellent, partly because villagers were curious about the author and did not mind talking for hours.[22] But when the novelty wore off, the subjects were reluctant to answer on lengthy health interviews taking 1-2 hours. An interview should not go beyond 1 hour as it is difficult to hold the interviewee's attention.

"Sometimes the subjects are reluctant to answer questions of a personal nature."

They do. You need to ask in a non-threatening way and try to ask the controversial questions last. And, in spite of your effort if the participants refuse to answer, you have to accept it.

"Isn't it important to know the language properly?"

Yes, not only do you need to know the language but also the dialect spoken in the area. If you use a translator, much of the data may get lost or misread while transcribing. If you are using an assistant or field worker for conducting an interview, training is necessary.

Construction of Interview Schedule:

The procedure for constructing an interview schedule is the same as in a questionnaire. First, have a few broad open-ended questions and interview 4 or 5 similar subjects. Record the interview data; and on the basis of these data, literature review, consult with experts to construct the schedule. Items can be either structured with single/multiple choice, semi-structured or unstructured.

As stated earlier, analysis is more complex but there are other advantages in getting a free response and an in-depth uninhibited expression of the subjects. A graduate student while conducting a study on psychiatric patients to find out the reasons for their delay in seeking medical help in time, found that although her interview of a patient's nearest relative was planned for 1 to 1½ hours, almost everybody took 2 to 2½ hours. The participants found in the researcher someone who would listen to their worries, anxieties and fear. Thus the data were rich and the other findings in the study were important.

Other Techniques in Questioning Method:

The questionnaire that we prepare to measure the belief or attitude of an individual is often known as **opinionnaire** or **attitude scale.**

"Is opinion same as attitude?"

The two terms are not synonymous but it is difficult to describe or measure attitude and "the researcher must depend upon what the individual says are his beliefs and feeling."[23] Thus statement of opinion is inferred as attitude or real belief. One of the common methods of preparing the scale is called

Likert-type scale where the respondent is required to express their opinion in terms of favourableness and unfavourableness on a 3 or 5 point scale. For example, if we want to know their attitude towards abortion as a family planning method:

(1) first you list down several statements—which are neither correct nor wrong.
(2) Then decide on the scale, say five point.
(3) Next, decide on scale value, for favouring items higher value is given to most favoured and least to most disfavoured whereas, for statements opposing the point of view, you reverse the scoring.

Statement:

Medical Abortion should be legalized as one of the methods of preventing full-term pregnancy.

Scale and scale value

a. Strongly agree	5
b. Agree	4
c. Undecided	3
d. Disagree	2
e. Strongly disagree	1

Although these types of instruments yield ordinal level data, by assigning a score, we get interval level data.

Observations

"When do we collect data by just watching something happen?"

Here, the observation method is used when the researcher intends to observe a natural phenomenon in a systematic way, such as watching the normal process of childbirth. This method is also used when the investigator seeks to predict what will happen. Often in an experimental study, the researcher looks for the effect of a treatment administered to the experimental group. Such as, an organized health teaching to primary school children on dental hygiene may be evaluated by observing their changes of behaviour practice of maintaining dental hygiene. One can measure the practice of dental hygiene habits by looking at the cleanliness of teeth, mouth, odour, number of cavities and/or the method of brushing teeth. The researcher may also attempt to develop theories to explain the occurrence of a particular phenomenon. Remember, observation is a two-part process, that is someone is observing and there is something to observe.

Types of Observation

"Who is an observer? Should the observer be the researcher, part of the research team, or should he/she be an outsider?"

Generally speaking, the investigator is the observer. Or, depending on the research design, the investigator may train external observers for the purpose of collecting data. If the observer participates in the care, she is called a **participant observer.** The observer can also be a **non-participant observer.** Both methods have certain merits and disadvantages. The subjects are less conscious of being observed if the observer is a participant observer. Whereas the observer may get involved in what is going on and may miss some relevant observation or he/she may alter the situation by participating which may influence the outcome. On the other hand, non-participant observation brings in more objectivity in data collection as the observer remains un-attached and unbiased. At the same time the observer may develop a feeling of guilt by not doing what he/she knows should be done in the situation. Sometimes the participants of the study may become hostile to the presence of observer. One way of avoiding being seen directly, is to use a one-way screen where the observer can see the subjects but the subjects can not see the observer.

The researcher needs to try out observation techniques with the observers to make sure they observe what they need to observe, observe them accurately and record the data correctly.

"Should the observer inform the people being observed as they may become conscious of the observer?"

There are two main issues involved here. Ethically speaking, permission of the respondents should be taken. At times, the knowledge of being observed may distort the situation. But the distortion can be made minimal if the observation period is long, soon respondents get used to the observer being present, and will continue behaving in a near normal way.

Observation Technique

In the first step in using the observation technique, the researcher creates an observation guide or instrument which can be structured or unstructured. But it is essential that behaviour description in the schedule is given in observable and measurable terms. The technique may involve direct observation where the observer and observed are in each other's presence, or it may be an indirect technique by the use of a one-way mirror, motion picture, or video-tape.

"I feel the observed events are always subject to the bias of cultural background and personal interpretation.

Yes, there is a chance, but the researcher can reduce bias by eliminating recall with a structured schedule and by training the observer. Use of instruments, such as a cardiac monitor, thermometer, weighing scale, haemoglobino metre help in making accurate observations. A very carefully planned schedule where the behaviours are listed, coded and exact time for observation is noted, helps in making accurate observation. One can observe continuously or intermittently. Continuous observation is difficult to make for a long period of time and is difficult to record also. If you are observing intermittently, the time schedule is to be prepared; for example whether you will observe at every 10th minute or for one minute after every 10 minutes. The time sample is selected randomly. When more than one observer records the events at a time, the data is more objective and more reliable. Although the technique may be time consuming, this method is most appropriate for behavioural description, skill evaluation, and providing data for making inferences.

"Can you tell something more on standardized instruments?"

Measurement

The third method of data collection is measurement and standardized instruments are used to measure variables.

"Is a weighing scale a standardized instrument?"

Yes, it is; the physical measure—such as weight, height, volume, temperature, humidity, are measured by scientific instruments. Precision of measure depends on refinement of the instrument. A standard instrument should be used and preferably, the same instrument should be used for measuring all subjects. In a study of growth and development, the two researchers found that their measures on each child's height differed 2-3 cm. Each one thought their recordings to be correct. On further proble, they found that the tape measures used were not identical. There can also be psychological tests which are used to measure intelligence, aptitude, interest, personality etc. While looking for a standardized test you need to look for: the title of the test, the name of author and publisher, purpose of the test and to whom is it appiicable, the form and the description of the test, cost and time required for administration, direction for administration, reliability and validity, the norms and general evaluation of the test. It is also important to find out the scoring direction and what kind of scaling/scoring system is to be used for statistical calculation.

"Where will I find information about standardized tests?"

Contact the department of psychology of the university, institutes of psychiatry, educational testing centres etc. to get detailed information.

Another example of measurement is the standardized achievement test used in entrance examinations and licence/registration examinations.

"It seems that the construction of the instrument such as questionnaries or observation schedules require careful consideration so that the instrument development, in fact, becomes a minor activity of a researcher or research team."

Yes, to collect data, you may observe, interview and question. To do this, you either make up the questions yourself, using a self-made instrument, or you use an instrument created by some one else or use the standardized instruments which have been tested on many people.

LETTER 7

"NOW THAT I KNOW WHAT DATA I NEED, HOW DO I COLLECT THEM?"

Methods of Data Collection

Dear Reader.

It's hard to believe, but so far, you have identified a problem, reviewed the literature, identified the variables to be studied, selected your sample and prepared your instrument.

"Did we really do all that? Seems as if we're almost done with our research!"

Well, let us say that the most difficult part has been completed and now we begin with the stage of implementation. We are going to discuss the five 'W' of data collection—**what** data to collect, from **whom** these are to be collected, **who** will collect them, from **where** and **when** are these to be collected.

1. **Considerations on Type of Data** (What Data to Collect)

By now you have selected or prepared the instrument that you want to use. It is necessary to find out the number of data to be collected. The number will depend upon the hypothesis to be tested, type of statistical computations to be done and the number of independent variables that you plan to study. If yours is an experimental study, the number of data will also be determined by the number of experimental and control groups you have.

"Can someone help me with this?"

You are the investigator and you should have a clear concept of what you need. It is necessary to take help of statisticians at this stage to make sure that you have sufficient data for analysis.

At this time you also consider the form of the data. For example, is it going to be putting a check or placing a number against the questions listed in a structured questionnaire or interview schedule; or is it going to be written statements of subjects on an unstructured questionnaire. You may need a tape recorder to interview when there are open-ended questions. In the same way—is observation data to be recorded on a highly coded form with tick (✓) marks, or is it to be written down in the observer's own language.

"Sometimes we have to collect data before and after a procedure. What do we do then?"

Experimental Treatment

If yours is an experimental study where you have to introduce an independent variable (treatment) to the experimental group, this is the time to plan for this. We need to consider (1) the nature of treatment; (2) method of administration; and (3) the schedule of application. Let us consider the following example: An experimental study was conducted to measure the effectiveness of pre-operative breathing exercises on post-operative respiratory functions. Here the nature of treatment was a structured teaching programme on breathing exercises. So the course outline was made, technique of doing the exercises were listed step by step; surgical nurse, physiotherapist, surgeon and anaesthetist, examined the content for validity. The next step was to plan the method of administration; the researcher demonstrated the breathing exercises two days before the operation to every experimental subject individually and took a return demonstration from the subject to make sure he/she carried out the exercises correctly. The schedule was planned as follows: the respiratory functions (dependent variables) of each subject of both groups were measured two days before the operation and first through seventh day after the operation. Whether the experimental treatment is introduced to the subject individually or in groups the schedule has to be worked out step by step, the content validity is to be obtained and tried out before the actual administration.

2. **Considerations on Sample Subjects** (From Whom is Data Collected)

"What is the role of the researcher in the selection of the sample and the preparation of the sample for participation in the study?"

One of the first steps for the researcher in selecting the sample is to define his/her population.* For example, we may say that our population consists of all children between 0-5 years, registered in the rural health centres under district A. Or we can say all the teachers working in the government primary schools who have the minimum teaching qualifications.

"Do you mean that I need to list the criteria for selection of the sample?"

Yes, as part of planning for data collection, the researcher outlines his/her plan for identifying the potential study subjects.[24]

"Should I tell my subjects what I am going to do?"

Rights of Human Subjects

We have gone into the details of the rights of human subjects in the chapter on ethics. We want to stress here that subjects' willingness to participate in the study should be according to their free will. Yes, you need to tell them the nature of their participation, how much of their time you will take, and the purpose of the study in simple language. You also need to assure them anonymity.

In cities and cosmopolitan areas, institutions have established committees which review research proposals to assure the rights of human subjects. In fact one may call it the Committee on Human Rights. And, some governments will not sponsor research activities unless and until the rights of subjects are shown to be protected. This degree of development has not reached many villages; however, all plans for conducting research should be cleared with government and/or village authorities. Usually, a detailed project proposal is required indicating the nature of the study, the subjects involved, the kind of independent variable or treatment which will be introduced and by whom. All activities, procedures, treatments, and/or methods must be delineated so that authorities can assess the study from a human rights point of view.[25] This not only protects the villager, but protects the investigator as well.

Approach

"Most important is the attitudes of villagers towards the data collectors."

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*for details of sampling procedure, see letter 5.

That's right. You will ask **what** will they observe? Or, **what** will they note? Is the **what** a human subject? If so, what characteristics, or things (variables) will the data collectors observe? For example, if I am observing mother-child relationships, am I interested in how many times the baby approaches the mother, or am I looking at the mother's approach to the baby? What is meant by "approaching", anyway? It could mean look at, move forward in the direction of, talk to, etc. Perhaps you are interested in both, approach and verbal interaction. This must be defined and observed in as unobtrusive a manner as possible.

As a researcher, you are interested in finding out the "way things are" or the natural state of affairs. You do not want to influence the outcome or colour the results. So you consider yourself a neutral entity. Let us give an example. When the psychologist is presented with a troubled child, the job is to find out the nature of the child's problems. So the psychologist talks with the child in a warm but neutral way so that the child feels free to talk about or act out his problem. When the psychologist administers a test, he presents the test items and lets the child respond to the items; he/she tries to keep personal biases or attitudes out of the way in order to get a true or natural picture of the child.

If you are asking questions, or observing or interviewing someone, you want the behaviour to be natural, as if you were not there.

"Well, say, I am observing villagers, they will see me watching them, and that will have an effect."

Right. It's understood that your presence will have an effect. But the effect can be minimized, and it can be kept constant for all in the sample.

"How can I minimize my presence and keep it constant?"

Let us suppose you are a medical anthropologist collecting data on attitudes of villagers towards family planning. You are with a team from the Ministry of Health and Family Welfare, and you drive up in a van which the villagers see. Naturally, you are not dressed in the clothing of the local people. Then you question the villagers about family planning.

"It's obvious. My appearance and mode of transport may certainly influence the villagers' answers to my questions."

That's right. Although it's an obvious example one needs to remember that our dress, manner of talking, and approach to a village may clearly influence answers we get. Who accompanies us to the village home is an important factor. What answers we get may very well depend on the status of the person in the community.

For example, a student from Nepal while doing a survey in a rural Indian village wanted to know the number of children in each family in a small section of the village. So, she went to each house and was politely told that there were two sometimes three, children in each household. She found that difficult to believe from observing the large number of children following her about. So she asked the village school teacher to accompany her to the same houses. Now the same families had four and five children per home.

"So how much you and your assistants are trusted is really a consideration."

That's right. And you must plan to spend as much time as is needed to gain the trust of villagers you plan to study. And it is important to identify this.

Trust and Cooperation are Basic Ingredients:

If you do not have the trust and cooperation of the village leader and/or authorities your efforts will fail.

"Well, do I go to the village leader and tell him what I am doing?"

You go to him not only to get his permission, but to enable the villagers to decide whether or not they wish to participate. We must remember, it's their data, and the ultimate decision as to whether or not they wish to share it, is theirs

"But they may not realize the long-term value of the findings to themselves and their families."

You can discuss these gains with them, and if there are other benefits to be gained, such as financial remuneration, these too can be discussed. But in the final analysis, research can only be done when people are willing to have it done. And if necessary, confidentiality must be assured. The ingredient of a willing respondent is an essential one in collecting data.

"Other than the kind of study, what else will a village leader need to know?"

He may want to know how many people will be coming to the village, when, and for how long. Will they be talking with villagers? Will you be bringing in equipment? If so, he may need to see the equipment and learn what the equipment does. If you are going to draw maps, the reasons may have to be given.

3. **Training the Data Collectors** (Who will Collect the Data)

One of the common question asked is "who will collect the data?" The researcher and/or his/her team is solely responsible for collection of data. If you are going to collect the data yourself, it is important to try out the procedure on a small sample on similar subjects. This is called **pre-testing**, and is often carried out during a pilot phase of research process. Pre-testing, as discussed in the previous letter, is a step in the development of the instrument. Besides its function in establishing reliability of the tool, it also helps the researcher in finding out whether the data collection procedure is feasible.

If you have people collecting data for you they need to be advised on how to answer questions honestly and use only the methods and equipment agreed upon by the villagers and the leaders. The integrity of the people collecting the data is a fundamental element of success.[26]

"How can I make sure that the people I hire for data collection will do the job well?"

A rigorous training programme has to be set up. First, you explain the collection procedure, approach to subject and method of recording the data. Then you accompany them when they collect data and simultaneously collect the same data; tally both recordings. Training is not complete till you find them capable of collecting data accurately and completely. In the case of observation techniques, the final data are always more reliable when activities are observed and recorded independently by two observers simultaneously.

"Now, who would introduce the independent variables?"

It does not matter who introduces them but there should be consistency and accuracy. For example, if a lecture method of teaching is to be used, the lecture could be taped or video-taped and played back to the experimental subjects in groups, sub-groups or on an individual basis. This would avoid any criticism arising from inconsistency of the method.

It is also important that if you plan to collect the data after 48 hours (or two weeks or any other time gap) of the administration of experimental variable, you have to maintain the same routine for all in regard to collection of data.

Obtaining Permission for All Studies

"The head of the institution is my friend, do I need to take permission?"

If you are collecting data in an institution, your first move should be to contact the director of that institution formally and obtain written permission. Earlier we discussed that every subject must be willing to participate in your study. The problem may arise when the subject is a small child or an unconscious or psychiatric patient. The procedure is to take permission from the nearest relative or the guardian. Here is an example of a letter that you might write to the director/administrator-head of the institution for permission to conduct your study.

Contents	**Remarks**
From____________________ ____________________ ____________________	Enter your official address
To The Medical Officer 'X' Health Centre 'Y' District 'Z' Country	Accurately address the head of institution/organization, including titles and initials
Date........	
Dear Dr. Tee,	Address by name if it is known t you.
I am conducting a study under the auspices of Kenka Primary Health Centre to investigate the "**[Title of Research]**". It is hoped that the information obtained from this study will be useful for [**state uses**]. I therefore request you and your staff to participate in the study.	Give your project title and the purpose of the study. Be concise, crisp, to-the-point.
In this study, a health staff member is one who is employed full-time for providing health care. Since the valid data necessitate the participation of entire health staff as defined above, I would ask you to request your staff to agree to such participation.	Roughly define your population.
Participants will be required to complete a questionnaire. Anonymity of participating health centres and individuals will be protected. Your participation in this study, **I may add here**, would involve the completion of : (a) a questionnaire; and, (b) an interview with me, both of which are not expected to take more than 1 to 1.1/2 hours of your time.	Assure anonymity and confidentiality; state the nature of the participation and approximate time commitment referred by the participants.

May I please have your permission to conduct this study in the ______________________ Health Centre? I also request you to send me the names of the staff, so that I can mail the questionnaire directly to the participants.

I will appreciate your consideration of this request at the earliest possible date. For your convenience, a reply sheet and return postage stamps are enclosed.

Thanking you for your cooperation.[27]

Yours sincerely,

....

Listing the population is necessary and a must if you want to do random sampling.

It is a courtesy to send the expenses involved - it shows you mean business.

Be gracious.

4. **Setting** (From Where you will Collect Data)

"Does it mean that beside knowing who the subjects are, I need to know their background?"

Sure, you do need to know the setting of your study. Depending on your problem for investigation you need to collect data about the location, road communications, climate, language spoken, food habits, religion etc. If your research is an experimental study, make sure the control group subjects and experimental group subjects do not mix up.

"Why?"

Then the experimental group after getting the "treatment" may "contaminate" the control group. For instance, in our example of breathing exercise, if the experimental subjects and control subjects stay in the same unit pre- and post-operatively—they may exchange views on breathing exercises. This also means that the independent variable does not remain well defined.

5. **Consideration for the Time of Collection** (When is the Data to be Collected)

In developing countries, the 'when' of data collection is a major consideration. In one study, data collection took place during the harvest season. Each participant had to be sought out at evening time because all men were in the fields during the study. The follow-up could not be conducted because two months later, the entire village was flooded during the monsoons.

"I think the village leaders could help us on that score. They know the seasons and climatic conditions which prevail in their communities."

That's right, and they will usually help you minimize these kinds of difficulties.

One rule we usually use is to "over-kill" when collecting data. That is, always collect as much data as possible. You can always discard, but you may not be able to go and collect more information. But, you must be careful not to irritate the people and annoy them with persistent questioning. And your method for collecting the data must be appropriate to the subjects and situation in which you find yourself.

Pilot Study

"Is there any way I can be more sure that my plan of data collection is most appropriate before I begin my large study?"

Yes, you can do a pilot study. A pilot study is done not only to test the data collection procedure but also to test the feasibility and practicality of the whole research design. If you are using a tape recorder, or any electrical appliances, the availability of electrical outlets must be ascertained. Many villages have no electricity. If you are using simple films, you will need some white background, and no white sheets may be available. If you need to collect data in the evenings, you will find during the pilot that torches are essential. The pilot study will help you to decide on suitable clothing, shoe wear, hiking gear, and type of camera film appropriate. (In fact, if extreme climatic conditions exist, you may have to alter your methods of data collection.) You may plan to test a hypothesis, but in your pilot study you find that it is not possible to do so. For example, in a study to see the relationship between health practices and different religious practices, the researcher found that in the particular setting, the population of leprosy patients belonged to one particular religion only. The researcher had to drop the hypothesis in the final study.

"I heard once that a villager did not allow any investigator to enter the village after a death occurred in the village due to penicillin shock?"

That can happen. A pilot study helps you in establishing a rapport with the village; you learn the approaches and you also find out many things that are not foreseen. It also gives you the plausible sample size.

It is also important to find out whether your plan of data analysis is workable as this will depend on the type of data you obtain.

"I suppose this will also give me some idea about the time and expenditure estimate."

Yes, not only you will be able to work out the major expenditures but you will also be able to identify alternative measures from which to select the type of treatment that is most suitable for your study.

The wise researcher will "run through" a small pilot, will listen to the villagers and use his/her own good sense about what to delete or alter in the real investigation. If this step is carried out carefully, the major study should proceed fairly smoothly.

LETTER 8

"YOU MEAN I AM GOING TO ANALYZE THE DATA?"

Levels of Data

Dear Reader,

Now that you have coded and tabulated your data, the next question is, "What do I do with it?" How do I "analyze all those numbers?" This is an important question, and requires a lengthy explanation, with some introduction.

"I am ready."

All right. In order to be effective as a health care provider one must first know the nature of a client's problem, and secondly one must know what must be done to help the client get better. For example, a man with coronary artery disease may require certain cardiac drugs, specialized nursing measures, and selected types of health teaching. We also know that anti-histamines are not appropriate drugs for the cardiac patient. We know this because of our knowledge of coronary disorders.

"I follow you, but what has this to do with my data?"

Well, just as each disorder has certain treatments, each type of data has its own types of statistical "treatment"; and, just as you must know the disorder, **and** treatment, here you must know the levels or types of data you have and the statistical techniques appropriate for such data.

Further, just as in medical diagnosis, when we do not know the appropriate treatment, we call in a specialist—**before** complications set in. So here too. When we have **complicated** data we call in specialists, or statisticians, to help us **before** we progress too far and develop "statistical complications".

"Sounds pretty complicated already. If it's anything like the enormous kinds of diseases and their treatment, this is going to be a long letter!"

Fortunately, there are only four kinds of data with which we have to deal.

"Just four?! I think I can handle that; what are they?"

The four types are: (1) nominal; (2) ordinal; (3) interval; and (4) ratio level data. In this letter we will discuss all four levels.

Nominal Level Data

The first type of data is called **nominal level** data—that is data which can be placed in two or more classes which are **mutually exclusive** or **exhaustive.**

"Can you give me an example?"

When you have nominal level data, you have categories with different **names** for different groups: Indian, American, African, Indonesian; these are examples of categories. The subject's scale value on a nominal variable simply indicates to which group he is a member. Putting people into the following categories would be examples of nominal level data: (1) boy-girl; (2) fraternal twin-identical twin; (3) student-non-student, and (4) Hindu-Muslim.

"You mean either-or-situations?"

Yes, let's see how these would look in tabular form. In the following two examples we are looking at the 1977 Census data on a group of rural villages, showing sex of Census participants and activity status. Table 8.1 shows the Census data on 678 rural villagers and Table 8.2 shows activity status on 100 villagers.

TABLE 8.1: Census Data on 678 Villagers

Census Data	Men	Women
1977	300	378

TABLE 8.2: Activity Status on 100 Rural Villagers

Census Data	Active	Non-Active
1977	70	30

In these examples, individuals are either men or they are women. They are either active or they are inactive. These are examples of nominal level data. Look at a third example as illustrated in a graph in Figure 8.1. Here we are grouping the villages according to religious preference or placing villages into nominal categories.

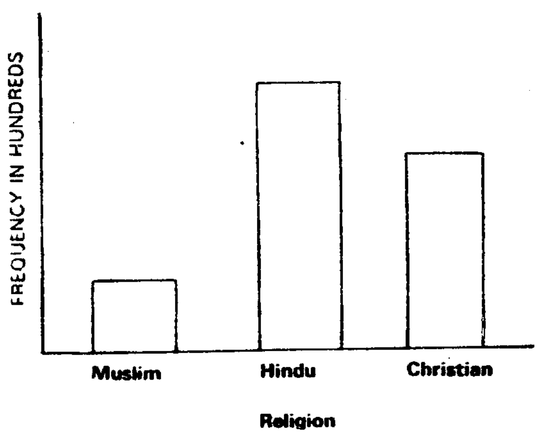


Figure 8.1: Religious Preferences of Selected Villagers

This is, by the way, a description of villages according to **one variable** and is thus called **univariate** data—the univariate dimension being: can you guess?

"Religion."

Right. Now we can combine the two nominal level data illustrations. First in Table 8.3, we look at two dimensions, say religious preference and activity status.

TABLE 8.3: Villagers According to Religious Preference and Activity Status

Type	Active	Inactive
Hindu		
Christian		
Muslim		

This Table represents a visualization of the two variables, and is called **bivariate** data by a process of **cross tabulation**, a procedure easily done with nominal level data.

A further combination could include three variables, that is, sex, activity status, and religious preference as shown in **Table 8.4**.

TABLE 8.4: Villagers Classified According to Sex, Religious and Activity Status

Type	Male		Female	
	Active	Inactive	Active	Inactive
Hindu				
Christian				
Muslim				

We are still **cross-tabulating** with nominal level data; the cells could be filled in with the numbers of people who fit into any of these categories. But there are no **mathematical relationships** among this data. I could say that the category "active Muslims" occurs most frequently. We could **count** the people and place the number in the appropriate cell, and identify the mode. And we could compute chi-square, a statistic we will be considering in a later chapter.*

"You mean that's it? What about all the fancy statistics I see in other texts?"

The kinds of techniques appropriate for this level data are really limited, aren't they? But you cannot compute a **median**—there is no middle anything,* there are really no **scores**, just numbers in categories.

*See Letter 10 on a discussion of the measure of central tendency, and Letter 13 for a discussion **on the chi-square**.

Well, sometimes nominal level data is all you have. No other information may be available; but it is better to collect nominal level data than no data at all.

Ordinal Level Data

The second type of data is called ordinal data.This is placing observations into a set of categories on a scale which has a rule of order (high, medium, low). The level implies ranking, but—there is no implication of equal distance between groups on the scale.

"Hmm, I understand the idea of ranking, because in nominal data, say, male-female, neither is higher or lower. But, for example, levels of nurses (staff nurses, supervisor, director) there is a rule of order. But what about that business of no equal distance between groups on a scale?"

"In your nurse example, is there just as much ranking space between a staff nurse and a supervisor as there is between a supervisor and a director?"

"How can one know?"

Well, is a director twice as high as staff nurse?

"No, you couldn't say that there was equal space between the ratings."

If you look above at the second half of the definition, you see it says that in the ordinal scale, there is no implication of equal distance between groups on the scale.

"I see it now."

Take Abdellah and Levine's attempt to create a graphic rating for assessing nursing care. The categories are ranked in order from "care of the highest quality", to "very poor care, with varying degrees of service in between" [28]

Care is of highest quality. Could not be better.	Care very good. A few things could be improved but for most part, fine.	Average care. No better or worse than could be expected.	Care is below average. Some services below par.	Very poor care. Many services could be improved.

So they took a concept of care and conceptualized it along a rank scale. Observe a second example of ordinal level data, as illustrated in Figure 8.2.

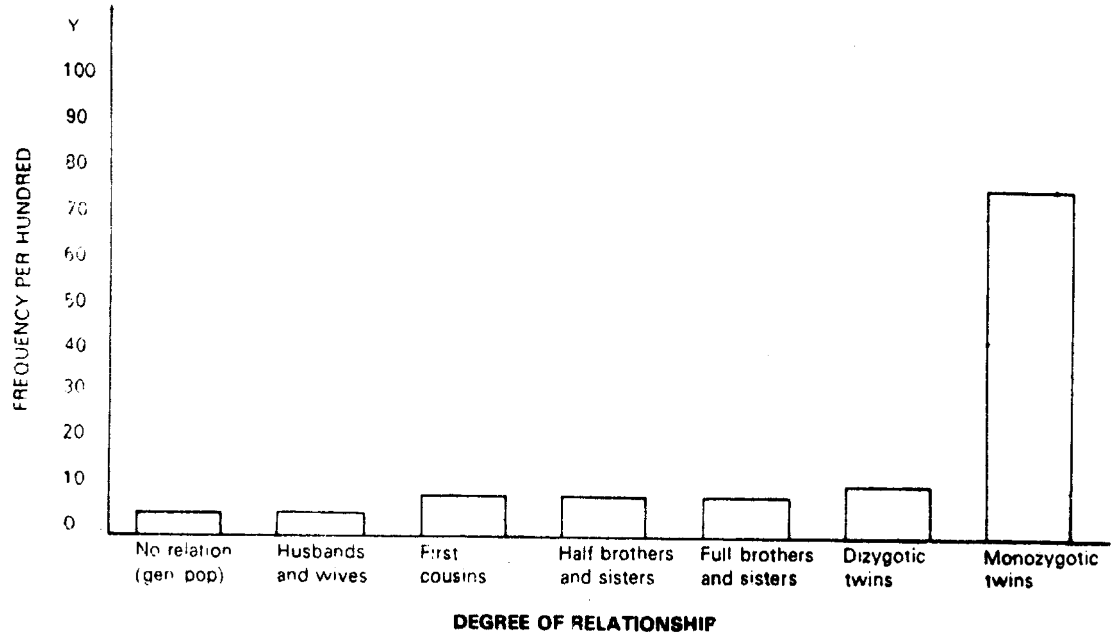


Fig. 8.2: Frequency of Schizophrenic Carpenters Among Relatives of Schizophrenics.

Figure 8.2 shows the frequency of schizophrenic carpenters for 100 persons among relatives of schizophrenics. Here we note that for ordinal level data we can put in categories, but we cannot add up the categories or get percentages. No numerals are assigned to the data.

"That is an interesting example–here it is degree of relationship that's ranked, and no indication of equal distance between categories. At least one person could not say that he was twice as close to his fraternal twin than he was to his full brother."

Right. Remember, you can put your data in categories but you cannot add up the columns and get percentages. For example, in Figure 3, you could not combine the registered nurse and auxiliary nurse columns–ordinal data does not lend itself to that kind of treatment.

"A good many of the studies in the social and behavioural sciences, though, seem to be at these two levels."

That's right, because in health and the social sciences, measurement is still in its infancy, and refinement will take time. The physical sciences are much more advanced in their levels of measurement and hence in their statistical freedom to use many kinds of techniques.

So, though for **ordinal level data, medians, percentiles** and **rank-order correlations** are available; techniques are still limited, but not as severely as with nominal level data.

Interval Level Data

The third level of measurement is the interval space. Here we place observations on a scale that has equal spaces (intervals or relative distance) between the units as well as a rule or order as shown in Figure 8.3.

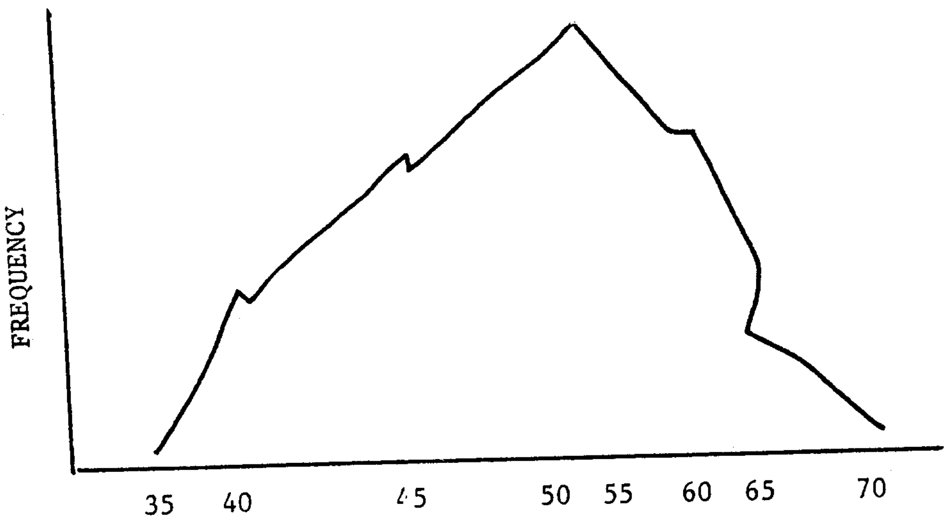


Fig. 8.3: Frequency Polygon of Social Worker's Essay Test Scores

"Interval level scales possess the characteristics of nominal and ordinal scales, especially the rank-order characteristic. In addition, numerically equal distances on interval scales represent equal distances in the property being measured."[29]

Let's say we measured three items on an interval scale and got the value of 21, 20, and 19. We can say that the difference between the first and the third number is two, which is one more than the differences between the second and third number.

"So here I can add and substract the intervals–not like the ordinal scale."

That's right.

But in using an interval scale, we cannot say, that one of the measure was twice as great as the other. We are not adding or substracting quantities or amounts, but intervals or distances. Put another way, a child 90 cm. is much taller than a child of 70 cm. In turn, a child of 70 cm. tall is only slightly taller than a child 68 cm. If we were speaking about an ordinal scale, we could only say that the first child was "taller than" the second. And that the second was taller than the first. For interval level data then, because the units or intervals of measurement are equal, mathematical relationships can be explored.

"Such as...?"

Such as: mean, standard deviation, product moment correlation, standard error and variance, plus all those used for the other two lower levels. Almost all statistical methods are appropriate for interval level data.*

Ratio Level Data

The final and highest level of data is called ratio level data. Here not only are there some rules of order (ordinal quality), and equal intervals (interval quality), but there is also a meaningful zero point. For example, if we are looking at the income of villagers by occupational category we might show the following bivariate data as illustrated in Table 8.5.

TABLE 8.5: Monthly Income and Occupational Background of the Respondents

Monthly Income	Occupations		
	Farmer	Carpenter	Blacksmith
401-500	10	5	1
301-400	70	35	32
201-300	15	30	47
0-200	5	10	20

Thus, in addition to possessing the characteristics of interval level data, ratio level data contains an absolute zero.

"So I could say that the farmer could earn twice as much as, say, the carpenter."

Right, you can because of the meaningful zero point, which became a very desirable quality in a variable, establishing a zero point in one of the goals in defining variables.

Summary

Let's see if we can summarize very briefly, the major points discussed in this letter.

"Data is: collected, organized, summarized, analyzed, interpreted and presented."

Right, the levels of data are....?

"Normal, ordinal, interval, and ratio."

Good. Finally, the meaning that these levels have is that they represent guidelines for the selection of appropriate statistical tests available to you. They also indicate the level of sophistication and refinement of your data gathering instruments. Thinking of data in terms of these levels, assists you in a fairly quick analysis of what you can and cannot do with your data.

LETTER 9

"WHERE'S THE STATISTICIAN?"

Handling Statistical Data

Dear Reader,

We just learned that you have completed your data collection, and are ready to begin the next step. Good for you.

"Thank you. A 70 per cent return on any questionnaire was not too bad, was it?"

No. As a matter of fact, that is considered excellent for a return on a mailed questionnaire.

"Now that I have all this data, where do I begin, and how do I get organized?"

Very good questions. Firstly, we suggest that you take your data and "mull it over". You are about to find out what your study has accomplished. Once a series of observations have been made or collected, the first object must be to express them in an easily understood form so they can be analyzed and conclusions drawn from them.[30]

You now must group and reorder your records, files or cards, in order to arrive at conclusions. This step in the whole process is quite important, and preparation of data for analysis can take as long as data collection, particularly if you are using data processing. In our letter on the computer, we will discuss these steps. This letter will concentrate on stages involved in by-hand processing or the use of simple calculators.

Use of a Master List

Before you begin sorting your data, review all information for precision and accuracy. Count your tallies, sum your rows and columns, check to be sure duplicated records are eliminated. Then, we suggest that you make a master list which acts as a control to show which individuals are to be covered, identifies basic identifying data, and the records secured for the individual studied. The master list is a very practical tool for the data processing stage for it provides a means of avoiding omissions and duplications of work.

Checking the data is extremely important particularly in surveys. It is highly unlikely that revisits can be made at this point in the research, so the person checking this must be able to make intelligent guesses on items which do not tally or are omitted. Intelligent guesses are permissible provided they constitute omissions, then these must be included under "not shown". So, you begin by making piles where like data are put together.

"How do I sort the data? According to what rule?"

Well, look at your study. Suppose you are studying the differences between men and women.

"You mean according to the variable I defined earlier."

That's right. And you keep subdividing until all cards, etc., have been used. Then, let us say, you take all the male cards, and divide them into youth, adulthood, old age. The female cards are handled in the same way. You spread out these categories and place each card in its appropriate category. You do this until all the data have been separated.

Then, you will want to run a check to be sure that your work is accurate. To follow with this example of two variables. you should have a total of six piles, a male group of three, and a female group of three.

After checking on the piles, you add up the number in each pile and record that number on a large sheet of paper along with the description of the piles.

Once you have separated the data, then further separations and divisions can be made.

"But supposing I wish to sort all the data according to height and weight. And wanted to divide it into those below 1.6 metres and those over 1.6 metres?"

Then you would have to go to the original records and re-sort the whole pile. But remember, you sort according to the variables being studied.

Sometimes you can devise schemes for simple recording and sorting. In one study we conducted on growth and development of Indian children we placed all southern records on one table, all northern records on another,etc. In another study we used green cards for our experimental group instrument and yellow cards for the control group.

What to do with Sorted Data?

"I do feel somewhat more organized. Now that I have sorted the data, what do I do?"

Well, take a look at the piles of data. You could not write up each record individually. It would take up too much time and it would not be very useful. Also, you will probably have more data, and tables than you can see, but as we said earlier, it is better to "overkill". You can always discard information, but you may not be able to collect it, once your respondents are no longer available.

"But the idea here is to lay out the data to see the patterns or trends in it."

Right. You want to see an overall picture, the range of numbers, how many high, low and/or average scores, clusters of scores, large gaps in the data, missing elements, etc.

"Now it's really getting interesting."

This aspect of research is really the most exciting, and many people can hardly wait to "see what they've got".

Leveling out the Data

Let's take a look at an actual study conducted by Krishna Gulani[31] concerning the results of a teaching programme for fathers concerning immunization of their infants. Gulani and her colleagues wanted to see if the experimental group of fathers who experienced a training programme would be more inclined to bring their infants for immunization than fathers who had no such training. They decided that the important variables were:(1) the age of the father; (2) the educational achievement level of the father; and (3) their occupation.

So, they separated the fathers into two overall groups: 20 in the experimental and 20 in the control group. Next, they separated the father cards into age categories consisting of two piles, those below 30, and those over 30.

"Now there would be four piles: experimental under 30, experimental over 30, control under 30, control over 30."

That's right. Now what would be done next?

"Well, then the groups would be divided according to their educational level."

Yes, and in this study there were four levels: NL (non-literate), M(middle and below), HS (higher secondary), and U (University). Now there would be eight piles with an experimental group below 30 consisting of:NLO, M4, HS8 and U1. The experimental group above 30 would have: NL3,M3, HS1, U0. The control group below 30 piles would have four piles of: NL2, M7, HS6, U0; and an above 30 years of NLO; M1, HSO, U4. Then totals can be tallied across and down. as illustrated in Table 9.1.

TABLE 9.1: Age, Educational Level of Experimental and Control Groups

		Age	Education				Total
			NL	M	HS	U	
	(	Below 30	-	4	8	1	13
Experimental	(	Above 30	3	3	1	-	7
	(	Total	3	7	9	1	20
	(	Below 30	2	7	6	-	15
Control	(	Above 30	-	1	-	4	5
	(	Total	2	8	6	4	20

"Ah, now the picture is clearer! It can easily be seen that in both the groups there were more below age 30 fathers than above age 30. Also, it can be seen the most (75 per cent) of the fathers had achieved middle or high school levels of education."

Yes. The picture becomes easier to visualize once you have presented the data in a table. We could then do the same thing for occupational level. In the above example you notice that we had only two age categories, above and below 30. This was done because we had such a small number in our sample.In a larger sample you may want to report the data in the following way:

TABLE 9.2: Age of Fathers Participating in Both Groups
(Hypothetical Data)

Age	Groups	
	Experimental	Control
23	13	12
24	18	17
25	20	21
26	16	17
27	14	15

Suppose, however, that you had to compare between 15 villages. To compare by inspection the differences between the groups within each village and then present all the data for the remaining 14 villages would be an enormous task.

Firstly, we want to find out: are there differences between the experimental and the control groups? Secondly, did these differences occur by chance, and/or are the variables related?

"You mean, for this example, you would ask, did the training programme make any difference?"

Right—And what else?

"Also, is education related to changes in level of learning. And is age related to level of learning?"

That's right. And to find these things, one must do some analysis. And you decide on this by looking over the data and thinking about the patterns, etc., which seem to form. The way you analyze the data will be a result of the way you think about or mull the data. And the type of analysis you wish carried out is closely tied in with the tabulation of data. If you are going to use a statistician, you will have to give him/her clear instructions on what you want done.

Thus, the tables are created based on the variables being studied, and the questions raised. Then you number all the tables and indicate against each number the type of analysis you require. Your analysis may differ from another researcher's list. The point is that the whole process must ensure that you have recorded correctly, that the data is accurate. You are sure that the data is carefully prepared for analysis, whether you do the work yourself, or if the statistician actually does the analysis.

LETTER 10

"NOW THAT I HAVE COLLECTED ALL THIS DATA, WHAT DO I DO WITH THEM"

Descriptive Statistics

Dear Reader,

So far you have completed two-thirds of your work, In this letter we will discuss the analysis of your data and in a later letter than we will talk of interpretation, and then discussion with findings. Finally some help on writing the report and preparing it for distribution, publication, or "sharing" will follow.

"Sounds good. Where do we begin."

Well, if you remember, in our last letter we suggested that certain kinds of data demand certain kinds of "treatment". And, we noted that you must determine the kind of treatment before you proceed, being sure, of course, to include the statistician in this important step.

"Right, And although I understood the need to identify the levels of data, I need to review again what statistics go with what level of data."

Sure, you remember that the idea was to show the reason for taking care, or being sensitive, to the kinds of data collection techniques you use because____

"Because the kind of data you have, determined the treatment or use of statistics available to you."

That's right. And the analysis demands that you take the data and reduce it to some numerical measures before you can analyze and interpret them. The data must be quantified, and statistics computed on them in order to describe the characteristics of the group you are studying. These statistics will tell the reader the results of your study, and allow for the comparison of your study with other studies.

In general, we usually categorize statistics into two broad types. These are either descriptive or inferential.

Descriptive Statistics

"Do descriptive statistics **describe** data?"

Yes, that's exactly right. **Descriptive statistics** are computed to determine the characteristics of the data at hand. These can be numbers, percentages, averages, or indications of how "spread-out" the data are. (variability) or the relationships among data.

However, sometimes we wish to find out something about thousands of people. We can't possibly question every person, so we ask a sample of people, assuming that what the sample reports will be somewhat similar to what the thousands would report if we asked them.

That is, we try to infer or to draw conclusions about the whole population on the basis of the information we have about the sample. And, this is the real purpose of the science. We want to be able to predict future events, with a high degree of accuracy by using inferences from past experience. Statistics enable us to judge the **probability** that our inference or estimates are close to the truth.[33]

In this letter, we are going to concentrate on descriptive statistics. We want to answer the questions: how typical are the data, how spread-out are the data, and what are the relationships amor.g or between sets of data.

"How do we look at 'typical-ness'—if there is such a thing?

To answer that question, we look at three measures, called the measures of central tendency. These include: the **mean**, the **median** and the **mode**, which we will explain shortly. To measure 'spread-outness' or spread, we use the **range**, the **standard deviation**, and the **variance**. To measure relationships, we use **correlation co-efficient** sometimes referred to as "r". Measures of relationships answer the implicit question that: "within a given population, is there a relationship between one variable (or set of variables)?"[34]

"Now what do these descriptive statistics have to do with our earlier discussion of the four levels of data?"

This will become clearer as we go along. As you learn what kinds of data are involved you will see that, say, the mode is suited for nominal level data, and that a certain kind of correlation is suitable for ordinal level data, etc. So, data having to do with degrees of "average-ness" must be interval level.

Descriptive Measures

The Range

In this section we will prepare our data for overall description, and describe how you will focus your attention on the qualities of accuracy, completeness, and objectivity.

'All ignt, what do I do first?"

When yo i have man subjects on whom you have some measurements, it is cumbersome to look at the c re indi idual so, w look at the **highest score** and the **lowest score** to find our **range** of observations

or e ple ppo e w ndu ed a study, where we rated five villages (villages A-E) on their le l san tati , and w de ed th following **raw scores***.

Raw Scores a e t only kind .ve have dealt with so far; others will be introduced later.

TABLE 10.1: Selected Village Scores, Levels of Sanitation

Village	Score on level of Sanitation	Village	Systematized scores on level of sanitation
A	65	D	98
B	43	A	65
C	27	B	43
D	98	C	27
E	24	E	24

On a scale of 0 to 99, if the lowest score is 24 and the highest is 98, the range would be________?

"74"

That's right. The highest integral minus the lowest integral equals the range, or

$$H - L = \text{Range}$$

This is simple enough, and it does give you some quick information about the data.

The advantage of the range is that it is very easy to find. But, it is often subject to distortion. Take this series of numbers:

95 95 95 94 92 91 91 90 15

What do you see?

"All of the scores are in the nineties, except one which is very low. and that number makes the range quite large."

Right, so extremes of scores can affect the range; and this makes the range a poor measure of spread-outness or **dispersion**.

The Mean

Use of a Frequency Distribution to Compute the Mean

Sometimes, however, you have many scores, for in behavioural science research we work with human behaviour–and humans have a high degree of variability. So, you may end up with extensive sets of data which are so cumbersome that general trends cannot be discerned. Some techniques for condensing sets of data into more concise form are necessary so that your research questions can be answered. A **frequency distribution** is one technique used in research to bring order out of massed data, with minimal loss of information.

The frequency distribution of scores from 18 to 91 would be made like this:

TABLE 10.2: Frequency Distribution Based on Infant Development Data for 25 Rural Infants

Rural Infants' Development Scores	Systematized	Interval=5	Mid-point	Frequency
75	91	95-99	97	0
45	87	90-94	92	1
66	87	85-89	87	2
52	83	80-84	82	1
54	75	75-79	77	1
70	71	70-74	72	2
91	70	65-69	67	1
49	66	60-64	62	2
48	62	55-59	57	3
48	60	50-54	52	3
46	58	45-49	47	5
34	58	40-44	42	1
84	55	35-39	37	0
60	54	30-34	32	1
58	52	25-29	27	1
58	51	20-24	22	0
51	49 L.I.L.	15-19	17	1
55	49			
43	48			N = 25
18	46			
27	45			
83	43			
87	34			
71	27			
62	18			

These steps are quite simple:

1. Find the range: the highest integral–the lower integral = 91 - 18 = 73.

2. Divide the range by 15 (ideally for this number of scores, it is best to have between 10 to 15 class intervals, if possible)

74 ÷ 15 = 4.9005 (so use 5 as class for internal convenience)

3. Find the lower integral unit (L.I.L.) which must be a multiple of 5, which is the class interval. Here, it is 15

4. Find the mid-point, the number that falls in the middle of each class interval. In our example, the mid-points are 97, 92, 87, 82, 77, etc.

5. Look at your raw data, and tally the number of babies whose scores fell within the class intervals, and tabulate them in the frequency column. In our example, one baby fell in the 90-94 range, five in the 45-49 range, and none in the 20-24 range.

"So, I need to know the scores received by each infant. Then I systematize them, highest to lowest, determine the class interval and mid-points, and not the frequencies."

Very good!

"I can see the need to do this, but why do I need the mid-point column?"

This is used to compute a very important measure, **the mean**, which we will discuss below. But first, several points must be made. When you create your intervals, they must not be so large that they hide some important qualities of your data. For example, if you are looking at infant growth, you would not want to lump babies from birth to one year in one pile because of the important monthly differences involved in such a sample. But also you do not want the frequency distribution to be so long that it isn't worth doing. Thirteen to seventeen intervals is a workable number. In our example, we have 17.

The next step is to determine fx^1, which is the mid-point times the frequency.

"All right. So, in this example, 92x1=92, 87x2=174. Then, these are added?"

That's right. This column is labelled fx^1 The sum of the mid-point times the frequency is Σfx^1. And the sum is 1440. Then, we divide the Σfx^1 by "N" or numbers of infants, and we derive the mean, which is 57.6 or

$$\bar{X} = \frac{f.x^1}{n}$$

$$\bar{X} = \frac{1440}{25}$$

$$\bar{X} = 57.6$$

Now, whenever the frequency distribution is fairly symmetrical the mean is the statistic of choice.

Application of the Mean

The mean is important to you because it is the most stable measure of central tendency and it lends itself to the computation of other stable measures.

When we say it is "most stable", we mean that it "varies least among repeated random samples from the same population."[35]

Let us suppose you were involved in a research project, where you were evaluating the effectiveness of a health training programme conducted for school-age children. You wanted to find the mean score on a test or **post-test** measure of their learning. But there were several hundred children involved in the programme. Well, you could test every school-age child in the programme, sum their scores, and divide by n. In fact, that is the simple procedure for calculating $\bar{X}$ with small numbers; the simple formula is $\bar{X} = \frac{\Sigma x}{n}$

* Sum is denoted by the symbol "Σ", and is read, "sum of"

Again, as we noted earlier, if you have data from many villages to analyze, it is easier to make a **frequency distribution** than to try to see all the information spread-out before you. This helps us to get a better picture of the data, and to see how the measurements are distributed.

The Median

The second **measure of central tendency** is the **median**. This refers to the point above which has 50 per cent of the total frequency, and below which is the other 50 per cent of the total frequency. The median divides the distribution in half. In our example, in Table 10.2, the median is 55, above and below which half the cases fall.

Use of the Median

If you want to know in which half of the distribution a particular case lies, then you find the median. When you have extreme cases, or when the distribution is not symmetrical, the median is useful.

The Mode

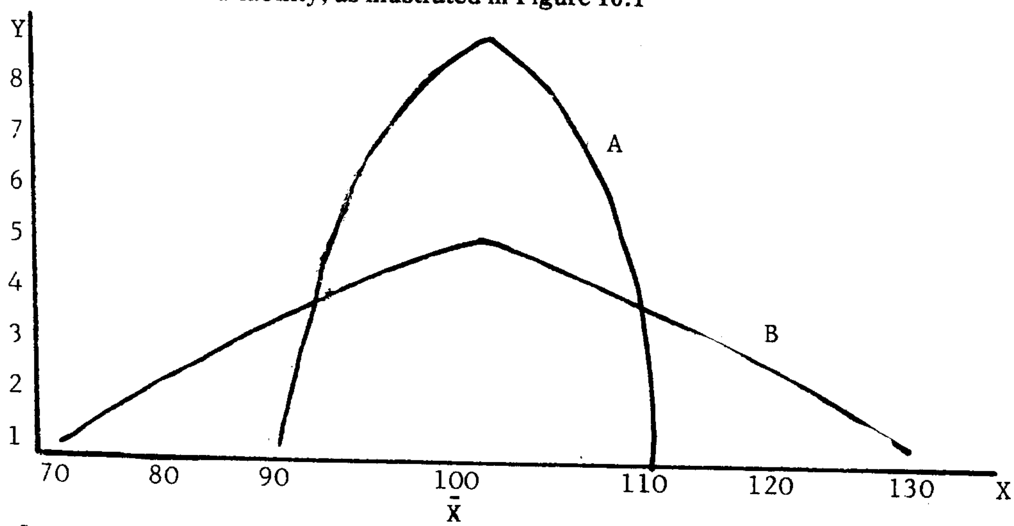
The mode refers to the point of greatest frequencies. Thus, in a series such as: 9 1 4 2 6 9 8 7 9 3 5 9, 9 would be the mode. It is used for very rough quick estimates, for identifying the most common score the "typical case".

Measures of Variability

Earlier in our letter we introduced the range in order to discuss the steps in making a frequency distribution.

"Right—and from there we computed the mean."

Well, the range really belongs to a different kind of measure group called the **measures of variability**. These measures reflect the spread-outness of the distribution whereas measures of central tendency reflect average-ness. Variability measures tell us more—they show us that some distributions **vary** more than those that seem "squashed together". The mean, median and mode are **points** on the baseline. Variability refers to **distances**. So that, two separate groups may have the same mean, but be quite different because of the measure of variability, as illustrated in Figure 10.1



Symmetrical Distributions with the **Same Mean**, having different Degrees of Dispersion.

Fig. 10.1: Frequency distribution of knowledge scores of TBAs

Figure 10.1 shows two symmetrical distributions of two different groups of trained birth attendants. Both groups have the same mean score ($\overline{X} = 100$) on a measure of Knowledge of Birth Complications; the means are the same, but they show different pictures of dispersion. Group B is more spread-out around the mean score of 100 very much more than Group A. That is, Group A is less valuable than Group B.

"Besides the range, what else comes under the measures of variability?"

Although other measures of variability include the average deviation and semi-interquartile range or quartile derivation, this discussion will be limited to the **standard deviation** and **variance**.

"I've heard people speak of the standard deviation—what does the term refer to?"

The standard deviation is based on the idea of individual deviations from the mean. The standard deviation takes a mean of **squared** deviation scores and then takes the square root of that mean.

So, if you have a mean ($\overline{X}$) and you want to know how the scores are spread-out on a baseline, you compute a deviation score.

Thus, the standard deviation is a kind of average of **individual deviation** from the mean of the distribution.[36]

The standard deviation is computed as follows:

Score (X)	Deviations (X-X)	Deviations Squared x^2
5	+2	4
4	+1	1
3	0	0
2	-1	1
1	-2	4

$\Sigma X = 15$ $\qquad\qquad\qquad$ $\Sigma x^2 = 10$

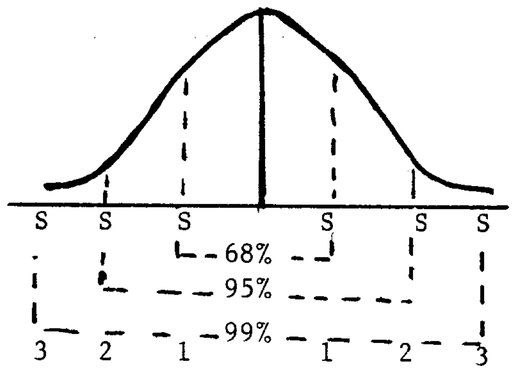
$n = 5$

$\overline{X} = \frac{\Sigma X}{n}$ $\qquad$ $S.d. = \sqrt{\frac{\Sigma x^2}{n}}$

$X = \frac{15}{3}$ $\qquad$ $S.d. = \sqrt{\frac{10}{5}} = S.d. = 1.4$

$\overline{X} = 5$ $\qquad$ $S.d. = \sqrt{2}$

The standard deviation is one of the most commonly used statistic, and is needed in computing other statistics. With standard deviation one can compute correlations (product moment) and some of the standard errors (these can be found in texts with more statistical emphases). Standard deviation relates to the normal distribution, as shown by the **bell shaped curve**. The total curve has about six standard deviations, with one standard deviation equal to about 1/6 of the range. If you divide a normal curve, about 68 per cent of the cases fall in the middle of the curve with half of these cases, or 34 per cent to the left and 34 per cent to the right. If you take in two standard deviations above and below the curve, you will have accounted for 95 per cent of the cases. Three standard deviations above and below comprises 97 per cent of the cases. See Figure 10.2.

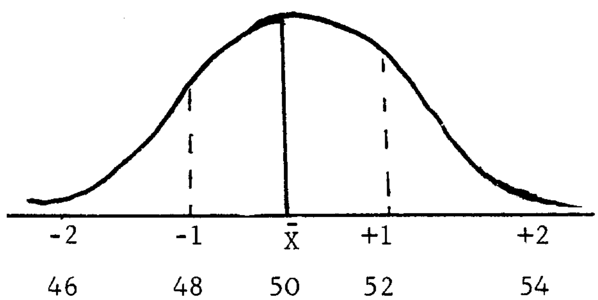


1. s.d. takes in 68% of cases
2. s.d. takes in 95% of cases
3. s.d. takes in 99% of cases

Fig. 10.2 Normal Curve and Standard Deviation

"Well, what does all this have to do with the trained birth attendants score on the test of birth complications?"

Good question. Let us say that you scored the post-test of your sample, and obtained the raw scores for all subjects. You could create a frequency distribution and then compute the mean and standard deviation, which would tell you important information about your traditional birth attendants. You could determine their average performance, and how the scores vary, by using the range and standard deviation. Then you could see exactly how one score compares with all others in a given sample.



$\bar{X} = 50$

S.d.= 2

Fig. 10.3: Normal Distribution with a Mean of 50 and Standard Deviation of Two

For example, look at Figure 10.3. If a person's score is 50 and the standard deviation is two, where will a score of 52 be in a normally distributed sample?

"A score of 52 will fall one standard deviation above the mean. Similarly, a score of 48 will fall one standard deviation below the mean."

That's right. You remember, that the area enclosed within one standard deviation below and one standard deviation above the mean represents 68 per cent of the case.

Measurements in health research can be of individual differences as well but an individual's score can seldom be understood out of context. When we say that Ms X has achieved a 50 on a test for traditional birth attendants. But we must ask, "in relation to what"? Her success cannot be understood except in relation to others' success.

Percentiles or Centiles

One very common measurement used in health research is the **centile**, or **percentile**. A centile shows where an individual stands in relation to a specified norm group. It does so by reporting first what percentage of that distribution falls below the selected individual's score.

"Then using percentiles would be useful for comparing our children to growth and development norms."

Yes. Height, weight and other anthropomorphic measures have been affected on a very large number of infants at the various months of age. Measures of central tendency, and measures of variability, have been computed. This makes it possible to convert your infant's score to other kinds of scores.

The norms that are published are usually revised to show the new norm tables in the form of percentiles. The raw scores are converted to a new form which we will discuss here.

TABLE 10:3: Frequency Distribution Based on Infant Development Data for 36 Rural Infants*

Scale of Measurement	f	cf
90 - 94	1	36
85 - 89	2	35
80 - 84	3	33
75 - 79	5	30
70 - 74	8	25
65 - 69	7	17
60 - 64	5	10
55 - 59	3	5
50 - 54	2	2
	$n = \Sigma f = 36$	

*f = frequency

cf = cumulative frequency

A percentile refers to a point on the scale of measurement and is denoted by P_{10}, P_{25}, P_{50}, P_{75}, P_{90}, etc. Thus, P_{25} refers to a point on the scale of measurement below which lie 25% of the cases. If there are total of 36 cases, 25% of 36 is equal to nine. Refer to the Table 10.3; roughly you can say that P_{25} lies in the interval 60-64. In determining percentiles we answer the question: "What is the score below which so many cases lie?"

$$P_{25} = l + i \frac{(N \times \frac{25}{100} - \text{c.f in the lower class interval})^{*}}{\text{f in the class interval in which the percentile lies}}$$

$$= 59.5 + (5)\ \frac{9-5}{5}$$

$$= 59.5 + 4 = 63.5$$

Now, can you answer: "What is the score below which 25 per cent of cases lie?"

"63.5"

Right. **Percentile rank** answers the reverse question, that is, given the score, what is the percentage of cases that falls below the given score? In the above example, if the score 63.5 is given and we are required to find the percentile rank we shall say that it corresponds to P_{25}. A percentile rank thus corresponds to an area of the frequency distribution, while percentile is a score or a point on the base line of a frequency distribution.[37]

"And if we divide the distribution into 100 equal parts, we would have centiles."

That's exactly right. By definition, a centile is "a point on the base line that lies above a specified number of hundredths of the distribution."[38]

If we divide the frequency distribution into ten equal parts, each unit would be a **decile**. Now, what per cent of the scores are below the first decile?

"Ten per cent."

Second decile?

"Twenty per cent."

Right. Another term used in describing percentiles is *Quartile;* quartiles are points on the scale that divide the frequency distribution into four quarters—P_{25}, P_{50}, P_{75} are three quartiles. The median and 50th percentile are the same. In the case of normal distribution, it is also the mean. Now, you have meaningful information. You can see how your infant compares with other infants in the group to which he is being compared.

"All right. Let's say that the infant I just weighed scored at the 50th percentile. What would this mean, or how would I interpret that ?"

---

*1 = lower limit
i = number in the class

You would say that his score is better than 50 per cent of the infants of that sex and in that particular age group. It is very important to select appropriate norms for comparing your infants.

"Well, babies are babies. How can one group be so different from the next?"

There are very distinct differences in growth patterns of infants from different regions. In fact, even in one country, considerable variations may occur due to nutritional, environmental and other geographical factors. If there are no norms available, then you can begin to collect information to establish some norms for your own area.

"How do I do that?"

Let's say you are the only health caretaker of a population of 10,000. By having the midwives and multipurpose workers keep simple charts on the infants, you, over time, can make your own reference group. Then you can compare an individual child to **that** group. The idea is to be able to compare **your** infant with some well-defined group. As you use the norms, you will be able to judge how well an individual child compares with other infants of the same sex, age in months and regional area.

LETTER 11

"I HAVE STATED MY HYPOTHESES. NOW WHAT DO I DO WITH THEM?"

Stating the Research Hypotheses or Questions

Dear Reader,

In an earlier letter we discussed the three approaches to research which were historical, survey, and experimental. Another way of looking at "types" of research is to look at them in terms of levels. And for our purposes we can describe two levels: those studies which describe certain attributes or gather descriptive information, and those studies which attempt to discover the merits of previous expectations, or to predict occurance of certain phenomenon.

"Which comes first, or does it matter?"

It certainly does. If you are researching an area about which you have little knowledge, you must begin at the descriptive level. First of all you identify the phenomena you want to observe then you record carefully your observations and write them up in a verbal descriptive fashion. To express the ideas numerically, you use descriptive statistics, such as the measures of central tendency, percentages, and percentiles.* This description of attributes only states "what they are" but does not answer "why are they so" or "what is the relationship between two phenomenon you have studied".

Variables

"What are these attributes?"

These attributes or phenomena are called **variables**. You must identify, define, and quantify them. In behavioural or social sciences, the data consists of the measurement of attributes of subjects—human beings or animals. According to Harshbarger[39] the attributes with respect to which individuals differ are called variables. But if there are attributes with respect to which individuals in a group do not differ, they are called "constants" or **controlled variables**. For example, if you take all your subjects as students of standard ten then the educational level of subjects is constant. Whereas educational levels of housewives may be termed a variable.

Defining Variables

If your area of interest is delivery of primary health care, you may be interested in assessing what variables support or inhibit the implementation of that model of health care delivery. The question is certainly timely and appropriate. Here the variables are stated but stated broadly,[40] Let us look at it more carefully.

"What factors influence the implementation of primary health care in rural village setting?" The variables here are "factors" and "primary health care".

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*See letter 10 for details on descriptive statistics, and a discussion of percentiles.

"Are the variables measureable?"

Well, they are stated in very broad terms; the variables here are identified but not defined or quantified. We have no idea what kind of "factors" the researcher has in mind. He/she could be referring to community participants, composition of the health team, environmental factors, or the interaction of all of these phenomena. What else do you notice about the statement?

"Well, primary care, the other variable, is also unclear, but may be I am supposed to know what that term means."

You may have a good definition on primary care. But we are interested in the term as defined by the researcher; that is, how primary care is to be viewed in this study. Having general problem statements like this one is not wrong. In fact, it's essential to have broadly conceived areas of concern, at least initially. But it is essential to define the term as variables so that they can be quantified and measured. That is, the variables have to be able to work for you, to operate, or become "operational". Thus you need to spend some time in formulating **operational definitions** of your variables.

For example, in one project by Pradilla[41] the overall area of concern was the magnitude of health and nutritional problems in South America. The authors then narrowed their focus to an identification of selected "risk factors" within a selected geographical area of South America (in this instance, Costa Rica). They further narrowed their focus to the local level, which they defined as small rural or urban communities, and selection of "priority actions" for "specific target groups" (in this instance, rural children in Cavdelaria, Columbia). The authors defined "risk indicators" as: (1) Infant mortality; (2) general mortality; (3) excreta disposal (any kind %houses), and (4) incomes % population with more than C-5,000-yr. Another excellent example is Peng's study where he operationalizes the "functions of traditional birth attendants". These are simply stated as: (1) the recruitment of acceptors; (2) the remotivation of drop-outs; and (3) the resupplying of pills to continuers.

"So the process is general to specific; from an overall area of concern, to a very careful definition of the variables."

I would say for the most part, yes. But in some areas, the process is not as clearly delineated because one may not even know which variables are operating. In their study of medical students, Becker and his associates, authors of the book *Boys in White* noted "We had no well-worked-out set of hypotheses to be tested, no data-gathering intruments purposely designed to secure information relevant to these hypotheses, no set of analytic procedures specified in advance." Furthermore, they noted, "We concentrated on **what** students learned as well as on how they learned it. Both of these assumptions committed us to working with an open theoretical scheme in which variables were to be discovered rather than with a scheme in which variables decided on in advance would be located and their consequences isolated and measured." [42]

But in general, the process begins with general ideas, and then narrows in focus.

But let's look at other "areas of concern" possibilities for, say, health services research. Such broad areas being considered could be those outlined in Table 11.1.

TABLE 11.1: Areas of Concern [43]

1. Needs and demands as a basis for planning, programme formulation and management.
2. Approaches to planning and management.
3. Alternative strategies for primary health care delivery and supporting infrastructure.
4. Economic aspects of health services.
5. Financing of health services.

6. Monitoring and evaluation, analysis of trends, definition of indicators.
7. Standardization of terminology, methods and procedures.
8. People's behaviour in relation to health and health services, community participation in health action.
9. Traditional practices.
10. Development of appropriate health technology.
11. Health manpower development and management and its integration with health services development.
12. Intersectoral action for health promotion.
13. Disease control.
14. Emergency services.

These are all broad areas which, as stated, are not researchable. In order to create a study on any one of these, one would have to further refine the topics and more clearly define the variables.

"How do I define variables?"

Part of your thinking on this comes from your conceptual model and part from a review of acceptable definitions used by others. The dictionary and other general references are also often useful. Ultimately, the definition is created and remains consistent throughout the study. These variables then must somehow be quantified or measured. For example the variable "traditional practices" may be quantified as the number of rituals related to birth which are carried out by a village religious leader over a specified period of time. "Traditional practices" is too vague an idea, but one could count numbers of specific religious rituals. You ask the question, is this the variable to be tested? As measured by what: a survey, an interview, or some other means of gathering data?

Independent and Dependent Variables

Let us examine this example: you conduct a health teaching programme for dental care for a group of school children. You measure their improved dental condition by counting the number of tooth caries at an interval of six months. In this example, variables identified are age, sex, socio-economic background of children, and frequency of dental caries. The researcher can manipulate the age, sex and socio-economic background of the children by grouping them or excluding certain groups and holding them constant (e.g. record only male children). These groups of variables are called **Independent** variables for they are considered the presumed cause of the **Outcome**. Whereas, the variable of "dental caries" is called the **dependent** variable as it is dependent on the independent variables and is considered the presumed effect.

"They are like 'output' measurements."

You are right. Independent variables are like the input or the stimulus whereas the dependent variables are like the output or response.

Let's examine another example:

"Traditional birth attendants who are exposed to 10 hours of training will show significantly lower infant mortality rates than traditional birth attendants who have not had 10 hours of training."

The independent variable is—?

"Well, it's the training that will affect the change in the birth attendants, so the type of training is the independent variable."

Correct. The dependent variable is—?

"The thing that is being affected by the training is infant mortality, so that is the dependent variable."

Very good. Now why is this important? We mean, what difference does it make that we have identified the variables, and that we have identified them as dependent and independent.

After you identify and define the variables, then you ask, now how do I measure them. Each variable will then be quantified in some way, so that the information can be collected and counted.

"What about the variables that we do not consider?"

Other Variables

That's a good question. In the above example, there are certain variables which may influence the relationship of dental knowledge and practice in the prevention of dental caries, even though they cannot be seen. Learning ability, motivation and anxiety are some of the factors that may intervene in a child's practice of dental hygiene. These are called **intervening variables**. The researcher's role is to recognize the existence of these variables and incorporate them in the discussion of findings.

"You have mentioned in your example of the dental study, the independent variables of age, sex, and socio-economic background. There could be other variables such as religion, parents' education, father's occupation, and so on, which may have a significant influence on the dependent variable."

"But I cannot manage all of them—what do I do then?"

You rightly guessed the importance of looking at all variables of the design. These independent variables that are not manipulated by the researcher are **extraneous variables.** You cannot ignore them, because your research result may give wrong conclusions. The best idea is to include them in the design if possible. When you design the experimental study, some of these variables remain common to both the control and the experimental group; thus, their effects get neutralized. There are several methods by which influence of extraneous variables can be minimized, a subject which can be explored in other texts.[44]

Hypothesis

"Why do I need to worry about how many variables I have? All that I have to do is to describe them."

In many countries, little research has been published or described in writing for others to study. Unless and until people are willing to share their exploratory or descriptive observations with others, the basic elements or variables which are important in a situation cannot be identified.

But let us say that you are in a country which has some basic knowledge of the issues related to a particular problem. Perhaps the problem has been known for sometime. Then further **description** of the issue is redundant; what is needed now are educated guesses, built on previous research, which have emerged from the literature and the experience of many researchers.

"You mean that these 'educated guesses' have some foundation in fact or opinion."

Right. And it's a very good idea to state, in writing, why you guessed what you did, that is, the basis for your rationale and your perception of the problem.

"Well, I see many research studies that do not elaborate on this rationale. In fact, some studies do not even state what their guesses are!"

That's right. In writing research, these "educated guesses" or hunches are formally termed **hypotheses.** And you undertake the study in order to come to some conclusion about each hypothesis you have stated. That is, after studying the problem and testing your hunches or hypotheses you either accept them or reject them. Now if your hypothesis is poorly stated, or when you can take no action on your hypotheses, your planning is poor. The hypotheses must be clear, specific, and consist of only one research prediction. And, if the research is designed in such a way that each hypothesis is testable, then the researcher will always be able to come to a definite conclusion on each one. If he cannot, then you can be certain that there was something wrong either in the statement of the hypothesis or the design of the research.[45]

"This explanation seems clear enough, but can you give an example ?"

All right. A good example can be found in India where concern had been expressed about the reluctance of nurses to work in rural areas.[46] Authorities believed that once the students experienced urban life and the busy hospital setting, the attractiveness of their own rural settings were quickly forgotten, This dearth was compounded by the move toward primary care coupled by the emerging patterns of health care delivery, and newer, more contemporary, health care models. The trend was fairly well established to the extent that revised models did not even mention a position for the professional nurse in the rural areas.[47] Also noted was the strategies adopted by other countries to alter this trend. That is, community-based nursing education programmes were created, providing students clinical experience not in hospitals, but in rural settings.

This picture was provided, at least in part, to create a level of comfort for working in the rural setting. And it was reasoned that if one's training is primarily rural in nature, one's job preference upon graduation would also be rural.

"So some methods had been proposed to solve the problem which was to educate nurses directly in the village settings."

That is right. And experience, as well as the literature, documented that the problem existed, and persisted.

After reading the literature, however, a group of nurse researchers in India had some doubts about the factors which had to do with job preference after graduation. Further, they, as nursing faculty, had taught and counseled many graduating nurses. That is, they had had direct, on hand experience with the issues related to this problem. They believed that other factors, in addition to setting of educational experiences, had to do with ultimate preferences.

"I am beginning to see the difference now between the descriptive study and the study where hypotheses are tested. This group with their experience and availability of literature, had some definite ideas about specific factors and perhaps the relationships those factors had to job preferences."

That is correct. And the researchers were able to state some tentative statements about those relationships.

Then in your hypothesis statement you have specified variables. Also needed is the population or reference group about or upon whom these variables are to be measured. In our earlier example, "rural health settings" suggest from where or from whom we are to get the data. Further, you need to state the question to be answered or statement to be addressed. In the above example the hypothesis is stated in statement form which gives a direction to the problem solution. In our question "What factors influence the implementation of primary health care in rural village settings?" The question you pose is to the question of finding out which factors have a bearing on a phenomenon, in this case, implementation of primary care.

Be careful that, when stating your hypothesis, you do not ask questions which cannot be answered. Questions which are moral, religious or ethical in nature are simply not fare for the researcher. For example, asking if one caste in India is better than another renders an untestable hypothesis. But you could ask if one caste is more effective in carrying out some activity. Then you would define "effective" in some way. Also, you should note that a hypothesis tests only one idea at a time. For example, the following hypothesis is not testable for it carries more than one prediction:

"The level of medical expertise and extent of financial support were related to decreases in infant morbidity and reduction in maternal infection."

This hypothesis would have to be altered because if the data support one prediction and not the other, you would have the problem of "partial support" for the hypothesis, a position which the research should avoid.

Let us look at our previous example of traditional birth attendants:

"Traditional birth attendants who are exposed to 10 hours of training will effect significantly lower infant mortality rates than traditional birth attendants who have not had 10 hours of training."

Research Hypothesis and the Null Hypothesis

Well, what has happened here is, you have stated your **research hypothesis,** and will later interpret your data only in terms of this hypothesis and these variables. But before you do that, we must discuss the way the research hypothesis is stated. The usual procedure is to put the research hypotheses (H_1) in its **null form**, or, to state the **null hypothesis**, or (H_0). This is necessary in order to develop a decision procedure for accepting or rejecting a single hypothesis.

"The important points are that there must be only two hypotheses, and they must be mutually exclusive and exhaustive. This permits rejection of one to imply acceptance of the other."[48]

Thus, in order to be tested, our hypotheses about birth attendants would be changed from:

"Traditional birth attendants who are exposed to 10 hours of training will demonstrate significantly lower infant mortality rates than traditional birth attendants who have not had 10 hours of training."

would be changed to :

"No significant difference in the infant mortality rates will be demonstrated for traditional birth attendants exposed to 10 hours of training and those not exposed to 10 hours of training."

Research dictates that a null hypothesis be formed so that a sample can be provided in order to decide to either reject or not reject the null hypothesis. If you can reject the **null** hypothesis, then you accept the **research hypothesis.** Thus, you do not **prove** anything in research, you only test your hypothesis. As a researcher, you hope the null hypothesis is faulty so it can be rejected in favour of the alternative or research hypothesis.

"Why must the hypothesis be in null form?"

Because the sampling distribution and the statistic can only be computed when the hypothesis is in null form.

The null hypothesis states that all samples are random samples from a single population. And you are attempting to negate that statement. Put another way, you are asking, "do the two samples I am measuring represent two populations, or are they merely two samples from the same population?"

In our example, we have randomly selected two groups of traditional birth attendants from the same population. We put one through our 10 hours of X special classes, and the other one gets no classes. Then we compare both groups on infant mortality rates. Now we want to know whether or not the two are still random samples from the same population. We hope they are not, if they are, the group exposed to our teaching has not changed. And there will be no significant difference between the two groups. Thus, we cannot reject the null hypothesis. And, we cannot accept the research hypothesis.

Levels of Significance

In our example, let us say that the group with the training scores 90 and the group without the training scored 80. The question is, is the difference significant? So we do a statistical test appropriate for our data, sample size and number of groups. The results are that indeed, our difference of 10 points is significant.

"Well, maybe you just happened, by chance, to select a bright group of attendants. Maybe you were lucky."

Good observation. To address that question, conventional **levels of significance** have been created to tell us the extent to which this sampling error has occurred.

"What are they?"

Generally, we want to know how seldom must the results be obtained before we are willing to say that they did not occur by chance? The level of significance is your statement of the **point** at which the significance probability is so large that you say it was chance rather than your teaching method. In behavioural research, we select two levels, the .05 and 01 levels. "Five percent means that if a study were done 20 times, in one of those 20 (5%) a spurious conclusion could be drawn. For the level of significance also may be seen as the maximum risk of error the researcher is willing to run when he rejects the null hypothesis and concludes that a difference is **not** attributable to chance.'[49] Can you say that .01 level would imply?

"Let's see using your example, I would say that is: if a study were done 100 times, in one of those 100 times (1%) a spurious conclusion could be drawn."

Right. Then the researcher states the research hypothesis, states the null hypothesis, then sets the level of significance. Once it is set, it is not changed. And generally, .05 and .01 levels are the levels used. Occasionally, where less precision is expected, we have seen .10 set. This means that these researcher were willing to run a 10 per cent error when he/she rejected the null hypothesis. After the level of significance is set, the statistical test is computed, and a result obtained. Then the number obtained is checked against a table designed for that test. The number in that table (for the researcher's "n" or sample size, or "df" (degree of freedom) is compared with the statistical test results, **for the level of significance previously determined by the researcher** (either .05 or .01).

Usually if the test result falls **above** the number listed in the table, the null hypothesis can be rejected, and the research hypothesis accepted. If the number falls **below,** the null hypothesis cannot be rejected and you cannot, therefore, accept the research hypothesis.

"Does this mean that we have stated the hypothesis without sufficient evidence? That is, our educated guess was wrong?"

Not necessarily so. We fail to reject null hypothesis when the statistical result is not significant. This is probably due to a sampling error or chance occurance. There can be two types of errors in rejecting or not rejecting the null hypothesis. When we fail to reject a null hypothesis of no difference when in actuality, the difference does exist, this is called a **Type II or Beta [ß] error**. When we take a problem where there are a number of independent variables that cannot be controlled or held constant we need to choose a liberal level of significance (say, 0.1). This will avoid a Type II error. Let us look at this example. In a study of the patients undergoing major abdominal surgery, the subjects of an experimental group went through an organized exercise programme pre-operatively. The patients of the control group received the routine instruction and did not go through the organized programme. Respiratory functions were assessed pre- and post-operatively for both groups. Although the extraneous variables, such as smoking habits, administration of antibiotics etc., and intervening variables as pre-operative anxiety, pain etc., were identified, the researcher could not hold this constant because of the non-availability of a large sample. The researcher set the level of confidence as 0.1. This error can occur the other way round. That is, we reject a null hypothesis of no difference to conclude that a difference does exist whereas in actuality no difference exists. This is called Type I or Alpha (α) error.

Similarly, we need to use a fine screen or high level of significance to avoid a Type I error where the study is set up in a more controlled situation, such as a study to assess the complications of a new drug. Often we are faced with a small size sample when we do an experimental study because of the problem of considering the extraneous variables. Small sample size tend to yield error in statistics; hence to avoid the chance for error we need to increase the size of sample.

One-tailed and Two-tailed Tests

"I noticed that when I looked up the tests in the Appendix, I was not sure what table to look under, for some of the tables said "one-tailed test" and some said "two-tailed test". What does that mean?"

Good question. If you remember earlier we said that there are only two hypotheses, the one you reject in order to imply acceptance of the other. Now, there are two ways of stating the null hypotheses. One way is to state a hypothesis of no difference:

"There will be no difference in incidence of infection of two groups receiving two different concentrations of the X vaccine".

Here we have not predicted the **direction** of the difference. When we predict no directionality, that is, if we have no reason to expect a difference in one direction rather than the other, then we use the **two-tailed test.**

"When you suspect or have reason to think there will be direction, then you say so."

Yes. When we can make a prediction, in advance, then we are justified in using a one-tailed test. An example of a hypothesis using a one-tailed test would be:

"The group exposed to vaccine A concentration will demonstrate a significantly lower incidence of infection than the group exposed to vaccine B concentration."

Here we are predicting a direction—that Group A will score lower than Group B.

"But then how do you state the null hypothesis?"

Simple. You could say—"The group exposed to Vaccine A concentration will not demonstrate a significantly lower incidence of infection than the group exposed to Vaccine B concentration."

Again, you: (1) state the hypothesis; (2) state it in its null form; (3) run the appropriate statistical test; and (4) compare your answer with the answer in the table. But now you are to be sure to look under the correct label, that is, for the one-tailed test or for the two-tailed test.

Remember, "since the probability of a difference in one specified direction is just half that of the same amount of difference in either direction, the one-tailed test is twice as sensitive as the one we would be obliged to use if we were merely exploring; a difference half as large will qualify at whetever level of confidence we have prescribed."[50]

LETTER 12

MY TWO SETS OF SCORES SEEM RELATED. HOW CAN I ANALYZE THESE RELATIONSHIP?

Measures of Relationships

Dear Reader,

Sometimes we want to know more than what is average, or where a person scores when compared to another person. Sometimes we are interested in the relationship or connection between one thing and another. In this letter, we will look at the issue of relationships, in order to see whether or not our tests or measures are doing what we want them to do.

"What do you mean?"

Suppose you were fortunate enough to develop a test which showed that if babies scored high on the test, they would probably be healthy by one year. Then you waited until the child was one year old. You then had a way of checking on your predictor of health by examining the infant on his first birthday. So you would look to see how closely the scores were related to your criterion of success and the test would tell you how good your test was for the purpose.

So here you are looking at an **index of relationship**. When the number is low, it would give you a coefficient showing a low degree, and when high, would give you a coefficient showing a high degree. This coefficient is called the coefficient of correlation. Basically, what correlation tells you is this: "two sets of measures are related if knowledge of an individual's score on one of them reduces **the range of possibilities** for his position on the other one of them."[51]

"Can you give me an example?"

Sure. Let us say that a measure of mental illness has been devised for your country. The scores on this measure range from 0 to 100, with a measure of family cohesiveness devised with possible scores of 10-50. Now let us say that for a person with a mental health score of 50, he can only score a family cohesive score from 28 to 33. Only one-fifth of the range of the family score can ever be measured for that individual. So knowing about one measure tells us about his ability or characteristic on the other.

If we notice that as one measure rises the other rises, and as one falls the other falls, then we say that a positive relationship exists.

"How is this relationship expressed in numbers?"

If a perfect correlation exists, then a 1.00 is scored. If no relationship exists, the score is 0. And, a relation can be a positive or negative one. So, a coefficient correlation provides a scale from 1.00 to .00 telling us the strength of the relation, and the direction expressed as a + or −.

Now, in other parts of this text, you will be learning how to determine if a relationship exists. Tests such as the t-test and chi-square test will establish the fact that a correlation exists or it does not. A chi-square value which attains a predetermined level of significance allows you to say that the two variables are related. But you do not know the extent of the relationship. To determine this, you must do further analysis.

Before going on, let us clarify what is meant by positive and negative correlation, and how one interprets a correlation coefficient.

A perfect positive correlation, as noted, means that changes in one variable, say change in height, is accompanied by an equivalent change in the **same** direction of another variable, say weight. A positive correlation can be low, .2, .3, or high positive, .8, .9. Remember that the size of the coefficient has nothing to do with its direction. So, you may have a low negative correlation or a high negative correlation. The range from +1.00 to —1.00 is not continuous however. There are two separate dimensions, one negative, one positive. Each one ranges from .00 to 1.00.

"So a 1.00 correlation is not greater than a—1.00 correlation."

Right. The negative dimension is separate. In our example, as height of the infant increases, weight tends to increase in positive correlation. Suppose that, as the height increased, the infant's weight decreased. This would render a negative correlation. Thus, a negative correlation means that changes in one variable, in this example **height**, are accompanied by equivalent changes in the opposite direction in the other variable, **weight.**

Further, computing a correlation coefficient requires two sets of measurements, or the use of **bivariate data**. The measurements are computed on the same groups of individuals, or matched pairs of individuals. A correlation coefficient cannot be computed on one person alone.

Two correlational methods used frequently are the rank-difference and the product-moment.

Rank-difference Coefficient

TABLE 12.1: Ordered Data for Rank-Difference and Height and Weight of Rural Infants

Subject	Rank for Variable Height	Rank for Variable Weight	Difference between two Ranks(D)	Square of Difference between Ranks (D^2)
A	6	5	1	1
D	4	6	2	4
B	5	4	1	1
C	2	3	1	1
E	3	1	2	4
F	1	2	1	1
G				12

In Table 12.1, the first column identifies the subject, the second column his rank on the first variable, height. the third column his rank on the second variable, weight; the fourth column, the differences, and the fifth the square of the differences. These data are needed for use in a formula which computes ρ or rho coefficient.

In the formula*, the rank differences are in the numerator of a fraction that is subtracted from 1.00. So the larger the rank differences, the smaller rho, until you reach .00 or no correlation.

Pearson "r"

The second measurement of correlation is the Pearson Product **moment coefficient of correlation,** otherwise known as the Pearson "r".

To illustrate the Pearson "r", we can begin with a scatter plot where we actually plot our scores. It is a place on which both the scores of each person can be represented by a single point.

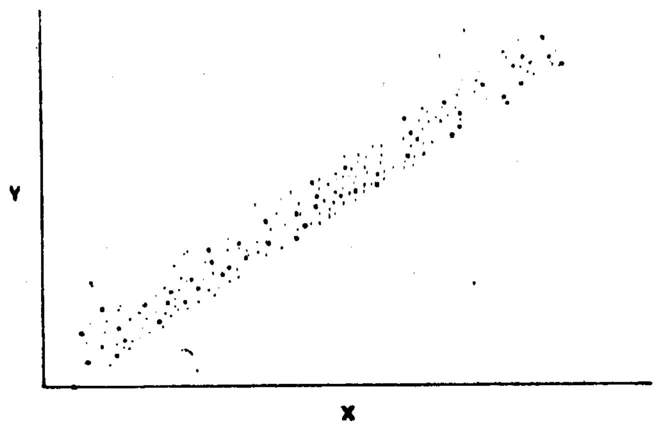

Fig. 12.1: Scatter plot of a High Positive Correlation between Education of Mothers and Completion of Infant Immunization Schedule of Infants.

Each mother is noted by a single dot which represents her on two variables X and Y. In this example, a straight regression line is formed. The scatter of scores determine the slope of the line; the smaller the scatter—

"The bigger the correlation."

Right. And the steeper the slope. Here a perfect correlation exists, for there is no scatter.

"Review again what this tells me."

If the relationship is strong, the deviations are small, there is little scatter. Thus, we can make fairly accurate predictions about Y by knowing about X. Now look at the other possibility. In Figure 12.2 the relationship is obviously—

'Weak. The dots look almost randomly scattered. The deviations are large and there is a great deal of scatter."

This means that there is no tendency for a low X to be associated with a low Y, or a high X with a high Y. So knowing X does not help us at all in knowing.

* $\rho = 1 - \frac{6\Sigma D^2}{N(N^2-1)}$

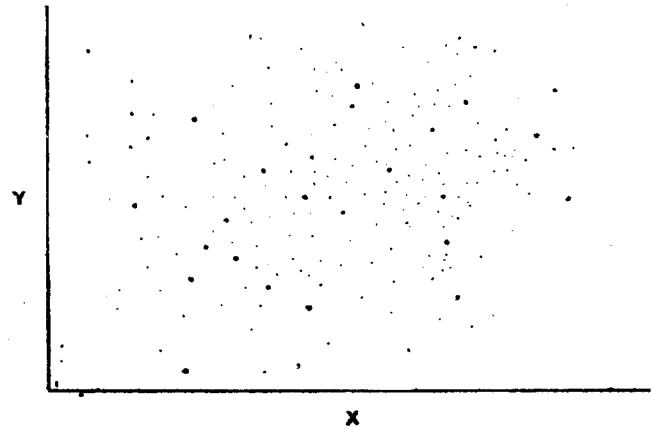

Fig. 12.2: Scatter plot of Zero Correlation between use of Prevention of Accidents, Slogans and Reduction in accidents.

The Pearson "r" is used to describe the degree of relationship between two variables of the kind for which a scatter diagram may be used. By using the formula* and solving for "r", you are representing the situations in the scatter plot.

The Pearson "r" is like rho except that it keeps data not kept by rho—that is the distances that separate subject of adjacent ranks on either of the variables being correlated [52] Further, the Pearson "r" assumes continuous data, while rank order correlation (rho) assumes ranked data. In addition, rank order is used when the number of cases is under 30, or for a small sample size. And finally, for both types of tests a correlation is relevant only to the population from which the sample has been drawn.

Summary

In this chapter, we have examined the ideas having to do with indices of relationships. We noted that relationships can range from 0 to 1.0, and can be either positive or negative. We reviewed the two major statistical tests used to compute correlations; these are the rank-order correlation and the Pearson "r".

*

$$r = \frac{\sum \left(\frac{X-\overline{X}}{Sx}\right)\left(\frac{Y-\overline{Y}}{Sy}\right)}{N}$$

$\overline{X}$ = mean of the X variable
$\overline{Y}$ = mean of the Y variable
Sx = Standard Deviation for X variable
Sy = Standard Deviation for Y variable
N = Total number of pairs of scores

LETTER 13

IS MY HYPOTHESIS STATISTICALLY SIGNIFICANT?"

Testing Hypotheses

Dear Reader,

In our previous letters on data analysis we explained how data are summarized through descriptive statistics. We also explored the basic elements of hypothesis testing. In this letter we are going to discuss some selected tests of statistical significance used when inferential statistics are appropriate.

"Could you further elaborate this?"

We need to know which test of significance is appropriate to your data. The choice of a test depends on the type of data available, the nature of population, manner of sampling (e.g., purposive and non-purposive), sample size and hypothesis to be tested. In order to make an objective decision as to whether or not a particular hypothesis can be rejected or accepted, one has to proceed in a systematic way.

Stating the Null Hypothesis

"I am ready. How should I begin?"

The first step is to state the null hypothesis, sometimes noted by "Ho". In our previous letter we said that the null hypothesis is the hypothesis of "no difference" and that it is stated in this way for the purpose of statistical testing.

For example, you have collected data on deliveries conducted by traditional birth attendants and trained health workers from two villages under your health centre. The health centre is situated within eight kilometers of village B, whereas the distance is more than three kilometers in the case of village A. Now you want to know whether or not the distance of the health centre from these villages (where the trained health workers live) makes any difference in the villagers' preference for the services of trained health workers. The research hypothesis may be stated as:

"Significantly more women of village B will prefer the services of trained health workers than women of village A for deliveries."

"Let me state the conventional null hypothesis required for hypothesis testing:

"There is no difference in preference of services of trained health workers for deliveries by women in villages A and B."

Good, you have got it. Let's look at this example shown in Table 13.1

TABLE 13.1: Home Deliveries by Type of Health Care Personnel

Villages	Home Deliveries by Trained Health Workers		Traditional Birth Attendants		Total
	No.	%	No.	%	
A	4	19.05	17	80.95	21
B	16	46.00	19	24.00	35
Total	20		36		56

Table 13.1 shows that there is a relative difference between the use of trained health workers in village A and B. In Village B, 46 per cent of women used the trained health workers whereas in Village A only 19.05 per cent utilized them. The test of significance would assess whether this difference is a true difference at a predetermined level of significance (e.g., .01 or .05 or any other) or has it occurred by chance only.

Choosing the Appropriate Test

"Now we have completed the first step—what do you do next?"

The next task is to select the appropriate test. There are several reasons for selecting a specific test, and we will discuss a few of them.[53]

1. Nature of Population

Earlier we have said that one consideration is the nature of the population. The population values are called "parameters". Parametric statistics refer to the statistical techniques where it is assumed that scores are drawn from a normally distributed population. That means, if we plot the scores of the sample it would form a normal curve.

"Does this mean that in non-parametric statistics we do not assume that the sample is drawn from a population having normal distribution?"

Yes, we may draw a random sample but find that the distribution is skewed. In such cases, we use nonparametric statistics.

2. Type of Data

Another consideration for selecting an appropriate test is the type of measurement or the level of data you are using. When we have continuous scores, such as internal and ratio level data, both parametric and nonparametric statistical methods may be used. One such parametric test is called, the t-test, which will be discussed later on in this letter.

"How do I analyse the ordinal or nominal level data?"

When the data are in the form of categories, say, on a five-point scale or a two-point scale of "Yes - No" or in the form of ranks, nonparametric statistics are used. One such example is the chi-square.

3. Size of the Sample

Another consideration in choosing a test is to consider the size of the sample. For example the Critical Ratio is applied to determine a significant difference between two sample means when the sample size is large, whereas the t-test is used for the same purpose when the sample size is small.

4. Hypothesis to be Tested

"Even after knowing the level data, population and size of sample, how do you determine which parametric or nonparametric statistics to apply?"

It depends upon the hypothesis to be tested. When the data contain frequencies based upon categorization (ordinal level data), a chi-square (chi² or x^2) test is generally used to study the association.

The Chi-square

The chi² test allows the rejection or non-rejection of the hypothesis of "no association" (the appropriate null hypothesis) that is, there is no degree of association between two variable categories.

"In correlation tests also, we assess relationships, then in what way is the chi-square different from correlation?"

That is a good question. The chi² test does not satisfactorily estimate the actual degree of the association as you find in the correlation coefficient. Moreover, correlation coefficient is derived from continous data and only looks at two variables at a time. Chi² can be applied to ordinal level data as well as data belonging to two or more sets of categories obtained from the same sample as shown in Table 13.2.

TABLE 13.2: Nutritional Status of 200 School-Children

		Beginning of Year Ratings				
		A	B	C	D	Total
End of year ratings	A	16	08	05	01	30
	B	08	38	10	04	60
	C	08	20	22	20	70
	D	02	10	15	13	40
Total		34	76	52	38	200

Two hundred school-children were examined for nutritional status at the beginning and at the end of the school year. You are interested in the relationship between these two ratings. For the purpose of statistical calculation, the data as given in Table 13:2 are called "observed frequencies".

"What do these columns and rows indicate?"

The column total (vertical) show the total number of children at the beginning of the year placed in particular categories, e.g., 34 children were found to have a particular nutritional or "A" status as of the beginning of the school year. The row total (horizontal) give the total number of children in each category at the end of the school year. The Table also indicates that 20 children who got "B" nutritional status in the beginning of the year got "C" at the end of the year and so on.

"But, what's the logic behind this test?"

Let's go back to our previous example of villages A and B. Here data are arranged in a 2x2 table as shown now in Table 13.3.

TABLE 13.3: Home Deliveries by Type of Health Care Personnel—Observed Frequencies

Villages	Home Deliveries by Trained Health Workers	Traditional Birth Attendants
A	4	17
B	16	19

Suppose, "if" women of villages A and B had no difference in their preference for having trained health workers for deliveries the data would have shown equal preference. The expected data are given in Table 13.4. These data are called "expected frequencies". The null hypothesis is stated with the assumption of "if".

TABLE 13.4: Home Deliveries by Type of Health Care Personnel—Expected Frequencies

Villages	Home Deliveries by Trained Health Workers	Traditional Birth Attendants	Total
A	10	18	28
B	10	18	28
Total	20	36	56

The chii-square test of significance has to demonstrate that our obtained frequencies as given in Table 13.3 are different from the expected frequencies as given in Table 13.4 if there is a real difference between the women of villages A and B using trained health personnel for deliveries.

"When you say 'real difference', do you mean that in terms of level of significance?"

Exactly so! The level of significance of .01 means that the probability that your obtained difference due to a sampling error is less than 1 per cent.

Now let us put both the frequencies together. The expected frequency is noted as "f_o" and the observed frequency is written as "f_e." Look at Table 13.5. The difference between f_o- f_e are noted in each cell.

TABLE 13.5: Home Deliveries by Type of Health Care Personnel

Villages	Traditional Health Worker		Traditional Attendant		Total
	f_o	f_e	f_o	f_e	
A	4 ($f_o - f_e$ = -6)	10	17 ($f_o - f_e$ = -1)	18	28
B	10 ($f_o - f_e$ = 6)	10	19 ($f_o - f_e$ = 1)	18	28
	20	20	36	36	56

The formula for $x^2 = \sum \frac{(f_o - f_e)^2}{f_o}$

If you look at the formula carefully you can see that the larger the deviation, i.e., $f_o - f_e$ the greater the chi-square value.

"How do I find out by looking at the chi-square value whether or not this is significant?"

You can look at the chi-square table given in standard statistics books. In order to read the table we need to understand "degrees of freedom" or df. For finding df we minus 1 each from the total columns and total rows. For example, in a 2x2 table, df would be (2-1) (2-1) = 1; in the case of Table 13.3 which is a 4x4 table, df = (4-1) (4-1) = 9. The chi-square table indicates that with 1 df a chi-square of 6.64 or more is significant at .01 level and 3.84 or more is significant at .05 level. Computed X^2 for Table 13.1 = 5.31, df = 1.

"Can you state the analysis in statistical terms?"

For your easy reference, let's recall the null hypothesis: "There is no difference in women's preference for trained health workers for deliveries in villages A and B. The null hypothesis is rejected as the Chi-square is 5.31, which is significant at .05 level and the probability that our obtained difference is due to sampling errors is less than five per cent. If we had set .01 as the level of significance, we state that Chi-square is 5.31 which is not significant at .01 level, and thus we have failed to reject the null hypothesis.

"What are the basic rules that I need to remember for getting data where the chi-square test is applied?"

Use of the Chi-square

The essential point is to develop a sound method for the categorization of data. The most pertinent points to remember for categorization are as follows: (1) categories must be exhaustive; (2) categories must be mutually exclusive; and (3) the categories are based on a single principle of classification. Let's examine each of these rules [54]

The categories must be exhaustive means that the data related to each subject must find a place somewhere in the categories listed. If you take categories, say, for occupation of the subjects as "teachers", "farmers", "technical workers", etc., you need to include "others" as another category for those who do not fall in categories of teachers, farmers or technical workers. It is not possible to make 100 categories to include occupations. So we take the categories where most of the workers would fall and keep "others" as a category where the remaining subjects are put together.

"How are mutually exclusive categories different from exhaustive categories?"

We are actually discussing the rules for categorization. It is not a question of one or the other, but we are to see that we take into consideration all relevant aspects of the variables under consideration.

Let us examine the meaning of mutually exclusive categories. In a study where the subjects are health supervisors, we want to know the previous experience of the subjects.The previous experiences listed are: worked as "nurse", "health educator", "sanitary inspector", etc. It is possible that subjects have had the experience in more than one category listed above. This will obviously lead to percentages which would exceed 100 per cent as one respondent may respond to more than one category. This can be seen in Table 13.6

TABLE 13.6: Previous Experiences of 50 Health Supervisors

Type of Experience	Number of Health Supervisors
Nurse	40
Health Educator	22
Sanitary Inspector	4

If you add the total, it amounts to 66, whereas you have a total of 50 Health Supervisors. This means some of the Health Supervisors who have worked as nurses may have also worked as health educators or sanitary inspectors or vice versa. But an individual should be capable of being categorized unequivocally in a certain category for the Chi^2 test to be applicable. Thus in each category each response has to be handled as a separate item; e.g., "has worked as nurse/has not worked as nurse", "has worked as health educator/has not worked as health educators", etc.

"Does this mean each should be 'independent'?"

Yes, that's the third consideration to be made when we say that the categories should be independent. The allocation of a subject to one category must not affect the allocation of another subject to that or any other category.

The next rule is to see that the categories are based on a single **principle** of classification. The sample given in Table 13.2 includes assessment of nutritional status at the beginning and end of the school year. The norms that govern the classification that a child's nutritional status falls into categories in A, B, C or D should be same for both measurements.

The t-test

"Now I know about a test of significance when the data are in the ordinal level. What happens when data are in the form of continuous scores?"

Let us discuss the use of the t-test here. The t-test, as we have mentioned earlier, is based on the assumption of normality.

"Does this mean that the variables I am working with are normally distributed in the population from which I have taken the sample?"

Yes, although there are chances that you may not find them normally distributed in the sample if the sample size is small. When the sampling technique is appropriate and the sample size is fairly large, the distribution tends to be normal if in the parent population the distribution is normal. However, there are statistical tests by which one can check whether or not the sample is normally distributed.

"When do I use a t-test?"

The t-test is used if the researcher is concerned with the significance of the differences between the means of two sets of data, either taken from the same sample or taken from two sets of random samples belonging to a single population. The following example will clarify this point. To measure the effectiveness of a unique workshop format for teaching research, an experimental design was carried out on a sample of nurses prepared at the graduate level. There were two groups taken from the same population, The workshop format of teaching was given to the experimental group and pre- and post-tests for research knowledge were administered to them. The control group was administered pre- and post-tests for research knowledge. Two of the hypotheses formulated for the study are given below:

H_1 Nurses who have participated in a two-week formalized workshop in nursing research will demonstrate significantly higher post-test than pre-test scores on a measure of research knowledge.

H_2 Nurses who have participated in a two-week formalized workshop in nursing research will score significantly higher on a measure of knowledge than nurses who have not been exposed to such a course.[55]

Table 13.7 shows the data related to pre- and post-test scores of knowledge, in the experimental group.

TABLE 13.7: Mean, Standard Deviation and t-Value of Pre- and Post-test Scores of Knowledge and Experimental Group

Variables	X	S.D.	t
Knowledge			
Pretest	9.30	4.37	5.38
Posttest	17.08	2.84	

Looking at the two means we find there is a difference of (17.08 - 9.30) 7.78 points. Now the question is whether the difference of 7.78 points is sufficiently large enough to be significant or can we say that the workshop method of teaching significantly increased the knowledge of research methods in the experimental group. The t-value was found to be 5.38. For this refer to the t-table in any statistics book.

"Shouldn't I find out the degrees of freedom first as I did in case of the chi-square?"

Right you are! In the case of the t-test, df is calculated from n (or sample size). Since we have two n (Pre-test N_1 and post-test N_2) the df is equal to $N_1 + N_2 - 2$. There were 13 subjects in the experimental group; hence df = 13 + 13—2 = 24. Are you now ready to see the table for t-distribution?

"Yes, I find that a t-value of 2.80 or more at df = 24 is significant at .01 level of significance."

You are getting the idea! Now you can say that a t-value of 5.38 at df = 24 is significant at .01 level, and thus H_1 is not rejected. This means that the nurses who participated in the research workshop showed significantly higher post-test scores than pre-test scores on a measure of research knowledge.

"In the above example you have explained how to find the significant difference between the means of two sets of data obtained on the same person. Can the t-test be applied to test the differences between the post-test scores of experimental and control groups?"

Yes. We have mentioned this earlier. The t-test is also used for testing the hypothesis of zero difference (null hypothesis) between two means using independent samples. Let us examine H_2 stated earlier. See Table 13.8.

TABLE 13.8: Mean, Standard Deviation and t-Value of Post-test Scores of Knowledge of Experimental and Control Groups

Groups	Post-test X	Knowledge SD	t
Experimental	17.08	2.84	
Control	7.20	3.40	5.90

There are two independent samples and the experimental group and the control group; we have means of post-test knowledge scores for both samples. The difference of the mean as shown in Table 13.8 is 9.88 (17.08 - 7.20) points. You could ask "Is this difference significant at the .01 level?" Now look at a t-table. We find that a t-value of 5.90 at df = 27 (13 + 16 - 2) between post-test means for the experimental and control group for knowledge is significant at the .01 level. The null hypothesis is therefore rejected and thus the nurses who participated in the nursing research workshop scored significantly higher on a measure of knowledge than nurses who had not been exposed to such a course.

Use of the t-test

"What is the reasoning behind the t-test?"

When we test hypotheses with the t-test, we use the same principle as with the normal curve distribution.

In order to study the relationships between two parameters we begin with an assumption that the relationship is zero. That is, if the two means are X_1 and X_2 then $X_1 = X_2$ or in other words the two means are identical. A word of caution in this—we always find a relationship in terms of relative value and not in absolute value, as hypothesis testing is done at certain probability levels particularly in the behavioural sciences. In behavioural science, the study of living organisms makes the research more complex as measures collected are often affected by many variables.

In the example of teaching research methods through a workshop, the researchers intended to evaluate the use of the format. In order to obtain a more meaningful interpretation of the effects of the format, a comparison with a group not exposed to the teaching would be most desirable. Thus, there are two things you can do—(1) You can compare the post-test mean with the pre-test mean of the same group; or

(2) by use of the mean from a control group (equated with the experimental group) which does not experience the experimental treatment i.e., the workshop method of teaching research.

"It seems in H_1 you have obtained pairs of measures, that is, each pre-test score is logically paired with a post-test score on the same subject in the experimental group."

Right, and in H_2 we have two independent measures where no such logical pairing is present and neither have we any reason for connecting any given scores in one sample with any given score in the other (because the subjects in the two groups are different from each other).

Now that you have seen various methods of comparing two samples, perhaps you could design a study proposal to compare the effects of triple vaccine in rural children on the incidence of whooping cough; in one village children are vaccinated and another village children have not received any vaccine.

Another exercise might be to study the effectiveness of various contraceptive methods in the population you serve where the dependent measures could be incidence of pregnancy, vaginal bleeding, anaemia and/or other complications.

"I would like to know more about other parametric and non-parametric tests".

That is good. We hope that you will want to explore additional parametric and non-parametric tests for use in additional research.

Remember, t-tests, and chi-square tests are just examples of tests of significance. One must plan the data analysis while stating the hypothesis, keeping in mind the nature of the population, sampling method, size of sample and the type of measurement. There is always one test which is appropriate to your data. Good luck!

Key to symbols used in this Chapter:

X	-	A score
$\bar{X}$	-	The mean of a sample ($\bar{X}_1$, $\bar{X}_2$ . . . mean of different samples)
x	-	deviation scores (A Score - mean of the sample)
$\sum x^2$	-	Sums of squared deviation score for the X values
n	-	number of cases in a sample (n_1 , n_2 . . . denotes different samples groups)
f	-	frequency of response
f_o	-	Observed frequencies
f_e	-	expected frequencies
$\sum$	-	summation
df	-	degree of freedom
$=$	-	is equal to
$\neq$	-	not equal to
k	-	represents any number, that is unspecified at this time

Formula for Chi-Square:

$$x^2 = \sum^{k} \frac{(f_o - f_e)^2}{f_e}$$

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sum x_1^2 + \sum x_2^2}{n_1 + n_2 - 2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}}$$

(For difference between two sample means where n is small and $n_1 \neq n_2$)

$$= \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sum x_1^2 + \sum x_2^2}{n(n - 1)}}}$$

(For difference between two sample means where n is small and $n_1 = n_2$)

LETTER 14

"MY CHI-SQUARE IS SIGNIFICANT. IS THAT ANALYSIS OR INTERPRETATION?"

Analysis and Interpretation

Dear Reader:

The tedious part of your work has been completed. You reviewed the literature, talked with experts in the field and have identified your problem.

Then you wrote the objectives of the research, the questions to be asked, and/or hypothesis to be tested. Your methodology section followed—research design, sample, setting, data collection instruments, pilot study and research study details, including a timetable for data collection.

You pre-tested your instruments, trained your data collectors, and collected your data. Finally you organized the data, laid it out, and spent time mulling over the data, looking for patterns, and trends. Now you will analyze your data to see what your statistical tests or descriptive data have to tell you However, analysis alone is not enough; you must explain and find meaning in the data—this involves interpretation. In this letter analysis and interpretation will be our area for discussion.

"The word analysis means the categorizing, ordering, manipulating and summarizing of data to obtain answers to research questions. The purpose of analysis is to reduce data to intelligible and interpretable form so that relations of research problems can be studied and tested."[56]

Before we begin to explore these topics, we need to discuss the help that the statistician can give at this point in the process. Early on, in designing of the research problem, the statistician plays a very important role. He helps in an almost preventative way, making sure there will be sufficient numbers in each category for investigation so that valid conclusions can be drawn. He helps earlier in advising on the survey design, the sample design and the analysis of data; he also advises on how to set up the tabulations.[57]

"What does the statistician expect of the researcher?"

The researcher should assume the basic responsibility for preparation of the tables and should understand the data collected. Paul Hedrick, WHO Statistician, New Delhi, believes that the researcher should know the basic measures, such as the mean and standard deviations of the variables, and the use of percentage distribution. If possible, he notes, the researcher can undertake some basic analyses such as assessing the significance of the difference between means, the difference between proportions, chi-square tests, and even the degree of correlation between items."[58]

The statistician will help you by checking your calculations, assist you in analyzing your results, including analysis of variance and co-variance so that the most can be gained from the results. He/she will be responsible for the accuracy of all statistical calculations and the validity of the statistical conclusions drawn from the data supplied by the research worker. You, as the researcher, must understand fully the meaning of the various analyses undertaken by the statistician. If you do not use the statistician from the beginning, you may find yourself with a research study which cannot be completed. Let us illustrate this point with an example.

One colleague of one of the authors was conducting a research study in psychology. He had completed all steps through the data collection phase of the study. He had studied perceptions toward mental illness of a particular sample of psychiatric nurses who were no longer at the university where he conducted the study. He approached the statistician expecting the expert's help to complete the statistical analysis. Only then did he learn that he did not have a large enough sample size to compute the appropriate statistical calculations. The psychiatric nurses who participated in the study were no longer available for interview and naturally, no other group could be used. An entire study became a fruitless effort because of the researcher's failure to use the help readily available early on the planning. When you analyze your data, you take the information and put it into a form so that the research problems asked (or hypotheses to be tested) can be studied.

In one study we conducted, we wanted to know whether or not a course given to nurses on research methods would significantly alter their attitudes toward research. So we hypothesized that by receiving this educational experience, group attitudes would be changed. We planned the study, set up a control group, and tested both the experimental and control groups, before and after the course. (The control group was experiencing another course of the same time duration but on another topic.)

Now to analyze this data, we had to order it, break it down and manipulate it so we could test the hypotheses. Two of these were:

"Nurses who have participated in a two-week formalized workshop in nursing research will score significantly higher on a measure of knowledge than nurses who have not been exposed to such a course." [59]

Also hypothesized was:

"Nurses who have participated in a two-week formalized workshop in nursing research will score significantly higher as a measure of research-mindedness than nurses who have not been through such a course."

Please note that we had a general plan for analysis already written in our research proposal. Our task was to carry out those plans with the actual data available to us. We took those hypotheses, tested them with the appropriate statistical tests, and analyzed the results in light of the theory we proposed.

Thus analysis begins from the designing stage when you think of the rationale of finding the type of data that are appropriate to your hypothesis as well as to the type of sample you want to study. The selection or the development of the research instrument is often guided by these considerations. It is difficult to say which comes first—the egg or the chicken. But the formulation of hypothesis that are to be tested is related to the appropriateness of data. Even if our study does not have an hypothesis (as in an explorative study), the analysis will include the way we want to describe and summarize the data.

Interpretation means that you study the results of your analysis, make inferences about the relations and draw conclusions about these relations.

"How do you make these inferences? What specifically do you do?"

As you are computing your correlation or "t" you infer and extract the meaning of the calculations. Also, as you work, you begin to compare what you found to what others found. You compare what you found with what you hypothesized. Remember from where you designed your hypotheses or, wrote your research questions. How did they come about?

"From a review of the literature. By looking at what the theory said."

That's right. You are looking to see how well your hunches compare with the theory statement. In our research attitude example, we did a review of literature. We learned from experts in the field that spending a concentrated amount of time in a subject area was basic to learning; further, a course designed to include active participation of the learners was essential for learning to occur.

Then we designed the course with those principles in mind and identified and/or created instruments designed to measure changes in knowledge and attitude towards research.

We analyzed the data using t-tests for the significance of the difference between the means and found significance for knowledge, but not for research-mindedness. This is the analysis.

"Now we have to ask, what does this mean."

That is correct. We judged correctly on the knowledge of hypothesis, but were wrong on the hypothesis related to research-mindedness.

Our data supported the theoretical literature which addressed the role of active participation in learning, which was the teaching method used in the workshop. So our findings were consistent with other research on learning. The study lent support to those who believe that learning research methods during a concentrated period of time can be effective.

"What do you do about the hypothesis that was not supported by the research?"

Negative findings are much more difficult to analyze than positive results. Positive results support our supposedly logical ideas and thinking, and we believe that our careful observations of phenomena have led us to test our ideas through research. However, we can never be really sure, for sometimes we get the expected results, but for the wrong reason. For example, suppose we took a sample of deprived, malnourished children and brought them to a lavish, beautiful centre with excellent facilities. And at this centre they were clothed, nourished properly, and kept clean. And let us suppose we wanted to see whether or not introducing them to selected educational materials would change their level of learning. So we pre-test the children's level of knowledge. We have them live in the centre one month and then we post-test them for changes in the level of learning. We find substantial change, that is, the difference between pre- and post-test measure are significant. But is the difference due to the educational materials? The change may be due to their change in level of health and/or their bodily responses to better food and clean environment. This "halo" effect must be considered when you analyze your results.

"It's something like getting a false negative on a laboratory test."

Something like that. Now with negative results, we must look back on the whole series of thinking–from our formulation of the theory, our deductions from that theory, the research design, methodology and measurement and analysis. A negative outcome can mean an error at any point or many points along the way. Usually, the more experience we have in a field, and the more we are familiar with a body of knowledge, the better are our predictions.

"That may be why some authorities say that experts in the field should suggest topics students should undertake for their research."

We know that is often said. The other argument is often suggested as well. Some feel that every student should have the opportunity of selecting his/her own topic for research and see for him/her-self what the outcome may be. But back to the issue. If indeed, your methods, design and analysis are correct, and your instruments have been determined to be valid and reliable, then negative findings, also, lend themselves to the greater body of research.

Incidental Findings

Many unforeseen events occur during the study, particularly during data collection, which may be as important as your findings of hypotheses tested. A discussion of these incidental findings are usually very helpful to a researcher who wishes to explore a similar area and who wishes to use a similar population. For example, one of the authors conducted a study at a large, urban university where she selected a random sample of professors to study effective college teaching.[60] She found that out of 250 professors contacted, only 30 would agree to have their classes videotaped. This largely negative response was definately unusual and required some notation and explanation. She found that at the time of the study, the university was in an economic retrenchment period, and faculty numbers were being reduced. Many faculties were mistrustful and avoided any form of observation and evaluation. The relationship between the academic atmosphere and the research results required further exploration. Perhaps different results may have been obtained if the study had been conducted at a time of full employment. This result may be fortuitous or spurious.

"How are these incidental findings reported? They are not answering one of the research questions or testing a stated hypothesis."

No, that is true. But you may want to consider presenting a separate section entitled "**Incidental Findings**". Here you would describe the observations as they occurred, or as they appeared in the data. You would then discuss the implications, as best as you could, in light of your experience and intelligence of the area under study. Or, you may believe that these findings had some bearing on the acceptance or rejection of your hypotheses. Then these observations would be incorporated into your analysis section.

The success of your analysis and interpretation is best predicted by the factors described by G.E.R. Burroughs.[61] He notes, that one's success depends on:

(1) The intelligence and diversity of thought one can bring to bear and has brought to bear on the whole process;
(2) The clarity with which one's hypotheses have been specified and one's techniques of testing them have been carried out;
(3) The breadth of one's understanding of the whole field of which one's own study;
(4) The extent to which one's mind is generally well-stocked;
(5) Serendipity*; and
(6) Luck.

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*An unforeseen, happy occurence.

LETTER 15

"WHAT IF THE VILLAGER REFUSES TO PARTICIPATE IN MY STUDY"

A Question of Ethics

Dear Reader,

Picture this scene. You are in your home. There is a knock on the door. You open the door and you see a man standing with a clipboard, a pen, and a briefcase. You have never seen him before. He tells you he is a researcher, and would like to ask you some questions. Further, he asks if he can come in and have you fill out some forms which you have never seen before. One hour before his arrival you and your spouse have had an argument which left you irritated. Further, your quarters were not in order, and the last thing you wanted to see were visitors.

What would be your reaction to this stranger?

"Well, first of all, I would be embarrassed by my situation which I would not want him to see. So, I might not invite him in. Secondly, I would have no way of knowing if he was telling the truth about who he was. Unless, of course, he had some form of identification—and one that I was familiar with. Also, I might be suspicious that he was a salesman and wanted to sell me something I couldn't afford. Thirdly, if I believed he was a researcher, I would want to know why he wanted the information, and what he was going to do with it. I mean, what if I told him something and later on it appeared in the newspapers? Some information I don't mind sharing, but some information is quite personal."

Some Issues

Well, your feelings are certainly appropriate. And the situation I described has often happened. The would-be participant, after weighing all the factors, sometimes decides after all that he is not interested in the study, and will not allow the researcher into his home.

An effective researcher anticipates these kinds of problems, and takes steps to avoid them before he/she encounters refusals. But what the effective researcher will **not** do is try to coerce the subject into participating, nor will he/she change the purpose of the study to make it more acceptable. Further, unless confidentiality can be guaranteed, no promises should be made. The use of the results of the study must also be made known to the subiect as well as how the results will be published.

The subjects must know enough about the research to determine whether or not their participation would cause them embarrassment or upset. They must also know that if they do agree to participate, they may refuse to answer any questions deemed inappropriate. For example, the questions that probe child abuse, family relationships, and emotional or social problems may bring out issues long forgotten and buried. The researcher must recognize this difficulty and respect the subject's refusal to answer. Researchers often ignore the fact that active participation, even in a simple way, may cause intense feelings which otherwise would not have occurred. If such a risk is a possibility, the researcher should be willing to establish whatever conditions are necessary to remedy the situation. A simple practice, for example, is to interview subjects privately in a quiet place. In a village this may be very difficult for often a village has few, if any, private places. Or, custom mav bar a woman from being alone in a house with a man, or vice-versa. The researcher, if he/she has done the necessary homework, will have anticipated this custom and made other provisions. Further, we must remember that in rural villages, many topics are not discussed outside the family, let alone with a stranger. How much money or how many possessions a family has, may be information the family holds secret. In their thinking, keeping this information secret protects them against unethical village leaders. Revealing this information can only mean that harm will come to them. The approval of the village leader is often crucial to the success of any project. As an example, Wiser and Wiser noted that in a village where they lived, a farmer would listen with interest to an explanation of the advantages of a new variety of seed. But he would not risk trying it unless his leader first tried it or at least sanctioned it.[62]

"Well, let's say that Ms X was randomly drawn to be a subject in your sample. You approached her and she refused. Could you gather data about her from a neighbour or relative?"

It is particularly tempting to gather data without permission but it is truly unethical and only hampers future research efforts in a village. If a villager is not interested in participating in a study he may simply walk away. No explanation. Maybe no answer at all. Sometimes researchers believe that by gaining the cooperation of the village leaders that all villagers will automatically be willing subjects. This may or may not be so. And, we have to be careful that leaders seen as powerful do not coerce or in any wav threaten the villager into participating when villagers do not agree to help. Most of the time, educated or illiterate, they wish to remain anonymous. Obviously, if a researcher fails to maintain that privacy, and if this breach becomes known to the subjects, future research efforts will not be permitted. At the worst, a law suit may result from violations of privacy.

The respect of privacy extends to other research activities, such as the snapping of pictures, use of tape recorders for interviews, and use of motion pictures. For the most part villagers thoroughly enjoy being photographed, and are pleased to know that their pictures will be shown to others. But we cannot assume that this is the case for all people. For example, women who observe purdah do not like to be photographed. For another example, in one leper colony we visited, the issue of photographs was a delicate subject. Parents were very concerned about the possibility of their children might be identified as lepers, a condition which, in many places, still carries a stigma.

The observation of ethical principles in relation to the collection of data is a most important consideration for the researcher. But the issue is particularly important in countries where few, if any, clear-cut guidelines on research ethics exist. More and more research will become an everyday occurrence in most countries, in most villages. And these activities are crucial to the assessment, implementation and evaluation of health care programmes. It is important to learn from the start that care must be taken to consider that indiscriminate data gathering is a means that cannot justify even the noblest of ends. In fact, observance of ethical principles must prevail throughout the research process—from the review of the literature to the writing of the final report.

Health workers are integral parts of a "thoroughly social-minded profession". Their purpose in curing and caring for people is viewed by humanity as just that—the desire to love and serve their fellow man. For health workers, particularly, unethical practices are contradictions to the ideals of the professions in which they serve.[63]

The issue of ethical behaviour is central to the health professions; in fact, the tradition of strict observance of confidentiality dates back to the ancient oath of Hippocrates, a Greek physician (460-349 B.C.). The oath contains the passage:

And whatsoever I shall see or hear in the course of my profession, as well as outside my profession in my intercourse with man, if it be what should not be published abroad, I will never divulge, holding such things to be holy secrets.''[64]

The nursing profession reflects a simple commitment to high standards of ethical behaviour, as examplified by an excerpt from the Pledge of Florence Nightingale:

'(I will) hold in confidence all personal matters committed to my keeping and all family affairs coming to my knowledge in the practice of my calling.''[65]

Let us take a look at the other areas of the research process where ethical factors are a consideration.

Ethics and the Review of the Literature

Initially you conduct two reviews of the literature, as we discussed in an earlier letter. To establish a rationale for carrying out your study, you need to report what research has been conducted by others in the area under investigation. And you must describe the findings of other relevant research, as it is reported.

''Must I report research that does not support my rationale?''

Yes, you should. In all likelihood, contrasting or contradictory evidence will exist. As one knowledgeable on the subject, you must present a critical perspective for the reader. The strengths and weakness of other efforts must be evaluated so that the reader can evaluate the relationship of your research with the greater body of knowledge in the subject.

Ethics and Methodology

The final questions or hypotheses you select must be of your own design. One study cannot copy another completed study. That serves no purpose. You are able, however, to replicate a study if it differs in some way from other research. In fact, replicated studies are quite appropriate, necessary and acceptable.

''What should I do if I want to use an instrument used by another researcher?''

You need to take permission from the author or publisher of the research instruments if you wish to use them. If you are modifying another researcher's tool in order to suit your purpose, you must acknowledge the author and indicate the modifications made.

In selecting and reporting on a research instrument, you must document the characteristics of the instrument, such as its cost, usefulness, reliability and validity. For example, in one study conducted by the authors, an instrument called a semantic differential for research-mindedness was used. The testees took one and one-half hours to complete the instrument because of language difficulties. This was an unforeseen result which we did not anticipate. However, the length of time necessary to complete the test would definitely affect another's decision as to whether or not it should be used again. We were aware of the instrument's limitation and had to report this liability and shortcoming in our study.

Honesty in-reporting the results of your data collection experience is also essential. Reports and records verifying the data collected should be a clear, concise, accurate presentation of ascertained facts.

In short, you should not hide the results of any research that is related to the problem under study or fail to report contradictory findings in order to highlight the findings from your work. And, it is important to indicate how extensive your review was. This can be accomplished by stating the years included in the review, and the sources consulted. As a researcher in a special area, you may be aware of certain experts or institutions which are knowledgeable about your topic. A comprehensive review would necessarily include these sources.

Let us say you decide to interview a random sample of 300 villagers. In your final sample you were only able to interview 35 people; 110 refused to be interviewed by the health worker, 37 were not at home, and 28 were too ill to be interviewed. The fact that only 16 per cent of the original sample provided data is of considerable importance, as are the reasons for the absence of a segment of the proposed sample.

Of course, the poor response does in some way, reflect the level of understanding and intelligence the researcher possesses about the sample and/or village situation. The researcher often realizes that he/she "should have known better" and should have tried to structure the data collection process more carefully.

Low response rates may or may not be related to the design created—but, in any event, the results must be reported.

"Should the subjects be informed about my observation?"

The observation method of data collection poses some difficult questions for the researcher. By being present in the environment, the observer necessarily alters the situation he/she is observing. Consider for a moment a village situation where the researcher is observing child-rearing patterns. The behaviour of both the mother and the child will be affected, in some way, by the presence of the researcher. Yet the purpose of the observation is to learn about the event as it occurs naturally. The view that the villager has of the person collecting the data must also be acknowledged. If the data collector is viewed as an authority, the behaviour of the villager will naturally be affected by that view.

Whether you use participant observer or non-participant observer methods, the subjects must be aware they are being observed. Your familiarity with the subjects or research setting prior to collection of data will minimize the uneasiness of subjects and allow them to behave naturally.

In an experimental design particularly, care must be taken to prevent the creation of designs in areas not acceptable for study. Obviously, a study which prevents one group from a known, effective, treatment and allows another group to receive needed treatment is highly unethical. This is not so when you are trying out new methods. One example comes to mind: a psychiatric resident during a case study conference told a patient that her mother had died. He wanted to show to the other participants the "Therapeutic effects of shock on depressed patients". The chief psychiatrist in charge used this opportunity to point out the unsuitability of this approach, and reviewed with the group the possible after-effects of this experience on the patient. He noted that the full impact of the experience may, in fact, be difficult to eradicate or even reduce. Not only do you need to avoid psychological trauma but you also must guard against inducing any physical trauma. Ethical issues on this is open to criticism. "The Friends of Animals' Society" protests against animal experiments on dogs and monkeys. We have also read about human experiments on psychiatric patients and prisoners. Such practices are highly unethical, and must be avoided. Health workers have the responsibility to guard against such practices, for the worker is really a protector of those who trust his/her judgement and for whom he/she assumes responsibility. That trust is a precious commodity and must be cherished by all who profess to being true professionals.

Ethical Considerations in Writing the Research Report

In writing the research report, the most obvious problem is that of plagiarism. Plagiarism, according to Lester, "is the offering of the words or idea of another person as one's own." [66] There are two essential ways of documenting material written by another person which avoids the unethical practice cited above. If you wish to quote directly the work of another person, you must put the material borrowed in the form of a quote, and credit the source by using a footnote. If you wish to put the **idea** into your own words, or **paraphrase** you must still credit the author with the use of a footnote. Some "rules of conduct" outlined by Lester can be stated:

(1) Acknowledge borrowed material within the text by introducing the quotation or paraphrase with the name of the authority from whom it was taken;
(2) Enclose within quotation marks all quoted materials;
(3) Produce a footnote for each borrowed item;
(4) Provide a bibliography entry for every book or magazine that appears in the footnotes.[67]

LETTER 16

"HELP! WHERE'S THE PROGRAMMER?"

The Use of Hand-calculators and Computer Services

Dear Reader,

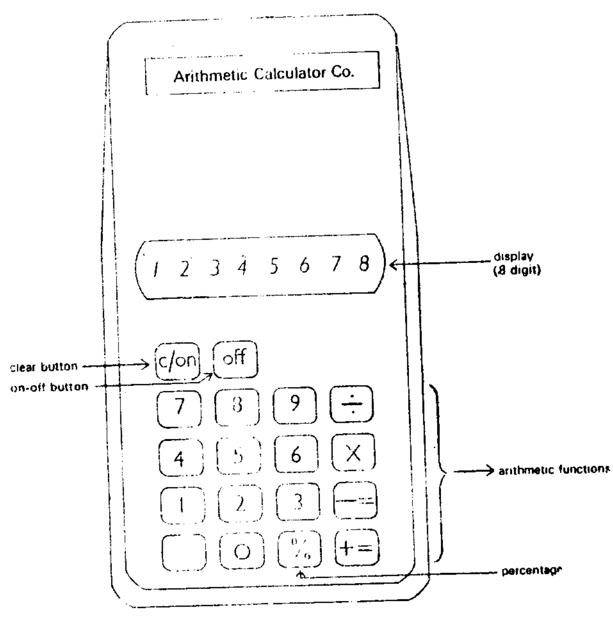
With the advent of calculators and computers, much of the work you have just completed by hand calculations can be done for you.

"What you mean, I didn't have to learn how to do all that analysis! I can't believe it!"

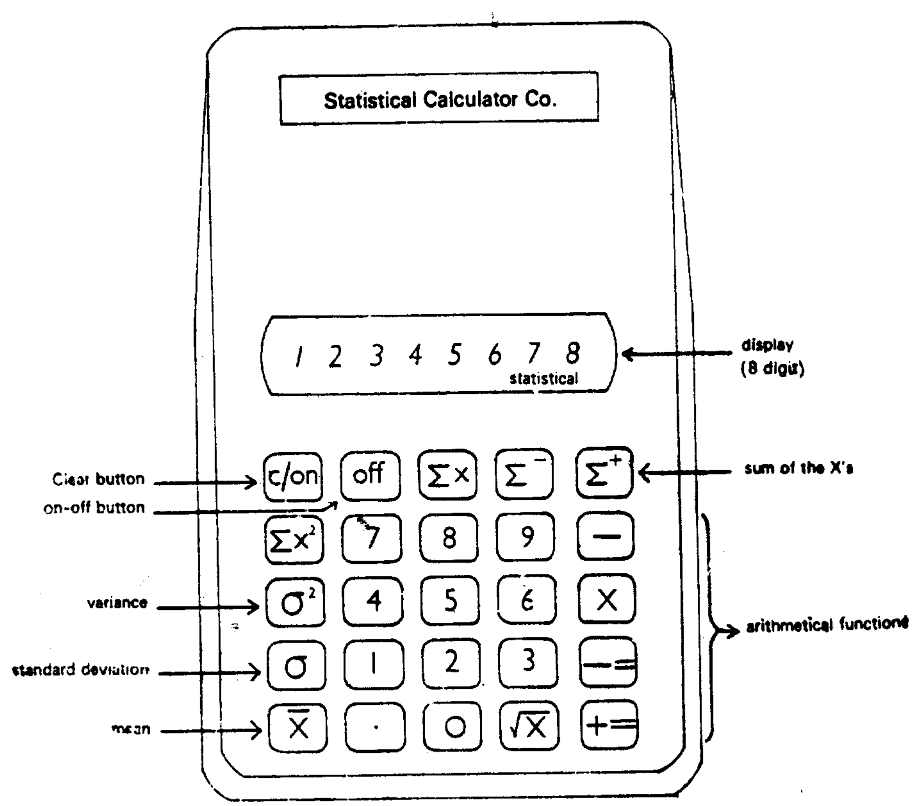
It is very important that you understand the statistical tests used, and how to compute them. But if you have a calculator or access to a computer the process is certainly faster. The calculator or computer will will compute the same statistics, but can do them more quickly and accurately. In this letter we will discuss the use of the hand-calculator, both the arithmetic and statistical types, make some introductory comments about the nature of computers and how you go about obtaining computer services.

Hand-calculators

If you can afford one, a statistical hand-calculator is worth the money. In some countries calculators are produced locally, and representatives are available to provide you with demonstrations of their different models. If a statistical calculator is unavailable and/or too costly, an arithmetic calculator is still quite useful and inexpensive. A hand-calculator can be purchased for about $ 10.00 (U.S.). The Arithmetic hand-calculator is small enough to hold in your hand (it weighs about 110 grams), is easily stored, runs on "C" batteries, and is simple to operate (See Figure 16.1).



It is turned on by a simple button, and can perform the operations of addition subtraction, multiplication, and division by pushing the number buttons called "Keys". Some can compute percentages as indicated by the notation "%", some can calculate the square of a number (X^2), square root ($\sqrt{x}$), sum of the scores (ΣX), sum of the scores squared (Σ^2), the mean ($\bar{X}$), standard deviation (σ), and variance (σ^2). All of these terms have been discussed in earlier letters. Some hand calculators have memory capability, often labelled (M). All types have a clear key (CE/C) which erases all previous calculations, and all the numbers in a **display** at the top of the calculator. If an error is made, some calculators blink on the word "ERROR", and some will simply blink the numbers if you have waited too long between calculating two functions. Figure 16.2 illustrates the statistical hand calculators available in most countries.



The Computer*

To make use of computer services, it is important that you understand some of the basic terms about the computer itself, the implements to run the computer, and the people who will assist you in processing your data.

The computer is an electronic device capable of making extremely rapid calculations, and storing large amounts of data in its memory. This means that what would take you weeks and months to compute, can be done by an electronic digital computer in about 20 seconds. That includes the calculations, reading in and printing the data. The computer can take thousands of repetitive operations and accurately compute the desired statistical tests.

Generally, there is a major piece of machinery, or main computer, which is made up of electronic parts. The actual machine is often referred to as the **hardware**. To operate, the computer must have a set of instructions, which are written in the form of a **computer programme**, called the **software.** The machine does not use English, it requires a machine language that tells it what to do and how to do it.The person who writes in machine computer language is a **programmer,** skilled in several computer languages, the most common of which is Fortran. Other languages are BASIC, and COBOL. Fortran then is the language mediator between your needs as a researcher and what the computer can do for you. There are some statistics and calculations used repeatedly, and thus the same directions are given to the computer time after time. For example, in your research, you probably will need measures of central tendency, standard deviation variance, t-test, and chi-square calculations. So do other researchers. To avoid writing the same programmes over and over, such complete programmes are available as **packages**, called "canned programmes". The one most frequently used by social and behavioural scientists is called **SPSS** or Statistical Package for the Social Science.

Cost of Computer Services

The cost of computer services are calculated by the length of time requires by the computers to complete your **run**. The calculations can be estimated by ascertaining the cost of computer time per hour, which currently runs about $ 650-750 (US) per hour. So if your data requires 15 seconds, the cost would be between $ 162-50 and $ 187-50. If you are writing a research proposal, the data analysis costs should be calculated as part of your budget. However, many universities and some government agencies grant free computer time to the faculty and students. And usually the programmes, professional help, and facilities are included in the service.

The People you Need

When you bring your materials to a data centre, your initial contact may be the **data processing manager**. He/She is a highly skilled professional with a background in several machine languages, understands users' research problems, and has an in-depth knowledge of the total computer system—its capabilities,etc. He/she will direct you to the appropriate person, perhaps an **applications programmer** who will examine your work and determine how to get you the information you need. Then a **key punch operator** types up your data on **computer cards,** with data for each element in your study per card. The cards are put in order, with directions inserted to tell the computer what calculations to perform on the data.

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*This section was developed with assistance of Mr. Jacques Farrell, M.B.A. Consultant Q.E.D. Wellesley Hills, Massachusetts, U.S.A.

Each card contains 80 columns and nine rows. So you must calculate how much data you need on each individual or elements, and how many cards you need for the entire sample. Suppose your questionnaire has 120 items, then you would require at least two cards for identifying data, and the subjects' responses or answers to the 120 item questionnaire. The programme is written in Fortran, and a computer programme called a compiler, translates the Fortran into a machine language programme. The computer will perform the calculations, and give you a print out of your data, large sheets of white paper with all the statistical calculations completed.

It is important to realize that a computer is absolutely stupid, and can perform only what you tell it to perform. Computers will never take over our work because they cannot think. In fact, computers, because of human error, produce garbled numbers. If you programme the computer with an error it will produce erroneous information, for it behaves exactly like a robot. Programmers even have a phrase for this - it is called "garbage in-garbage out"; you put in nonsense, you will get nonsense. "Ductility" or stupidity is a prominent feature of computers, but should **not** be a characteristic shared by the user of the computer.

LETTER 17

"WRITE UP THE WHOLE STUDY! WHERE DO I BEGIN?"

Writing The Research Report

Dear Reader,

Congratulations! You have gone through the process of designing and implementing a research plan through collection of data and analysis of data. You have now reached the final stage of reporting and applying the results of research.

"Yes, but I am stuck! I can't begin! I seem to have wasted a ream of paper!"

Well! It sounds familiar. Getting down to write is a difficult task. Let's see if we can review some labour-saving devices to minimise the task, and maximize the creativity. The first step towards writing a report is to develop a meticulous habit of maintaining proper notes as you progress. These notes should include: the research problem statement, data or information to support and justify the study, statement of objectives and hypotheses, theoretical consideration, description of setting and sample, notes on pre-testing of tool or pilot study, difficulties faced at each stage of development and, of course, all your data and analysis sheets. Don't throw out any papers, until after you completed the report. Inevitably, you need a reference that just went out with the trash!

Search for References

As you read books and articles, maintain a list for an annotated bibliography.

"What are annotations?"

Usually you write annotations for all the related literature that is of use in your study. The annotations include the main ideas expressed in the book, article, or any other reference material that you read, and that also include the relative value of the reference.

"Can you illustrate this with example?"

Take the following reference and annotation:

Miller, M.S.G. "Custom, Pregnancy and Child rearing Practices in Tanganyika," **Journal of Tropical Paediatrics**, 7:66-80, September 1961.

Rituals, customs, beliefs and taboos among various individual tribes in East Africa are described, as are the activities of the village midwife with respect of child birth. The author emphasizes the importance of this information to health workers as a means of preventing misunderstandings and improving health education activities.[68]

"I find this very brief!"

Yes, brevity is an essential feature of annotations and we find it useful to use active verbs such as "explains", "describes," "lists" or "analyzes".[69] If you wish to quote any sentence or passage, be very particular in copying them accurately, and note the page numbers. Later in this letter we will discuss, in detail, how to write bibliographies and footnotes.

"First of all, how do we locate sources of information?"

In the present day, literature retrival systems have become very advanced. In some countries, you can get computer printouts if you put in your request on most areas of study.

MEDLARS is one such computerized list of bibliography on topics related to health studies. ERIC is another computerized programme to retrieve materials on educational research.

"I do not have these sources available in my institution, so how can I have access to them?"

Usually you can get **MEDLARS** through national libraries and/ or national institutions. But if you do not have this option the second best is to learn how to use the "Cumulative Index". Most medical and university libraries have cumulative indices on different subjects, such as "Index Medicus". "Nursing Studies Index", "Cumulative Index to Nursing Literature," etc. The content is arranged by subject in alphabetical order.

"Dissertation Abstracts" is another referral journal where abstracts of research studies are noted. This is a very expensive source–your library may not have the budget to purchase these materials but any central libraries will probably hold subscriptions. When you find a related research report, look at the list of references and bibliography; and you will find references for other studies. Professional journals usually publish a yearly index which gives you clues to related research studies reported in that particular journal.

"I thought we are going to start writing!"

Have patience!

The purpose of this chapter is to discuss the use of reports, organization of reports, the format, writing style and the documentation procedure used in writing research.

Purpose of Research Report

"I have seen various research reports, such as, research articles, theses, monographs, etc. How should I write mine?"

There are various factors that guide your writing activities. First of all, it depends upon your purposes. Are you writing the study for partial fulfilment of your degree or are you writing the report for a professional journal? Thesis reports are mostly used by other researchers to study the whole research methodology as well as the relevance of findings of their own research.

Journal articles present up-to-date information on research in different areas of a discipline. You will get a general idea of the research design, analysis, and findings in a research article, but if you are looking for the tool used and the various literature studies or details of sample distribution, etc., you may have to write to the author of the article.

"What should be the length of my report?"

Usually there is no limit to the length of writing theses and monographs, whereas the length of articles for publication in journals depends upon the expected format of the journal to which you are submitting the article. Also, if you are funded by your government or a foundation, they stipulate the requirements and usually some of them require a monograph. Another factor that governs the length and type of publication is to estimate your time and financial budget.

"If the research report is of public interest, say something on smoking, how do you communicate to a larger population?"

You can write for the newspaper or for a popular magazine. But the use here is to communicate to the public the findings of the research. The readers here are not interested in the details of the scientific method that you have used. Just indicate how reliable your findings are, and in detail, the implications of the findings avoiding complex scientific terms.

"This leads to my next question–what exactly goes in the report?"

Organization of the Report

In order to facilitate your writing, we have outlined for you the contents of a typical report. How they are to be elaborated upon depends on your purposes in writing the report. But remember, there is no one way of writing a report:

1 Introduction

1.1 Background of the Problem

1.2 Need and justification for the study: Explain the need for your study—wherever possible, use available statistical data like rates, ratio; quote studies recommending for further exploration of the problem of your choice and justify the need for doing this study.

1.3 Problem statement: The problem may be stated in statement from or in a question form. The problem statement should indicate the nature of study e.g., "to find relationship between", "to compare the performance of", "to explore the", "to answer the question".

1.4 Statement of objectives: The objectives are written in observable and measurable terms. Each objective states one purpose, e.g. "to identify the indigenous treatment procedure for diarrhoea." It would be incorrect to say to identify the indigenous treatment of diarrhoea and evaluate its effectiveness. "To evaluate the effectiveness" would be a second objective and you also need to mention the criteria against which you evaluate.

For A Thesis Or Monograph

These areas are usually included in Chapter 1. Some studies may include a separate chapter on conceptual framework if various theoretical expositions are explained.

For An Article

These areas of the content are included in the introductory section of the article covering 2-3 paragraphs. The section on outline of the Chapter is omitted.

For A Thesis Or Monograph | **For An Article**

1.5 Rationale for the study: This could be developed into a theoretical framework that supports your investigation, that is in developing hypothesis, in constructing instruments and in analyzing and interpreting results.

1.6 Operational definition of terms: All terms do not require definitions. But terms that present concepts are to be defined, e.g. perception, image, nursing graduates, health educators, etc.

1.7 Scope and delimitation: The scope indicates the areas that are covered and where the results could be applied, whereas the delimitation indicates what you are not investigating and the limitations that you have already taken into consideration. You also justify delimitations.

1.8 Outline of other chapters: A paragraph on what the reader is to expect in later chapters.

2 Literature Study

2.1 Overview of the organization: The first paragraph contains the areas of related literature reviewed and the outline of the presentation.

2.2 Usually, in the organization of the report, the review of studies from broader areas are presented first and the specific areas later.

2.3 The description of research reviewed includes the design, analysis and findings in brief. Emphasis is put on what areas are explored and what is yet to be studied. The presentation also discusses the areas that are relevant to the present study—such as problem, design, instrument, theory and analysis.

2.4 Acknowledge all sources of literature using accepted form of presentation (will be discussed later)

2.5 Literature reviews mostly include research materials. The non-research literature, if included, are mostly theories and principles.

2.6 Summary of the literature review.

For A Thesis Or Monograph: This is the second chapter of the report. Theoretical framework may follow the review of literature. It is important to bring out a comprehensive summary in the last paragraph.

For An Article: Usually a paragraph or two are written on the related research literature. Only salient points in findings, instrument or limitations are brought out.

3 Methodology

3.1 Overview of the Chapter.

3.2 Research approach: In case of experimental study this area is given more prominence for designing the study. However, it is important to describe the independent and dependent variables and list the extraneous and confounding variables.

3.3 Research techniques: Justification for the choice of technique is given.

3.4 Selection or development of research instrument. Discuss the rationale, norms, conditions for administration, etc. If the tool is developed, include steps in developing the tool including pre-testing, reliability, and validity.

For A Thesis Or Monograph: This is the third chapter of the report. You may have questions regarding which one to write first—the sample or the instrument. But it is hard to say. Use your intuition and logic. Use figures necessary to show experimental research design or relationship of variables.

For An Article: This is a major area of your article. Brief description of research approach, sample setting, instrument and procedure for collection of data are included. The salient features are brought out like sampling technique, size of sample, reliability and validity of instrument, etc.

3.5 Description of the tool: This includes the main feature of the tool, e.g. "the questionnaire consists of three parts - Part I - background of the subject, Part II - the knowledge items and Part III - containing items related to research mindedness." This also include the tool, number of items, types of items (structured or open, forced choice, or multiple response, etc.).

3.6 Description of study setting: This section include all relevant information related to the background of the subjects to be studied e.g. in the case of the traditional birth attendant, one would include the description of setting, geographic background, communications by road, religion of subjects, etc. In a way, this would help the reader understand the background of the respondents.

3.7 Procedure for data collection: The first step is to obtain administrative permission and willingness from the subjects. This also includes conditions maintained while collecting data. For example, if we have to collect the growth data of children under one, we would first take permission from the administrative head of the health centre, then ask the parents. The weight of all children need to be taken on the same standard balance; all children are to be weighed without clothes or with clothes of known weight and so on. Next you describe the strength and weaknesses of the data collection procedure. Usually, problems faced while collecting data are listed, such as of work delays due to calamities (e.g. floods), etc.

3.8 Sampling: Includes description of population, sample size and criteria for selection of sample. For example, out of 200 mothers how do you select 50. Sampling technique applied is described.

3.9 Plan of data analysis: Expected levels of data and the type of statistics selected are described. For example, in the study of growth pattern data would be continuous, i.e., in grams (weight) and cms (length); the descriptive statistics of mean and standard deviation could be used analyse the height and weight of the sample, other statistics might include significance of difference of mean of sample from population means, using the t-test.

3.10 Summary of the chapter: This is especially necessary when the chapter has been long.

For A Thesis Or Monograph

The instrument is given in the Appendix. Geographical map describing setting may be put in the main part of the report or in the appendix.

If you use a standardized test, you need to take the author's permission.

There are certain tests where confidentiality needs to be maintained. Then the instrument is not included in the appendix.

For An Article

4 Data Analysis

4.1 Overview of presentation: This includes review of objectives for organization of data presentation.

This is one of the major chapters of the thesis and manuscript. Analysis and interpretation

	For A Thesis Or Monograph	For An Article
4.2 Descriptive Statistics: One of the most common methods of presenting statistical analysis is to answer each objective. Use tables and graphs to present data. 4.3 Test of Significance: Usual method of presenting statistical analyses is by stating the null hypothesis and indicating the result of test of significance by rejection or nonrejection of the null hypothesis. Use tables to present data. 4.4 Interpretation: Usually interpretation of statistical analysis is done as you present each table or graph. But a summary of analysis to include major findings are often presented at the end of this chapter.	are done side by side. Quote findings of other researches indicating similarities.	Data analysis and discussion makes the main body of the article. Essential tables and figures are included.
5 Summary 5.1 Summary: Contains briefly all the research steps including the list of major findings. Usually tables are not used unless a summary requires a table. 5.2 Conclusion: State conclusions drawn from each finding whether it has been expected or unexpected. Researcher also reasons out if the hypothesis tested is found to be not significant. It also explains how far a generalization of results can be made. 5.3 Implication: Includes reflective thinking in terms of possible application of the result. For example, if the survey indicates 70% of children are malnourished in a community, the implications may be written as probable reasons for malnutrition and what nutritional strategies are to be adopted to improve the status. Implications suggest the values of these findings. Limitations of the present study are noted here. How your findings can apply to the larger population is discussed here.* 5.4 Recommendation: Gives direction to future research and suggestion for improving the present study.	This chapter is also an important part of the thesis. Usually a monograph expounds on the conclusions and implications. For example, if a survey is conducted on the present educational system, after the data are presented the investigators present not only what may happen if the present system continues but also what need be done for future. Besides a summary an abstract is prepared which is usually 500-1000 words.	Two or three paragraphs are written to discuss the implications. A short summary is made which is usually put as a synopsis at the beginning of the article.
6 Other 6.1 Acknowledgements, Preface. 6.2 Table of Content 6.3 List of Tables and Figures. 6.4 Bibliography. 6.5 Appendices.	Acknowledgement, table of content, list of figures and tables are included in the first part of the study.	Not needed except for a list of references. Bibliography and appendices are included after the last chapter.

"That is a lot to write!"

True. Every researcher first makes an outline of the written presentation as this organizes his/her thinking process. The general tendency is to postpone writing as the task seems colossal. We suggest that you make a very rough and sketchy draft from the beginning of the planning stage.

"Is there a particular way of writing reports?"

There is no particular way of writing the reports. We have given you a guideline. Consult your professor, agency or appropriate authority, e.g. the journal for article writing, publisher for books, university for the thesis, guidelines, etc.

The Format of the Research Report

"What is the format of the report?"

Research papers usually have the following structure:

A Beginning:

- Title page
- Sponsor's Approval
- Table of Contents
- List of Tables and Figures
- Acknowledgement
- Abstract.

A Middle

- Five to six chapters as discussed in the organization of report.

And End

- Bibliography

Appendix

- Letters
- Instrument
- Master sheet data
- Curriculum vita of researcher.

"I seem to have difficulty in writing the bibliography and footnotes. There are so many ways of writing them."

Yes, there are technical ways of writing these. You can refer to any standard book for more details. However, we have outlined some principles below.

Bibliography

Let us examine the following format for bibliography:

For example

Kerlinger, Fred N.V. **Foundations of Behavioural Research.** New York: Holt, Rinehart and Winston, Inc., 1973.

- It begins with name of the author - last name comes first followed by a comma (,) the first name comes next, which is written in full with all initials and is followed by a period (.) (However, some texts suggest the use of the first initial of the first name only).

- Leave two typing spaces.

- Title of the book is written exactly as given on the title page of the book with first letter of each main word in capital letter form. The title is underlined and followed by a period.

- Leave two typing spaces.

- The place of publishing followed by a colon (:).

- Leave two typing spaces.

- The name of the publisher as given on the title page followed by a comma.

- Leave typing space.

- Year of Publication

Note: If there is a notation of the edition - this comes between title and place of publication. For example:

A book with one author

Kerlinger, Fred N. **Foundations of Behavioural Research.** 2nd ed. New York: Holt, Rinehart and Winston, Inc., 1973

We have given the example of one author, let us look at other examples where there are more than one author or it is an article from a journal or a government publication.

A book with two authors

Stahl, Sidney M. and James D. Hennes. **Reading and Understanding Applied Statistics.** St. Louis: The C.V. Mosby Company, 1975.

(Note: The second name is written with the first name first). The same principle is applied to three authors.

Books of more than three authors

First the author's name is written as a single author book, then, "and others" is added. The rest remains the same.

Journal articles:

Marshall, Jon C, and Sally Freeney. "The Structural Versus Intuitive Intake Interview." **Nursing Research;**21:269-272. May-June 1972.

Published documents

Government of India, the Research and Reference Division of Ministry of Information and Broadcasting, **India: A Reference Annual**, 1973, New Delhi: Publication Division, 1974.

Unpublished Sources:

Dissertation

Griffin, Gary A. "Curricular Decision Making in Selected School Systems" Unpublished Ed.D. dissertation, University of California, Los Angeles, 1970.

Mimeographed reports

Government of India, Director-General of Health Services. "Report of Workshop on Ways and Means of Bringing Nursing Education within the General System of Education of the Country", New Delhi, College of Nursing, 1972, (mimeographed).

"How is the footnote form different from the bibliography form?"

Footnotes

Campbell and Ballou state four purposes of writing footnotes:[70] Firstly, they are written to acknowledge indebtedness, secondly to establish validity of evidence as one can verify the authenticity of the source of evidence. They also provide for cross-references. Sometimes footnotes are also used to explain or elaborate on certain ideas that are presented in the next.

"Where do you write footnotes?"

Footnotes are written at the bottom of the page of which reference material appears. Usually the footnotes are numbered consecutively in each chapter. Small alphabets or standard symbols (*, †, ‡) also used to explain or elaborate ideas in footnotes.

"How are footnotes written?"

They are similar to bibliography in some ways. Let us see the same example of a single author as footnote:

Book

Fred N. Kerlinger, **Foundations of Behavioural Research**. New York: Holt, Rinehart and Winston, Inc., 1973, p. 32.

If there are more than 1 page to which you have referred then the notation is put as "pp. 100-102".

The journal articles also have a particular style in footnotes. For example·

Articles

Jon C. Harshall and Sally Feeney, "Structural versus Intuitive Interview", **Nursing Research**, 21:269-272, May-June, 1972.

If the reference material is one page, then only that page is noted.

Government Publication

Government of India, the Research and Reference Division of the Ministry of Information and Broadcasting, India: **A Reference Annual, 1973**, New Delhi: Publications Division, 1974, P. 13.

Unpublished Documents - Dissertation

Gary A. Griffin, "Curricular Decision Making in Selected School Systems" unpublished doctoral dissertation, University of California, Los Angeles, 1970, p.1.

Documents

Government of India, Director-General of Health Services, "Report of Workshop on Ways and Means of Bringing Nursing Education within the General System of Education of the Country", New Delhi: College of Nursing, 1972, p.9 (mimeographed).

"Why do you make it so complicated with punctuation, paranthesis and underlines? Why can't we write any wav we want?"

To answer your first question we can say that we need to write in one particular way, first of all to make sure that all relevant information regarding the source is noted; secondly to make sure that everybody has a common understanding. There are several accepted forms. Whichever form you choose make sure that you maintain that form throughout in writing a report.

References and Quotations

"How are footnotes different from references?"

Usually references are written at the end of the article or chapter. The purpose is same as in the footnote. There are two formats of writing references - author - and - year format and author - and number format.[71] In the author-and-year format, the author's name followed by year of publication are written after the citation in the text. For example it could be written as Campbell (1978) "or" (Campbell, 1978). The list of references are then noted at the end of the article or chapter in alphabetical form. In author-and-number format, all the references are listed in alphabetical form at the end of the text and the numbers are then written in the text at the place of citation. Sometimes it is also written in the order of appearance in the text in which case one reference may have to be listed more than once.

Example of writing reference (numbered in order of text):

1. Wilcox J. "Observer Factors in the Measurement of Blood Pressure," **Nursing.** 10(1961), 16.

"Can we know anything from other writing and put it in the text provided we acknowledge the source?"

Yes. If the quotation is short. Provided the quotation is no more than four lines long, we put it in the body of the text with quotation marks.[72] Quotation should flow smoothly with the text of your presentation. If the quotation is longer than four lines then it is put in a paragraph form single spaced and indented; Quotation marks are not included.

Let us see the following example:

"When introducing short reference material (four lines or less)" states James Lester, "you should avoid repetition of a stereotyped phrase for example 'Professor Jones says' ...Other words that will give variety to your introductions are accepted, add, admit, affirm, believe, (italics in the original)."[73]

The quoted matter is written verbatim and accurately with exact punctuation. The footnote normally is written at the end of the quotation (after the parenthesis). In the above example, you have noted three spaced periods (...), these are called 'ellipsis' points and are used to indicated omission of a word or words.[74]

"Why do I need to quote? Is it a must?"

Yes, if you are borrowing some other person's words it is ethical to quote and a quotation is not valid if you do not cite the source.

Quotations also give authoritative views and findings of theorists and other researchers; it also strengthens the writer's views and ideas. Often quotations are also used to clarify ideas.

"With all these instructions, surely my typist is going to make a lot of mistakes!"

Typing of the Research Paper

Probably you are correct if your typist is not familiar with these preparations. The typists who take up the job of typing research articles or papers, have usually learned the technique of typing the papers. The common instructions are that the draft is typed in double space to allow corrections. It is advisable to prepare a guide sheet giving the margin spaces on all four sides, and place for putting the page number. Any approved pattern can be followed for writing chapter heads and subtitles. Campbell and Ballou suggest—.

"If a chapter is divided into sections, the recommended order of successive levels of headings is (1) centred, (2) side, and (3) paragraph ......" All these are underlined.[75]

"Do I have to follow Cambell's way of doing the chapter heads?"

No. Consult several books and develop one way of doing it. Usually the main heading is in the centre and other subheadings are on the side of the left hand margin. But be consistent throughout the text.

"Do I have to remember anything else?"

Yes, there are many points to consider in typing the manuscript. Editing and proofreading are often done by professional people if you can afford them.

"Can you tell us something about tables and figures? Will the editors do this for us?"

Tables

Preparing tables are the writer's job as their use is to make data more meaningful and make a report easier to understand. They should not be used to impress the reader with the amount of data collected. Imagine the data being spelled out in words and numbers in the text; how boring and difficult it would be to read! The raw data is put on a table called a **master data sheet** and is usually put in the Appendix of a thesis. You do not put this in monographs.

Tables and figures are mostly used in the data analysis chapter. They help in presenting descriptive findings, relationships and statistical analysis.

"Should every table be explained in the text?".

Every table should be mentioned in the text but tables should be readable without reference to the text. The text should be written so that the reader can follow the main argument without having to refer to the tables and figures.

Placement of Tables

A table should be placed as soon as possible after the text which analysis the details contained in it.

Guidelines to follow for placing tables, in order of priority are:

(1) Put the whole table on one page;

(2) If the table takes up more than half a page, do not put text on that page;

(3) Leave three lines between text and table, above and below;

(4) A page with text and table should begin with the text; and

(5) A table should come between paragraphs and avoid breaking a paragraph.

Constructing a Table

Tables arrange data which may read in horizontal **lines**, that run across, and in **columns** that run down.

The stub, (shown in the left of table 00) will have **line captions** for each line and a **stub head**, describing the group of line captions, such as Sex, Males and Females.

A **column head** will appear at the top of each column (e.g. years of age).

A **title**, placed above each table, will describe its contents concisely by referring to the numbers in the table, the column heads, the stub head and the spanning head (if any). There is no full stop at the end or titles, captions and headings. See table 00. All tables are numbered. Keep the title short. If necessary it may be elaborated upon in a sub-title or footnote as shown in the example:

TABLE 00: Numbers of Patients by Age, Group and Sex (Title)

	Years of Age [a]		
Sex	0-19	20-49	50+
Males	6 [b]	7	8
Females	3	4	5 [c]

[a] As shown on birth certificate
[b] Including only one above ten years
[c] Including only one above 60 years

Use capitals only for initial letters. Words are easier to read if written in lower Case with Inital Capitals than if they are ALL WRITTEN IN CAPITALS.

"Should all the tables be written in the same way?"

Yes. All references to subject categories (line captions, stub heads, etc.) should be consistent in all tables.

Use only easily understood abbreviations. If necessary, explain them in a footnote or key. Use them consistently.

Units or symbols (%, Kg., etc.) should be included in the column head (or spanning head) if possible. If in the column, they should be placed with the first entry in a column only. Do not use verticle lines unless absolutely necessary. They are difficult to print. The stub heading should be arranged to the left. All other headings should be centered in the space allotted to them.

Each column head or spanning head should have a line beneath it, spanning the entry(ies) to which it refers.

Some Other Considerations:

At least one letter space should be left on each side of the widest entry (or heading) in each column. All columns of figures should be aligned on the decimal point.

A line space should be left above and below and horizontal lines should be double-spaced.

If there is no entry the space should be filled with a symbol (such a dash - not a 0 which has a specific meaning) and the symbol should be explained in a footnote. Footnotes in tables should be lettered **a, b,c,** etc. in order, from left to right and top to bottom. The footnotes should appear immediately below the table. See table 00.

Close the table with a line across its full width. If the table is long and must be carried over to a following page, do not draw a line at the bottom of the first page. Begin the next page with:

Table 00 (continued)

and omit the title but include all other headings again.

Referring to Tables in the Text

Number each table consecutively throughout the text. Sometimes tables are numbered with the chapter number. For example Chapter Two will have all tables 2.1, 2.2 and Chapter 4 will have all tables 4.1, 4.2 and so on. The advantage of Chapter-wise numbering is that if any tables are added or removed, one does not have to go through correcting the numbers of tables throughout the text.

Refer to tables by the table number and the page number (except if the table is on the same page) while discussing them in the text.

Figures

"Sometimes maps and photographs are also included besides the tables. How do I do this?"

Strictly speaking, figures are like illustrations and exhibits. These could be graphs, such as, bar, line, and pie graphs. Or the figures could be like the chart or diagram as given in the example of a theoretical model (as discussed in an earlier letter).

"Are these illustrations always hand drawn?"

No. They can be photographs or other mounted work. Figures should be self-explanatory and as in tables, they should be centrally placed. The text should be placed immediately before the figures. Any svmbol or abbreviations used should have a key and when figures contain numbers, as in graphs, the scales should be noted. Remember, lay out is an important consideration that is to be made in the case of figure presentation.

"How do we label a figure?"

Usually we write below the figure number and the title. Figures are usually numbered continuously throughout the text or these could be numbered for each chapter.

"Now I know all the techniques involved in writing a research paper. I am still hesitant as I am not a writer."

Use Correct Language

Since we are writing this book in English, we will select our examples from this language. One of the difficult tasks is to keep to the correct tense. Most frequently, past tense is used as we report what has already happened. We also report others findings in past tense as that refers to the generalizations related to their sample studied. If we report in the present tense it may mean wrongly speaking of the generalization of the result.

"How do I write the sentence? Do I use first, second or third **person**?"

Most commonly third person is used. Occasionally, you may come across reports written in first person (i.e. as 'I') but you will have to be consistent throughout.

Editing the grammatical mistakes by a professional person is a must for any written document for publication, even if it is written in your national language.

If we write short sentences there are less chances of making grammatical mistakes.

"Sometimes I write such abbreviations that I cannot read them later!"

True. This happens to many people. Use only formally acceptable forms and resort to abbreviations only for measurement units and statistical symbols.

The most important activity in all writing is proof-reading. You will be amazed to see that you never cease to detect an error either in typing or in grammer. So read again and again—and good luck!

LETTER 18

"WHAT IS NURSING RESEARCH?"

Some Thoughts on Nursing Research

Dear Reader,

We would like to raise three questions with you which we believe are basic to the acceptance of nursing research as a viable and essential component of nursing (a question which we are sure you have raised at one time or another). The first is: is there a body of knowledge unique to nursing; or to put it in our non-nursing friends' language: "What is nursing research, anyway?" If we can effectively answer this question, then the second question can be raised: "What needs to be researched?" That is, which of the problems facing us today are the essential ones demanding immediate attention by nurses? And, finally, if we can resolve these two issues, the third arises, that is, "Who must do this kind of research?"

Nursing—An Applied Discipline

Nursing is what we would call an applied discipline, that is, it uses the ideas, findings, and information from many social, psychological, and biological sciences. For example, every day the nurse applies psychology in explaining illnesses to the family; she applies bacteriology when she boils the syringe before re-use, she applies sociology as she talks with the village panchayat administrator about village health problems; and she uses the anthropological data about village practice as she plans for health man-power.

Three Orientations in Sciences

In applied sciences like nursing there are three views or orientations used. The first is basic science research, the second is "extrapolated" research in the basic sciences (sometimes viewed as inductive research) and the third is nursing research at the applied level (sometimes viewed as deductive research). Let us examine the first of these.

1. Basic Science Research

In basic science research, the argument is that the "stuff" for the applied sciences comes from research at the basic or first level. For example, advances in engineering (an applied discipline) are often closely preceded or followed by advances in physics, and advances in dentistry (also an applied science) are closely related to advances in biochemistry or bacteriology. However, in basic science research, two issues must be clarified. The first issue has to do with the purpose of the research, and the second is that of the level of application. Basic science research concerns itself with the discovery of general laws, the "basic-facets" of biology, chemistry and other sciences; that is, the discovery of knowledge for its own sake. For example, the study of gastric enzymes under different environmental stress conditions is an example of basic research. However, the basic science researcher does not object if the applied scientist uses basic research results to find solutions to practical everyday problems. Indeed, some basic or pure science may have been conceived with this goal in mind. Much cancer research may be a general search for knowledge but it certainly has an overriding goal of finding cures for the disease

The researcher who does pure or basic research designs his study with his objectives in mind. These objectives have no intended relationship at all to problems in the applied disciplines. For example, Jean Piaget, the famous Swiss epistemologist, carried out monumental work on the structure of children's intelligence. Educators (applied scientists) immediately wanted to apply his theories to children in the classroom. That is, the educators wanted to take the pure basic research and use it in their practical situation. But the purpose of Piaget's research had to be kept in mind. When he did his research he was not interested in the educational application of his theories; he did not share the educator's goal when he studied the children—his aim was solely to advance knowledge and his response to the educator's questions was just that—he said that his theoretical formulations may have application, and they may not—he did not know. Surely such findings on children's intelligence are applicable in a broad sense to education, but since his research had not been created to solve the practical problems, the level of applicability was apt to be quite indirect. That is, what Piaget observed about children in a nursery may (or may not) apply under the very different conditions of a classroom with 20-30 children learning mathematics. In other words, one must be careful in generalizing to specific situations which may, in fact, be very different from the situation in which the pure scientist has conducted his experiments. Thus, one must be aware of the level of applicability appropriate to one's undertaking. At what level can findings in the basic sciences be applied once their relevancy has been established? Usually these findings are very broad and cannot be applied to a small or limited problem. So, applying general principles to specific problems is inappropriate. The general principles must be specifically reduced and specified for each problem.

For example, knowledge about how baby monkeys feed from a surrogate mother does not tell us how a hospitalized child will relate to a surrogate mother or nurse, or to a rigid form of handling; nor does it tell us how a human baby will take milk from a bottle propped up in a baby holder. Knowledge about the growth of the *tuberele bacilli* in the presence of strepotomycin in a test tube, does not tell us how a group of debilitated sixty-year old alcoholics with tuberculosis will react to similar test doses of streptomycin; i.e., what happens in a laboratory environment under strictly controlled conditions is not necessarily what may happen in the real world.

In nursing, the real issue is that the practical problems exist at a much higher level of complexity than the basic science findings. Rats may learn how to pass quickly through a learning maze when they are rewarded with food. But children in a classroom may not learn quickly when rewarded with food. They may have just eaten their lunch, they may be distracted by their friends in the corridor, or they may have an unrecognized perceptual or hearing problem. That is, in the world, many other factors enter into the situation which may significantly alter these general principles so much that the basic or pure research principles have no real meaning. Thus, one cannot simply take the findings of basic sciences and apply them to problems in nursing. Here many more factors are operating which makes the situation far from "pure". Much of contemporary nursing research is not preoccupied with the discovery of basic laws of science; rather, contemporary nursing focuses on the application of these laws at the "users" level, where the basic laws interact within a nurse-patient context. This is not to say that nurse researchers do not carry out basic research. Some do, and have contributed to the knowledge base in anthropology, physiology, and the behavioural sciences.

2. Extrapolated or Inductive Research

The second type of research can be called "extrapolated or inductive research". Here, the process works from the problem to the general principle. A problem is identified, and experiments are designed to solve the problems. This approach is acceptable, if you recognized the problem as a hunch or as a hypothesis to be tested, or if you see the work as tentative. For example, a child is listless and apathetic. There are many reasons for this behaviour, according to psychological and physiological literature. Possibilities may include: he may be anaemic, he may have worms, or a learning disability. He may lack stimulation, he may have an infection, he may lack physical exercise, he may be bored, and/or he may be lonely. The researcher decides the problem is, say, lack of stimulation. So, she provides a programme of stimulation for two hours each day. If she finds that the apathetic behaviour disappears, she can say that a relationship exists between the child's level of apathy and the amount and nature of stimulation. Perhaps while stimulating the child, she provided companionship, or engaged him in physical exercise. Thus, the researcher must be aware of the complexity of the problem, and must not ignore the possibility that other factors are also operating in this situation. Thus, the generalities in moving to solutions of problems by the process of extrapolating the findings of basic research is a second approach, but one which must be handled carefully, and explicitly qualified.

3. Deductive or Applied Research

The third approach, that at the applied level, is the most relevant and least recognized is deductive or applied research. And here is the crux of the argument why nurses must do nursing research, and here is the rationale for the existence of a body of knowledge unique to nursing.

If research is done in actual relationship to problems in nursing, at the level of complexity at which they exist, the issues of relevancy and extrapolation do not arise. The business of nursing research is not the general laws of learning, but with those laws of learning that can be related to a change in behaviour in patients or groups of patients. The nurse is not a psychologist who is interested in general types of learning; rather she is interested in learning as it applies and relates to changes in patients' behaviour, under certain conditions idiosyncratic to that patient or group of patients. Put another way, the goal of nursing research includes the testing, confirmation and expansion of the body of nursing knowledge for better nursing practice and patient care.

Thus, other disciplines can contribute to nursing's body of knowledge, but the application of principles and knowledge of other disciplines to nursing is the contribution and responsibility of the nurse. There is little validity to the arguments that a science of nursing does not exist and that the basic purpose of nursing is to carry out the orders of yet another discipline.

The nursing research that has been conducted in some countries of the world has focused on various areas of nursing; some researches have created instruments of measurement, some have focused on building a science of nursing practice, a few on cost of services.

Patterns and Trends

"What patterns or trends in nursing research have you observed?"

It is interesting to note that in the past, many of the studies in nursing have explored the nurses themselves. Like a self-conscious adolescent, the emerging profession has looked at itself—what am I like. how do I look, how do I think, what are my attitudes, how do I work?

"This is interesting. What about developing countries?"

Many studies have been conducted on the characteristics of student nurses, attitudes of nurses, nurses' attitudes towards wearing uniform, how patients see the nurse, how the health team sees the nurse, etc.* In India too, a review of many of these beginning studies show that they tend to focus on the Indian nurse: her personal and professional adjustment, why Indian women do not enter nursing, satisfaction of

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* A list of all Masters theses completed in India is available at the RAK College of Nursing, Department of Nursing Research, New Delhi, India.

staff nurses, to name a few. Perhaps for the adolescent the self-conscious behaviour is appropriate and necessary—for what emerges is a self with identity and a further differentiation of the self as a separate entity. The same can be said for nursing. After a careful scrutinized look to who he/she is, the nurse may emerge with an identity prepared to enter "adulthood" and contribute to society in a more meaningful way. The question, "what should be researched?" is related to many issues, one being the state and development of the profession as a whole. Some do not believe that the nursing profession has developed to the point where a clear body of knowledge demanding exploration and knowledge exists.

Another factor which has influenced what is researched is the status and role of woman in society. Characteristically, nursing is a woman's profession, and women have been given an inferior status in some countries. One reason for the resistance to the idea of nurses engaging in research may be related to, the fact that nurses have to work with physicians who are supposed to be the repository of all knowledge, whether it is the psychology of patients or the nursing care which includes giving assurance to the patient or changing the attitudes of fathers and mothers towards immunization or sterilization.

But the status of women will change, and these changes will be reflected in nursing. The focus of research will change with a self-conscious realization that this stage in development has passed. And, we believe that, as other professional groups influence and are influenced by medical practitioners, a stance of mutual respect for each professional's contribution will emerge.

What Needs to be Researched

"What should nurses in developing countries be researching?"

This is a very interesting question. If the nursing profession has to grow and develop, we need to enlarge the body of nursing knowledge which applies to the problems of nursing. Some feel that nursing, as a service profession, is concerned with the application of related scientific knowledge that has been discovered by others. And with the rapid advancement of basic science there is an increasing need for its application in clinical settings and for an examination of traditional and current methods in the light of rapidly developing technology.

"Because nursing is considered to be an applied science, and nursing principles are developed by interrelating natural and social sciences, shouldn't we then concentrate more on nursing as applied research?"

That is one way of looking at what we should research. At the same time, we need to ask, "what is nursing knowledge?" especially if we consider nursing as a profession in its own right. Some renowned nurse scientists, such as Martha Rogers, believe that nursing is concerned with the responses of man to his internal and external environment; that nursing utilizes the knowledge of other sciences to understand the wholeness of man and to help the individual to adjust and adapt accordingly. Thus, there is need for developing nursing theory, nursing principles, which in fact are claimed as nursing knowledge where the patient or the client is the main source of knowledge.

"But which type of research should we start first?"

It is difficult to say, what came first, the chicken or the egg? In most countries, we do not have enough basic data in nursing; most of the time we depend on the findings of other countries. For example in the area of health manpower, on what basis do health planners decide on one auxiliary nurse midwife or multipurpose health worker for a population of 5,000? Are there any data to indicate how much time an auxiliary nurse midwife needs to give one unit of post-natal care, or to assist at a delivery, or carry out health teaching activities about vaccination? Let us take another issue. Nursing education takes place mainly in an institution of service where learning on the job is the central approach to learning. Often the mission is really service and not education. It is known that this service-oriented teaching discourages the development of critical and objective thinking. Thus the question arises, "do we have a scientific way of teaching students, of finding which curriculum would be most appropriate, or adopting a satisfactory system for the evaluation of students?" In many countries, data and tools for planning an effective nursing education system are sorely needed.

Lastly, and the most important of all, is data which will help us to determine the most efficient and appropriate nursing actions. The basic data needed is the data about the patient, the whole man within the context of the family and community in which he works and lives. Systematic findings about the responses of individuals and groups of patients to health problems, and their needs for assistance are essential parts of devising nursing actions. Once we have acquired enough evidence through systematic investigation of health practices, we would have sufficient base line data for developing more complex designs. Thus, some areas which are ripe for nursing research include: (1) recruitment and education of nurses: (2) models of health services delivery; (3) administration of nursing services; (4) health manpower models; and (5) assessment of selected informative models of care currently used. Effective approaches to education and practice of auxiliary personnel is desperately needed. Also urgent is the need for nurses to become integrated into research teams studying models of primary health care delivery, and expanded programmes of immunization.

If you can agree with the above statements, then the final question arises: what and who is needed for the implementation of research in nursing? We need the nurse, the client, and the environment in which the two are interacting. The nurse must be aware of her own knowledge of nursing and research methods, and she should be sure that the area she is researching is familiar to her. Further, research is not a one-person operation, and the quicker the nurse recognizes the resources and talents of others, the more effective will be her efforts. The nurse must have full support from the administrator, village leaders or supervisor of the institution in which he/she plans to work. This point cannot be over-emphasized, for the environment the nurse wishes to use is the one under the responsibility and control of the administrator. (Or in the case of a village, the control may be vested in the village headman without whose endorsement the study will fail.) The administrator can help the researcher by reading his/her proposal, assessing the cost of the project, and assist the researcher in thinking through the crucial management issues of the proposed plan. Many research projects have to be abandoned because they become too complex, too costly, and/or too threatening to patients.

In nursing, the tradition of research does not exist as it does in other professions. There is resistance that nurses encounter from hospitals, clinics, villages, schools and individual clients. In each research effort, the individual nurse is obliged to conduct his/her own separate negotiations with health authorities every time he/she wishes to work out a problem; very often he/she meets with suspicion or outright refusals. It should be noted that this is in sharp contrast to the traditionally well-established working agreements which all medical schools have with hospitals, clinics and health centres. To solve this problem in some instances, we have had nurses work through their best allies, the physicians.

These physicians, always interested in research, have written letters for the nurse to the hospital administration indicating their collaborative research effort. At this point in nursing research development, we very much need medical (and other professional) help and support. We might add that in the experience of the researchers, no physician approached has ever refused to help. In fact, most have offered their services and the use of their facilities!

"This reliance on the help of other professions may not be necessary in some institutions and in some areas."

Right. If the nursing administrator is supportive and committed to nursing research, she can usually interpret these interests to other hospital or health authorities.

Thus, nurse researchers and administrators form an essential core of leaders who share the challenging and often difficult task of identifying essential areas for research, and in finding the best people who can ask the best questions. It is well known that not everyone is interested or inclined to conduct research. But all nurses may develop research-mindedness; by this we mean, nurses should feel the need for analysing the effectiveness of working methods or any event in the clinical field that affects patient care. They encourage and cooperate with others conducting research, and, lastly (perhaps, firstly), they themselves are consumers of research, as are all health professionals. So, although not all nurses need to become nurse researchers, all have a stake in the effective use of findings and in the way research findings are ultimately implemented.

In summary, we discussed three general approaches which are used in applied disciplines: the basic science approach, the extrapolated research approach, and the third and most appropriate for nursing, research at the applied level. The first point we made is that a rationale for nurses to conduct research does exist. The second point is that successful implementation of research plans depends on both the skill of the researcher and on the cooperation and resourcefulness of the administrator. And the third and final point is this: nursing research may be in its beginning stages reflecting an obvious degree of self-consciousness, but this is the way of all new disciplines, and in time the self-consciousness will give way to other issues and will be reflected in a higher level of sophistication. Finally, we explored some of the areas which demand immediate exploration, and the approach nurses may use in securing cooperation to research such areas.

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