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# A Practical Guide to Writing Quantitative and Qualitative Research Questions and Hypotheses in Scholarly Articles

**Edward Barroga** [1] **and Glafera Janet Matanguihan** [2]

[1]Department of General Education, Graduate School of Nursing Science, St. Luke's International University, Tokyo, Japan
[2]Department of Biological Sciences, Messiah University, Mechanicsburg, PA, USA



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**Address for Correspondence:**
**Edward Barroga, PhD**
Department of General Education, Graduate School of Nursing Science, St. Luke's International University, 10-1 Akashi-cho, Chuo-ku, Tokyo 104-0044, Japan.
Email: edward-barroga@slcn.ac.jp



**ORCID iDs**
Edward Barroga
https://orcid.org/0000-0002-8920-2607
Glafera Janet Matanguihan
https://orcid.org/0000-0003-2624-1219

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## ABSTRACT

The development of research questions and the subsequent hypotheses are prerequisites to defining the main research purpose and specific objectives of a study. Consequently, these objectives determine the study design and research outcome. The development of research questions is a process based on knowledge of current trends, cutting-edge studies, and technological advances in the research field. Excellent research questions are focused and require a comprehensive literature search and in-depth understanding of the problem being investigated. Initially, research questions may be written as descriptive questions which could be developed into inferential questions. These questions must be specific and concise to provide a clear foundation for developing hypotheses. Hypotheses are more formal predictions about the research outcomes. These specify the possible results that may or may not be expected regarding the relationship between groups. Thus, research questions and hypotheses clarify the main purpose and specific objectives of the study, which in turn dictate the design of the study, its direction, and outcome. Studies developed from good research questions and hypotheses will have trustworthy outcomes with wide-ranging social and health implications.

**Keywords:** Research Questions; Hypotheses; Quantitative Research; Qualitative Research

## INTRODUCTION

Scientific research is usually initiated by posing evidenced-based research questions which are then explicitly restated as hypotheses.[1,2] The hypotheses provide directions to guide the study, solutions, explanations, and expected results.[3,4] Both research questions and hypotheses are essentially formulated based on conventional theories and real-world processes, which allow the inception of novel studies and the ethical testing of ideas.[5,6]

It is crucial to have knowledge of both quantitative and qualitative research[2] as both types of research involve writing research questions and hypotheses.[7] However, these crucial elements of research are sometimes overlooked; if not overlooked, then framed without the forethought and meticulous attention it needs. Planning and careful consideration

are needed when developing quantitative or qualitative research, particularly when conceptualizing research questions and hypotheses.[4]

There is a continuing need to support researchers in the creation of innovative research questions and hypotheses, as well as for journal articles that carefully review these elements.[1] When research questions and hypotheses are not carefully thought of, unethical studies and poor outcomes usually ensue. Carefully formulated research questions and hypotheses define well-founded objectives, which in turn determine the appropriate design, course, and outcome of the study. This article then aims to discuss in detail the various aspects of crafting research questions and hypotheses, with the goal of guiding researchers as they develop their own. Examples from the authors and peer-reviewed scientific articles in the healthcare field are provided to illustrate key points.

## DEFINITIONS AND RELATIONSHIP OF RESEARCH QUESTIONS AND HYPOTHESES

A research question is what a study aims to answer after data analysis and interpretation. The answer is written in length in the discussion section of the paper. Thus, the research question gives a preview of the different parts and variables of the study meant to address the problem posed in the research question.[1] An excellent research question clarifies the research writing while facilitating understanding of the research topic, objective, scope, and limitations of the study.[5]

On the other hand, a research hypothesis is an educated statement of an expected outcome. This statement is based on background research and current knowledge.[8,9] The research hypothesis makes a specific prediction about a new phenomenon[10] or a formal statement on the expected relationship between an independent variable and a dependent variable.[3,11] It provides a tentative answer to the research question to be tested or explored.[4]

Hypotheses employ reasoning to predict a theory-based outcome.[10] These can also be developed from theories by focusing on components of theories that have not yet been observed.[10] The validity of hypotheses is often based on the testability of the prediction made in a reproducible experiment.[8]

Conversely, hypotheses can also be rephrased as research questions. Several hypotheses based on existing theories and knowledge may be needed to answer a research question. Developing ethical research questions and hypotheses creates a research design that has logical relationships among variables. These relationships serve as a solid foundation for the conduct of the study.[4,11] Haphazardly constructed research questions can result in poorly formulated hypotheses and improper study designs, leading to unreliable results. Thus, the formulations of relevant research questions and verifiable hypotheses are crucial when beginning research.[12]

## CHARACTERISTICS OF GOOD RESEARCH QUESTIONS AND HYPOTHESES

Excellent research questions are specific and focused. These integrate collective data and observations to confirm or refute the subsequent hypotheses. Well-constructed hypotheses


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are based on previous reports and verify the research context. These are realistic, in-depth, sufficiently complex, and reproducible. More importantly, these hypotheses can be addressed and tested.[13]

There are several characteristics of well-developed hypotheses. Good hypotheses are 1) empirically testable[7,10,11,13]; 2) backed by preliminary evidence[9]; 3) testable by ethical research[7,9]; 4) based on original ideas[9]; 5) have evidenced-based logical reasoning[10]; and 6) can be predicted.[11] Good hypotheses can infer ethical and positive implications, indicating the presence of a relationship or effect relevant to the research theme.[7,11] These are initially developed from a general theory and branch into specific hypotheses by deductive reasoning. In the absence of a theory to base the hypotheses, inductive reasoning based on specific observations or findings form more general hypotheses.[10]

## TYPES OF RESEARCH QUESTIONS AND HYPOTHESES

Research questions and hypotheses are developed according to the type of research, which can be broadly classified into quantitative and qualitative research. We provide a summary of the types of research questions and hypotheses under quantitative and qualitative research categories in **Table 1**.

### Research questions in quantitative research

In quantitative research, research questions inquire about the relationships among variables being investigated and are usually framed at the start of the study. These are precise and typically linked to the subject population, dependent and independent variables, and research design.[1] Research questions may also attempt to describe the behavior of a population in relation to one or more variables, or describe the characteristics of variables to be measured (*descriptive research*

**Table 1.** Summary of types of quantitative and qualitative research questions and hypotheses

| Quantitative research questions | Quantitative research hypotheses |
|---|---|
| Descriptive research questions | Simple hypothesis |
| Comparative research questions | Complex hypothesis |
| Relationship research questions | Directional hypothesis |
| | Non-directional hypothesis |
| | Associative hypothesis |
| | Causal hypothesis |
| | Null hypothesis |
| | Alternative hypothesis |
| | Working hypothesis |
| | Statistical hypothesis |
| | Logical hypothesis |
| | Hypothesis-testing |
| **Qualitative research questions** | **Qualitative research hypotheses** |
| Contextual research questions | Hypothesis-generating |
| Descriptive research questions | |
| Evaluation research questions | |
| Explanatory research questions | |
| Exploratory research questions | |
| Generative research questions | |
| Ideological research questions | |
| Ethnographic research questions | |
| Phenomenological research questions | |
| Grounded theory questions | |
| Qualitative case study questions | |


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**Table 2.** Definitions and examples of quantitative research questions

| Quantitative research questions |
|---|
| Descriptive research question |
| - Measures responses of subjects to variables |
| - Presents variables to measure, analyze, or assess |
| What is the proportion of resident doctors in the hospital who have mastered ultrasonography (response of subjects to a variable) as a diagnostic technique in their clinical training? |
| Comparative research question |
| - Clarifies difference between one group with outcome variable and another group without outcome variable |
| Is there a difference in the reduction of lung metastasis in osteosarcoma patients who received the vitamin D adjunctive therapy (group with outcome variable) compared with osteosarcoma patients who did not receive the vitamin D adjunctive therapy (group without outcome variable)? |
| - Compares the effects of variables |
| How does the vitamin D analogue 22-Oxacalcitriol (variable 1) mimic the antiproliferative activity of 1,25-Dihydroxyvitamin D (variable 2) in osteosarcoma cells? |
| Relationship research question |
| - Defines trends, association, relationships, or interactions between dependent variable and independent variable |
| Is there a relationship between the number of medical student suicide (dependent variable) and the level of medical student stress (independent variable) in Japan during the first wave of the COVID-19 pandemic? |

*questions*).[1,5,14] These questions may also aim to discover differences between groups within the context of an outcome variable (*comparative research questions*),[1,5,14] or elucidate trends and interactions among variables (*relationship research questions*).[1,5] We provide examples of descriptive, comparative, and relationship research questions in quantitative research in **Table 2**.

## Hypotheses in quantitative research

In quantitative research, hypotheses predict the expected relationships among variables.[15] Relationships among variables that can be predicted include 1) between a single dependent variable and a single independent variable (*simple hypothesis*) or 2) between two or more independent and dependent variables (*complex hypothesis*).[4,11] Hypotheses may also specify the expected direction to be followed and imply an intellectual commitment to a particular outcome (*directional hypothesis*)[4]. On the other hand, hypotheses may not predict the exact direction and are used in the absence of a theory, or when findings contradict previous studies (*non-directional hypothesis*).[4] In addition, hypotheses can 1) define interdependency between variables (*associative hypothesis*),[4] 2) propose an effect on the dependent variable from manipulation of the independent variable (*causal hypothesis*),[4] 3) state a negative relationship between two variables (*null hypothesis*),[4,11,15] 4) replace the working hypothesis if rejected (*alternative hypothesis*),[15] explain the relationship of phenomena to possibly generate a theory (*working hypothesis*),[11] 5) involve quantifiable variables that can be tested statistically (*statistical hypothesis*),[11] 6) or express a relationship whose interlinks can be verified logically (*logical hypothesis*).[11] We provide examples of simple, complex, directional, non-directional, associative, causal, null, alternative, working, statistical, and logical hypotheses in quantitative research, as well as the definition of quantitative hypothesis-testing research in **Table 3**.

## Research questions in qualitative research

Unlike research questions in quantitative research, research questions in qualitative research are usually continuously reviewed and reformulated. The central question and associated subquestions are stated more than the hypotheses.[15] The central question broadly explores a complex set of factors surrounding the central phenomenon, aiming to present the varied perspectives of participants.[15]

There are varied goals for which qualitative research questions are developed. These questions can function in several ways, such as to 1) identify and describe existing conditions


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**Table 3.** Definitions and examples of quantitative research hypotheses

| Quantitative research hypotheses |
|---|
| Simple hypothesis<br>- Predicts relationship between single dependent variable and single independent variable<br>If the dose of the new medication (single independent variable) is high, blood pressure (single dependent variable) is lowered. |
| Complex hypothesis<br>- Foretells relationship between two or more independent and dependent variables<br>The higher the use of anticancer drugs, radiation therapy, and adjunctive agents (3 independent variables), the higher would be the survival rate (1 dependent variable). |
| Directional hypothesis<br>- Identifies study direction based on theory towards particular outcome to clarify relationship between variables<br>Privately funded research projects will have a larger international scope (study direction) than publicly funded research projects. |
| Non-directional hypothesis<br>- Nature of relationship between two variables or exact study direction is not identified<br>- Does not involve a theory<br>Women and men are different in terms of helpfulness. (Exact study direction is not identified) |
| Associative hypothesis<br>- Describes variable interdependency<br>- Change in one variable causes change in another variable<br>A larger number of people vaccinated against COVID-19 in the region (change in independent variable) will reduce the region's incidence of COVID-19 infection (change in dependent variable). |
| Causal hypothesis<br>- An effect on dependent variable is predicted from manipulation of independent variable<br>A change into a high-fiber diet (independent variable) will reduce the blood sugar level (dependent variable) of the patient. |
| Null hypothesis<br>- A negative statement indicating no relationship or difference between 2 variables<br>There is no significant difference in the severity of pulmonary metastases between the new drug (variable 1) and the current drug (variable 2). |
| Alternative hypothesis<br>- Following a null hypothesis, an alternative hypothesis predicts a relationship between 2 study variables<br>The new drug (variable 1) is better on average in reducing the level of pain from pulmonary metastasis than the current drug (variable 2). |
| Working hypothesis<br>- A hypothesis that is initially accepted for further research to produce a feasible theory<br>Dairy cows fed with concentrates of different formulations will produce different amounts of milk. |
| Statistical hypothesis<br>- Assumption about the value of population parameter or relationship among several population characteristics<br>- Validity tested by a statistical experiment or analysis<br>The mean recovery rate from COVID-19 infection (value of population parameter) is not significantly different between population 1 and population 2.<br>There is a positive correlation between the level of stress at the workplace and the number of suicides (population characteristics) among working people in Japan. |
| Logical hypothesis<br>- Offers or proposes an explanation with limited or no extensive evidence<br>If healthcare workers provide more educational programs about contraception methods, the number of adolescent pregnancies will be less. |
| Hypothesis-testing (Quantitative hypothesis-testing research)<br>- Quantitative research uses deductive reasoning.<br>- This involves the formation of a hypothesis, collection of data in the investigation of the problem, analysis and use of the data from the investigation, and drawing of conclusions to validate or nullify the hypotheses. |

(*contextual research questions*); 2) describe a phenomenon (*descriptive research questions*); 3) assess the effectiveness of existing methods, protocols, theories, or procedures (*evaluation research questions*); 4) examine a phenomenon or analyze the reasons or relationships between subjects or phenomena (*explanatory research questions*); or 5) focus on unknown aspects of a particular topic (*exploratory research questions*).[5] In addition, some qualitative research questions provide new ideas for the development of theories and actions (*generative research questions*) or advance specific ideologies of a position (*ideological research questions*).[1] Other qualitative research questions may build on a body of existing literature and become working guidelines (*ethnographic research questions*). Research questions may also be broadly stated without specific reference to the existing literature or a typology of questions (*phenomenological research questions*), may be directed towards generating a theory of some process (*grounded theory questions*), or may address a description of the case and the emerging themes (*qualitative case*


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*study questions*).[15] We provide examples of contextual, descriptive, evaluation, explanatory, exploratory, generative, ideological, ethnographic, phenomenological, grounded theory, and qualitative case study research questions in qualitative research in **Table 4**, and the definition of qualitative hypothesis-generating research in **Table 5**.

Qualitative studies usually pose at least one central research question and several subquestions starting with *How* or *What*. These research questions use exploratory verbs such as *explore* or *describe*. These also focus on one central phenomenon of interest, and may mention the participants and research site.[15]

**Table 4.** Definitions and examples of qualitative research questions

| Qualitative research questions |
|---|
| Contextual research question |
| - Ask the nature of what already exists |
| - Individuals or groups function to further clarify and understand the natural context of real-world problems |
| What are the experiences of nurses working night shifts in healthcare during the COVID-19 pandemic? (natural context of real-world problems) |
| Descriptive research question |
| - Aims to describe a phenomenon |
| What are the different forms of disrespect and abuse (phenomenon) experienced by Tanzanian women when giving birth in healthcare facilities? |
| Evaluation research question |
| - Examines the effectiveness of existing practice or accepted frameworks |
| How effective are decision aids (effectiveness of existing practice) in helping decide whether to give birth at home or in a healthcare facility? |
| Explanatory research question |
| - Clarifies a previously studied phenomenon and explains why it occurs |
| Why is there an increase in teenage pregnancy (phenomenon) in Tanzania? |
| Exploratory research question |
| - Explores areas that have not been fully investigated to have a deeper understanding of the research problem |
| What factors affect the mental health of medical students (areas that have not yet been fully investigated) during the COVID-19 pandemic? |
| Generative research question |
| - Develops an in-depth understanding of people's behavior by asking 'how would' or 'what if' to identify problems and find solutions |
| How would the extensive research experience of the behavior of new staff impact the success of the novel drug initiative? |
| Ideological research question |
| - Aims to advance specific ideas or ideologies of a position |
| Are Japanese nurses who volunteer in remote African hospitals able to promote humanized care of patients (specific ideas or ideologies) in the areas of safe patient environment, respect of patient privacy, and provision of accurate information related to health and care? |
| Ethnographic research question |
| - Clarifies peoples' nature, activities, their interactions, and the outcomes of their actions in specific settings |
| What are the demographic characteristics, rehabilitative treatments, community interactions, and disease outcomes (nature, activities, their interactions, and the outcomes) of people in China who are suffering from pneumoconiosis? |
| Phenomenological research question |
| - Knows more about the phenomena that have impacted an individual |
| What are the lived experiences of parents who have been living with and caring for children with a diagnosis of autism? (phenomena that have impacted an individual) |
| Grounded theory question |
| - Focuses on social processes asking about what happens and how people interact, or uncovering social relationships and behaviors of groups |
| What are the problems that pregnant adolescents face in terms of social and cultural norms (social processes), and how can these be addressed? |
| Qualitative case study question |
| - Assesses a phenomenon using different sources of data to answer "why" and "how" questions |
| - Considers how the phenomenon is influenced by its contextual situation. |
| How does quitting work and assuming the role of a full-time mother (phenomenon assessed) change the lives of women in Japan? |

**Table 5.** Definitions of research hypothesis under qualitative research

| Qualitative research hypotheses |
|---|
| Hypothesis-generating (Qualitative hypothesis-generating research) |
| - Qualitative research uses inductive reasoning. |
| - This involves data collection from study participants or the literature regarding a phenomenon of interest, using the collected data to develop a formal hypothesis, and using the formal hypothesis as a framework for testing the hypothesis. |
| - Qualitative exploratory studies explore areas deeper, clarifying subjective experience and allowing formulation of a formal hypothesis potentially testable in a future quantitative approach. |


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### Hypotheses in qualitative research

Hypotheses in qualitative research are stated in the form of a clear statement concerning the problem to be investigated. Unlike in quantitative research where hypotheses are usually developed to be tested, qualitative research can lead to both hypothesis-testing and hypothesis-generating outcomes.[2] When studies require both quantitative and qualitative research questions, this suggests an integrative process between both research methods wherein a single mixed-methods research question can be developed.[1]

## FRAMEWORKS FOR DEVELOPING RESEARCH QUESTIONS AND HYPOTHESES

Research questions followed by hypotheses should be developed before the start of the study.[1,12,14] It is crucial to develop *feasible* research questions on a topic that is *interesting* to both the researcher and the scientific community. This can be achieved by a meticulous review of previous and current studies to establish a *novel* topic. Specific areas are subsequently focused on to generate *ethical* research questions. The *relevance* of the research questions is evaluated in terms of clarity of the resulting data, specificity of the methodology, objectivity of the outcome, depth of the research, and impact of the study.[1,5] These aspects constitute the FINER criteria (i.e., Feasible, Interesting, Novel, Ethical, and Relevant).[1] Clarity and effectiveness are achieved if research questions meet the FINER criteria. In addition to the FINER criteria, Ratan et al. described focus, complexity, novelty, feasibility, and measurability for evaluating the effectiveness of research questions.[14]

The PICOT and PEO frameworks are also used when developing research questions.[1] The following elements are addressed in these frameworks, PICOT: P-population/patients/problem, I-intervention or indicator being studied, C-comparison group, O-outcome of interest, and T-timeframe of the study; PEO: P-population being studied, E-exposure to preexisting conditions, and O-outcome of interest.[1] Research questions are also considered good if these meet the "FINERMAPS" framework: Feasible, Interesting, Novel, Ethical, Relevant, Manageable, Appropriate, Potential value/publishable, and Systematic.[14]

As we indicated earlier, research questions and hypotheses that are not carefully formulated result in unethical studies or poor outcomes. To illustrate this, we provide some examples of ambiguous research question and hypotheses that result in unclear and weak research objectives in quantitative research (**Table 6**)[16] and qualitative research (**Table 7**)[17], and how to transform these ambiguous research question(s) and hypothesis(es) into clear and good statements.

## CONSTRUCTING RESEARCH QUESTIONS AND HYPOTHESES

To construct effective research questions and hypotheses, it is very important to 1) *clarify the background* and 2) *identify the research problem* at the outset of the research, within a specific timeframe.[9] Then, 3) *review or conduct preliminary research* to collect all available knowledge about the possible research questions by studying theories and previous studies.[18] Afterwards, 4) *construct research questions* to investigate the research problem. Identify variables to be accessed from the research questions[4] and make operational definitions of constructs from the research problem and questions. Thereafter, 5) *construct specific deductive or inductive predictions* in the form of hypotheses.[4] Finally, 6) *state the study aims*. This general flow for


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**Table 6.** Examples of ambiguous research question and hypothesis that result in unclear and weak research objective in quantitative research, how to transform them into clear and good statements, and points to avoid

| Variables | Unclear and weak statement (Statement 1)[a] | Clear and good statement (Statement 2)[b] | Points to avoid |
|---|---|---|---|
| Research question | Which is more effective between smoke moxibustion and smokeless moxibustion? | "Moreover, regarding smoke moxibustion versus smokeless moxibustion, it remains unclear which is more effective, safe, and acceptable to pregnant women, and whether there is any difference in the amount of heat generated."[16] | 1) Vague and unfocused questions<br>2) Closed questions simply answerable by yes or no<br>3) Questions requiring a simple choice |
| Hypothesis | The smoke moxibustion group will have higher cephalic presentation. | "Hypothesis 1. The smoke moxibustion stick group (SM group) and smokeless moxibustion stick group (-SLM group) will have higher rates of cephalic presentation after treatment than the control group.<br>Hypothesis 2. The SM group and SLM group will have higher rates of cephalic presentation at birth than the control group.<br>Hypothesis 3. There will be no significant differences in the well-being of the mother and child among the three groups in terms of the following outcomes: premature birth, premature rupture of membranes (PROM) at < 37 weeks, Apgar score < 7 at 5 min, umbilical cord blood pH < 7.1, admission to neonatal intensive care unit (NICU), and intrauterine fetal death."[16] | 1) Unverifiable hypotheses<br>2) Incompletely stated groups of comparison<br>3) Insufficiently described variables or outcomes |
| Research objective | To determine which is more effective between smoke moxibustion and smokeless moxibustion. | "The specific aims of this pilot study were (a) to compare the effects of smoke moxibustion and smokeless moxibustion treatments with the control group as a possible supplement to ECV for converting breech presentation to cephalic presentation and increasing adherence to the newly obtained cephalic position, and (b) to assess the effects of these treatments on the well-being of the mother and child."[16] | 1) Poor understanding of the research question and hypotheses<br>2) Insufficient description of population, variables, or study outcomes |

[a]These statements were composed for comparison and illustrative purposes only.
[b]These statements are direct quotes from Higashihara and Horiuchi[16].

**Table 7.** Examples of ambiguous research question and hypothesis that result in unclear and weak research objective in qualitative research, how to transform them into clear and good statements, and points to avoid

| Variables | Unclear and weak statement (Statement 1) | Clear and good statement (Statement 2) | Points to avoid |
|---|---|---|---|
| Research question | Does disrespect and abuse (D&A) occur in childbirth in Tanzania? | How does disrespect and abuse (D&A) occur and what are the types of physical and psychological abuses observed in midwives' actual care during facility-based childbirth in urban Tanzania? | 1) Ambiguous or oversimplistic questions<br>2) Questions unverifiable by data collection and analysis |
| Hypothesis | Disrespect and abuse (D&A) occur in childbirth in Tanzania. | Hypothesis 1: Several types of physical and psychological abuse by midwives in actual care occur during facility-based childbirth in urban Tanzania.<br>Hypothesis 2: Weak nursing and midwifery management contribute to the D&A of women during facility-based childbirth in urban Tanzania. | 1) Statements simply expressing facts<br>2) Insufficiently described concepts or variables |
| Research objective | To describe disrespect and abuse (D&A) in childbirth in Tanzania. | "This study aimed to describe from actual observations the respectful and disrespectful care received by women from midwives during their labor period in two hospitals in urban Tanzania."[17a] | 1) Statements unrelated to the research question and hypotheses<br>2) Unattainable or unexplorable objectives |

[a]This statement is a direct quote from Shimoda et al.[17]
The other statements were composed for comparison and illustrative purposes only.

constructing effective research questions and hypotheses prior to conducting research is shown in **Fig. 1**.

Research questions are used more frequently in qualitative research than objectives or hypotheses.[3] These questions seek to discover, understand, explore or describe experiences by asking "What" or "How." The questions are open-ended to elicit a description rather than to relate variables or compare groups. The questions are continually reviewed, reformulated, and changed during the qualitative study.[3] Research questions are also used more frequently in survey projects than hypotheses in experiments in quantitative research to compare variables and their relationships.


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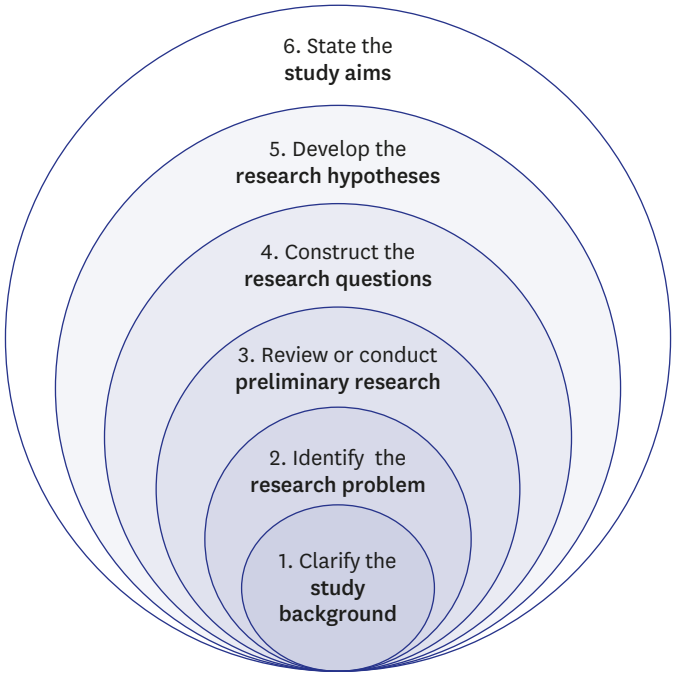


**Fig. 1.** General flow for constructing effective research questions and hypotheses prior to conducting research.

Hypotheses are constructed based on the variables identified and as an if-then statement, following the template, 'If a specific action is taken, then a certain outcome is expected.' At this stage, some ideas regarding expectations from the research to be conducted must be drawn.[18] Then, the variables to be manipulated (independent) and influenced (dependent) are defined.[4] Thereafter, the hypothesis is stated and refined, and reproducible data tailored to the hypothesis are identified, collected, and analyzed.[4] The hypotheses must be testable and specific,[18] and should describe the variables and their relationships, the specific group being studied, and the predicted research outcome.[18] Hypotheses construction involves a testable proposition to be deduced from theory, and independent and dependent variables to be separated and measured separately.[3] Therefore, good hypotheses must be based on good research questions constructed at the start of a study or trial.[12]

In summary, research questions are constructed after establishing the background of the study. Hypotheses are then developed based on the research questions. Thus, it is crucial to have excellent research questions to generate superior hypotheses. In turn, these would determine the research objectives and the design of the study, and ultimately, the outcome of the research.[12] Algorithms for building research questions and hypotheses are shown in **Fig. 2** for quantitative research and in **Fig. 3** for qualitative research.


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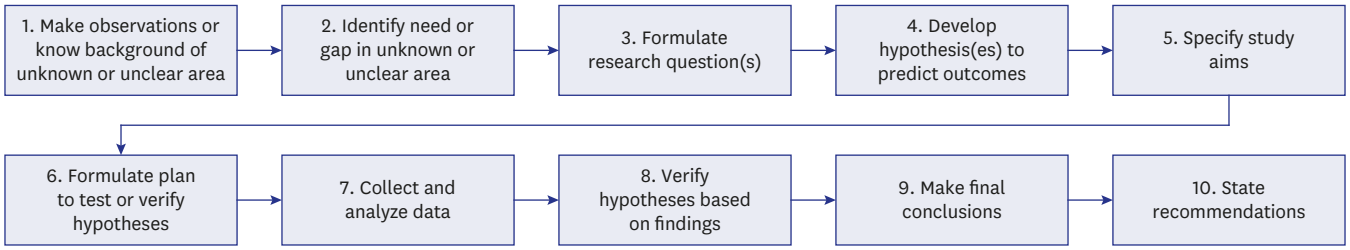


**1. Make observations or know background of unknown or unclear area**

"To the best of our knowledge, there are presently no studies comparing and verifying smoke moxibustion, smokeless moxibustion, and control treatments for breech presentation as a three-arm pilot trial."[16]

**2. Identify need or gap in unknown or unclear area**

"Therefore, to successfully establish an effective moxibustion method for breech presentation, a pilot study is necessary to compare smoke moxibustion and smokeless moxibustion simultaneously."[16]

**3. Formulate research question(s)**

"Moreover, regarding smoke moxibustion versus smokeless moxibustion, it remains unclear which is more effective, safe, and acceptable to pregnant women, and whether there is any difference in the amount of heat generated."[16]

**4. Develop hypothesis(es) to predict outcomes**

"Hypothesis 1. The smoke moxibustion stick group (SM group) and smokeless moxibustion stick group (-SLM group) will have higher rates of cephalic presentation after treatment than the control group."[16]

"Hypothesis 2. The SM group and SLM group will have higher rates of cephalic presentation at birth than the control group."[16]

"Hypothesis 3. There will be no significant differences in the well-being of the mother and child among the three groups in terms of the following outcomes: premature birth, premature rupture of membranes (PROM) at < 37 weeks, Apgar score < 7 at 5 min, umbilical cord blood pH < 7.1, admission to neonatal intensive care unit (NICU), and intrauterine fetal death."[16]

**5. Specify study aims**

"The specific aims of this pilot study were (a) to compare the effects of smoke moxibustion and smokeless moxibustion treatments with the control group as a possible supplement to ECV for converting breech presentation to cephalic presentation and increasing adherence to the newly obtained cephalic position, and (b) to assess the effects of these treatments on the well-being of the mother and child."[16]

**6. Formulate plan to test or verify hypotheses**

"We used a quasi-experimental design with 3 arms: a smoke moxibustion (SM) (n = 20) and smokeless moxibustion (SLM) (n = 20) groups (20-min acupoint BL67 stimulation once or twice daily for 10–14 days), and a control group (n = 20). The participants had singleton breech presentations between 33 and 35 gestation weeks. The primary outcome was cephalic presentation at the conclusion of intervention. The secondary outcomes were cephalic presentation at birth and effects on mother and child well-being."[16]

**7. Collect and analyze data**

"At the conclusion of intervention, cephalic presentation was higher in the SLM (60.0%) than the control groups (25.0%), Relative Risk 2.40, 95% Confidence Interval [1.04–5.56]; there was no significant difference for SM. At birth, there were no significant differences in cephalic presentation or well-being."[16]

**8. Verify hypotheses based on findings**

"These results showed that the rate of cephalic presentation after 10–14 days of the intervention was higher in the SLM group than in the control group. This indicates that **Hypothesis 1** is supported for the SLM group, but not for the SM group."[16]

"……Thus, **Hypothesis 2** was not supported by the present results."[16]

[Note: The text for "Cephalic presentation at birth" of this paper (reference 16) indicates no significant difference in the proportion of cephalic presentation at birth]

"There were no significant differences in the well-being of the mother and child in all the outcomes (Table 3). Thus, **Hypothesis 3** was supported by the present results."[16]

**9. Make final conclusions**

"SLM treatment showed an increasing trend towards cephalic presentation at the conclusion of intervention. Although significant differences were not observed at birth possibly due to the small samples and non-randomization, moxibustion was safe, and not associated with perinatal morbidity and mortality."[16]

**10. State recommendations**

"A randomized controlled trial with a larger sample is warranted to ascertain SLM treatment as a possible ECV supplement for converting and increasing adherence to cephalic position."[16]

**Fig. 2.** Algorithm for building research question and hypothesis in quantitative research, and illustrative example based on the study of Higashihara and Horiuchi.[16]


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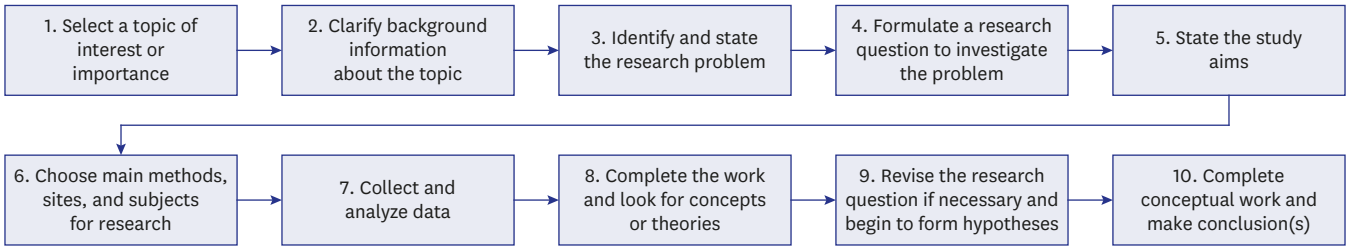


**1. Select a topic of interest or importance**

Midwives' respect and disrespect of women during facility-based childbirth in urban Tanzania

[Note: This phrase is not a direct quote from the published paper and was composed here based on the background and context of the whole paper to show the main research topic for illustrative purposes only]

**2. Clarify background information about the topic**

"Over the last two decades, facility-based childbirths in Tanzania have only minimally increased by 10% partly because of healthcare providers' disrespect and abuse (D&A) of women during childbirth."[17]

**3. Identify and state the research problem**

"Although numerous studies have substantiated women's experience of D&A during childbirth by healthcare providers, few have focused on how D&A occurred during the midwives' actual care."[17]

**4. Formulate a research question to investigate the problem**

How does D&A occur in midwives' actual care during facility-based childbirth in urban Tanzania?

[Note: This research question is not a direct quote from the published paper and was composed here to show a possible initial research question that can be formulated based on the background and context of the whole paper for illustrative purposes only]

**5. State the study aims**

"This study aimed to describe from actual observations the respectful and disrespectful care received by women from midwives during their labor period in two hospitals in urban Tanzania."[17]

**6. Choose main methods, sites, and subjects for research**

"This descriptive qualitative study involved naturalistic observation of two health facilities in urban Tanzania. Fourteen midwives were purposively recruited for the one-on-one shadowing of their care of 24 women in labor from admission to the fourth stage of labor. Observations of their midwifery care were analyzed using content analysis."[17]

**7. Collect and analyze data**

"All the 14 midwives showed both respectful and disrespectful care and some practices that have not been explicated in previous reports of women's experiences. For respectful care, five categories were identified: 1) positive interactions between midwives and women, 2) respect for women's privacy, 3) provision of safe and timely midwifery care for delivery, 4) active engagement in women's labor process, and 5) encouragement of the mother-baby relationship. For disrespectful care, five categories were recognized: 1) physical abuse, 2) psychological abuse, 3) non-confidential care, 4) non-consented care, and 5) abandonment of care. Two additional categories emerged from the unprioritized and disorganized nursing and midwifery management: 1) lack of accountability and 2) unethical clinical practices."[17]

**8. Complete the work and look for concepts or theories**

"Both respectful care and disrespectful care of midwives were observed in the two health facilities in urban Tanzania. Several types of physical and psychological abuse that have not been reported were observed. Weak nursing and midwifery management was found to be a contributor to the D&A of women. To promote respectful care of women, pre-service and in-service trainings, improvement of working conditions and environment, empowering pregnant women, and strengthening health policies are crucial."[17]

**9. Revise the research question if necessary and begin to form hypotheses**

**Revised research question**: How does D&A occur and what are the types of physical and psychological abuses observed in midwives' actual care during facility-based childbirth in urban Tanzania?
**Hypothesis 1**: Several types of physical and psychological abuse by midwives in actual care occur during facility-based childbirth in urban Tanzania.
**Hypothesis 2**: Weak nursing and midwifery management contribute to the D&A of women during facility-based childbirth in urban Tanzania.

[Note: These research question and hypotheses are not direct quotes from the published paper and were composed here based on the background and context of the whole paper for illustrative purposes only]

**10. Complete conceptual work and make conclusion(s)**

"Both respectful care and disrespectful care of midwives were observed in the two health facilities in urban Tanzania. Several types of physical and psychological abuse that have not been reported were observed. Weak nursing and midwifery management was found to be a contributor to the D&A of women. To promote respectful care of women, pre-service and in-service trainings, improvement of working conditions and environment, empowering pregnant women, and strengthening health policies are crucial."[17]

**Fig. 3.** Algorithm for building research question and hypothesis in qualitative research, and illustrative example based on the study of Shimoda et al.[17]


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## EXAMPLES OF RESEARCH QUESTIONS FROM PUBLISHED ARTICLES

**EXAMPLE 1. Descriptive research question (quantitative research)**

- Presents research variables to be assessed (distinct phenotypes and subphenotypes)

"BACKGROUND: Since COVID-19 was identified, its clinical and biological heterogeneity has been recognized. Identifying COVID-19 phenotypes might help guide basic, clinical, and translational research efforts.

RESEARCH QUESTION: Does the clinical spectrum of patients with COVID-19 contain distinct phenotypes and subphenotypes?"[19]

**EXAMPLE 2. Relationship research question (quantitative research)**

- Shows interactions between dependent variable (static postural control) and independent variable (peripheral visual field loss)

"Background: Integration of visual, vestibular, and proprioceptive sensations contributes to postural control. People with peripheral visual field loss have serious postural instability. However, the directional specificity of postural stability and sensory reweighting caused by gradual peripheral visual field loss remain unclear.

Research question: What are the effects of peripheral visual field loss on static postural control?"[20]

**EXAMPLE 3. Comparative research question (quantitative research)**

- Clarifies the difference among groups with an outcome variable (patients enrolled in COMPERA with moderate PH or severe PH in COPD) and another group without the outcome variable (patients with idiopathic pulmonary arterial hypertension (IPAH))

"BACKGROUND: Pulmonary hypertension (PH) in COPD is a poorly investigated clinical condition.

RESEARCH QUESTION: Which factors determine the outcome of PH in COPD?

STUDY DESIGN AND METHODS: We analyzed the characteristics and outcome of patients enrolled in the Comparative, Prospective Registry of Newly Initiated Therapies for Pulmonary Hypertension (COMPERA) with moderate or severe PH in COPD as defined during the 6th PH World Symposium who received medical therapy for PH and compared them with patients with idiopathic pulmonary arterial hypertension (IPAH)."[21]

**EXAMPLE 4. Exploratory research question (qualitative research)**

- Explores areas that have not been fully investigated (perspectives of families and children who receive care in clinic-based child obesity treatment) to have a deeper understanding of the research problem

(continued to the next page)

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"Problem: Interventions for children with obesity lead to only modest improvements in BMI and long-term outcomes, and data are limited on the perspectives of families of children with obesity in clinic-based treatment. This scoping review seeks to answer the question: What is known about the perspectives of families and children who receive care in clinic-based child obesity treatment? This review aims to explore the scope of perspectives reported by families of children with obesity who have received individualized outpatient clinic-based obesity treatment."[22]

**EXAMPLE 5. Relationship research question (quantitative research)**

- Defines interactions between dependent variable (use of ankle strategies) and independent variable (changes in muscle tone)

"Background: To maintain an upright standing posture against external disturbances, the human body mainly employs two types of postural control strategies: "ankle strategy" and "hip strategy." While it has been reported that the magnitude of the disturbance alters the use of postural control strategies, it has not been elucidated how the level of muscle tone, one of the crucial parameters of bodily function, determines the use of each strategy. We have previously confirmed using forward dynamics simulations of human musculoskeletal models that an increased muscle tone promotes the use of ankle strategies. The objective of the present study was to experimentally evaluate a hypothesis: an increased muscle tone promotes the use of ankle strategies. Research question: Do changes in the muscle tone affect the use of ankle strategies?"[23]

## EXAMPLES OF HYPOTHESES IN PUBLISHED ARTICLES

**EXAMPLE 1. Working hypothesis (quantitative research)**

- A hypothesis that is initially accepted for further research to produce a feasible theory

"As fever may have benefit in shortening the duration of viral illness, it is plausible to hypothesize that the antipyretic efficacy of ibuprofen may be hindering the benefits of a fever response when taken during the early stages of COVID-19 illness."[24]

"In conclusion, it is plausible to hypothesize that the antipyretic efficacy of ibuprofen may be hindering the benefits of a fever response. The difference in perceived safety of these agents in COVID-19 illness could be related to the more potent efficacy to reduce fever with ibuprofen compared to acetaminophen. Compelling data on the benefit of fever warrant further research and review to determine when to treat or withhold ibuprofen for early stage fever for COVID-19 and other related viral illnesses."[24]

**EXAMPLE 2. Exploratory hypothesis (qualitative research)**

- Explores particular areas deeper to clarify subjective experience and develop a formal hypothesis potentially testable in a future quantitative approach

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(Continued)

"We hypothesized that when thinking about a past experience of help-seeking, a self distancing prompt would cause increased help-seeking intentions and more favorable help-seeking outcome expectations."[25]

"Conclusion

Although a priori hypotheses were not supported, further research is warranted as results indicate the potential for using self-distancing approaches to increasing help-seeking among some people with depressive symptomatology."[25]

**EXAMPLE 3. Hypothesis-generating research to establish a framework for hypothesis testing (qualitative research)**

"We hypothesize that compassionate care is beneficial for patients (better outcomes), healthcare systems and payers (lower costs), and healthcare providers (lower burnout)."[26]

"Conclusion

Compassionomics is the branch of knowledge and scientific study of the effects of compassionate healthcare. Our main hypotheses are that compassionate healthcare is beneficial for (1) patients, by improving clinical outcomes, (2) healthcare systems and payers, by supporting financial sustainability, and (3) HCPs, by lowering burnout and promoting resilience and well-being. The purpose of this paper is to establish a scientific framework for testing the hypotheses above. If these hypotheses are confirmed through rigorous research, compassionomics will belong in the science of evidence-based medicine, with major implications for all healthcare domains."[26]

**EXAMPLE 4. Statistical hypothesis (quantitative research)**

- An assumption is made about the relationship among several population characteristics (gender differences in sociodemographic and clinical characteristics of adults with ADHD). Validity is tested by statistical experiment or analysis (chi-square test, Students t-test, and logistic regression analysis)

"Our research investigated gender differences in sociodemographic and clinical characteristics of adults with ADHD in a Japanese clinical sample. Due to unique Japanese cultural ideals and expectations of women's behavior that are in opposition to ADHD symptoms, we hypothesized that women with ADHD experience more difficulties and present more dysfunctions than men. We tested the following hypotheses: first, women with ADHD have more comorbidities than men with ADHD; second, women with ADHD experience more social hardships than men, such as having less full-time employment and being more likely to be divorced."[27]

"Statistical Analysis

(*text omitted*) Between-gender comparisons were made using the chi-squared test for categorical variables and Students t-test for continuous variables…(*text omitted*). A logistic regression analysis was performed for employment status, marital status, and comorbidity to evaluate the independent effects of gender on these dependent variables."[27]


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## EXAMPLES OF HYPOTHESIS AS WRITTEN IN PUBLISHED ARTICLES IN RELATION TO OTHER PARTS

**EXAMPLE 1. Background, hypotheses, and aims are provided**

BACKGROUND

"Pregnant women need skilled care during pregnancy and childbirth, but that skilled care is often delayed in some countries …(*text omitted*). The focused antenatal care (FANC) model of WHO recommends that nurses provide information or counseling to all pregnant women …(*text omitted*). Job aids are visual support materials that provide the right kind of information using graphics and words in a simple and yet effective manner. When nurses are not highly trained or have many work details to attend to, these job aids can serve as a content reminder for the nurses and can be used for educating their patients (Jennings, Yebadokpo, Affo, & Agbogbe, 2010) (*text omitted*). Importantly, additional evidence is needed to confirm how job aids can further improve the quality of ANC counseling by health workers in maternal care …(*text omitted*)"[28]

HYPOTHESES

"This has led us to hypothesize that the quality of ANC counseling would be better if supported by job aids. Consequently, a better quality of ANC counseling is expected to produce higher levels of awareness concerning the danger signs of pregnancy and a more favorable impression of the caring behavior of nurses."[28]

AIMS

"This study aimed to examine the differences in the responses of pregnant women to a job aid-supported intervention during ANC visit in terms of 1) their understanding of the danger signs of pregnancy and 2) their impression of the caring behaviors of nurses to pregnant women in rural Tanzania."[28]

**EXAMPLE 2. Background, hypotheses, and aims are provided**

BACKGROUND

"We conducted a two-arm randomized controlled trial (RCT) to evaluate and compare changes in salivary cortisol and oxytocin levels of first-time pregnant women between experimental and control groups. The women in the experimental group touched and held an infant for 30 min (experimental intervention protocol), whereas those in the control group watched a DVD movie of an infant (control intervention protocol). The primary outcome was salivary cortisol level and the secondary outcome was salivary oxytocin level."[29]

HYPOTHESIS

"We hypothesize that at 30 min after touching and holding an infant, the salivary cortisol level will significantly decrease and the salivary oxytocin level will increase in the experimental group compared with the control group."[29]


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**EXAMPLE 3. Background, aim, and hypothesis are provided**

BACKGROUND

"In countries where the maternal mortality ratio remains high, antenatal education to increase Birth Preparedness and Complication Readiness (BPCR) is considered one of the top priorities [1]. BPCR includes birth plans during the antenatal period, such as the birthplace, birth attendant, transportation, health facility for complications, expenses, and birth materials, as well as family coordination to achieve such birth plans. In Tanzania, although increasing, only about half of all pregnant women attend an antenatal clinic more than four times [4]. Moreover, the information provided during antenatal care (ANC) is insufficient. In the resource-poor settings, antenatal group education is a potential approach because of the limited time for individual counseling at antenatal clinics."[30]

AIM

"This study aimed to evaluate an antenatal group education program among pregnant women and their families with respect to birth-preparedness and maternal and infant outcomes in rural villages of Tanzania."[30]

HYPOTHESIS

"The study hypothesis was if Tanzanian pregnant women and their families received a family-oriented antenatal group education, they would (1) have a higher level of BPCR, (2) attend antenatal clinic four or more times, (3) give birth in a health facility, (4) have less complications of women at birth, and (5) have less complications and deaths of infants than those who did not receive the education."[30]

## CONCLUSION

Research questions and hypotheses are crucial components to any type of research, whether quantitative or qualitative. These questions should be developed at the very beginning of the study. Excellent research questions lead to superior hypotheses, which, like a compass, set the direction of research, and can often determine the successful conduct of the study. Many research studies have floundered because the development of research questions and subsequent hypotheses was not given the thought and meticulous attention needed. The development of research questions and hypotheses is an iterative process based on extensive knowledge of the literature and insightful grasp of the knowledge gap. Focused, concise, and specific research questions provide a strong foundation for constructing hypotheses which serve as formal predictions about the research outcomes. Research questions and hypotheses are crucial elements of research that should not be overlooked. They should be carefully thought of and constructed when planning research. This avoids unethical studies and poor outcomes by defining well-founded objectives that determine the design, course, and outcome of the study.

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