JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH

How to cite this article:
KRISHNA R , MAITHREYI R ,SURAPANENI K M. RESEARCH BIAS: A REVIEW FOR MEDICAL STUDENTS.Journal of Clinical and Diagnostic Research [serial online] 2010 April [cited: 2010 April 5]; 4:2320-2324.

Available from
http://www.jcdr.net/back_issues.asp?issn=0973-709x&year=2010 &month= April &volume=4&issue=2&page=2320-2324 &id=565

REVIEW ARTICLE

Research Bias: A Review For Medical Students

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ABSTRACT

Bias can be defined as a systematic deviation from what would have been the most effective route to one goal because of commitment to another particular tendency or inclination, especially the one that prevents unprejudiced consideration of a question. A biased study loses validity with respect to the degree of the bias. There are two types of biases which are associated with most forms of research viz Random Bias and Systematic Bias. Random biases are those which occur due to sampling variability or measurement precision, they occur in essentially all quantitative studies and can be minimized but not avoided. Systematic biases are reproducible errors that produce a consistently false pattern of differences between the observed and the true values. Both random and systematic errors can question the validity of any research study. The most common categories of bias that can affect the validity of research include the following: Selection biases, which may result in the subjects in the sample being unrepresentative of the population of interest. Measurement biases, which include issues related to how the outcome of interest was measured. Intervention (exposure) biases, involve differences in how the treatment or intervention was carried out, or how the subjects were exposed to the factor of interest. The common methods that are used to reduce Bias in Research are – Randomization, Consecutive recruitment, Prospective versus Retrospective Studies and Blinding. Bias is a universal problem which is faced while designing the research study as well as during the execution of the designed research plan and it is well established fact that no study design is exempted from bias.

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I) Definition of Bias

Bias is a form of systematic error that can affect scientific investigations and distort the measurement process. A biased study loses validity with respect to the degree of the bias. While some study designs are more prone to bias, its presence is universal [1].

II) Types of Research Studies:

Mainly research studies are of 2 types.

1. **Quantitative Research**
2. **Qualitative Research (The "Soft" Side of Research)**

1. Quantitative Research

Quantitative research is generally made using Scientific Methods which can include:

- The generation of models, theories and hypotheses
- The development of instruments and methods for measurement
- Experimental control and manipulation of variables
- Collection of empirical data
- Modeling and analysis of data
- Evaluation of results

2. Qualitative Research

Definition [Table/Fig 1]

"Qualitative research is the kind of research that generates insight and understanding rather than quantifiable measurements".

The Salient features of Qualitative Research are as follows:

(Table/Fig 1)Qualitative vs Quantitative Research

- A key objective of qualitative research is a holistic understanding of the phenomenon.

	Quantitative	Qualitative
Purpose	To explore	To understand
Questions	Not standardized	Standardized
Instrument	Camera, recorder	Questionnaire
Sample	Very small	Much larger
Analysis	Subjective	Objective
Result	Tentative	Conclusive

III) Study Designs

Study designs can be broadly categorized as descriptive or analytic [Table/Fig 2]:

(Table/Fig 2)Hierarchic Model of Study Design Based on Grades of Evidence

Grade of Evidence	Study Design
I: Analytic-intervention	Randomized controlled trial
II-1: Analytic-intervention	Controlled trial without randomization
II-2: Analytic-observational	Cohort
	Case control, preferably multi center or Research group
III: Descriptive	Case series
	Case reports
	Reports of expert committees
	Opinions of respected authorities

Source: Reference [2]

IV) Major Sources of Bias in Research Studies

It can be further categorized into

A) Types of BIAS

B) Major Categories of Research Bias

A) Types Of Bias

There are two types of biases associated with most forms of research:

1. **Random Bias**
   and
2. **Systematic Bias**.

1. Random Bias

- Random Biases are those results which occur due to sampling variability or measurement precision.
- They occur in essentially all quantitative studies and **can be minimized but not avoided.**
- The idea of Qualitative Research is inherently problematical.
- There is Qualitative Data or Evidence and Quantitative Data or Evidence *but Research itself* is essentially neither Qualitative nor Quantitative.
  Research consists of question, evidence, assessment, findings – deduction and induction.
- Research has a lot to do with reflection and conceptualizations.

2. Systematic Bias

- Systematic Biases are **reproducible inaccuracies** that produce a consistently false pattern of differences between the observed and the true values.

Random Vs Systematic Bias

- Both random and systematic errors can threaten the validity of any research study.
- However, random errors can be easily determined and addressed by using statistical analysis; most systematic errors or biases cannot be determined and addressed.
- This is because biases can arise from innumerable sources, including complex human factors.
- For this reason, avoidance of systematic errors or biases is the task of a proper research design.

B) Major Categories of Research Bias

There are many different types of biases which have been described in the research literature [3].

The most common categories of bias that can affect the validity of research include the following:

1. **Selection biases**, which may result in the subjects in the sample being unrepresentative of the population of interest.

2. **Measurement biases**, which include issues related to how the outcome of interest was measured.

3. **Intervention (exposure) biases,** which involve differences in how the treatment or intervention was carried out, or how the subjects were exposed to the factor of interest.

1. Selection Biases

- Selection biases occur when the groups to be compared are different.
- These differences may influence the outcome.
- The common types of sample (subject selection) biases include volunteer or referral bias, and non respondent bias.
- By definition, nonequivalent group designs also introduce selection bias. So it can be sub divided into two groups.

A) Volunteer or referral Bias
B) Non respondent Bias

A) Volunteer or Referral Bias

- Volunteer or referral bias occurs because people who volunteer to participate in a study (or who are referred to it) are often different than non-volunteers/non-referrals.
- This bias usually, but not always, favours the treatment group, as volunteers tend to be more motivated and concerned about their health.

B) Non Respondent Bias

- Non respondent bias occurs when those who do not respond to a survey, differ in important ways from those who respond or participate.
- This bias can work in either direction.

2. Measurement Biases

- Measurement biases involve systematic error that can occur in collecting relevant data.
- Common measurement biases include instrument bias, insensitive measure bias, expectation bias , recall or memory bias, attention bias and verification or work-up bias.
- It can be sub – divided into 6 types.

a) Instrument bias
b) Insensitive measure bias
c) Expectation bias
d) Recall or memory bias
e) Attention bias
f) Verification or work-up bias

A) Instrument Bias: Instrument bias occurs when calibration errors can lead to inaccurate measurements being recorded, e.g., an unbalanced weight scale.

B) Insensitive Measure Bias: Insensitive measure bias occurs when the measurement tool(s) which are used are not sensitive enough to detect what might be important differences in the variable of interest.

C) Expectation Bias: Expectation bias occurs in the absence of masking or blinding, when observers may err in measuring data towards the expected outcome. This bias usually favours the treatment group.

D) Recall or Memory Bias*:* Recall or memory bias can be a problem if outcomes which are being measured require that subjects recall past events. Often, a person recalls positive events more than negative ones. Alternatively, certain subjects may be questioned more vigorously than others, thereby improving their recollections.

E) Attention Bias: Attention bias occurs because people who are part of a study are usually aware of their involvement and as a result of the attention received, may give more favourable responses or perform better than people who are unaware of the study's intent.

F) Verification or Work-Up Bias: Verification or work-up bias is associated mainly with test validation studies. In these cases, if the sample which is used to assess a measurement tool (e.g., diagnostic test) is restricted only to those who have the condition of factor being measured, the sensitivity of the measurement can be overestimated.

3. Intervention (Exposure) Biases

- Intervention or exposure biases generally are associated with research that compares groups.
- Common intervention biases include 6 sub types:

a) Contamination Bias
b) Co-Intervention Bias
c) Timing Bias
d) Compliance Bias
e) Withdrawal Bias
f) Proficiency Bias

a) Contamination Bias: Contamination bias occurs when members of the 'control' group inadvertently receive the treatment or are exposed to the intervention, thus potentially minimizing the difference in outcomes between the two groups.

b) Co-Intervention Bias: Co-intervention bias occurs when some subjects receive other (unaccounted for) interventions at the same time as that of the study treatment.

c) Timing Bias: Different issues related to the timing of intervention can be biased. If an intervention is provided over a long period of time, maturation alone could be the cause for improvement. If the duration of the treatment is very short, there may not have been sufficient time for a noticeable effect in the outcomes of interest.

d) Compliance Bias: Compliance bias occurs when differences in subject adherence to the planned treatment regimen or intervention affect the study outcomes.

e) Withdrawal Bias: Withdrawal bias occurs when subjects who leave the study (drop-outs) differ significantly from those that remain.

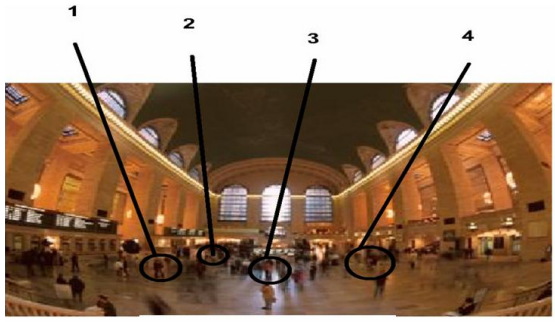
f) Proficiency Bias*:* Proficiency bias occurs when the interventions or treatments are not applied equally to the subjects. This may be due to skill or training differences among the personnel and/or due to differences in resources or procedures used at different sites.

V) Reduction in Bias

The common methods that are used to reduce Bias in Research are as follows.

1) Randomization

Randomization is a well-documented and powerful tool which is to reduce bias. Non random subject recruitment or group assignment may result in bias by introducing selection characteristics or unknown variables (eg, age, sex, duration and severity of disease, co morbid factors) to the study population. This bias is not always obvious, though. Randomization helps ensure that on an average and other than for the intervention or technique under study, different groups will be comparable with respect to known and unknown variables. Randomization schemes are also used in the (retrospective) review of comparative imaging sets to reduce reader-order bias. It is important to recognize, however, that because randomization relies on the averaging of sampling variation, in studies with small numbers of subjects or cases, it may not effectively reduce bias and may actually introduce bias [4] [Table/Fig 3].



(Table/Fig 3) Random Selection

2) Consecutive Recruitment

Nonconsecutive recruitment might inadvertently introduce characteristics that are not in proportion to those found in the target population [5].

3) Prospective versus Retrospective Studies

Retrospective studies are prone to various biases which can minimize the usefulness and impact of a given study. So it is important to define the study population and the methods of data collection and review for reader assessment. Prospective subject recruitment or data collection can be designed to reduce bias [6].

4) Blinding

Double blinded study is the best way to minimize the bias in research. A double blinded study refers to one in which both the investigator and the study subject are blinded to group assignment. Inappropriate blinding also leads to inaccuracy of the results [7].

Vi) Conclusions

Bias is a universal problem in designing the research study as well as the execution of the designed research plan and it is a well established fact that no study design is

exempted from bias. Bias will distort data and a given study's result will not reflect that which would be otherwise found in the target population [8].

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