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The aim of this article is to outline types of 'bias' across research designs, and consider strategies to minimise bias. Evidence-based nursing, defined as the "process by which evidence, nursing theory, and clinical expertise are critically evaluated and considered, in conjunction with patient involvement, to provide the delivery of optimum nursing care,"¹ is central to the continued development of the nursing professional. Implementing evidence into practice requires nurses to critically evaluate research, in particular assessing the rigour in which methods were undertaken and factors that may have biased findings.

What is bias in relation to research and why is understanding bias important?

Bias is defined by the Oxford Dictionary as: "an inclination or prejudice for or against one person or group, especially in a way considered to be unfair"; "a concentration on an interest in one particular area or subject"; "a systematic distortion of statistical results due to a factor not allowed for in their derivation" (<http://www.oxforddictionaries.com>). Understanding research bias is important for several reasons: first, bias exists in all research, across research designs and is difficult to eliminate; second, bias can occur at each stage of the research process; third, bias impacts on the validity and reliability of study findings and misinterpretation of data can have important consequences for practice. The controversial study that suggested a link between the measles-mumps-rubella vaccine and autism in children² resulted in a rare retraction of the published study because of media reports that highlighted significant bias in the research process.³ Bias occurred on several levels: the process of selecting participants was misrepresented; the sample size was too small to infer any firm conclusion from the data analysis and the results were overstated which suggested caution against widespread vaccination and an urgent need for further research. However, in the time between the original publication, and later research refuting the original findings, the uptake of measles-mumps-rubella vaccine in Britain declined, resulting in a 25-fold increases in measles in the 10-year period following the original publication.

Although different study designs have specific methodological challenges and constraints, bias can occur at each stage of the research process (table 1). In quantitative research, the validity and reliability are assessed using statistical tests that estimate the size of error in samples and calculating the significance of findings (typically p values or CIs). The tests and measures used to establish the validity and reliability of quantitative research cannot be applied to qualitative research. However, in the broadest context, these terms are applicable, with validity referring to the integrity and application of the methods and the precision in which the findings accurately reflect the data, and reliability referring to the consistency within the analytical processes.⁴

How is bias minimised when undertaken research?

Bias exists in all study designs, and although researchers should attempt to minimise bias, outlining potential sources of bias enables greater critical evaluation of the research findings and conclusions. Researchers bring to each study their experiences, ideas, prejudices and personal philosophies, which if accounted for in advance of the study, enhance the transparency of possible research bias. Clearly articulating the rationale for and choosing an appropriate research design to meet the study aims can reduce common pitfalls in relation to bias. Ethics committees have an important role in considering whether the research design and methodological approaches are biased, and suitable to address the problem being explored. Feedback from peers, funding bodies and ethics committees is an essential part of designing research studies, and often provides valuable practical guidance in developing robust research.

In quantitative studies, selection bias is often reduced by the random selection of participants, and in the case of clinical trials randomisation of participants into comparison groups. However, not accounting for participants who withdraw from the study or are lost to follow-up can result in sample bias or change the characteristics of participants in comparison groups.⁷ In qualitative research, purposeful sampling has advantages when compared with convenience sampling in that bias is reduced because the sample is constantly refined to meet the study aims. Premature closure of the selection of participants before analysis is complete can threaten the validity of a qualitative study. This can be overcome by continuing to recruit new participants into the study during data analysis until no new information emerges, known as data saturation.⁸

In quantitative studies having a well-designed research protocol explicitly outlining data collection and analysis can assist in reducing bias. Feasibility studies are often undertaken to refine protocols and procedures. Bias can be reduced by maximising follow-up and where appropriate in randomised control trials analysis should be based on the intention-to-treat principle, a strategy that assesses clinical effectiveness because not everyone complies with treatment and the treatment people receive may be changed according to how they respond. Qualitative research has been criticised for lacking transparency in relation to the analytical processes employed.⁴ Qualitative researchers must demonstrate rigour, associated with openness, relevance to practice and congruence of the methodological approach. Although other researchers may interpret the data differently, appreciating and understanding how the themes were developed is an essential part of demonstrating the robustness of the findings. Reducing bias can include respondent validation, constant comparisons across participant accounts, representing deviant cases and outliers, prolonged involvement or persistent



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Table 1 Types of research bias

Design bias	Poor study design and incongruence between aims and methods increases the likelihood of bias. For example, exploring HIV testing using a survey is unlikely to obtain in-depth rich data about individuals' experiences. Bias can occur when a researcher's personal beliefs influence the choice of research question and methodology. For example, a researcher working for a pharmaceutical company may choose a research question which supports the usefulness of the drug being investigated
Selection/participant bias	Selection bias relates to both the process of recruiting participants and study inclusion criteria. Successful research begins with recruiting participants who meet the study aims. For example, recruitment bias could occur if participants were invited to participate in a survey posted on the internet, which automatically excludes individuals without internet access Inclusion bias in quantitative research typically relates to selecting participants who are representative of the study population, and where applicable allocation of participants to ensure similarity between comparison groups. In addition, accounting for the differences between people who remain in a study and those who withdraw may be important in some study designs. For example, an evaluation of a weight loss programme may be affected by participant withdrawal; participants who become disillusioned because of not losing weight may drop out, which may bias the findings towards more favourable results. Confounding bias can also occur because of an association between 'cause' and 'effect'. For example, comparing treatment outcomes for similar conditions between general and specialised centres may find higher mortality rates at specialised centres yet patients referred to these centres are more likely to have high-risk factors and more complex needs In qualitative research, it is usual to recruit participants with a range of experiences in relation to the topic being explored; therefore, accounting for biases in relation to the sampling strategies is essential. For example recruiting parents from a parent and toddler group is likely to be biased towards mothers; the findings are unlikely to represent both mothers' and fathers' perspectives
Data collection bias and measurement bias	Data collection bias can occur when a researcher's personal beliefs influence the way information or data is collected In quantitative studies, measurement bias can occur if a tool or instrument: has not been assessed for its validity or reliability (eg, using a shared decision-making tool that measures patient satisfaction rather than decision-making); is not suitable for the specific setting or patient groups (eg, using an adult verbal pain assessment tool with young children); an instrument not calibrated properly may consistently measure inaccurately (eg, weighing babies with poorly calibrated weighing scales) In retrospective studies, for example, when completing questionnaires about eating habits when data collection relies on recall, participants may not remember and report events accurately In qualitative research, interviewing is a commonly used method of data collection; how questions are asked will influence the information elicited. For example a leading question, "Do you find the health service poor?", is likely to receive a closed yes or no response, and not gain insight into participants experiences and could be replaced with; "Please describe your last visit to hospital?"
Analysis bias	When analysing data, the researcher may naturally look for data that confirm their hypotheses or confirm personal experience, overlooking data inconsistent with personal beliefs
Publication bias	Published studies nearly always have some degree of bias. For example, in quantitative research, studies are more likely to be published if reporting statistically significant findings. ⁵ Non-publication in qualitative studies is more likely to occur because of a lack of depth when describing study methodologies and findings are not clearly presented ⁶

observation of participants, independent analysis of the data by other researchers and triangulation.⁴

In summary, minimising bias is a key consideration when designing and undertaking research. Researchers have an ethical duty to outline the limitations of studies and account for potential sources of bias. This will enable health professionals and policymakers to evaluate and scrutinise study findings, and consider these when applying findings to practice or policy.

Competing interests None.

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