

COMMENTARY

## CASE-CONTROL STUDIES FALSE AND TRUE: MISLABELED STUDY DESIGNS IN REHABILITATION RESEARCH, AND A MASTER CLASS IN CASE-CONTROL STUDY DESIGN

Rehabilitation is an interventional specialty, not a diagnostic one. While good methods are required to diagnose patients' problems and assess their functioning in the many areas that are important to treatment and quality of life, ultimately we need to provide or prescribe treatments that are of benefit to patients, that are efficient in providing that benefit, and that expose them to minimal risk. Research on rehabilitation interventions is relatively sparse (1), and the limited research that is done tends to be of inadequate quality (2–7). Improvements in the quality of interventional research in rehabilitation are urgently needed (8).

In addition, observational research relevant to injuries, disorders and chronic ailments and their impact on functioning is useful to rehabilitation practitioners and researchers. Often this type of research into cause and effect is necessary to provide clues as to where we can intervene preventively, or what are the most fruitful approaches to treatment. These types of studies are not easy to perform, as many causes have multiple effects, and almost all effects have several causes. Determining how multiple causes interact, and what are their individual and joint effects, requires sophisticated research designs implemented with a high degree of refinement. Ideally, we would like to manipulate presumed causes to observe their effects on the outcomes of interest, but such research is often unethical, or too expensive, or takes more time than we have available because the time period needed for a cause to have its effect may be years if not decades.

The science of epidemiology has developed 2 research designs for observational studies to circumvent this problem; the cohort study and the case-control study. The cohort design reasons "forward" from known exposure to causal agents or events, to determine if hypothesized events are associated with this exposure. The case-control design reasons "backward" from a known dichotomous outcome to hypothesized causes, and is especially useful in the case of rare outcomes. These designs have been fine-tuned over many years, in which researchers have learned to recognize potential confounders that may result in a study providing the wrong answers, and to eliminate them by adjustments in data collection or statistical analysis. Each year, thousands of case-control and cohort studies are performed, which increase our knowledge of the causes of illness and the factors causing or contributing to disorders, including those more permanent and chronic disorders that rehabilitation specialists treat.

In this issue of the *Journal of Rehabilitation Medicine*, Mayo & Goldberg (9) publish a report demonstrating that researchers publishing in rehabilitation journals tend to misapply the term "case control study", and do so much more frequently

than investigators in other healthcare fields. At first reading, this would appear to be just a question of terminology: rehabilitation researchers have a more encompassing definition of the term "control," and use it for non-cases in what epidemiologists acknowledge as case-control studies, as well as for comparators in all kinds of other research designs. However, Mayo & Goldberg (9) demonstrate quite convincingly that the confusion is more than just in terminology: the wrong use of the term "case-control" is likely to result in an inappropriate analysis of one's data, and/or conclusions that inappropriately generalize beyond the group sampled.

Shakespeare may have told us that words do not matter ("What's in a name? That which we call a rose by any other name would smell as sweet." *Romeo and Juliet* II, ii, 1–2), but his entire life's work argues against this. Terms matter, and that is true in science as much as in other areas of life where words rather than numbers are used to argue one's case. In fact, because in scientific discourse the coin of the realm is data, carefully collected and analyzed using methods that are clearly specified and that follow standard protocols as much as possible, issues of terminology are more important in science than in other domains. If the reckless borrowing of the term "controls" from epidemiology results in reaching wrong conclusions because the data collection in our investigation was set up wrongly, and/or we used the wrong statistical analysis methods, words matter very much. Unfortunately, the inappropriate use of the term "case-control" is now very much ingrained, and unlearning the bad habit may not happen until someone comes up with an acceptable alternative to the term "control." The perfectly innocent and equally Latinate "comparator" is available, but has never caught on.

Many clinicians and even researchers in the rehabilitation sciences have had limited training in research methodology and statistical analysis, and it would appear that researchers in this field are less likely than their counterparts in other health sciences to invoke the assistance of statisticians and methodologists, possibly because so much rehabilitation research is conducted without major or even any funding, and the fear may be that experts are not interested in cooperating on a project for which there is no financial payoff. This, of course, may be an erroneous assumption. Developments in methodology areas from psychometrics to meta-analysis, and from proper formats for reporting of research to imputing missing data, are continuous, and even those investigators who have had extensive training in research methods and statistics as part of graduate and postgraduate study may do well to call upon an expert when they want or need to step outside their areas of expertise.

For those who lack training in epidemiology, and those who have received cursory exposure to it many years ago, a second paper in this issue by Mayo & Goldberg offers a primer in the case-control methodology (10). Omitting all details of statistical analysis, they set forth clearly the proper approach to case-control studies and clarify what types of conclusions can be reached using this design, and why. For those who desire further details, or who want to explore additional aspects of this observational study design, they refer to the literature. In its conciseness this article may not be an easy read, but *Journal of Rehabilitation Medicine* readers are encouraged to study this paper and work through its examples. It may help them to recognize wrong uses of the terminology “case-control study”, and wrong analyses and conclusions, in their professional reading. It also is certain to improve their own investigations (using case-control, cohort or yet other designs) of linkages between effects and their presumed causes. If these readers were to call upon their colleagues in biostatistics, clinical epidemiology or similar departments to help them design and analyze their next research project, it would provide a win-win situation for investigators and research consumers alike.

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