

# STRENGTHENING ANALYTICAL THINKING FOR OBSERVATIONAL STUDIES (STRATOS):

## Introducing the Measurement Error and Misclassification Topic Group (TG4)

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on behalf of STRATOS TG4

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In the last two issues of the Bulletin, the STRATOS initiative was introduced and the Missing Data Topic Group (TG1) described their activities. Here, we introduce the Measurement Error and Misclassification Topic Group (TG4). Measurement error and misclassification occur as frequently in observational studies in the biomedical sciences as do missing data. However, while the complete absence of a value for a particular variable is obvious and difficult to ignore, error in an observation is usually less obvious and easier to ignore. Unfortunately, ignoring error can sometimes lead to erroneous conclusions, and possibly erroneous decisions. As described below, our Topic Group sees as its main objective, the development of awareness among biomedical investigators of the impact of measurement error and misclassification on the results of their studies, and the need to adjust for this impact.

The members of the Topic Group are: Laurence Freedman and Victor Kipnis (Joint Chairpersons), Raymond Carroll, Veronika Deffner, Kevin Dodd, Paul Gustafson, Ruth Keogh, Helmut Kuechenhoff, Pamela Shaw and Janet Tooze, all of whom have many years of experience working with data that have measurement error and misclassification and devising and using methods to adjust for the impact of the error.

The first task that the Topic Group set for itself was to conduct a survey of the literature in four areas of epidemiology in which measurement error is known to be extensive: (i) population surveys of dietary intake; (ii) nutritional cohort studies; (iii) physical activity cohort studies and (iv) air pollution studies. Each area was surveyed by one or two members, with the main focus being on whether the research investigators used statistical methods to adjust for the impact of measurement error in the estimates that they reported. The results of this survey have been summarized in a forthcoming manuscript by lead author Pamela Shaw, and are quite revealing. We can report that in all four areas of epidemiology only a minority of published papers (and, except for population dietary surveys, a small one at that) present estimates (e.g. risk estimates or percentiles of distributions) that are adjusted for measurement error. For further details, you can access an unpublished version of the report at arXiv.org, <https://arxiv.org/abs/1802.10496>.

This general observation has set the scene for our further work. We are now engaged in activities that are aimed at increasing awareness of the problems caused by measurement error and misclassification in statistical analyses and in removing barriers to using statistical methods that deal with such problems. These activities include

(i) writing and publishing papers and (ii) presenting papers and workshops at conferences. With regard to papers, we are currently engaged in publishing the literature survey mentioned above in a journal read by epidemiologists, so as to bring the problem to the attention of the epidemiological community.

We have also been developing a guidance paper for biostatisticians on dealing with measurement error and misclassification and are now close to its completion. We felt the need to reach out to biostatisticians because it is apparent that, although much has been written on this topic, many are unaware of its importance and its subtleties. To give an example of the subtleties involved in measurement error work, it is not generally appreciated that the effects of measurement error depend critically both on the nature of the error, as described by the measurement error model, and the nature of the quantity being estimated. Two simple models of measurement error are the "classical" and the "Berkson" models. These two types of error can have opposite effects on estimates. For example, when estimating a distribution, classical error leads to underestimating the lower percentiles and overestimating the upper percentiles, whereas Berkson error leads to overestimating the lower percentiles and underestimating the upper percentiles. Although Berkson error occurs less frequently than classical error in biomedical science, it is becoming more common due to the increasing use of prediction and calibration equations for measuring individuals' levels of risk or exposure. Such measures usually have Berkson error and appropriate care is needed when they are included in analyses.

A second barrier to dealing with measurement error is lack of familiarity with software available for implementing analyses that adjust for the error. Our guidance paper includes a section that summarizes the main software available for performing a range of such analyses. On the other hand it cannot be denied that more and better software is needed.

A third barrier to dealing with measurement error is the need for validation studies to determine the measurement error model and estimate its parameters, which serve as the basis for adjusting estimates and tests, when needed. Such validation studies are often lacking or imperfect due to lack of resources or sometimes lack of a suitable reference instrument. Our guidance paper includes a final section that discusses how to proceed when information about the measurement error is incomplete or even totally missing. In these cases some form of sensitivity analysis is required.

Further papers that deal with more specific problems or areas are planned, including a guidance paper for nutritional epidemiologists, and a paper providing worked examples of measurement error correction in real studies.

Several presentations were made on behalf of STRATOS TG4 in 2017. Victor Kipnis and Pamela Shaw presented at the bi-annual conference of the Eastern Mediterranean Region of IBS (Greece, May 2017); Ruth Keogh contributed to a pre-conference course at the annual meeting of the Netherlands Epidemiological Society (Antwerp, June 2017); Ruth Keogh and Pamela Shaw taught a half-day course at the Central European Network of IBS and also presented lectures at the conference (Austria, August 2017); and Veronika Deffner presented at the German Association for Medical Informatics (GMDS) (Oldenburg, Germany, September 2017). Slides are available on the STRATOS website (<http://www.stratos-initiative.org/>). Further presentations and courses are being planned for 2018, so keep a lookout for us in the coming year!