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- A Generic Method for Estimating and Smoothing Multispecies Biodiversity Indicators Using Intermittent Data by Stephen N. Freeman, Nicholas J. B. Isaac, Panagiotis Besbeas, Emily B. Dennis and Byron J. T. Morgan
- Bias Correction in Estimating Proportions by Imperfect Pooled Testing by Graham Hepworth and Brad J. Biggerstaff
- Spatial Sampling Design Using Generalized Neyman–Scott Process by Sze Him Leung, Ji Meng Loh, Chun Yip Yau and Zhengyuan Zhu
- Reproducible Research with R and RStudio (3rd Edition) by Christopher Gandrud, a book review by Richard Glennie

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Brian Reich, Editor in Chief

STRENGTHENING ANALYTICAL THINKING FOR OBSERVATIONAL STUDIES (STRATOS): Updates from the Measurement Error and Misclassification Topic Group (TG4)

Pamela A Shaw (1) and Hendriek Boshuizen (2), (3) on behalf of STRATOS TG4

(1)Department of Biostatistics, Epidemiology, and Informatics, Perelman School of Medicine, University of Pennsylvania, USA; Email: shawp@upenn.edu

(2)National Institute for Public Health and the Environment, the Netherlands;

(3)Wageningen University and Research, Wageningen, the Netherlands; Email: hendriek.boshuizen@wur.nl

The STRATOS Initiative has recently published a series of Bulletin articles introducing its mission and the activities of its Topic Groups. Here, we provide an update from the Measurement Error and Misclassification Topic Group (TG4). The main objective of our Topic Group is to raise awareness among statisticians and biomedical researchers of: 1) the impact that measurement error and misclassification can have on study results, 2) the need to adjust for this impact in study analyses, and 3) the methods and software that are available to accomplish this adjustment. To this end, we aim to publish articles in the statistical and biomedical literature, give talks and short courses at professional conferences, and offer other educational materials online.

Since its inception, membership in our Topic Group has grown. Our current members are: Laurence Freedman and Victor Kipnis (Joint Chairpersons), Hendriek Boshuizen, Raymond Carroll, Veronika Deffner, Kevin Dodd, Paul Gustafson, Ruth Keogh, Helmut Kuechenhoff, Douglas Midthune, Pamela Shaw, Anne Thiébaud, Janet Tooze, and Michael Wallace who collectively have many years of experience working with error-prone data across a variety of disciplines and with developing and applying methods to adjust for the impact of the error.

To date, the group has published a literature review of current practice in handling measurement error in *Annals of Epidemiology* (2018), an educational piece in *Significance* (2020), and a 2-part tutorial in *Statistics in Medicine* (2020). We are now engaged with special topics in measurement error and misclassification to draw attention to common pitfalls and shortcomings in analyses currently appearing in the literature in specific settings. We are focused on two settings that are occurring quite frequently in epidemiologic and public health journals: when predicted values are used instead of observed data in study analyses and when continuous error-prone variables are analyzed as categorical variables.

In settings where an outcome or exposure of interest is either too expensive or too hard to measure precisely, predicted values may be used instead. Examples include usual nutrient intake values that are predicted from recovery biomarker-derived calibration equations and Schofield’s prediction equation for Resting Energy Expenditure (REE). Predicted values typically have Berkson measurement error, a type of error that makes the derived quantity less variable than the quantity it estimates. The impact that Berkson error has on study analyses will depend on whether the predicted value is analyzed as an exposure or an outcome. When the Berkson error in a predicted covariate is independent of other variables in the regression model, and the predicted value has the correct conditional expectation, using it in place of an observed exposure will not bias regression coefficients; however, using the predicted value as a regression outcome under these same assumptions will. The independence of the Berkson error is an important assumption that is difficult to verify in practice and one that is likely not to hold in the presence of a mis-specified prediction model. These impacts of Berkson error are not widely appreciated and, consequently, often ignored. We are working on a series of three manuscripts that highlight important considerations for the handling of Berkson error and appropriate methods for analysis. Our first manuscript will introduce Berkson

measurement error and consider the example of estimating a distribution with predicted values. Our second manuscript will discuss issues that can arise when applying regression calibration, a popular method to address covariate measurement error that replaces the error-prone covariate by a predicted value. Finally, we will consider important issues for analysis when a prediction equation is used to construct a variable that is then used as an outcome variable.

When a continuous variable is prone to measurement error, a common practice is to categorize this variable in study analyses in an attempt to reduce the impact of measurement error. Depending on the nature of the error and statistic of interest, the degree to which this approach can ameliorate the effects of measurement error or exacerbate them is not broadly understood. For instance, even when measurement error of the original, continuous variable is non-differential, that is, independent of the outcome studied, the misclassification of the categorized variable no longer is non-differential. Furthermore, categorization assumes a step function between the variable and the outcome, which is unrealistic. This will cause lack of fit of the statistical model used, which in turn might hamper proper adjustment for confounding. Our Topic Group is currently engaged in developing a guidance document to improve understanding of the analytical issues that arise when categorizing an error-prone covariate. Concepts and methods will be illustrated with a series of examples built with synthetic data, so that the different methods of analysis can be directly compared in terms of their success in handling the bias induced by measurement error.

As part of our educational efforts, Topic Group 4 has developed a website (<http://www.stratostg4.statistik.uni-muenchen.de>), where slides from previous presentations and other resources are provided. We are also developing a series of short videos that will help the viewer readily appreciate the impact of measurement error in different settings through a series of examples. Pamela Shaw and Ruth Keogh developed a short course on measurement error, which includes a series of R vignettes. A version of this course has been presented at multiple international conferences, most recently at the International Society for Clinical Biostatistics (ISCB) Conference in August 2020 and is currently being organized as a 2021 traveling course for the American Statistical Association. We have also developed a shiny app to demonstrate the effects of measurement error (<https://mem-explorer.shinyapps.io/MEM-Explorer-v3/>).

The Topic Group continues to be engaged in conference presentations. Helmut Kuechenhoff and Veronika Deffner presented on guidelines for dealing with measurement error in epidemiologic studies at ISCB in August 2020. A symposium on the use and misuse of prediction equations was presented at the International Conference for Dietary and Physical Activity Assessment (ICDAM) in February 2021, featuring talks by Daniela Sotres-Alvarez and Laurence Freedman. At the same conference, Hendriek Boshuizen presented work on categorizing error-prone variables. Pamela Shaw will also present on the use of predicted values in nutritional epidemiology at the Society for Epidemiologic Research (SER) in June 2021. Be sure to check out our Topic Group's website (<http://www.stratostg4.statistik.uni-muenchen.de>), where you can find up-to-date news regarding upcoming presentations and all latest resources. There are many activities and helpful resources being developed by all the STRATOS Topic Groups. You can find out more about these at the STRATOS Initiative's central website (<http://www.stratos-initiative.org/>).

Meet the International Biometric Office

It's not too late to wish you and your family a Happy New Year from the International Biometric Office (IBO). We look forward to working with you and your Region in 2021. If you have any questions, comments or concerns, you can reach us by email at ibs@biometricsociety.org.



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