Reviewer’s report

Title: LEVEL (Logical Explanations & Visualizations of Estimates in Linear mixed models): Recommendations for reporting multilevel data and analyses

Version: 0 Date: 28 Aug 2019

Reviewer: Marco Geraci

Reviewer's report:

The main limitation of this paper is that the authors only discussed linear mixed models (LMMs) with independent random effects. They completely forwent discussing GLMMs for, e.g., binary and count data; and barely mentioned correlated random effects. Moreover, these guidelines should be motivated by showing hard evidence of common mistakes in reporting mixed model results, and how widespread they are.

Specific comments

- What was the process that led to formulating the guidelines in Table 4? Majority/unanimity among the authors? Were statisticians and/or users besides the authors involved in the discussion?

- p.3 "incorporating random effects into a generalized linear model (GLM)". This may confuse the reader since GLM are not discussed in the paper. Could write "incorporating random effects into a regression model".

- p.3 "Mixed effects models, multilevel data, contextual analysis, hierarchical studies, longitudinal designs, panel and repeated-measures studies, are some of the different names given to the analysis of correlated data, and are essentially the same in their analytic approaches". This sentence puts together different things (data, methods, designs).

- p.3 "The methodology for generalized linear mixed models (GLMM) can seem complex due in part to how poorly results of multilevel analyses are reported". This is a broad, unsubstantiated statement.

- p.3 "Most manuscripts do not describe the hierarchical structure of the data or mention the level of the various variables used in the model; and almost none report the intra-level correlation coefficients (ICC)". Another broad, unsubstantiated statement. The authors should do a literature search, perhaps focus on specific fields/take a random sample of studies given the large literature, and obtain some solid evidence to support the need for these guidelines.

- p.3 "A standardized guideline for the reporting of multilevel data and the presentation of GLMM models will promote adequate reporting of correlated data analyses". The paper actually deals with LMMs only. GLMMs are only mentioned on page 5 "similar interpretations are applicable to the linear link function of any GLMM". Too bad GLMMs with a linear link function (other than normal) are
rarely used. These guidelines are of limited use without a proper account of GLMMs with different link functions.

- Some discussion about a marginal approach (e.g., GEE) as an alternative to mixed models is warranted. This is an important aspect often neglected by researchers. If the only concern is to account for intraclass correlation and conditional inference is not of interest, then researchers might be better off with marginal models. Interpreting regression coefficients of marginal models may also be easier as compared to some GLMMs.

- "GLMM models" is redundant since GLMM already includes "model".

- p.4 "As the term ICC is often mistaken for an estimate of a correlation coefficient". Which coefficient? I guess the authors refer to Pearson's linear correlation.

- p.9 "It may be of special interest to report these for the 'null' model (i.e. with no independent variables), as well as for the final model (and other 'intermediate' models), so that the reader may understand the impact of explanatory variables on the variance components." This sentence does not make much sense. The null model by definition has only one random effect (intercepts). So what does "impact of explanatory variables on the variance components" mean if there is nothing to compare to?

- p.9 "Finally, measures of model fit, such as either the Akaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC), or the area under the ROC curve (AUC) for logistic regression models, may be useful for readers". This is a superficial account of something that is not yet clearly understood. How do you calculate AIC/BIC/AUC in mixed effects models? Conditionally or marginally? See for example the excellent article by Vaida and Blanchard on conditional AIC for mixed-effects models (Biometrika, 2005).

- The paper deals with independent random effects and barely mentions complex structures of random effects.

- There is no recommendation on REML vs ML estimation.

- The paper does not clarify how to calculate and interpret the VPC (1) in the presence of random slopes and (2) for a GLMM other than normal. This is surely more complicated than what the authors present in the methods, and interpretation is not as immediate.

- In the real data example, the authors state they used a logistic mixed model, with equations in supplementary. However, in the latter they indicate a "linear link function" for prevalence with (apparently) normal residuals. So what is the actual model? And if it's logistic, how was the VPC calculated? Moreover, why not introduce random slopes to give a more exhaustive example of how to report results?

Are the methods appropriate and well described?
If not, please specify what is required in your comments to the authors.

No
Does the work include the necessary controls?
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Unable to assess

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