ARTICLE

Introducing 'powerlmm' an R package for power calculations for longitudinal multilevel models

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Over the years I've produced quite a lot of code for power calculations and simulations of different longitudinal linear mixed models. Over the summer I bundled together these calculations for the designs I most typically encounter into an R package. The purpose of *powerlmm* is to help design longitudinal treatment studies, with or without higher-level clustering (e.g. by therapists, groups, or physician), and missing data. Currently, *powerlmm* supports two-level models, nested three-level models, and partially nested models. Additionally, unbalanced designs and missing data

can be accounted for in the calculations. Power is calculated analytically, but simulation methods are also provided in order to evaluated bias, type 1 error, and the consequences of model misspecification. For novice R users, the basic functionality is also provided as a Shiny web application.

The package can be install from CRAN: http://cran.r-project.org/package=powerlmm (http://cran.r-project.org/package=powerlmm), or GitHub github.com/rpsychologist/powerlmm (http://github.com/rpsychologist/powerlmm). Currently, the packages includes three vignettes that show how to setup your studies and calculate power.

```
# CRAN
install.packages("powerlmm")

# GitHub
devtools::install_github("rpsychologist/powerlmm", build_vignette
```

A basic example

```
library(powerlmm)
# dropout per treatment group
d <- per_treatment(control = dropout_weibull(0.3, 2),
                   treatment = dropout_weibull(0.2, 2))

# Setup design
p <- study_parameters(n1 = 11, # time points
                      n2 = 10, # subjects per cluster
                      n3 = 5, # clusters per treatment arm
                      icc_pre_subject = 0.5,
                      icc_pre_cluster = 0,
                      icc_slope = 0.05,
                      var_ratio = 0.02,
                      dropout = d,
                      cohend = -0.8)

# Power
get_power(p)
```

```
##
##      Power calculation for longitudinal linear mixed model (th
##                              with missing data and unbalanced de
##
##                n1 = 11
##                n2 = 10  (treatment)
##                     10  (control)
##                n3 = 5   (treatment)
##                     5   (control)
##                     10  (total)
##           total_n = 50  (treatment)
##                     50  (control)
##                     100 (total)
##           dropout =  0,  1,  2,  3,  4,  5,  6,  7,  8,  9, 10
##                      0,  0,  1,  3,  6,  9, 12, 16, 20, 25, 30
##                      0,  0,  1,  2,  4,  5,  8, 10, 13, 17, 20
## icc_pre_subjects = 0.5
## icc_pre_clusters = 0
##         icc_slope = 0.05
##         var_ratio = 0.02
##            cohend = -0.8
##             power = 0.68
```

Feedback

I appreciate all types of feedback, e.g. typos, bugs, inconsistencies, feature requests, etc. Open an issue on github.com/rpsychologist/powerlmm/issues (http://github.com/rpsychologist/powerlmm/issues) or via my contact info here (http://rpsychologist.com/about).

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About Kristoffer Magnusson

I'm a clinical psychologist from Sweden with a passion for research and statistics. My Ph.D. thesis focuses on a mix of therapist effects, psychotherapy, and gambling problems. You can read the thesis here: **Methodological issues in psychological treatment research** (https://openarchive.ki.se/xmlui/handle/10616/46909).

This is my personal blog about psychological research and statistical programming with R.

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