Using the BlandAltman method to measure agreement with repeated measures http://bja.oxfordjournals.org/content/99/3/309.full

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0.1 Random effects Model

? proposes the use of Random effects models to address the issue of repeated measurement.

Myles proposes a formulation of the BlandAltman plot, using the within-subject variance estimated by the random effects model, with the time of the measurement taken as a random effect. He states that *random effects models account for the dependent nature of the data, and additional explanatory variables, to provide reliable estimates of agreement in this setting.*

Agreement between methods is reflected by the between-subject variation.The Random Effects Model takes this into account before calculating the within-subject standard deviation.

0.1.1 Myers Random Effects Model

The presentation of the 95% limits of agreement is for visual judgement of how well two methods of measurement agree. The smaller the range between the two, the better the agreement is The question of small is small is a question of clinical judgement

Repeated measurements for each subjects are often used in clinical research.

0.1.2 Random Effects Modelling

Random effects models are used to examine the within-subject variation after adjusting for known and unknown variables, in which each subject has a different intercept and slope over a time period period.

? remarks that the random effects model is an extension of the analysis of variance method, accounting for more covariates.

A random effect (in Myles's case, time of measurement) is chosen to reflect the different intercept and slope for each subject with respect to their change of measurements over the time period.

In Myles's methodology, the standard deviation of difference between the means of the repeated measurements can be calculated based on the within-subject standard deviation estimates.

A random effects model (also variance components model)is a type of hierarchical linear model. Hierarchical linear modelling (HLM) is a more advanced form of simple linear regression and multiple linear regression. HLM is appropriate for use with nested data.

Faraway comments that the random effects approach is *more ambitious than the LME model in that it attempts to say something about the wider population beyond the particular sample.*

0.2 Random Effects and MCS

The methodology comprises two calculations. The second calculation is for the standard deviation of means Before the modified Bland and Altman method can be applied for repeated measurement data, a check of the assumption that the variance of the repeated measurements for each subject by each method is independent of the mean

of the repeated measures. This can be done by plotting the within-subject standard deviation against the mean of each subject by each method. Mean Square deviation measures the total deviation of a

0.2.1 Random coefficient growth curve model

(Chincilli 1996) Random coefficient growth curve model, a special type of mixed model have been proposed a single measure of agreement for repeated measurements.

$$\mathbf{d} = \mathbf{Xb} + \mathbf{Zu} + \mathbf{e} \tag{1}$$

The distributional asummptions also require $\mathbf{d}$ to $\mathbf{N}$

0.3 Repeated Measurements

The original BlandAltman paper (1983) has been cited on more than $11,500$ occasions indicative of its importance in medical research.

Myers also remarks up on this : *The BlandAltman method can even include estimation of confidence intervals for the bias and limits of agreement, but these are often omitted in research papers.*

When repeated measures data are available, it is desirable to use all the data to compare the two methods. However, the original BlandAltman method was developed for two sets of measurements done on one occasion (i.e. independent data), and so this approach is not suitable for repeated measures data. However, as a nave analysis, it may be used to explore the data because of the simplicity of the method.

Myers comments upon the misuse of the Bland Altman methods is literature, citing several research papers.

Myers et al propose using random effects models.

> The original Bland Altman Publication has been cited on more than 11,500 occasions, compelling evidence of its importance in medical research.

The Bland Altman method can even include estimation of confidence intervals for the bias and limits of agreement, but these are often omitted in research papers.

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The original Bland Altman Method was developed for two sets of measurements done on one occasion (i.e. independent data), and so this approach is not suitable for repeated measures data. However, as a nave analysis, it may be used to explore the data because of the simplicity of the method. Myles states that such misuse of the standards Bland Altman method is widespread in Anaesthetic and critical care literature.

Bland and Altman have provided a modification for analysing repeated measures under stable or chaninging conditions, where repearted data is collected over a period of time. Myers proposes an alternative Random effects model for this purpose.

0.4 Random Effects Model (Myers)

- With repeated measures data, we can calculate the mean of the repeated measurements by each method on each individuals
- The pairs of means can then be used to compare the two methods based on the 95
- However the variation of the differences will be underestimated by this practice because the measurement error is, to some extent, removed. Some advanced statistical calculations are needed to take into account these measurement errors.
- Random effects models can be used to estimate the within-subject variation after accounting for other observed and unobserved variations, in which each subject has a different intercept and slope over the observation period
- On the basis of the within-subject variance estimated by the random effects model, we can then create an appropriate Bland Altman Plot.
- The sequence or the time of the measurement over the observation period can be taken as a random effect.