

Agreement between measurements Bland Altman Plots

Statistical concepts for clinical investigators

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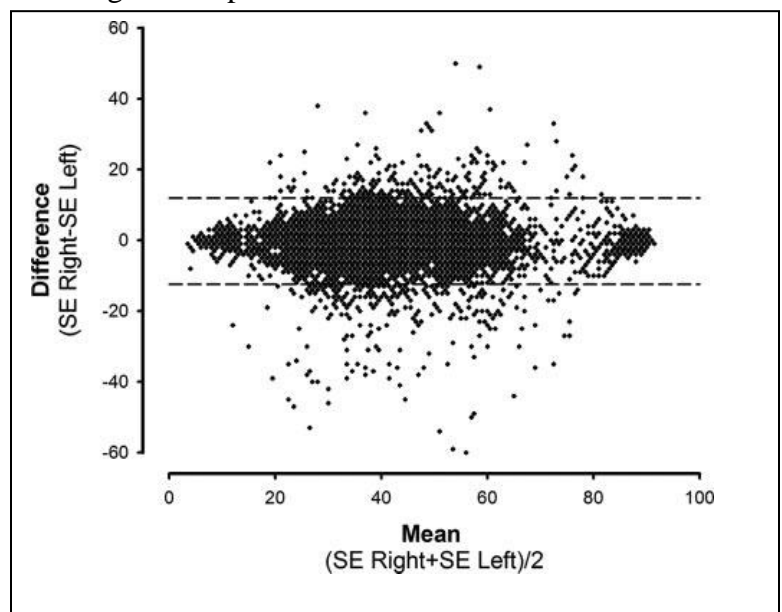
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Bland and Altman (1986) offer a respected and widely used graphical method to assess agreement between measurements. The basic “Bland-Altman plot” maps the difference between paired measurements (depicted on the vertical axis) with the magnitude of the measurements (on the horizontal axis). The magnitude is often quantified as the average of the paired measurements.

The example of the plot to the right is from:

Ozcan MS. Thompson DM. Cure J. Hine JR. Roberts PR. Same-patient reproducibility of state entropy: a comparison of simultaneous bilateral measurements during general anesthesia. *Anesth Analg*. 2009 Jun;108(6):1830-5. PMID: 19448208

In calculating the mean difference between the paired measurements, the technique quantifies bias, a systematic difference in the measurements.



Bland-Altman plots customarily include horizontal lines that illustrate the 95% limits of agreement. The limits are determined by multiplying by 1.96 the *standard error of the difference*. This standard error, itself an estimate of within-subject measurement variability or measurement error, is calculated from a statistical model that accounts for the observations' patterns of correlation. If the differences in scores at the limits of agreement are not clinically meaningful, then the two measurement methods are arguably of equal usefulness and can be used interchangeably.

References

Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* 1986;1:307-10.

Bland JM, Altman DG. Agreement between methods of measurement with multiple observations per individual. *J Biopharm Stat* 2007;17:571-82.

Myles PS, Cui J. Using the Bland-Altman method to measure agreement with repeated measures. *Br J Anaesth* 2007;99:309-11.