Book: Measurement in medicine
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www.cambridge.org/9780521133852

CHAPTER 5. RELIABILITY

BASED ON: De Winter AF, Heemskerk MA, Terwee CB, Jans MP, Devillé W, Van Schaardenburg DJ, Scholten RJ and Bouter LM. (2004). Inter-observer reproducibility of measurements of range of motion in patients with shoulder pain using a digital inclinometer. Biomed Central Musculoskeletal Disorders, 5, 18.

****

*Chapter 5.2 Paired t-test and Pearson's r.

GET FILE *database chapter 5 database short*.

```
T-TEST
  PAIRS = ROM.1  WITH ROM.2 (PAIRED)
  /CRITERIA = CI(.95)
  /MISSING = ANALYSIS.

CORRELATIONS
  /VARIABLES=ROM.1 ROM.2
  /PRINT=TWOTAIL NOSIG
  /STATISTICS DESCRIPTIVES
  /MISSING=PAIRWISE .
```

****

Chapter 5.4.1. Intraclass correlation coefficients for single measurements.

* there are three ways to calculate ICCs. See also 'Calculation of ICCs in SPSS'.

*1. calculation of ICCs using variance components.

GET FILE *chapter 5 database long*.

```
* var comp REML.
VARCOMP
  ROM  BY patcode PTAorB
  /RANDOM = patcode PTAorB
  /METHOD = REML
  /CRITERIA = ITERATE(50)
  /CRITERIA = CONVERGE(1.0E-8)
  /DESIGN = patcode PTAorB
  /INTERCEPT = INCLUDE .
```

*manual calculation of ICCs: 237.502/(237.502 + 16.539 + 55.131) = 0.77 (ICC agreement).
* 237.502 / (237.502 + 55.131) = 237.502 / 292.633 = 0.81 (ICC consistency).

****
* 2. calculation of ICC using Mean Squares.

* First, the data set needs to be reordered.

GET FILE *chapter 5 database long*.

```
SORT CASES BY patcode PTAorB .
CASESTOVARS
 /ID = patcode
 /INDEX = PTAorB
 /GROUPBY = VARIABLE .

SAVE OUTFILE= … 'chapter 5_book_SHORT.sav'.
```
(this is the same database as *chapter 5 database short*)

```
* calculation of ICCs using Mean Squares.

RELIABILITY
  /VARIABLES=ROM.1 ROM.2
  /SCALE('ALL VARIABLES')  ALL /MODEL = ALPHA
  /STATISTICS=ANOVA
  /ICC=MODEL(RANDOM) TYPE(CONSISTENCY) CIN=95 TESTVAL=0 .

*manually:.
* MSpat          = 530.135 = 2 s2 pat + s2 error .
*          530.135 - 55.131 = 2 s2 pat .
*          475.004 = 2 s2 pat .
*          237.502 = s2 pat .
*MSrater         = 882.090 = 50 s2 rater + s2 error .
*          826.959 = 50 s2 rater .
*          16.53918 = s2 rater .
*MSerror         = 55.131 = s2 error .

*ICC agreement .
*  = s2pat / (s2pat + s2rater + s2error)  .
*  = 237.502 / (237.502 + 16.53918 + 55.131) = 237.502 / 309.17218 = 0.768 .

*ICC consistency .
*  = s2 pat / (s2 pat + s2 error)  .
*  = 237.502 / (237.502 + 55.131) = 237.502 / 292.633 = 0.8116 .

**********
* 3. Calculation of ICCs direct via scale.
```

GET FILE *chapter 5 database short*.

```
RELIABILITY
  /VARIABLES=ROM.1 ROM.2
  /SCALE('ALL VARIABLES')  ALL / MODEL = ALPHA
  /STATISTICS=ANOVA
  /ICC=MODEL(RANDOM) TYPE(ABSOLUTE) CIN=95 TESTVAL=0 .


**********************************************************************************************
```

Chapter 5.4.2.1. Standard error of measurement (SEM)

* there are three ways to calculate Standard error of Measurements. See also 'Calculation of ICCs in SPSS'.

* 1. Calculation of SEM using variance components.

* SEM agreement= $\sqrt{(s^2t + s^2residual)}$ = $\sqrt{(16.539 + 55.131)} = \sqrt{(71.67)} = 8.47$.
* SEM consistency = $\sqrt{(s^2residual)} = \sqrt{55.131} = 7.43$.

* 2. Calculation of SEM usinf SD difference .
* SEM consistency = SD difference / $\sqrt{2}$ = .

GET FILE *chapter 5 database short*.

COMPUTE diffscore = ROM.1 - ROM.2 .
EXECUTE .

FREQUENCIES
  VARIABLES=diffscore
  /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN MEDIAN
  /ORDER= ANALYSIS .

* manually: .
* SEM consistency = SD difference / $\sqrt{2}$ = 10.50055 / 1.41421 = 7.43 .

* 3. Calculation of SEM using ICC .
* SEM = $s_y \sqrt{(1-ICC)}$.

FREQUENCIES
  VARIABLES=ROM.1 ROM.2
  /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN MEDIAN
  /ORDER= ANALYSIS .

* ROM 1: .
* SEMconsistency = 17.86029 x $\sqrt{(1-ICC)}$ = 17.86029 x $\sqrt{(1-0.8116)}$ = 17.86029 x $\sqrt{}$ 0.1884 = 17.86029 x 0.434050688 = 7.752 .
* SEMagreement = 17.86029 x $\sqrt{(1-ICC)}$ = 17.86029 x $\sqrt{(1-0.768)}$ = 17.86029 x $\sqrt{}$ 0.232 = 17.86029 x 0.48166378 = 8.603 .

* ROM 2: .
* SEMconsistency = 16.31796305816 x $\sqrt{(1-ICC)}$ = 16.31796305816 x $\sqrt{(1-0.8116)}$ = 16.31796 x $\sqrt{0.1884}$ = 16.31796 x 0.434050688 = 7.083 .
* SEMagreement = 16.31796305816 x $\sqrt{(1-ICC)}$ = 16.31796305816 x $\sqrt{(1-0.768)}$ = 16.31796 x $\sqrt{0.232}$ = 16.31796 x 0.48166378 = 7.860 .

****

Chapter 5.4.2.2. Limits of Agreement (Bland and Altman method).

GET FILE *chapter 5 database short*.

FREQUENCIES

```
  VARIABLES=ROM.1 ROM.2 diffscore
  /STATISTICS=STDDEV MINIMUM MAXIMUM MEAN
  /ORDER=  ANALYSIS .

COMPUTE meandiff = (ROM.1 + ROM.2)/2 .
EXECUTE .
```

* to calculate the limits of agreement and to draw the Bland and Altman plot, please see Assigment 2.