

Measurement in Health and Disease

Exercise: Measurement error and observer variation

In a study of the measurement of muscle strength, tests were carried out on 20 healthy subjects, 5 men and 15 women aged between 60 and 84, by two observers. Among others, isometric tests were carried out on elbow and knee. The results were presented in two ways: as intraclass correlation coefficients (ICC) and as within-subject standard deviations, for which the authors used the term ‘standard error of measurement (SEM)’. Each was calculated for observations by the same observer, intra-rater, and for observations by two different observers, inter-rater (Richardson et al 1998).

(a) What do ICC and SEM each tell us about the measurement error?

The following results were given (measurements in kgf):

	Intra-rater			Inter-rater		
	ICC	(95% CI)	SEM	ICC	(95% CI)	SEM
Elbow	0.88	(0.75,1)	1.57	0.87	(0.78,1)	1.67
Knee	0.89	(0.76,1)	1.84	0.67	(0.44,1)	3.16

- (b) What can we conclude about the measurement of muscle strength using this dynamometer?
- (c) The upper 95% confidence limits for ICC are all given as 1. Why must this be wrong? (This is a difficult one!)
- (d) The authors comment that the results suggest that the two raters’ techniques were different for the knee but not for the elbow. Do you agree?

Muscle strength varied considerably in the sample:

	Range	Mean	SD
Elbow	1.8–18.8	7.8	4.9
Knee	9.2–35.4	19.1	6.3

- (e) The authors commented that the variation between subjects contributed to the size of the reliability coefficient. Why is this? Does it affect the SEM?
- (f) What shape does the distribution of muscle strength have? (Hint: look at the position of the mean in the range and whether we could have observations 2 SD less than the mean.) Does this affect the results in any way?
- (g) What would be the best way to improve the study?

Reference

Richardson J, Stratford P, Cripps D. (1998) Assessment of reliability of the hand-held dynamometer for measuring strength in healthy older adults. *Physiotherapy theory and practice*, **14**, 49-54.