A Study of The Reliability on Tandem Gait Test with The Bland-Altman Analysis

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relevance and purpose

- walking heel to toe (tandem gait) is
  - a dynamic balance assessment
  - a balance exercise

prevention exercise of fall for elderly
in social elderly care insurance of Japan

- tandem gait test
  - tandem gait as a dynamic balance assessment
  - no general procedure
    - expended timing
    - consideration about the number of mistakes during tandem gait (mis-step(s))
  - no report about reliability and validity
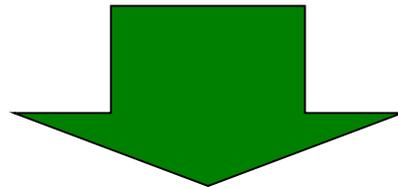
The purpose of this study is to investigate the intra-rater and the inter-rater reliability of tandem gait tests

method

- subjects
  - 57 older people

    49 females and 8 males, 66.2 ±8.3 years

- tandem gait
  - The participants were instructed
    - to place one foot in front of the other making sure that, with each step, the heel of one foot was directly in front of the toes of the other foot on a line of red tape (50mm width).
    - to walk forward as fast as possible without falling or making any mistakes

- dependant variables
  - TGT: tandem gait time
    - the expended timing of 5m tandem gait
  - TGI: tandem gait index (*Liu et al. 2005*)
    - TGI = expended timing + 2×mis-step(s)
    - the mis-step(s)
      - steps taken with the whole foot outside the bounds of the red tape

- assessors
  - assessor A: resident physical therapist (6 y. experience)
  - assessor B: physical therapy student
  - two assessors measure the TGT and TGI at the same time of day

statistics

- Intraclass Correlation Coefficient (ICC)
  - The intra-rater reliability was calculated with $ICC_{(1,1)}$
  - in order to guarantee high reliability, we determined the number of measurements with $ICC_{(1, k)}$
 - The inter-rater reliability was calculated with $ICC_{(2, 1)}$

- Bland- Altman analysis *(Bland and Altman, 1986)*
  - purpose
    - to define the "limit of agreement"
    - to define the potential sources of systematic bias (fixed and proportional bias)

- procedure
  - plot the differences between pair of values, (V1-V2), against the corresponding means, (V1+V2)/2
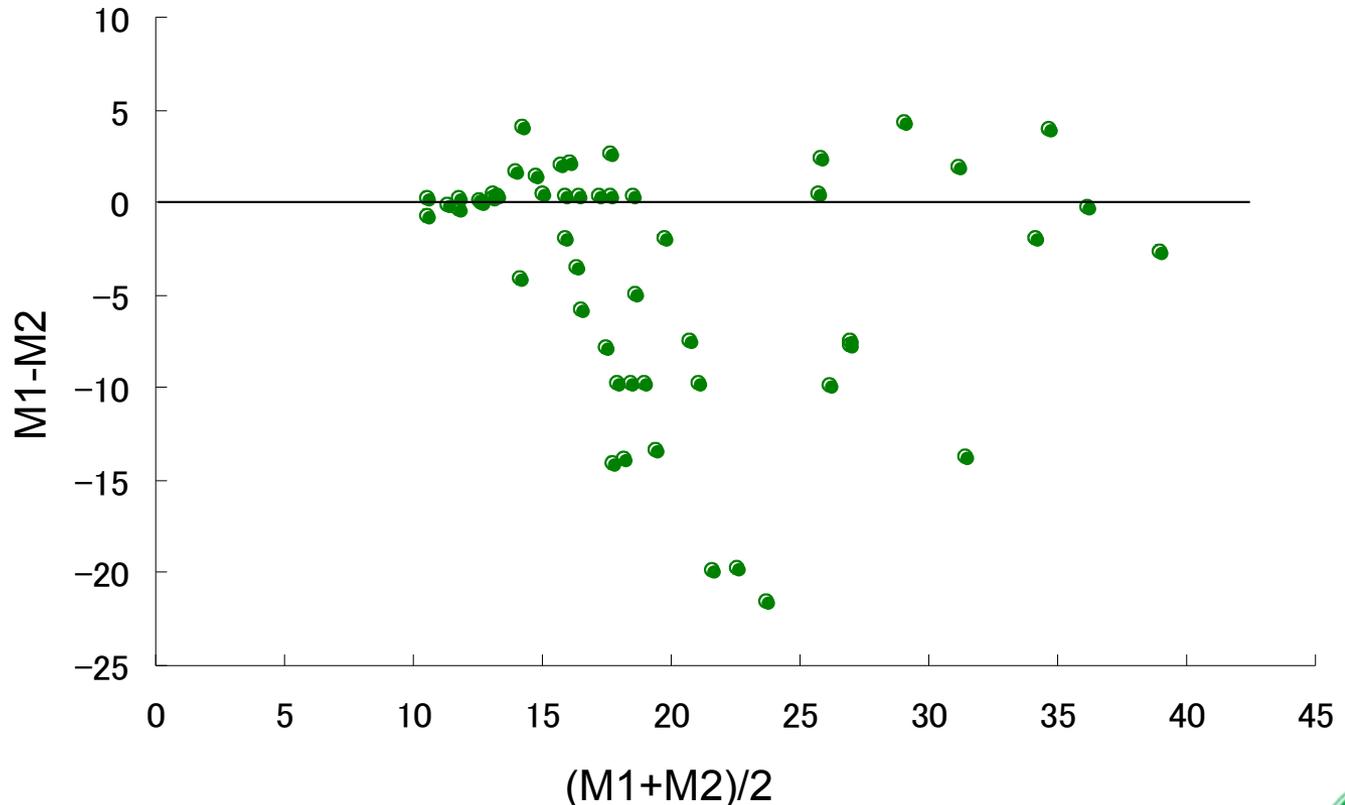   - M1, M2: values resulting from measurement of the same variable by two methods or two assessors
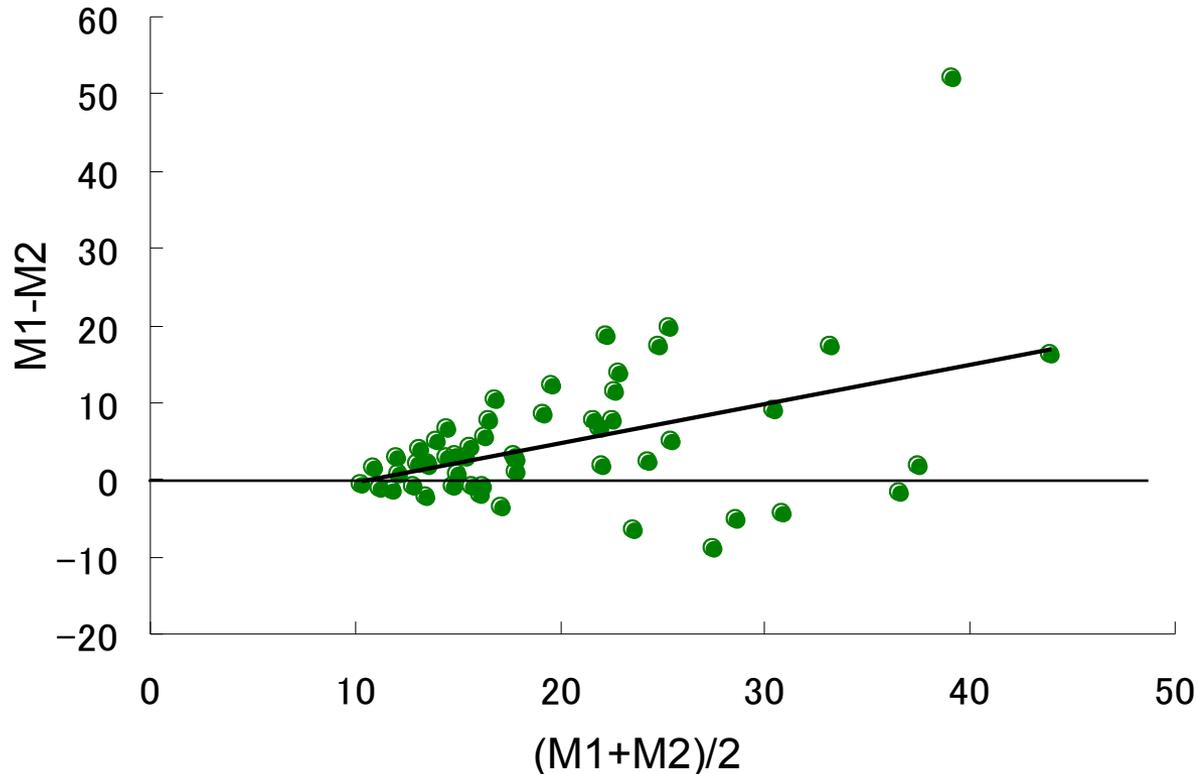
- "(optimistic) limit of agreement"
  $$(d- 2s)+ t{\times}SE(d{\pm}2s) \sim (d+ 2s)- t{\times}SE(d{\pm}2s)$$

define the systematic bias

fixed bias

- if there is no fixed bias between the two values, the mean of (M1-M2) should be zero
- this hypothesis be tested by using 95% confidence interval (95% CI)

define the systematic bias

proportional bias

- if there is no proportional bias between the two values, the regression of differences on means should have a slope of zero

- the Peason's product-moment correlation coefficient and testing the hypothesis that r=0
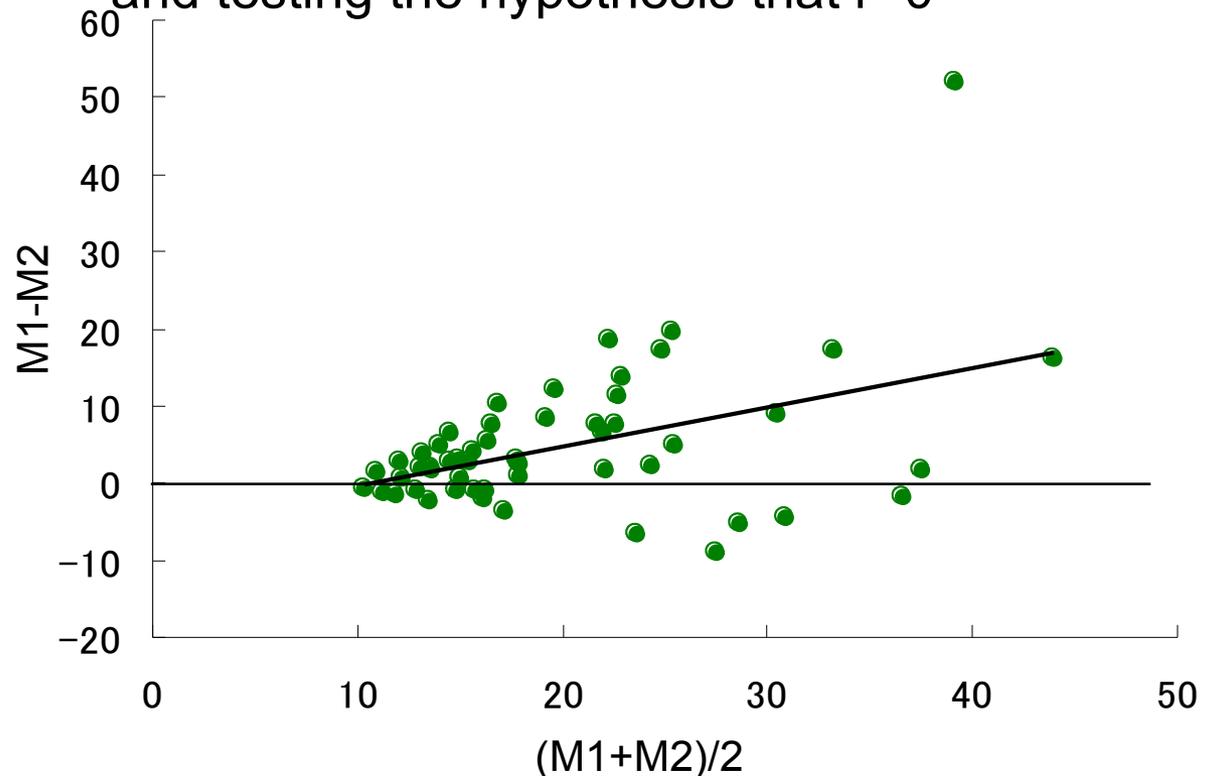
result

- ## the intra-rater reliability

		ICC (1, 1)	Bland-Altman analysis					
			limit of agreement [sec]	fixed bias			proportional bias	
				95% CI			slope	
TGT	assessor A	0.78	-4.5 ～ 6.1	-0.11 ～1.73	no		0.18 p=0.05	no
	assessor B	0.76	-5.1 ～ 6.3	-0.36 ～1.60	no		0.23 p=0.02	yes
TGI	assessor A	0.71	-6.0 ～ 8.5	-0.07 ～2.50	no		0.20 p=0.06	no
	assessor B	0.53	-7.6 ～11.9	0.39 ～3.89	yes		0.41 p=0.00	yes

the inter-rater reliability

		ICC (3, 1)	Bland-Altman analysis					
			limit of agreement [sec]	fixed bias			proportional bias	
				95% CI			slope	
TGT	first test	0.77	-4.6 ～ 6.1	-0.16 ～1.69	no	0.20	p=0.04	yes
	retest	**1.00**	**-0.6 ～ 0.5**	**-0.13 ～0.04**	**no**	**0.01**	**p=0.19**	**no**
TGI	first test	0.75	-5.3 ～ 8.2	0.19 ～2.63	yes	0.15	p=0.08	no
	retest	**0.98**	**-1.3 ～ 1.8**	**-0.01 ～0.55**	**no**	**-0.03**	**p=0.23**	**no**

discussion

- the tandem gait time (TGT)
  - has "fair" intra-rater reliability
  - has little systematic bias
  - can guarantee high reliability by two or more repetitive measurements.
- the tandem gait index (TGI)
  - has the systematic bias (fixed and/or proportional bias)
- The reliability of both TGT and TGI depend on the experience of assessor

conclusion and future study

- TGT (expended timing of 5m tandem gait) has
  - simple procedure
  - higher reliability than TGI, considering mis-step(s)

- future study
  - "validity" as dynamic balance assessment
  - "mis-step(s)"
    - connoting possibility of falling