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COMMENTARY

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RESPONSE TO LETTER TO THE EDITOR FROM FRANCO FRANCHIGNONI AND ANDREA GIORDANO

We thank Franchignoni and Giordano for their insightful comments (1) on our article (2). As their comments suggest, our study has problems regarding generalization based on the sample size, subject characteristics (i.e. subjects with mild-to-moderate balance impairment), and as the 2 shorter versions of the Balance Evaluation Systems Test (BESTest) were not directly administered. We are aware of the limitations of our study. However, this study is significant because it reveals the internal structure of the 3 BESTest in older adults with hip or vertebral fractures and suggests the best possible intervention. This may reveal the characteristics of older adults with hip or vertebral fractures, unlike previous studies that analysed neurological disorders, such as stroke and Parkinson's disease (3–6).

Franchignoni et al. comment that it is important to understand the internal structure of the balanced rating scales in order to define quality outcome measures. In order to contribute to the future development of the discussion on the internal structure for the 3 BESTests, we present the results of our analysis in older adults with hip or vertebral fractures below.

Firstly, regarding the multidimensionality of the BESTest; using exploratory factor analysis, we examined the multidimensionality using a method similar to that used in our previous reports (7). The results suggested 4 dimensions (dynamic balance with gait, static standing balance, sitting balance, and stepping reaction). The results of the present and previous studies suggest that the BESTest has a multidimensional structure, not the original 6 dimensions, which may not be relevant to disease.

Secondly, the modified model proposed in previous studies (4, 8, 9) regarding the internal structure of the Brief-BESTest is discussed. The results of the confirmatory factor analysis for each model are shown in Table I. Compared with the original Brief-BESTest, the modified model showed a significant improvement in the goodness-of-fit index. These results are similar to those reported by Godi et al. (10) for neurological disorders, and Brief-BESTest may be preferable for use in a modified model.

Thirdly, we performed Rasch analysis on the unidimensional model for Mini-BESTest. As a result of the Rasch analysis, principal component analysis for the standardized residuals showed that the eigenvalue of the unexplained variance in the first construct was 2.45, which was a little high. This can be interpreted as unidimensional by using the criterion that less than 3, but not less than 2, is unidimensional. Only one item had slightly high infit values, including the item "Stance on foam surface, eyes closed" (infit mean of the squared residuals = 1.70). The person-item map is shown in Fig. 1. The difficultly level of the items range from –3.24 to 3.46 logit and person ability ranged from –3.84 to 5.00 logit. From the results of this analysis, although one item did not fit, the item response when Mini-BESTest was regarded as unidimensional was clarified. Although the degree of difficulty of the item did not differ from that of the research on neurological diseases (5, 6), it was found that older adults with hip or vertebral fractures had less difficulty in the item related to the sensory function.

Fourthly, we also analysed the construct validity in each of the 4 dimensions (i.e. factors) considered in the present study. In our study, the structure of the 4-factor Mini-BESTest model was most plausible in older adults with hip or vertebral fractures, although there were some limitations. Correlations between other factors, comfortable walking speed (CWS) and other balance assessment scale (Berg Balance Scale; BBS) for each factor were analysed and examined for construct validity. As a result of the correlation analysis, each factor significantly correlated with other factor (rho = 0.365–0.582), CWS (rho = 0.401–0.692) and BBS (rho = 0.363–0.681) (Table II). There were not very strong (r > 0.9) correlations between factors, with only poor-to-moderate correlations. Although other aspects of validity could not be examined, the correlation analysis suggests that each factor may have certain associations, but can be independent of each other.

Clarifying the internal structure of the balance assessment scale is an important part of the interpretation of the data. Our additional analysis suggested that the same measure may have different characteristics depending on the disease. Despite the effect of sample

Table I. Goodness-of-fit indices related to our 3 confirmatory factor analyses of the Brief-BESTest

Model	CFI	TLI	RMSEA (90% CI)	SRMR
1 (Padgett et al., 2012) (8)	0.710	0.594	0.214 (0.175–0.255)	0.170
2 (Franchignoni and Giordano, 2012) (9)	0.998	0.998	0.016 (0.001–0.095)	0.048
3 (Bravini et al., 2016) (4)	0.982	0.969	0.058 (0.001–0.120)	0.047

CFI: comparative fit index; TLI: Tucker-Lewis index; RMSEA: root-mean square error of approximation; SRMR: standardized root-mean-square residual; 90% CI: 90% confidence interval.

Table II. Correlation between each factor of the Mini-BESTest and assessment scale

Factor or measure	Anticipatory postural adjustments	Postural response	Sensory orientation	Stability in gait	CWS
Postural response	0.558*				
Sensory orientation	0.424*	0.400*			
Stability in gait	0.582*	0.473*	0.365*		
Comfortable walking speed	0.692*	0.464*	0.401*	0.618*	
Berg Balance Scale	0.681*	0.469*	0.363*	0.664*	0.774*

*$p < 0.01$. CWS: comfortable walking speed.

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size, the background diseases and symptoms were different between Franchignoni et al.'s series study (1, 3–6, 9) and the present study (2). Balance is a complex ability that involves rapid, automatic, anticipatory, reactive integration, and sensory strategies, and its properties should differ between age-related functional decline and balance disturbances with neurological symptoms. Therefore, the selection of the balance assessment scale is important for appropriate evaluation and intervention in the subject. It is desirable to be able to translate the results of the assessment into interventions that have been reported in recent years (11, 12). In the future, we will continue to conduct studies to promote discussion of internal structures and study interpretability, including minimal clinically important difference (MCID) and cut-off value calculations, which are useful in clinical decision-making.

```
MEASURE     Person - MAP - Item
                 <more>|<rare>
   5                ##  +
                        |
                       T|
                        |
                        |
   4                 .  +
                        |T
                        |
                        |  Cognitive Get Up & Go
                 .###   |
   3                    +
                       S|
                .####   |  Stand on L/R foot
                        |
                 .###   |
   2                    +
                        |S
                  .##   |  Compensatory step L/R
             ########   |  Pivot turns
                        |
   1              .##  M+
                        |
                .####   |
                  ###   |  Step backward
                   ##   |  Rise to toes
   0                    +M
                   ##   |  Obstacles
                    #   |  Head turns; Step forward
                    .  S|
                        |
  -1                #   +
                    #   |
                    #   |  Stance, eyes closed; Change speed
                        |
                   ##   |S
  -2                .   +
                        |
                       T|  Incline, eyes closed
                        |
                    .   |
  -3                    +
                    .   |  Sit to stand
                        |
                        |
                    .   |T
  -4                    +
                 <less>|<freq>
```

Fig. 1. Person-item map of the unidimensional model for Mini-BESTest from Rasch analysis

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The authors have no conflicts of interest to declare.

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Kazuhiro Miyata, PhD, PT[1] *and Shigeru Usuda, PhD, PT*[2]
From the [1]Department of Physical Therapy, Ibaraki Prefectural University of Health Science, Ami-Machi and [2]Department of Rehabilitation Sciences, Gunma University Graduate School of Health Sciences, Maebashi, Japan. E-mail: miyatak@ipu.ac.jp