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The Screening Balance Ability to Identify Fall Risk Using the Mini-BESTest in the Pre-elderly

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Abstract

A fall is a common problem in all ages. The age-related physiological changes of various systems. (e.g., cardiovascular system, nervous system, musculoskeletal system, etc.). Especially, the balance control is the main factor that affects the fall in elderly and can lead to the death of elderly. The preparation of fall prevention in pre-elderly is needed. Mini-BESTest is important screening tool for evaluating fall risk and dynamic balance. The Mini-BESTest has the sensitivity of 68% and specificity of 65% in the pre-elderly people who are at a risk to fall. The scores of the Mini-BESTest are less than 22.5 that represented a risk to fall. The Mini- BESTest is suitable for screening risk to fall in pre-elderly due to the accuracy, sensitivity and specificity. The evaluation of sensitivity and specificity of the Mini-BESTest screen falls in the pre-elderly. Healthy male and female pre-elderly participants were divided into two groups; non-fall group and fall group (History of past 6-month of falls) (n=64 per group). Their balance abilities were assessed by using the Mini-BESTest, BBS, and TUG. An analysis of the resulting receiver operating characteristic curves was performed to calculate the area under the curve (AUC), sensitivity, specificity, cutoff score, and post-test accuracy. The results show that the Mini-BESTest had the highest AUC (0.71) compared with the BBS (0.59) and TUG (0.62). It demonstrates that the Mini-BESTest has the highest accuracy for identifation of pre-elderly with history of falls. At the cutoff score of 22.5 (out of 28), the Mini-BESTest demonstrated a post-test accuracy of 66% with a sensitivity of 64.06% and specificity of 68.75%. The Mini-BESTest has the highest post-test accuracy, with the others having results of 57% (BBS), and 52% (TUG).

Introduction

A fall is defined as "to come or drop down suddenly to a lower position, especially to leave a standing or erect position suddenly". Slips and trips are the causes of falls and unexpected changes during walking that lead to injury and death. (Onla-or et al., 2004). A fall in the elderly is considered as a major health problem. Since the world population is entering to the aging society,a fall is the cause of injury and leading to death in the elderly (Lausawatchaikul, 2000).

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falls in pre-elderly aged 50 to 59 years was 66% in developing countries and 34 % in high-income developed countries (Williams et al., 2015). Previous study found that the prevalence of falls increased 27% in 55-59 years old (Peeters et al., 2018). The result showed that the fall rates of Thai pre-elderly people were similar to the Thai older elderly people (Sorysang et al., 2014).

One of the majority consequences of fall is fracture (Sorysang et al., 2014). Therefore, the preparation and prevention of a fall are need. The balance assessments were used to examine the risks of fall in clinical and research. However, the lack of the balance ability during external perturbations or sensory conflicts assessment were limitations of balance assessments. Balance Evaluation Systems Test (BESTest) is a comprehensive clinical tool for evaluating postural control systems that focus on static and dynamic balance. The BESTest can identify the underlying postural control systems (Horak et al., 2009). Franchignoni et al., (2010) developed a shorter version of the BESTest. The Mini- Balance Evaluation Systems Test (Mini-BESTest) designed as a comprehensive clinical tool for evaluating dynamic balance that is related with a fall. The Mini-BESTest requires less administration time and less equipment. (Franchignoni et al., 2010). In addition, the Mini-BESTest has excellent interrater (ICC $\geq$ 0.91) and test-retest (ICC $\geq$ 0.88) reliability, compared to the Berg Balance Scale (BBS), the Mini-BESTest test lacks the ceiling effects (Leddy et al., 2011b) and has better sensitivity and specificity to identify people with Parkinson who have more of a chance to fall. The previous studies in individuals with PD showed the sensitivity 62-89% and the specificity 74-81%. In individuals with stroke showed a cut off 17.5 out of 28, sensitivity 64% and specificity 64.2%. (Tsang et al., 2013). The Mini-BESTest was used to assess the balance performance. It may be accurate in screening of the pre-elderly people who have balance problems and people who are at a risk of falls.

Therefore, the purpose of the present study was to determine the sensitivity and the specificity of Mini-BESTest for predicting the pre-elderly with having risk of a fall.

Participants and methods

Participants were recruited from the Pathum Thani of the Thailand between which October 2016 and which February 2017. Participants aged between 55 to 59 years were asked to participate in the present study (mean age 56.6 ± 1.4). There were 128 participants and were divided into two groups; non-fall (n=64) and fall groups (n=64) (history of fall in past 6-months) by convenience sampling. The research design is cross sectional study. This study defined a faller as a subject who fell at least once. Participants were included in the study if they met the following inclusion criteria: 1) with and without history of fall of their 6 months fall history 2) independence basic activities daily 3) able to walk 6 meters without using gait aids 4) able to communicate and follow instructions 5) being in good health and not affected with diseases such as stroke, spinal cord injury, Parkinson's and severe musculoskeletal problem disease that impact on movement and balance in the day of assessment 6) giving informed consent. Participant characteristics and others related information were gathered using the questionnaire and assessment through physical examinations. The cognitive functions and comprehensions were assessed by using the Mini-Mental State Examination Thai version 2002 (MMSE-Thai). The fear of falling was assessed by using the fear of falling scales. Randomly assessment balance ability was assessed by using the Mini- Balance Evaluation Systems Test (Mini-BESTest), Berg Balance scale (BBS) and Timed up and go test (TUG). Vital signs and blood pressure were measured before and after the testing. Participants were allowed to rest as long as they needed for muscle fatigue prevention during the test. This study was conducted using a cross-sectional approach. This study was approved by the Human Research Protection Committee, Rangsit University, Thailand (RSEC18/2559).

The statistical analysis was performed using SPSS version 11.5. A descriptive statistical analysis of the baseline characteristics of the participants was conducted. The Mann-Whitney U test was used to compare mean balance scores between the pre-elderly with and without a fall history 6 months. A statistically significant considered was p-value less than 0.05. Receiver operating characteristic curves was performed to calculate the area under the curve (AUC), sensitivity, specificity, cutoff score and post-test accuracy. The receiver operating characteristic (ROC) curves were used to determine the relative performance of the Mini-BESTest score, the BBS scores and the TUG scores for classifying pre-elderly into fallers and non-fallers. ROC curve used plots graph between true positive rate (sensitivity) and false positive rate (1-Specificity). Cutoff score selected the score that demonstrated the best balance between high sensitivity and high specificity.

Locating the cut-off point that requires a compromise between sensitivity and specificity. A method of determining the cutoff was used to calculate from post-test accuracy whether the selected cutoff score could correctly screen the pre-elderly fallers, the percentage accuracy of the pre-elderly who actually fell was calculated using the cutoff score (McHorney et al., 1994). Area under the curve (AUC) assessed accuracy of each balance test to discriminate the fallers and the non-fallers. If AUC closely was the 1 which representing the test corresponds to a perfect classification the fallers and the non-fallers (Akobeng, 2007).

Results and discussion

Subject characteristics data from pre-elderly in the community totaled 128 people and were categorized at entry into 64 participants per group based on their one fall history within the last 6 months. The characteristics data of the groups with no history of falls reported average age was 56.67 ± 1.35 years, Proportion of female and male was 56/6, the average score of the Mini mental state examination was 25.75 ± 9.19 and the average score of Fear of falling scale was 25.75 ± 9.19. Body mass index showed 23.92±3.76. Twenty-six participants with no history of falls reported chronic diseases such as hypertension, diabetes and dyslipidemia.

The characteristics data of the groups with a history of falls in 6 months reported average age was 56.49 ± 1.41 years, Proportion of female and male was 47/17, the average score of the Mini mental state examination was 24.03 ± 5.65 and the average score of Fear of falling scale was 30.89 ± 7.97. Body mass index showed 23.44±4.03. Thirty participants with history of falls reported chronic diseases such as hypertension, diabetes and dyslipidemia. The causes of falls in pre-elderly were mostly tripping, slipped and Postural transition was 25.69%, 13.49% and 1.92%, respectively.

Table 1 Score of Mini-BESTest, BBS and TUG between pre-elderly who had a fall history in 6 months and those who had no history of falls in 6 months

Balance assessments	pre-elderly who had no history of fall in 6 months; N=64	pre-elderly who had fall history in 6 months; N=64	*p* value
Mini-BESTest (/28)	23.47 ±2.68	21.14±2.82	0.021*
Berg Balance scale (/56)	54.81 ±1.50	54.08±1.76	0.081
Time up and go test (/12)	8.97 ±1.70	10.45±1.59	0.042*

Remark: * Significant difference between fallers and non-fallers at p <0.05

There were statistically significant differences in the scores of the Mini-BESTest ($p<0.05$) and TUG ($p<0.05$) between the pre-elderly with and without history of fall groups. Nonetheless, there were no statistically significant differences in the BBS between both groups ($p>0.05$). The results showed that the BBS had a trend of ceiling effect as 15 participants from the pre-elderly who had a history of falls in past 6 months and showed the maximum score at 56 points (Table 1).

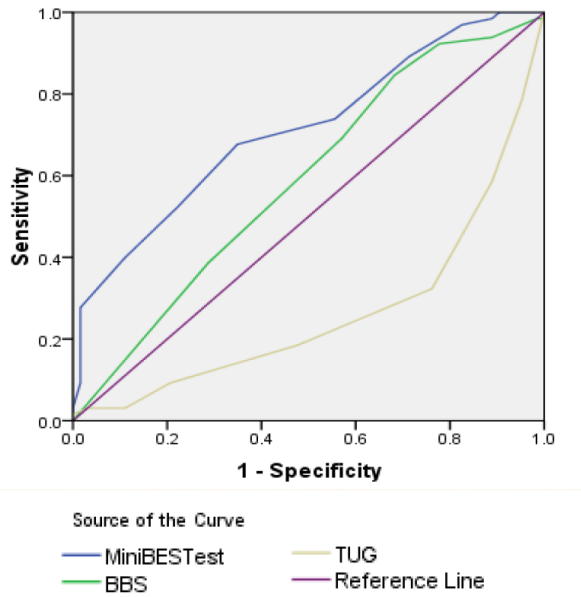

Fig. 1 Receiver Operating Characteristic (ROC) Curves of measurements (Mini-BESTest, BBS and TUG)

Fig. 1 illustrates that the area under the curve (AUC) of the Mini-BESTest is 0.71, which is closer to 1 than the BBS and TUG, which was 0.59 and 0.26, respectively. Moreover, the results show the cutoff score of the Mini-BESTest at 22.5 (68% sensitivity and 65% specificity) in predicting fallers in the pre-elderly. The findings show that the BBS, TUG have the cutoff score at 54.5 (69% sensitivity and 43% specificity) and 8.5 seconds (59% sensitivity and 11% specificity), respectively. The Mini-BESTest shows that the accuracy of predicting a fall was 66 %, which is higher than the BBS (57%) and the TUG (52%).

The Mini-BESTest could predict fall and has the ability to assess balance deficit that causes a fall. Because the Mini-BESTest had a comprehensive composition of postural control during walking (Franchignoni et al., 2010). Approximately, 10-25% of individuals with

history of a fall occurred due to poor postural stability (Shumway-Cook et al., 1997). The falls during a slip or a trip were caused by lack of automatic postural responses. The Mini-BESTest could capture these abilities as the test included the automatic postural response items (Yingyongyudha et al., 2016). This result shows the causes of a fall, including tripping 25.69 % and slipping 13.49% and the hazard environment in and outside places lead to falls. The results of the present study are consistency with the findings of the previous studies. They reported that the causes of fall, tripping 41.8% and slipping 38.2%, led to injury, such as fracture (Sorysang et al., 2014). The results demonstrate the Mini-BESTest has the accuracy tool for predicting a fall in pre-elderly more than BBS and TUG with the AUC of 0.71, sensitivity of 68% and specificity of 65%. The cutoff point was 22.5 score. The AUC in the present study is similar to the range in the previous study. Compared with the Mini-BESTest, the accuracy for fall prediction in healthy elderly with a history of a fall of the BBS and the TUG was 1 time or more within 12 months. They reported that the AUC of the Mini-BESTest was 0.84, sensitivity of 85% and specificity of 75% (Yingyongyudha et al., 2016).

In addition, the Mini-BESTest evaluated the accuracy for predicting falls in people with neurological problems, with a history of falls more than 2 times in the past 6 months. It was found the sensitivity of 88% and specificity of 78% (Leddy et al., 2011b). The previous study investigated the sensitivity and specificity of the Mini-BESTest in individuals with Parkinson's disease that had a history of falls in the past 6 months. The results showed the sensitivity of 79% and the specificity of 69% (King et al., 2012). Even though the BBS was considered as a reference standard for assessing the balance in the elderly, as it is one of the most commonly used balance assessments in the clinic and in research (Leddy et al., 2011a).

However, the BBS had 77% sensitivity, specificity 42% for predicting a fall in the elderly (Yingyongyudha et al., 2016). The present study shows that 11.72% of pre-elderly demonstrated a trend of ceiling effect. Therefore, BBS was unable to differentiate the postural control in the elderly. In contrast, the Mini-BESTestdid not show the ceiling effect (King et al., 2012). Hence, it could be an appropriate tool for identification for the risk of falls in the elderly.

There were two limitations to the present study. Firstly, the other fall risk factors, such as psychological aspects, medications and co-morbidity, was not assessed. Therefore, further study is needed to examine the other fall risk factors. Secondly, the fallers in this study had fall experience for only one time. Fall risks may have several factors, internal factors and consideration of the nature of occupation. Thus, subsequent studies is needed to compare three different groups, the additional group is the group of pre-elderly subjects with 2-times or more in history of falls.

Conclusion

Mini-BESTest is suitable evaluating postural stability and screening falls in the pre-elderly. Mini-BESTest has accuracy for screening falls in the pre-elderly. In clinical, Mini-BESTest could be helpful in directing treatment and prepare a suitable fall prevention strategy for the pre-elderly.

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