Comparing tools of balance tests in assessing balance of middle-aged women with or without exercises
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ABSTRACT

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Background: Fall risks among middle-aged women are relatively high. However, there is a lack of studies on tools of balance tests and their accuracy among middle-aged women.

Objective: The aim of this study is to compare three tools of balance tests to predict falls of middle-aged women who exercise regularly and who do not.

Methods: Eighty-five middle-aged women (50-64 years old) were included in this study, and 40 women of them (47.1%) exercised regularly. The Berg Balance Scale (BBS), Timed Up and Go Test (TUG), and 30-second Chair Stand Test (30-s CST) were the tools examined in this study. The numerical data of this study were analyzed by using a Mann-Whitney test. Those were significant if p<0.05. Accuracy of the tools of balance tests was evaluated by using Receiver Operating Characteristic (ROC) curve. Area under the curve (AUC) was significant if ≥0.70.

Results: Based on this study, the middle-aged women (EG) indicated lower score of TU than sedentary (SG) test (6.9 ± 0.9 vs 8.3 ± 1.7, p = <0.000), and higher score of 30-s than sedentary (SG) test (20.1 ± 3.6 vs 17.2 ± 5.6, p = 0.026). Three participants (3.53%) reported history of falls. The TUG test had better accuracy to predict the falls (AUC 0.922, 95% CI 0.840 - 1.005, sensitivity 1.00, specificity 0.84, p=0.013). Mostly, the participants (≈70%) preferred to practice Tai Chi and Yoga.

Conclusion: The middle-aged women who exercised could have a better score of the balance tests, and the TUG test could predict falls of them.


Tujuan Penelitian: Tujuan dari penelitian ini adalah untuk membandingkan tiga tes keseimbangan dalam memprediksi risiko jatuh pada perempuan paruh baya yang melakukan olahraga dan yang tidak melakukan olahraga.

Metode: Delapan puluh lima perempuan berusia 50-64 tahun mengikuti penelitian, 40 orang (47.1%) mengikuti olahraga. Uji keseimbangan yang dipergunakan adalah Skala Berg Balance (BBS), Timed Up and Go Test (TUG), dan Chair Stand Test 30 detik (30-s CST). Perbedaan variabel numerik antar kelompok dianalisis menggunakan uji Mann-Whitney. Hasil bermakna ditentukan bila p<0.05. Akurasi tes keseimbangan dievaluasi menggunakan area ROC. Area di bawah kurva (AUC) bermakna jika ≥0.70.

Hasil: Perempuan yang mengikuti latihan jasmani (EG) memiliki skor tes TUG lebih rendah dibanding SG (6.9 ± 0.9 vs 8.3 ± 1.7, p = <0.000), dan skor 30-CST lebih tinggi dibanding SG (20.1 ± 3.6 vs 17.2 ± 5.6, p
INTRODUCTION
A fall is a serious event that may occur in all ages but commonly in older people. Age is usually associated with the fall, so that older people are at greater risks of the fall. Unfortunately, most previous studies on incidence of the falls tend to focus on older people, while incidence of falls of younger people has been less reported. A prior study reported that incidence of falls in middle-aged groups was quite high (21%). A study by Timsina et al reported that the highest prevalence falls in middle-aged women reached 49%.

High prevalence of falls in middle-aged women is related to decreases of physical functions of a body. The decreases can increase fall risks. It is estimated that about 25% of middle-aged people has at least one functional impairment that continues or worsens. Moreover, decreases of muscle performances and physical functions has already begun at age of 50 years old. Relationship between lack of exercises (physical activities) and higher incidence of falls had also been investigated. A prior study indicated that incidence of falls and fall-related injuries were low in middle-aged groups who were physically active. Beneficial effects of exercises in improving physical functions and decreasing fall risks have also been proven. Moreover, exercises are recognized as the most frequent interventions to prevent falls for older people.

Women can have higher risk of falls than men. A study by Campbell et al reported that women had greater risks of experiencing falls than men (32.7% vs 23.0%). A higher incidence of falls in women can be influenced by decreases of muscle mass and muscle strength, which occur greater and earlier in female than in male. This could lead to decreases of physical functions and balance. Women are also at greater risks of fractures than men. Decreases of bone mass in women are faster than in men, and menopause of women is considered as a contributing factor increasing fracture risks of women.

Several tests are commonly used to assess the physical functions and balance. Among those, The Timed Up and Go test (TUG), Berg Balance Scale (BBS), and 30-second Chair Stand Test (30-s CST) are most widely used in some examination. As reported by previous studies, those tests were simple, reliable, and good to assess physical functions and fall risks. However, those test are applicable only for older people and may not have been tested in middle-age. The aim of this study was to compare TUG, BBS, and 30-s CST to evaluate balance between sedentary and active middle-aged women.

METHODS
Ethical clearance was approved by Ethics Committee of the Faculty of Medicine and Health Sciences, Universitas Katolik Indonesia Atma Jaya (02/04/KEP-FKUAI/2017). This study applied a cross sectional design. Participants of this study were middle-aged women between 50-64 years old. The following inclusion criteria were required: 50-65 years old, community dwelling, following instructions, and walking for daily activities without assistance. Meanwhile, its exclusion criteria were having mobility-limited illnesses, taking medication affecting balance and gait, and having injuries that can restrict mobility. Informed consent was obtained directly from the participants by signing a form.

Exercise activities and history of falls were documented by using questionnaires. Exerciser group was participants following regular exercise at least for 8 weeks and performing at least three times a week with minimal duration of thirty minutes. This was determined by...
considering the participants’ time availability to do exercises. Falls were defined as a sudden or involuntary event make a body falling down or weak.\textsuperscript{16} Falls in the past two years were recorded.

The 30-s chair stand test
The 30-s CST was conducted by standard procedures and equipments. The participants performed repetitive standing up and sitting down as many as possible for 30 seconds. Its results was classified as normal if they performed 12 times or more.\textsuperscript{17}

The timed up and go (TUG) test
The test was conducted by standing from a standard chair, walking 3 meters or 10 feet, turning, walking back to the chair and sitting down. Time spent to complete the activities was recorded. Referring results of a study by Kear et al, the results of this study were categorized into normal if time to complete TUG test was 10 seconds or less. While subjects in their 60s was normal if they were 12 seconds or less.\textsuperscript{17–19}

Berg Balance Scale (BBS)
The BBS consisted of 14 items of movements of daily activities. Each movement was assessed by a five-point scale ranging from 0-4, in which ‘0’ indicated the lowest function level and ‘4’ was the highest function level. Total maximum score was 56. The equipment for the test were two standard chairs (one with arm rests, and the others are without), bed, footstool, 15 foot walkway, and stopwatch or wristwatch.\textsuperscript{17,19,20} A score of 45 or above was considered as normal.\textsuperscript{20}

The participants were taught how to do the tests before running the tests. All the tests were conducted in an examination room and supervised by a medical staff.

Statistical analysis
Numerical data were demonstrated by mean ± standard deviation (SD), whereas categorical data were demonstrated in frequency and percentage. Comparisons of numerical data between groups were analyzed by using Mann-Whitney test due to abnormal distributions. Their significant levels were determined at p < 0.05. The ability of balance tests in predicting falls was evaluated by using a receiver operating (ROC) curve area. If the curve area was > 0.700, it was significant. Statistical analysis was conducted by using statistical analysis software.

RESULTS
Eighty-five women participated in this study, and 40 (47.1%) of them were engaged in regular exercises. Three participants (3.53%) from sedentary group reported history of falls that happened six to twelve months ago. The mechanisms of falls were slipping (2 cases) and stripping (1 case) on the same level, and they occurred inside the home and outside. Minor injuries on lower legs due to the falls were reported, included bruising. No participants

| Table 1. Comparison of age and results of the three tests between the groups |
|------------------|------------------|------------------|
| Variables         | No Exercise (n=45) | Exercise (n=40) |
| Age (years)      | 55.6 ± 4.9        | 55.7 ± 4.3       |
| BBS score        | 54.5 ± 1.6        | 54.6 ± 1.6       |
| TUG test         | 8.3 ± 1.7         | 6.9 ± 0.9        |
| 30-s CST test    | 17.2 ± 5.6        | 20.1 ± 3.6       |
| History of falls |                   |                  |
| Absence          | 42                | 40               |
| Presence         | 3                 | 0                |

\textsuperscript{*}Mann-Whitney test; †Fisher Exact Test.

ND = not determined; BBS = Berg Balance Scale; TUG = The Timed Up and Go; 30-s CST= 30 second Chair Stand Test.
experienced fractures. Mann-Whitney test indicated that age and BBS score were not different between the groups (p=0.767, and p=0.663, respectively), whereas TUG test and 30-s CST score were better in the exerciser group (p<0.001 and p=0.026, respectively) (Table 1). Lower score of TUG test indicated that the participants in EG completed the three tests faster, whereas higher score of 30-s CST indicated that they in EG performed the three tests with more repetitions. The falls were not related to participation in the exercises (p=0.242).

The TUG, 30-s CST, and BBS score revealed different sensitivity and specificity in identifying the falls (Figure 1). The 30-s CST and BBS had no significant results with the area under the ROC curve 0.069 and 0.232. The TUG showed good accuracy with the area under the ROC=0.922 (95% CI=0.840 - 1.005, p = 0.013) (Table 2 and Figure 1). The cut-off score for TUG test was 8.45 that provided the highest sensitivity (1.00) and specificity (0.84).

Table 2. Receiver operating curve for the tools of balance assessment

<table>
<thead>
<tr>
<th>Balance tests</th>
<th>AUC</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>95%CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBS test</td>
<td>0.225</td>
<td>0.67</td>
<td>0.27</td>
<td>0.036 - 0.414</td>
<td>0.107</td>
</tr>
<tr>
<td>TUG test</td>
<td>0.922</td>
<td>1.00</td>
<td>0.84</td>
<td>0.840 - 1.005</td>
<td>0.013</td>
</tr>
<tr>
<td>30-s CST</td>
<td>0.066</td>
<td>0.30</td>
<td>0.20</td>
<td>-0.037 - 0.169</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Table 3 presented several types of exercise training done by the participants. Eight types of exercise training were documented. Most participants participated in an exercise modality (28 or 65%). Tai Chi and Yoga were the most preferred exercise. Thirty participants (69.8%) practiced Tai Chi and Yoga as a single exercise or combined them with other exercise modalities. Thirteen participants practiced Tai Chi, and none of them combined it with any other types of exercises. Seventeen participants practiced Yoga, and 12 of them (71%) also participated in other forms of exercises, especially fitness (8 or 18.6%). The duration of exercise activities was 30-90 minutes per session for 3 - 5 times a week.
DISCUSSION

Fall risks and physical functions in elderly people have been previously investigated, but there are only few studies examining fall risks and physical functions in middle-aged women. This study attempted to evaluate the risks and the physical functions by using different tools of balance tests in middle-aged women between 50-64 years old and to document types of exercise activities practiced by the participants. Prevalence of falls in middle-aged women in this study was 3.53%, which mostly occurred in women who did not exercise. Women practicing exercises had better results in TUG test and 30-s CST but not BBS test. This could support results of a previous study that found BBS being unable to detect mild changes in balance.21 Compared to the BBS, measurements in TUG and 30-s CST are to test strength and speed rather than the only balance. Sitting up followed by walking 3 meters back and forth in the TUG test, and repetitive sitting-to-standing for 30 seconds in the CST test require not only lower limb strength, but also speed and muscle endurance.22 This may indicate that speed and strength of lower limb can decrease earlier in middle-aged women than their balance.

<table>
<thead>
<tr>
<th>Exercise Activities</th>
<th>Participants (%)</th>
<th>Duration/session</th>
<th>Times/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taichi</td>
<td>13 (30.2%)</td>
<td>60 min</td>
<td>3-5</td>
</tr>
<tr>
<td>Yoga</td>
<td>5 (11.6%)</td>
<td>60-90 min</td>
<td>3</td>
</tr>
<tr>
<td>Fitness</td>
<td>4 (9.3%)</td>
<td>60-90 min</td>
<td>3-4</td>
</tr>
<tr>
<td>Pilates</td>
<td>1 (2.3%)</td>
<td>90 min</td>
<td>4</td>
</tr>
<tr>
<td>Zumba</td>
<td>1 (2.3%)</td>
<td>60 min</td>
<td>3</td>
</tr>
<tr>
<td>Aerobic dance</td>
<td>1 (2.3%)</td>
<td>60 min</td>
<td>4</td>
</tr>
<tr>
<td>Swimming</td>
<td>3 (7.0%)</td>
<td>60 min</td>
<td>3</td>
</tr>
<tr>
<td>Yoga, fitness</td>
<td>8 (18.6%)</td>
<td>45-60 min</td>
<td>3-5</td>
</tr>
<tr>
<td>Yoga, pilates</td>
<td>1 (2.3%)</td>
<td>30 min</td>
<td>5</td>
</tr>
<tr>
<td>Yoga, swimming</td>
<td>1 (2.3%)</td>
<td>30 min</td>
<td>4</td>
</tr>
<tr>
<td>Yoga, cycling</td>
<td>1 (2.3%)</td>
<td>45 min</td>
<td>5</td>
</tr>
<tr>
<td>Yoga, fitness, cycling</td>
<td>1 (2.3%)</td>
<td>30 min</td>
<td>3</td>
</tr>
<tr>
<td>Aerobic dance, jogging</td>
<td>2 (4.7%)</td>
<td>30-45 min</td>
<td>5</td>
</tr>
<tr>
<td>Zumba, jogging</td>
<td>1 (2.3%)</td>
<td>30 min</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>43 (100.0%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Types and duration of exercises
Findings of this study revealed that the TUG was the only test having good accuracy in predicting the falls in middle-aged women, whereas BBS and 30-s CST were not. However, a previous study by Jeon & Kim argued that the BBS had good sensitivity and specificity and could predict the falls. This discrepancy may due to the very low incidence of falls in this study compared to the previous studies showing percentage of 47.4%. A better predictive function of TUG compared to the BBS and 30-s CST in this study could not be explicitly explained. It might be influenced by decreases of physical ability as they grow older, especially speed. If decreases of speed occur earlier than other parameters such as strength and endurance, the first decrease that will be found is TUG test.

There was only 3 participants reported as getting falls in this study. The falls occurred mostly at home on the same level. They had minor injuries on their lower limbs. This finding is similar with a study by Hefny et al.

However, the fall incidence was much lower than what was reported by Talbot et al who also included men as participants. Physically more active than women, men are more exposed to a conducive situation to injury. This puts men at higher risk of falls leading to higher incidence of falls.

Effects of exercise to minimize fall risks have been widely investigated. In general, most studies indicate that any types of exercises are helpful to reduce fall risks at the elderly people. A previous study suggested that daily physical activities performed by middle-aged women could improve risks of functional limitation and disability in future. In addition, multimodal or multicomponent exercises ought to be more advantageous because they can impact on many aspects associated with fall risks, such as strength, balance, gait, coordination, etc. The fall risks were not evaluated in this study. However, considering the results of three tests, middle-aged women practicing exercises indicated lower risk of falls.

Tai Chi and Yoga were the most favored exercise in this study. The effects of Tai Chi in reducing fall risks have been widely investigated but their results were not established. Meta-analysis studies demonstrated that Tai Chi could improve physical capabilities and reduce risks and rates of falls in elderly people. However, RCT studies showed that effects of Tai Chi on fall risks were not different compared to other exercises. Effects of Yoga in reducing fall risks have also been widely investigated. Two studies reported that Yoga was effective to improve mobility and balance; therefore, it could reduce fall risks. Mechanisms of the effect of Yoga and Tai Chi to improve balance have been proposed. It is hypothesized that the effect of Yoga is alleged through down-regulation of the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system (SNS), whereas Tai Chi is felt by enhancing sensory motor and proprioceptive system. The participants practicing Tai Chi in this study did not practice another exercise, while the participants practicing Yoga mostly got involved in other types of exercises. The participants in Tai Chi believed that practicing Tai Chi alone was appropriate to improve their health; meanwhile, the participants in Yoga believed that practicing other exercises could enhance the effects of Yoga. Furthermore, being conversant of any types of exercises could help the participants to choose what type of exercise is suitable for them.

This study also has some limitations. The first limitation is related to its sample size. Larger samples are needed to obtain more representative and valid data and more fall incidence. The second limitation was related to its study design. A cross-sectional design is considered to be less strong in verifying the cause-effect relationship between the exercise activities and the test performance. A longitudinal study comparing the effects of some exercise types on the test performance would be more useful and conclusive.

CONCLUSION

In conclusion, the TUG test has the highest sensitivity and specificity to predict fall risks of middle-aged women compared to the BBS, and 30-s CST. The women practicing exercises had
better score of balance tests.

CONFLICT OF INTEREST
Authors declare that there is no conflict of interest.

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