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Original Article

# Comparison of Fallers and Nonfallers on Four Physical Performance Tests: A Prospective Cohort Study of Community-Dwelling Older Indigenous Taiwanese Women

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ABSTRACT

*Background:* In this study of older indigenous Taiwanese women, we sought to compare the scores of fallers and non-fallers on four tests of physical performance. Additionally, we aimed to establish cutoff scores that would be discriminate fallers from nonfallers.

*Methods:* At baseline, study participants were evaluated using the Short Physical Performance Battery (SPPB), the Timed Up and Go (TUG) test, gait speed, and the Elderly Mobility Scale (EMS). Their falls were recorded monthly for the next 1 year, and individuals who fell at least once were classified as fallers. For each of the four tests, we estimated the area under the curve (AUC), as well as cutoff points and odds ratios (ORs) with confidence interval (CI) for falls.

*Results:* The study included 112 participants, with a mean (±standard deviation) age of 75.5 ± 6.2 years. Thirty-six (32%) of the participants were fallers. Except for the EMS, all tests had AUCs >0.8, as well as moderate sensitivities and specificities. The cutoff point for predicting being a faller were 10.5 for the SPPB (OR, 8.4; CI, 3.3–21.4), 13.9 s for the TUG test (OR, 19.4; CI, 6.9–55.1), 0.84 m/s for gait speed (OR, 8.9; CI, 3.6–22.0), and 19.5 for EMS (OR, 3.4; CI, 1.5–8.0).

*Conclusion:* The SPPB, TUG, and gait speed might provide effective means of fall screening among older indigenous Taiwanese women.

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## 1. Introduction

In aging societies, falls among older adults are a serious social concern and public health issue, mainly because falls are strongly associated with loss of independence, institutionalization, and mortality.[1–3] Each of these outcomes poses a heavy burden on the families of affected individuals, and requires considerable governmental medical resources.[3,4]

Although it has been reported that the etiology of falls is multifactorial, intrinsic physical factors contribute substantially to falls among older adults.[2–5] Therefore, fall-related screening tools that are related to physical and balance functions have been developed for fall prevention among community-dwelling older adults.[1,5–7] However, to date, no report has specifically focused on indigenous older populations. Further, the selection of participants has varied across previous studies, which could limit the applicability of their results for community-dwelling older adults.[2,5,7]

In Taiwan and many developed countries, indigenous people have poorer health and more health needs than do nonindigenous people.[8–12] According to Council of Indigenous Peoples (CIP), the average life expectancy of community-dwelling indigenous people living in the remote areas of Taiwan was lower than that of other community-dwelling older adults.[8] Accident events, including falls, occur more often among indigenous older adults than among other community-dwelling older adults in Taiwan.[8] Although it has been noted that indigenous Taiwanese face high rates of healthy concerns and accident events, the incidence of falls and fall prevention-related screening tools have yet to be reported for the community-dwelling, older, indigenous Taiwanese population. On the other hand, previous studies have shown that women have higher risks of falls than men.[3,12,13] Moreover, older indigenous women have more higher fall risks than do older indigenous men in Taiwan.[14]

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Therefore, the present study of community-dwelling older indigenous Taiwanese women was undertaken for two purposes: First, we sought to investigate the actual incidence of falls during a 12-month follow-up period. Second, we aimed to apply common and easy-to-administer physical performance tests, and to determine cutoff scores and odds ratios (ORs) for predicting which individuals were fallers. The following four tests were investigated: the Short Physical Performance Battery (SPPB), the Timed Up and Go (TUG) test, gait speed, and the Elderly Mobility Scale (EMS).

## 2. Patients and methods

### 2.1. Participant selection

This study enrolled a convenience sample of female participants living in indigenous communities in Hsiu-Lin Township (Hualien County, Taiwan). Enrollment was conducted through local community centers, churches, and places of public assembly. The inclusion criteria were as follows: age $\geq$65 years, ability to follow the steps involved in the assessments/tests, and ability to ambulate independently (with or without a mobility aid). The exclusion criteria were as follows: severe heart disease, a history of nervous system disorders (such as stroke or Parkinson's disease) or severe orthopedic diseases that rendered the individuals unable to walk or stand even with an aid; hospital admission within 6 months.

In this study, a fall was defined as any accidental event that resulted in the person coming to rest on the ground, but not as a consequence of sustaining a violent blow, loss of consciousness, sudden onset of paralysis, alcoholic drink. Fall events were recorded on a “fall calendar” for 1 year by each participant or her family members, who were instructed to update the calendar daily. One therapist who was not involved in the study visited or called the participants at the end of every month. Participants with one or more fall events during the study year were assigned to the faller group, and the remaining participants assigned to the nonfaller group.

At the start of the study, the demographic characteristics of all participants were collected and four physical performance tests were subsequently conducted in a random order by an experienced physical therapist. Before performing each test, each participant was taught how the test was executed to minimize variation in test performance. The participant had one trial attempt to familiarize themselves with the procedure and was given a 1-min resting period between each pair of performance tests.

### 2.2. Physical performance tests

#### 2.2.1. SPPB

The SPPB is a reliable and valid test for assessing lower extremity functional performance, and is one of the most frequently used physical performance tests for older adults. It consists of three major items: balance, five-repetition chair-stand, and gait speed. The test participant stands up from a seated position in a chair without using arm support for five repetitions, which are performed as quickly as possible and timed in seconds. Subsequently, the participant is given a balance test (from close feet to tandem position). Finally, the time that the participant needs to complete a 4-m walk test is recorded. Each item is scored on a 4-point scale, the possible range of total scores is 0–12, and higher scores indicate better function.[15,16]

#### 2.2.2. TUG test

The TUG test is a screening tool that is commonly used to assist clinicians in identifying older adults who are at risk of falling. In this test, participants are timed while they stand up from a seated position in a chair with a seat height of 40–50 cm, walk a 3-m distance at a usual pace, turn, walk back to the chair, and finally sit down again.[17] In this study, two trials were performed with a 30-s interval, and the mean time of the two trials was considered the final score.

#### 2.2.3. Gait speed

This study used a 10-m walk test with 5 m provided for acceleration/deceleration.[18] The participants used their self-selected walking pace with a 30-s interval between trials. The time that was taken to traverse the middle 10 m was averaged over two trials and used as the final score.

#### 2.2.4. EMS

The EMS was designed for analyzing the following crucial functions associated with mobility: movement from a lying position to a sitting position, movement from a sitting position to a lying position, movement from a sitting position to a standing position, standing, gait, walking speed, and functional reach. The maximum score is 20, which represents independent mobility, whereas the minimum score is 0, which represents total dependence. A previous study reported that EMS scores showed high, significant correlations with Barthel scale scores and functional independence measure scores, thus establishing the concurrent validity of the EMS.[19]

The Research Ethics Committees of Tzu Chi General Hospital approved the study, and all participants provided informed consent prior to participation.

### 2.3. Statistical analysis

To assess the statistical significance of between-group differences in baseline data and performance outcomes, we used independent $t$ tests for continuous data and chi-square tests for categorical data. To evaluate the intrarater test–retest reliability of the physical performance tests, 19 participants were retested within 2 weeks using the four physical performance tests, based on which intraclass correlation coefficients (ICCs) were estimated. To test the predictive powers of the tests, we calculated receiver operating characteristic (ROC) curves, estimated areas under the curves (AUCs), and used Youden's index to select cutoff points. We estimated the sensitivities and specificities of the four physical performance tests to investigate their performance as means of screening older indigenous Taiwanese women who were at high risk of falling.

Bivariate logistic regression was used to calculate the odds ratios (ORs) with 95% confidence intervals and the cutoff values of the 4 physical mobility tests for the faller group versus the nonfaller group. Variables with $p < 0.05$ in the bivariate analysis were entered into a multiple regression analysis. The variances inflation factor (VIF) was evaluated for multicollinearity. The significance level was set at 0.05 in all cases. Analyses were performed using SPSS Version 19.0 for Windows (SPSS Inc., Chicago, USA).

The sample size was estimated by using MedCalc software (MedCalc Software, Ostend, Belgium) and at least 81 participants would be needed to achieve a power of 0.8 at an alpha level of 0.05 for an AUC of at least 0.69.

## 3. Results

In total, 124 community-dwelling older indigenous Taiwanese women were enrolled and participated in the study. However, 12 participants were excluded because of 2 moved out to live with their children, 3 for institutionalization, 4 was lost contact, and 3 participants died. Ultimately, 112 participants (mean ± standard

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