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Original Research

# Testing the Validity of the Diamond Steps Test for Balance in Healthy Adults

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**KEYWORDS**
Healthy aging;
Postural balance;
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**Abstract** *Objectives:* To test the validity of the Diamond Steps Test (DST), a new test to assess balance.
*Design:* This cross-sectional study evaluated the validity of the DST, a brief new balance assessment tool.
*Setting:* The implementation site was the rehabilitation center of a hospital. Data collection was conducted from February to June 2017.
*Participants:* Healthy adults (N=65) between the ages of 40 and 72 years who volunteered to participate.
*Interventions:* Not applicable.
*Main Outcome Measures:* Two measures were used to assess DST: the time required to step around the diamond 5 times (5-DS) and the time required to step around the diamond twice, once using the dominant foot and the other using the non-dominant foot (LRDS).
*Results:* Multiple regression analysis was performed for each of the 2 methods for measuring DST. Five variables were predictive of DST as measured by the 5-DS test: the 10-Second Open Close Stepping Test, timed Up and Go (TUG) test, Y Balance Test (YBT) posterolateral reach for the left leg, Standing on One Leg with Eyes Closed (SOLEC) test for the right leg, and sex. The coefficient of determination was 0.54. For DST measured by the LRDS, 4 variables were found to be predictive: the 30-Second Chair Stand Test, YBT posterolateral reach for the left leg, TUG, and SOLEC for the right leg. The coefficient of determination was 0.49.
*Conclusion:* The DST was shown to assess 7 of the 9 components of balance (static stability, functional stability limits, underlying motor systems, anticipatory posture control, dynamic

*List of abbreviations:* 5-DS, time required to step around the diamond 5 times; BESTest, Balance Evaluation Systems Test; CS-30, 30-second Chair Stand Test; DS, diamond steps; DST, Diamond Steps Test; LRDS, the time it takes to walk the diamond twice, one time starting with the dominant foot (right) and the other time starting with the non-dominant foot (left); OCS-10, 10-second Open-Close Stepping Test; SOLEC, Standing on One Leg with Eyes Closed; TUG, timed Up and Go test; YBT, Y Balance Test; YPLL, Y Balance Test, posterolateral Left.
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stability, reactive postural control, and sensory integration), suggesting that it is a valid test to use for balance assessment.


As the world's population increases toward an aging or super-aging society,[1] maintaining health is an increasingly important task for both individuals and society. For middle-aged individuals, balance is a very important consideration when evaluating their health-related physical capabilities. Therefore, balance needs to be assessed in healthy adults before they reach older ages for the early prevention of problems. In the analysis of standardized measures of balance using the posture control system framework, Sibley et al[2] identified 9 elements of balance and analyzed 66 balance tests issued between 1946 and 2014 (fig 1), including the timed Up and Go Test (TUG), Functional Reach Test, and Berg Balance Scale, which are commonly used in clinical settings. It has been determined that all tests except the Balance Evaluation Systems Test (BESTest) can evaluate only part of the balance elements. In addition, according to a survey conducted among clinical physiotherapists, it is necessary to measure balance in a short time (ie, <10min) clinically, while still providing a balance test with objective and clinically meaningful results.[3] Although the TUG and Functional Reach Test take a short time to complete, they can only evaluate 3 elements. Conversely, although the Berg Balance Scale and the revised Mini-BESTest can evaluate many elements, both require a longer time to complete (approximately 15min).

To quickly assess most components of balance, the authors devised the Diamond Steps Test (DST). There are 3 possible ways to administer the DST, depending on what components are being considered: the number of times an individual can step around the diamond in 30 seconds; the time required to step around the diamond 5 times (5-DS); and the time required to step around the diamond twice, first in the direction of the dominant leg and then in the reverse direction, starting with the non-dominant leg (LRDS). The 5-DS and LRDS tests have been shown to be particularly reliable, with each having an intraclass correlation coefficient of 0.91 or higher.[4] In this study, we examined the validity of the DST as a new method to assess balance in healthy adults.

## Methods

### Participants

The sample consisted of 65 healthy individuals between the ages of 40 and 72 (22 men, 43 women). "Healthy" was defined in this study as being independent in one's daily life, having no problems in cognitive function, and having no central nervous system disorders or obvious orthopedic disorders in the lower back or limbs. Participants, all of whom were hospital staff members who volunteered to be included in the study, were selected and excluded based on these criteria. They were sampled and recruited by posting recruitment announcements in the facility's staff lounge. The main content of the recruitment announcement included the age of the recruitment target, time required for measurement, and benefits of participation. The data collection period was from February to June 2017, and the study was implemented at the rehabilitation center of the same hospital.

Participant characteristics are shown in table 1. Of the participants, 37 were in their 40s, 19 were in their 50s, 8 were in their 60s, and 1 was older than 70. Only 4 participants were aged 65 years or older.

This study was conducted with the approval of the Research Ethics Review Committee (16-Io-219) of the appropriate university. Participants were fully informed about the study's purpose and methods, that their participation was voluntary and that withdrawing from the study would not result in any disadvantages, and that their privacy would be protected. Verbal consent for participation was obtained.

### Procedure

A total of 10 tests related to balance were randomly conducted, and the order was determined by drawing lots. The tests were: the 5-DS and the LRDS for the DST,[4] Functional Reach Test,[5] Standing on One Leg with Eyes Closed (SOLEC) Test,[6] Mini-BESTest,[7] Finger-Floor Distance Test,[8] 10-second Open-Close Stepping Test (OCS-10),[9] Plisky et al.'s improved version of the Star Excursion Balance Test known as the revised Y Balance Test (YBT),[10] 30-second Chair Stand Test (CS-30),[11] and grip strength test.[12] To standardize the conditions under which the measurements were taken, all participants performed the tests barefoot. Protocols for each measure are discussed below. Most methods used a stopwatch or measure; cases for which special instructions applied are described individually.

The diamond used for the DST had angles at the opposing vertices of 60 and 120 degrees, and the length of each side was half the participant's height (fig 2).[4] To resolve the individual differences caused by different heights, a dedicated DST measuring ruler was used in this study. The dedicated DST measuring ruler first assumed that the participant's height is in the range of 130 to 200 cm. Thereafter, the hypotenuse (half the participant's height) and a 30-degree trigonometric function were used to calculate the long and short diagonal values of the rhombus. Finally, the height values corresponding to the long and short diagonal values were written into the ruler, resulting in a diamond suitable for participants according to their height. "Diamond steps" (DS) referred to the 8 steps (fig 3) taken

| The posture control system framework`s nine elements | Functional Reach Test | TUG | Balance Evaluation Systems Test (BESTest) | Berg Balance Scale | Mini-BESTest |
|---|---|---|---|---|---|
| 1) Static stability | No | No | **Yes** | **Yes** | **Yes** |
| 2) Underlying motor systems | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| 3) Functional stability limits | **Yes** | No | **Yes** | **Yes** | No |
| 4) Verticality | No | No | **Yes** | No | **Yes** |
| 5) Reactive postural control | No | No | **Yes** | No | **Yes** |
| 6) Anticipatory postural control | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| 7) Dynamic stability | No | **Yes** | **Yes** | **Yes** | **Yes** |
| 8) Sensory integration | No | No | **Yes** | **Yes** | **Yes** |
| 9) Cognitive influences | No | No | **Yes** | No | **Yes** |

Partially quoted Table 2 of Reference 2 (with slight modification)

**Fig 1** The 9 elements of balance identified by Sibley et al.[2]

from vertex to vertex around the diamond, starting at the bottom 60 degrees vertex and, always facing forward, stepping forward then backward, and leading with the leg closer to the next vertex to avoid crossing one leg over the other. Participants started out by stepping to the vertex on their dominant side with their dominant leg, and moving their trailing leg to stand with the vertex between their feet (dominant foot, right; non-dominant foot, left; then vice versa). Subsequently, participants stepped forward and backward around the diamond, always leading with the leg closest to the next vertex. One turn around the diamond was counted as "1-DS." The 5-DS test measured the time required to go around the diamond 5 times. Meanwhile, the LRDS test measured the time required to step around the diamond twice, once starting with the dominant (right), and the other time starting with the non-dominant foot (left) (fig 4). Participants were asked to keep their torso facing forward as much as possible and to look ahead to ensure that their feet would be on either side when they arrived at the diamond's vertices. They were also asked to go as quickly as they could without falling.

Before any measurements were taken, participants were given an explanation and demonstration of the walking method required for the DST. All participants practiced the DS 3 times. Measurements were then taken twice for each test, and the average value was used for the analysis. However, a DS was not counted during measurement if participants over- or understepped the vertex by more than half the length of their leading foot vertically, more than the maximum width of their foot horizontally, or if their feet were more than 10 cm apart when the trailing foot was brought next to the leading foot.

Measurements for the Functional Reach Test were based on the method described by Duncan et al.[5] While standing, participants were asked to reach a raised arm forward as far as possible without taking a step. The difference between the start and endpoints was the "functional reach." The test was conducted 3 times, and the largest value was used for the analysis.

The SOLEC test was conducted based on the method in the manual published by the Central Labor Accident Prevention Association.[6] Participants were asked to stand on one leg for as long as possible with their eyes closed, and the length of time they were able to do this was measured. The participants' left and right legs were each tested twice, and the maximum value was used for the analysis.

The Mini-BESTest measurements were taken using the Japanese version of the Mini BESTest by Otaka et al.[7] This test consisted of 14 items in 4 sections: (1) anticipatory: sit to stand, rise to toes, stand on one leg; (2) reactive postural control compensatory stepping correction-forward, compensatory stepping correction-backward, compensatory stepping correction-lateral; (3) sensory orientation: stance (feet together, eyes open, firm surface), stance (feet together, eyes closed, foam surface), incline (eyes closed); and (4) dynamic gait: change in gait speed, walk with head turns-horizontal, walk with pivot turns, step over obstacles, TUG with dual task (3-meter walk). Each item was rated from 0 to 2, with higher scores indicating higher levels of functioning. Equipment needed for the tests consisted of a medium-density Temper foam pad (T41), a 40×40 cm incline ramp with a 10-degree slope, a path for walking a total of 3 meters back and forth, and a chair with arms and a 40-cm high

**Table 1** Participant characteristics

| Characteristics | Total | Men | Women |
|---|---|---|---|
| Number of participants, n | 65 | 22 | 43 |
| Age, y | 49.5±8.0 | 48.0±8.2 | 50.3±7.9 |
| Height, cm | 162.3±9.4 | 172.4±6.5 | 157.1±5.8* |
| Weight, kg | 60.4±13.0 | 71.6±12.0 | 54.7±9.4* |

NOTE. Values are given as mean ± SD.
* $P<.05$.

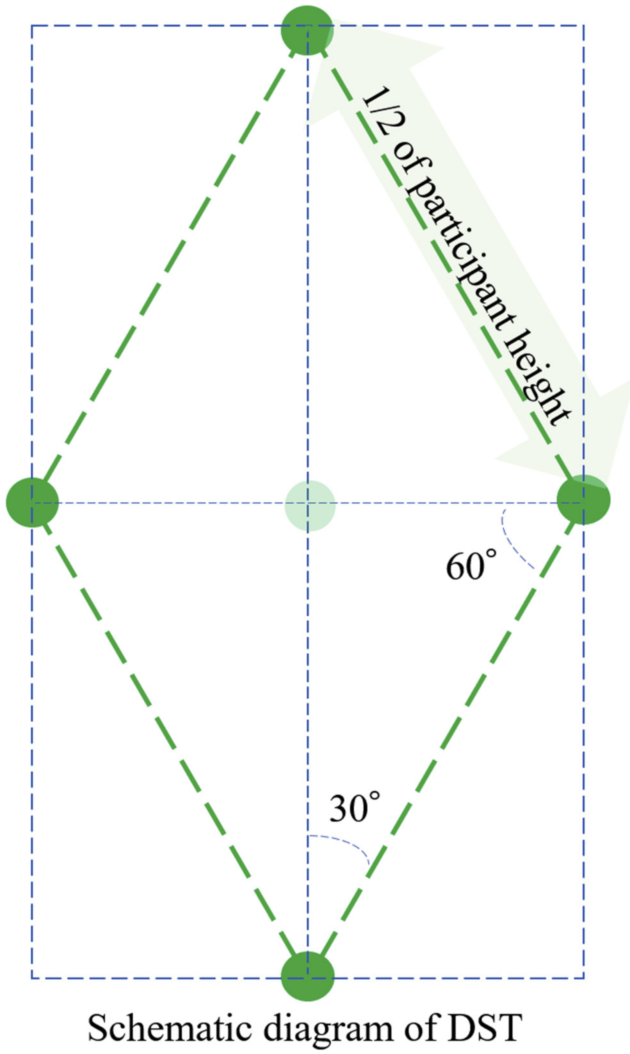


**Fig 2** Schematic diagram of the DST.

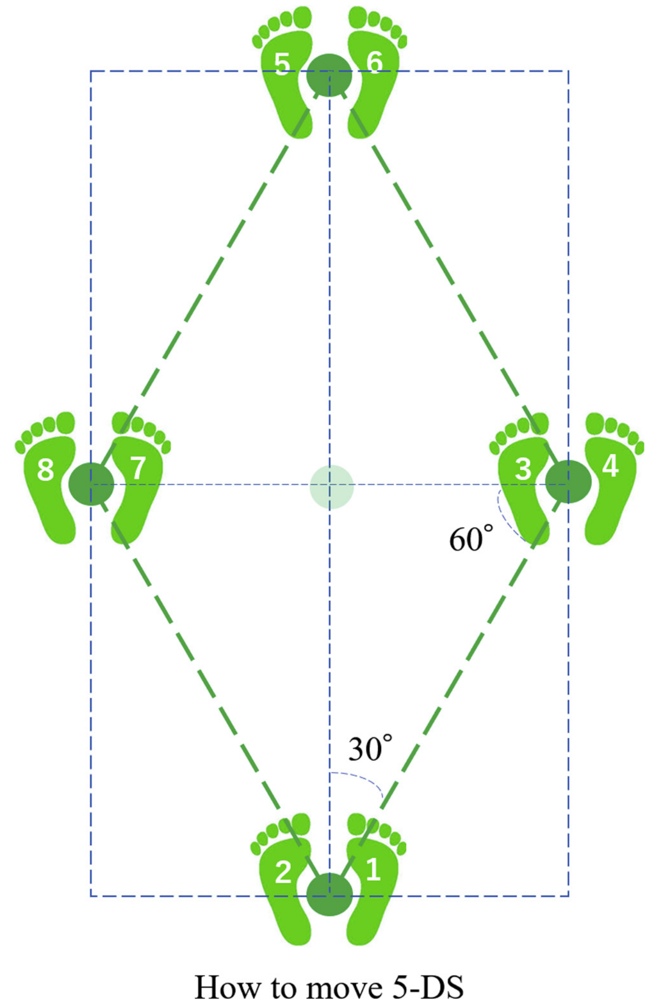


**Fig 3** Illustration showing how to move during the 5-DS.

seat. In our statistical analyses, the TUG test was treated as an independent variable.

Measurement of the Finger-Floor Distance Test was based on procedures described by Calin.[8] Participants stood erect on a small 30-cm high platform and bent forward, reaching toward the floor as far as possible. The distance between the tip of the middle finger and the floor was then measured. After a practice round, measurements were taken twice at an interval of approximately 20 seconds. The larger value was used for the analysis.

For the OCS-10, the procedures described by Kobayashi et al[9] were followed. Participants sat in a chair with their feet placed together on a small board (closed position). They then opened their legs, placing their feet down flat on either side of the board (open position), and returned to the closed position as quickly as possible. This counted as one iteration. The test consisted of the number of iterations performed in 10-second increments. Participants had one practice round, after which 2 measurements were made at an interval of approximately 30 seconds. The larger value was used for the analysis.

In the YBT,[10] participants stood on one leg and reached in 3 directions with the other leg so that the anterior, posterolateral, and posteromedial reaches could be measured. The test was performed for both the right (dominant foot) and left (non-dominant foot) leg, and the reaches were denoted as Y-anterior left or right, Y-posterolateral left (YPLL) or Y-posterolateral right, and Y-posteromedial left or right. Including practice, 6 trials were conducted for each, and the largest values for successfully executed trials were used for the analysis.

The protocol for the CS-30 was based on that described by Nakatani et al.[11] This measured the number of times participants could stand up from a sitting position on a chair 40 cm high in 30 seconds. Participants' arms were always crossed and placed in front of the chest. They were told not to bend their knees while standing. Participants had one practice round, and then measurements were taken only once.

Grip strength was measured following the protocol set forth in the *Requirements for Implementing New Strength Tests* published by the Ministry of Education, Culture, Sports, Science and Technology,[12] with an Evernew digital grip meter. Alternating measurements for the left and right hands were taken while participants were standing. This was done twice, and the larger values were used for analysis.

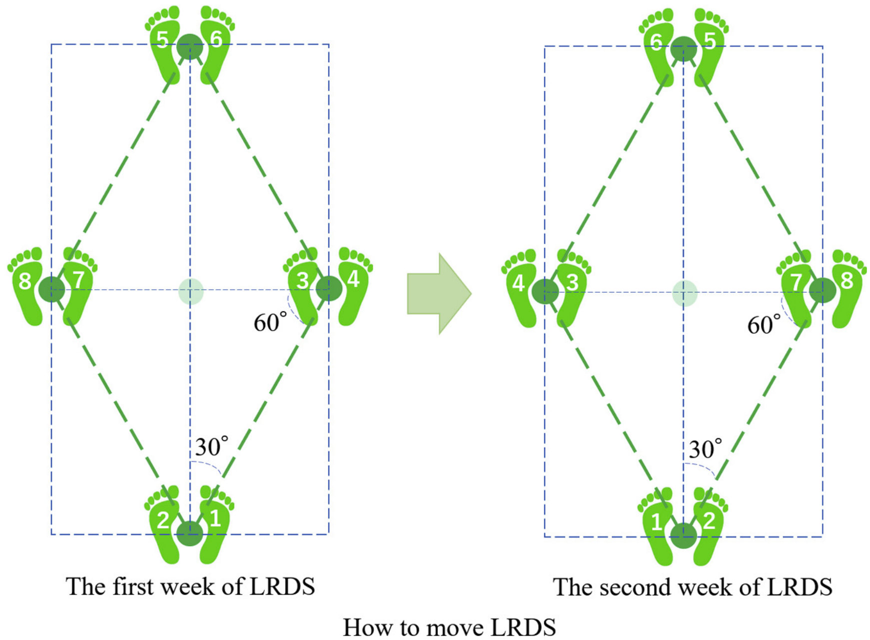


**Fig 4** Illustration showing how to move during the LRDS.

To focus on the overall universality without ignoring individual and sex differences, sex was used as a detection factor in the present study. An independent sample *t* test was used to assess participant characteristics. Stepwise regression was performed separately for the dependent variables (5-DS and LRDS). To prevent multiple collinearity, the correlations among the independent variables were first calculated using the Pearson product-moment

**Table 2** Test results by sex

| Test (units) | Total (N=65) | Men (n=22) | Women (n=43) |
|---|---|---|---|
| 5-DS, s | 21.3±2.8 | 21.6±3.7 | 21.2±2.3 |
| LRDS, s | 8.3±1.0 | 8.4±1.2 | 8.3±0.9 |
| Finger-Floor Distance Test, cm | 0.4±9.1 | -3.6±9.6 | 2.4±8.2 |
| YBT, cm | | | |
| Anterior left | 72.5±10.8 | 80.5±10.7 | 68.5±8.4 |
| Posteromedial left | 83.7±16.2 | 92.8±18.3 | 79.0±12.9 |
| YPLL | 85.8±17.0 | 95.9±17.8 | 80.6±14.2 |
| Anterior right | 71.1±11.0 | 78.5±11.7 | 67.4±8.4 |
| Posteromedial right | 82.1±16.8 | 91.2±20.0 | 77.5±12.7 |
| Posterolateral right | 87.5±17.8 | 98.4±21.8 | 81.9±12.2 |
| Functional Reach Test, cm | 34.4±5.9 | 37.3±5.9 | 32.9±5.4 |
| OCS-10, no. of times | 15.1±2.6 | 15.9±3.1 | 14.7±2.3 |
| CS-30, no. of times | 20.4±4.4 | 20.5±5.0 | 20.4±4.1 |
| TUG (s) | 7.8±0.9 | 7.9±0.8 | 7.8±1.0 |
| Mini-BESTest, score | | | |
| Anticipatory | 5.3±0.5 | 5.3±0.6 | 5.3±0.5 |
| Reactive postural control | 5.4±0.9 | 5.5±1.0 | 5.4±0.9 |
| Sensory orientation | 6.0±0.2 | 6.0±0.2 | 6.0±0.2 |
| Dynamic gait | 8.5±1.0 | 8.8±1.1 | 8.3±1.0 |
| Total | 25.2±1.6 | 25.5±1.8 | 25.0±1.5 |
| Grip Strength Test (kg) | | | |
| Left hand | 28.9±9.3 | 39.2±7.4 | 23.7±4.6 |
| Right hand | 30.2±9.4 | 40.5±8.1 | 24.9±4.2 |
| SOLEC (s) | | | |
| Left leg | 16.6±15.5 | 15.8±15.3 | 16.9±15.8 |
| Right leg | 17.0±16.7 | 10.6±12.5 | 20.2±17.7 |

NOTE. Values are given as mean ± SD.

| | | 5-DS | LRDS | YPLL | YPLR | FRT | CS-30 | TUG | GS L | GS R | SOLEC L | SOLEC R | OCS-10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-DS | | | -.83⁂ | -.62‡ | -.59‡ | -.49* | -.58‡ | .42* | -.40 | -.27 | -.44* | -.20 | -.71⁂ |
| LRDS | | -.81⁂ | | -.65‡ | -.47* | -.45* | -.57‡ | .54* | -.30 | -.06 | -.54‡ | -.30 | -.64‡ |
| YPLL | | -.43‡ | -.33* | | .87⁂ | .46* | .56‡ | -.20 | .22 | .06 | .21 | .02 | .55‡ |
| YPLR | | -.30 | -.21 | .81⁂ | | .58‡ | .48* | -.23 | .31 | .19 | .10 | -.01 | .58‡ |
| FRT | | .02 | -.04 | .13 | .17 | | .27 | -.37 | .71⁂ | .55‡ | .23 | .24 | .39 |
| CS-30 | | -.44‡ | -.54⁂ | .10 | -.06 | .22 | | -.45* | .24 | .11 | .07 | .05 | .64‡ |
| TUG | | .54⁂ | .47‡ | -.31* | -.20 | -.20 | -.45‡ | | -.37 | -.27 | -.34 | -.20 | -.43* |
| GS | L | -.23 | -.27 | .36* | .22 | -.05 | .09 | -.23 | | .89⁂ | .33 | .27 | .16 |
| | R | -.19 | -.20 | .26 | .24 | -.07 | .10 | -.13 | .76⁂ | | .15 | .11 | -.07 |
| SOLEC | L | .16 | .24 | -.10 | .03 | -.14 | -.26 | .36* | .20 | .22 | | .74⁂ | .21 |
| | R | -.09 | -.03 | -.11 | -.15 | -.24 | -.05 | .27 | .12 | .07 | .54⁂ | | .18 |
| OCS-10 | | -.39* | -.36* | .10 | .00 | .16 | .39‡ | -.35* | .13 | .14 | -.14 | -.22 | |

Triangle: blue indicates male, red indicates female; Only items related to the final result are shown; *$p<.05$, ‡$p<.01$, ⁂$p<.001$; YPLR: YBT-posterolateral right; FRT: Functional Reach Test; GS: Grip strength Test; L: left; R: right

**Fig 5** Correlations among test results by sex (Pearson).

correlation coefficient. When independent variables were highly correlated, only one was used in the stepwise regression. In the regression analysis, 6 independent variables were expected to be added considering the number of participants. IBM SPSS 23.0[a] was used for the statistical analyses, and the significance level was set at 5%.

## Results

There was no significant difference in age between the sexes, but there were significant differences in height and weight (table 1). The test results by sex are shown in table 2, and the correlations among them are shown in figure 5. The independent variables with significant correlation coefficients of 0.70 or greater were the YPLL and Y-posterolateral right, left and right Grip Strength Test, and the left and right SOLEC. In the regression analysis, after repeated testing and confirmation, 6 independent variables (sex, OCS-10, TUG, YPLL, SOLEC [right leg], and CS30) were finally added. Results of the regression analysis identified 5 tests as significant predictors of the 5-DS: the OCS-10, TUG, YPLL, SOLEC-right, and sex. The coefficient of determination was 0.54 (table 3). For the LRDS test, 4 tests were identified as predictors: the CS-30, YPLL, TUG, and SOLEC-right. The coefficient of determination was 0.49 (table 4).

## Discussion

This study examined the validity of the DST using a sample of healthy adults between the ages of 40 and 72 years. Four balance tests and sex were identified as being predictive of the 5-DS testing method for the DST. The coefficient of determination was 0.54. Moreover, 4 balance tests were identified for the LRDS method. The coefficient of determination was 0.49. This suggested that the 5-DS testing method was the more valid measure.

The components of balance assessed by each of the tests that are predictive of the DST were as follows: the TUG has been characterized as a test of underlying motor systems, anticipatory postural control, and dynamic stability.[2] The OCS-10 test has been found to be an important indicator of agility in the lower limbs, as the participant executes the required switching between movements.[13]

**Table 3** Multiple regression results for the 5-DS

| Predictor Variable | *r* | β | VIF |
|---|---|---|---|
| OCS-10 | .52* | -0.37† | 1.28 |
| TUG | .61‡ | 0.28† | 1.22 |
| YPLL | .65† | -0.39† | 1.39 |
| SOLEC, right leg | .71‡ | -0.23† | 1.12 |
| Sex | .74† | -0.23† | 1.35 |
| $R^2$ | 0.54 | | |
| N | 65 | | |

Abbreviations: β, standard partial regression coefficient; $R^2$, coefficient of determination; VIF, multicollinearity.
* $P<.001$.
† $P<.05$.
‡ $P<.01$.

**Table 4** Multiple regression results for the LRDS

| Predictor variable | *r* | β | VIF |
|---|---|---|---|
| CS-30 | .55* | -0.36† | 1.27 |
| YPLL | .62‡ | -0.31† | 1.10 |
| TUG | .66† | 0.30† | 1.28 |
| SOLEC, right leg | .70† | -0.22† | 1.05 |
| $R^2$ | 0.49 | | |
| N | 65 | | |

Abbreviations: β, standard partial regression coefficient; $R^2$, coefficient of determination; VIF, multicollinearity.
* $P<.001$.
† $P<.05$.
‡ $P<.01$.

| Compare content | Functional Reach Test | TUG | YBT | Mini-BESTest | DST | |
|---|---|---|---|---|---|---|
| | | | | | 5-DS | LRDS |
| 1) Static stability | No | No | Yes | Yes | No | Yes |
| 2) Underlying motor systems | Yes | Yes | Yes | Yes | Yes | Yes |
| 3) Functional stability limits | Yes | No | Yes | No | Yes | Yes |
| 4) Verticality | No | No | No | Yes | No | No |
| 5) Reactive postural control (agility) | No | No | No | Yes | Yes | No |
| 6) Anticipatory postural control | Yes | Yes | Yes | Yes | Yes | Yes |
| 7) Dynamic stability | No | Yes | Yes | Yes | Yes | Yes |
| 8) Sensory integration | No | No | No | Yes | Yes | Yes |
| 9) Cognitive influences | No | No | No | Yes | No | No |
| * Gender: as a factor of balance | No | No | No | No | Yes | No |
| * Measurement time: about 3 minutes | Yes | Yes | Yes | No | Yes | Yes |

Comparison of DST with commonly used balance test and Mini-BESTest etc.

**Fig 6** Comparison between the DST and commonly used tests.

Agility is the ability to react quickly to stimuli and swiftly change bodily position or direction of movement. In other words, it is an indicator of reactive postural control. Similar to the revised Star Excursion Balance Test, the YBT measures the reach of the contralateral leg while an individual is standing on one leg. Sibley et al[2] described this test as an assessment of static stability, underlying motor systems, functional stability limits, and anticipatory postural control. As a measure of the reach of the left leg, the YPLL may have important significance in balance measurement. Given the difficulty of using the right leg as the supporting leg,[14] this action is believed to require strong balance ability. The SELOC is a measure of posture control, a form of automatic motor control in which higher brain function is used to process information from all senses and unconsciously readjust posture to respond to a situation. The sensory systems believed to be necessary for this are the somatosensory, vestibular, and visual systems.[15,16] Interrupting the visual system increases dependence on the other sensory systems, and an adjustment in sensory integration functions takes place.[17] Thus, the SELOC test includes the assessment of 3 balance components: sensory integration, static stability, and underlying motor systems. The CS-30 demands leg muscle strength and control of the shift in the center of gravity up and down and forward and back by flexing and extending the trunk and legs.[18] Therefore, it includes the assessment of static stability, underlying motor systems, and anticipatory postural control.

Thus, the 5-DS was shown to include assessment of 6 components of balance: functional stability limits, underlying motor systems, anticipatory posture control, dynamic stability, reactive postural control, and sensory integration. It was also shown that one of the predictors of the 5-DS testing method was sex. The existence of sex differences has been reported in studies of gait stability in healthy adults[19] and balance ability and lower extremity strength in older adults.[20] The present study's results were consistent with these previous findings. Thus, sex should be taken into consideration when measuring balance. The results of the current study also suggested that the LRDS testing method included the assessment of 6 theoretical components of balance, namely static stability, underlying motor systems, functional stability limits, anticipatory postural control, dynamic stability, and sensory integration.

Of the many balance tests currently in use, the Mini-BESTest covers 8 components of balance. The DST measures of 5-DS and LRDS together cover 7 components and show that sex is an important factor related to balance (fig 6). Although verticality and cognitive influences are not assessed, measures of cognitive influences could potentially be added. For example, the DST could be conducted with the addition of a cognitive task, such as a calculation problem or a word game. In addition, a major advantage of the DST over the Mini-BESTest is that the DST can be conducted quickly, requiring only 3 minutes for both preparation and practice. Therefore, in addition to assessing most of the components of balance, given how little time it takes to administer, the DST should be easily adaptable for clinical use. This will allow more time to be devoted to clinical treatment, which is beneficial to patients and less burdensome for physiotherapists.

### Study limitations

Given that most of the participants in the current study were aged between 40 and 65 years, it is difficult to evaluate these results may apply to people younger than 40 or older than 65 years old. Therefore, future studies using larger samples of people older than 65 years old are needed to examine the validity of DST in older adults. In addition, future studies should consider the wide clinical application of DST, including patients with early Parkinson disease. Finally, to measure verticality, tests would also need to be conducted on a sloping platform.

## Conclusions

This study aimed to evaluate the validity of the DST in assessing balance in healthy adults. The results showed that the DST measures 7 components of balance in a very period brief time and can be adapted for universal use, allowing for individual and sex differences. Of the 2 methods for administering the DST, the 5-DS test was shown to have more predictor variables and a higher coefficient of determination, suggesting that it may be the more valid of the 2 methods. The DST corrected and standardized by height is a simple measurement method, because the equipment requires little preparation and the test does not take up much space. Furthermore, as it needs few measuring devices and can be conducted in a short time, the DST is also low cost. Compared with existing measures to evaluate balance, the DST with these features can evaluate many components of balance with one method, is highly practical, has high clinical significance, and is considered versatile.

## Supplier

a. SPSS, version 23.0; IBM Corp.

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