# Assessing Fall Risk Appraisal Through Combined Physiological and Perceived Fall Risk Measures Using Innovative Technology

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## ABSTRACT

The current study aimed to categorize fall risk appraisal and quantify discrepancies between perceived fall risk measured subjectively using the short Fall Efficacy Scale-International and physiological fall risk measured objectively using the portable BTrackS™ Assess Balance System. One hundred two community-dwelling older adults were evaluated in this cross-sectional study. Approximately 40% of participants had maladaptive fall risk appraisals, which were either irrational (high perceived risk despite low physiological fall risk) or incongruent (low perceived risk but high physiological fall risk). The remaining 60% of participants had adaptive fall risk appraisals, which were either rational (low perceived risk aligned with low physiological fall risk) or congruent (high perceived risk aligned with high physiological fall risk). Among participants with rational, congruent, irrational, and incongruent appraisals, 21.7%, 66.7%, 28%, and 18.8%, respectively, reported having a history of falls ($p < 0.01$). Using technology to identify discrepancies in perceived and physiological fall risks can potentially increase the success of fall risk screening and guide fall interventions to target perceived or physiological components of balance. [*Journal of Gerontological Nursing, 46*(4), 41-47.]

Falls and fear of falling are mostly hidden issues in older adults, as they often worry they will forfeit self-reliance and be required to move to a nursing facility if they report fear of falling to family members or health care providers (Fletcher & Hirdes, 2004). Accurate assessment of fear of falling and falls in community-dwelling older adults is thus essential; however, assessment is usually based on either self-reporting or physiological measures rather than a combination of measures. Using only a self-reporting measure results in underreported falls and is influenced by older adults' cultural, economic, and social biases, which also affect fall risk estimation (Dierking et al., 2016). Older adults with a high fear of falling have three times higher risk for mobility disability (Auais et al., 2016), and up to 50% of older adults who have a fear of falling limit their social or physical activities because of this fear (Dionyssiotis, 2012). A cross-sectional study revealed that older adults with a fear of falling overestimate their gait performance and present deficits in their motor imagery of gait (Sakurai et al., 2017). Falls may be reduced and older adults may not exhibit increased fear of falling if they undergo accurate appraisal of physical abilities (Delbaere, Close, Brodaty, et al., 2010) and have regular accessibility to fall risk assessment.

*Maladaptive fall risk appraisal* is a discrepancy between physiological fall risk versus perceived fall risk. In one study, approximately 20% of older adults had high physiological fall risk

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but low perceived fall risk, and 40% of these individuals fall, whereas 11% of older adults had low physiological fall risk but high perceived fall risk, and 30% of these older adults fall (Delbaere, Close, Brodaty, et al., 2010). If fall risk assessment and prevention measures are not taken in the right direction, injurious falls will contribute to increasing direct and indirect care costs and remain a critical burden to the health care system (Houry et al., 2015). Although one in three older adults have disparities between physiological fall risk and perceived fall risk (Delbaere, Close, Brodaty, et al., 2010), fall risk assessment is still based primarily on either self-perception or physiological measures. A systematic review and meta-analysis indicated that no single self-report demonstrated to be a powerful instrument for assessing older adults at risk of future falls (Lusardi et al., 2017). In addition, no single performance-based measure demonstrated reliable diagnostic accuracy, as indicated by sensitivity and specificity (Lusardi et al., 2017).

Nurses are at the forefront of health assessment and prevention and can play a crucial role in fall risk screening. Rapidly growing improvements in portable technology, such as the BTrackS™ Assess Balance System (Balance Tracking Systems, 2018), can serve as an effective and low-cost solution for measuring physiological fall risk among older adults at home or in their community (Goble, 2015). Currently, many different measures are used by hospitals to assess fall risk and having simple tools can streamline the process, which can help patients and nurses. For measuring perceived/subjective fall risk, the short Fall Efficacy Scale-International (FES-I) has been shown to have better validity and reliability in measuring fear of falling or fall risk concerns than any one question assessment (Kempen et al., 2008). Therefore, a two-dimensional approach that combines physiological (objective) and perceived (subjective) measures was proposed to categorize fall risk appraisal and quantify discrepancies between perceived fall risk and physiological fall risk.

## METHOD

### Design

A cross-sectional research design was used to categorize fall risk appraisal and quantify the discrepancy of perceived fall risk and physiological fall risk in community-dwelling older adults. Ethical approval was granted by the Institutional Review Board at the University of Central Florida.

### Participants

A total of 102 community-dwelling older adults in Orlando, Florida were recruited by a flyer in their communities and by word of mouth. Participants were enrolled if they met all of the following inclusion criteria: (a) age ≥65; (b) no marked cognitive impairment (Mini-Mental State Examination score ≥24 [Folstein et al., 1975]); and (c) live in their own homes or senior/retirement units.

### Instruments

*Portable BTrackS Assess Balance System.* The portable BTrackS balance system was used to assess physiological fall risk. This balance system comprises a portable balance plate, balance software, and a computer/tablet with Windows 7 or higher. The portable BTrackS balance plate is a U.S. Food and Drug Administration–approved medical force plate that is used to measure balance performance. The BTrackS balance plate dimensions are 15.5″×23.5″×2.5″, weight 14.5 lbs, operated in Windows 7 or higher via a universal serial port, and powers directly from the connected computer.

The BTrackS balance system, which included the BTrackS Balance Test (BBT), was used to measure the balance performance of each older adult, and the average center of pressure path length was recorded (Goble, 2015). The BBT has good validity using Pearson correlations ($r > 0.90$) and excellent test–retest reliability using intraclass correlation coefficients (0.83) (Levy et al., 2018). BBT scores range from 1 to 100, where scores 0 to 30 indicate low physiological fall risk (Goble & Baweja, 2018). In the current study, scores ≥31 indicated high physiological fall risk. BBT scores are dependent on age and sex but not body size; therefore, the percentile rankings were determined across various age groups and for men and women separately (Goble & Baweja, 2018).

*Short Fall Efficacy Scale-International.* Perceived fall risk was assessed using the short FES-I. The short FES-I is a 7-item self-report questionnaire with a 4-point Likert scale that provides information on the level of concern about falls for a range of activities of daily living, such as getting dressed or taking a bath (Delbaere, Close, Mikolaizak, et al., 2010; Kempen et al., 2008). Scores range from 7 to 28, where scores of 7 to 10 indicate low concern about falling and scores 11 to 28 indicate high concern (Delbaere, Close, Mikolaizak, et al., 2010). The short FES-I has been validated in community-dwelling older adults (Kempen et al., 2008) with good validity, reliability, and responsiveness (Marques-Vieira et al., 2016). The short FES-I has accurately predicted future falls, psychological falls risk, and muscle weakness (Delbaere, Close, Brodaty, et al., 2010).

### Data Collection

The first author (L.T.) met with participants at their community center and provided information about the study's aims and data collection process. After receiving verbal informed consent to collect data, participants were asked to complete a survey that included demographic information, history of falls, level of fear of falling, and the perception of their fall risk using the short FES-I. Following the survey, participants were instructed to perform the BBT. The BBT protocol comprises four 20-second trials. For each trial, the participant needed to stand as still as possible on the BTrackS balance plate with hands-on-hips and

eyes closed (Goble & Baweja, 2018). The first trial was for familiarization; the following three trials were used to measure the average number of centimeters of postural sway. Total time spent in giving instruction, completing the survey, and performing the test was approximately 20 to 30 minutes per participant.

### Data Analysis

Descriptive statistics and cross-tab analysis were computed using SPSS version 25. The cross-tab analysis was used to categorize participants into two groups (adaptive and maladaptive) and four subgroups (rational/congruent/irrational/incongruent) based on physiological fall risk (i.e., BBT score) and perceived fall risk (i.e., short FES-I score), and used cut-off values for high and low risk as a proposed fall risk appraisal matrix:

- *rational* (low physiological fall risk [BBT ≤30] aligned with low perceived fall risk [short FES-I ≤10]);
- *congruent* (high physiological fall risk [BBT >30] aligned with high perceived fall risk [short FES-I >10]);
- *irrational* (low physiological fall risk [BBT ≤30] despite high perceived fall risk [short FES-I >10]); and
- *incongruent* (high physiological fall risk [BBT >30] but low perceived fall risk [short FES-I ≤10]).

Rational and congruent fall risk appraisals were considered to be adaptive fall risk appraisal. Rational fall risk appraisal was a positive state of adaptive fall risk appraisal, and congruent fall risk appraisal was a negative state of adaptive fall risk appraisal. Irrational and incongruent fall risk appraisals were considered to be maladaptive fall risk appraisal. For selected participant characteristics, proportions were compared among four groups using the chi-square test.

## RESULTS

The majority (78%) of participants were female, with a mean age of 78.02 (*SD* = 7.56, range = 65 to 103 years). Race and ethnicity were represented: 60.8% non-Hispanic White, 23.5% Hispanic, 9.8% African American, and 5.9% Asian American. Approximately 47% of participants had a college degree or higher; 37% identified as having good general health; 5% identified as having poor general health; 23% identified as having no financial problems, whereas 12% identified as often having financial problems; and 36% lived alone, whereas 43% lived with a spouse or partner. Regarding fall history, 70.6% had no history of falls, 33% did not worry about falling, and 44% reported that fear of falling limited their daily activities. Average BBT score was 29.44 (*SD* = 13.34, range = 12 to 77), and the average short FES-I score was 10.31 (*SD* = 4.43, range = 7 to 28) (**Table 1**).

From the scatterplot of physiological fall risk and perceived fall risk, categorized into four groups, and compared by gender (**Figure 1**), 40.2% of participants had maladaptive fall risk appraisal, which included irrational fall risk appraisal (15.7%) and incongruent fall risk appraisal (24.5%). The majority (59.8%) of participants had adaptive fall risk appraisal, which included rational fall risk appraisal (45.1%) and congruent fall risk appraisal (14.7%). In addition, men tend to cluster in rational and incongruent groups, whereas women were widely distributed among the four groups.

**Table 2** presents the results from statistical analyses of gender, age, history of falls, and fear of falling by fall risk appraisal groups. Fall risk appraisal groups were significantly associated with a history of falls or had at least one fall in the previous year and fear of falling ($p < 0.05$). Among participants with rational, incongruent, irrational, and congruent appraisals, 21.7%, 28%, 18.8%, and 66.7%, respectively, reported having a history of falls ($p < 0.01$). Participants with congruent fall risk appraisal tend to be women, more likely to report at least one fall in the previous year, and have a fear of falling.

**TABLE 1**
**Participant Characteristics (*N* = 102)**

| Variable | *n* (%) |
|---|---|
| Gender | |
| Female | 79 (77.5) |
| Male | 23 (22.5) |
| Ethnicity | |
| Non-Hispanic White | 62 (60.8) |
| Hispanic | 24 (23.5) |
| African American | 10 (9.8) |
| Asian | 6 (5.9) |
| Education | |
| College or higher | 48 (47) |
| High school | 41 (40.2) |
| Primary or middle school | 13 (12.8) |
| General health | |
| Poor | 5 (4.9) |
| Fair | 22 (21.6) |
| Good | 38 (37.3) |
| Very good | 28 (27.5) |
| Excellent | 9 (8.8) |
| Financial difficulty | |
| Rarely | 31 (30.4) |
| Often | 8 (7.8) |
| Occasionally | 36 (35.3) |
| Never | 23 (22.6) |
| Always | 4 (3.9) |
| Living with | |
| Partner or spouse | 44 (43.1) |
| Family or friend | 18 (17.7) |
| Alone | 37 (36.3) |
| Other | 3 (2.9) |

## DISCUSSION

The current study aimed to categorize fall risk appraisal and quantify discrepancies between perceived fall risk measured subjectively using the short

TABLE 1 (CONTINUED)
**Participant Characteristics (*N* = 102)**

| Variable | *n* (%) |
|---|---|
| History of falls | |
| None | 72 (70.6) |
| One | 17 (16.7) |
| Two | 10 (9.8) |
| More than two | 3 (2.9) |
| Injurious falls | |
| None | 86 (84.3) |
| One | 9 (8.8) |
| Two | 6 (5.9) |
| Three | 1 (1) |
| Afraid of falling | |
| A lot | 5 (4.9) |
| A little | 37 (36.3) |
| Somewhat | 26 (25.5) |
| Not at all | 34 (33.3) |
| Fear of falling influences ADL | |
| A little | 34 (33.3) |
| Somewhat | 11 (10.8) |
| Not at all | 57 (55.9) |
| | **Mean (*SD*) (Range)** |
| Age (years) | 78.02 (7.58) (65 to 103) |
| BBT score | 29.44 (13.34) (12 to 77) |
| Short FES-I score | 10.31 (4.43) (7 to 28) |

*Note. ADL = activities of daily living; BBT = BTrackS™ balance test; FES-I = Falls Efficacy Scale-International.*

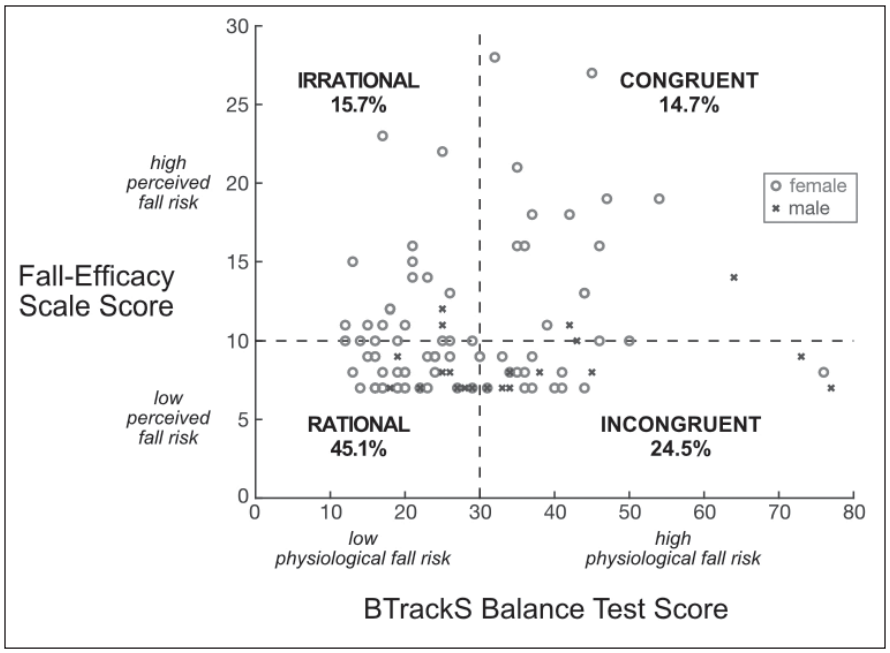


**Figure 1.** Scatterplot of physiological fall risk and perceived fall risk, categorized into four groups and compared by gender.

FES-I and physiological fall risk measured objectively using the portable BTrackS balance system. To the authors' knowledge, this study presents the first analysis of the discrepancies between perceived fall risk measured subjectively using the short FES-I and physiological fall risk measured objectively using the BTrackS balance system in community-dwelling older adults. The authors created the fall risk appraisal matrix, which is a graphical grid categorizing older adults' perceived fall risk and physiological fall risk in four quadrants (irrational/incongruent/congruent/rational), based on the cutoff values for high and low risk of the BBT and short FES-I.

Approximately 40% of participants had maladaptive fall risk appraisal, which is slightly higher when compared with similarly aged and healthy older adults (33%) (Delbaere, Close, Brodaty, et al., 2010) but lower when compared with individuals with multiple sclerosis (50%) (Gunn et al., 2018). The percentage of participants who had irrational fall risk appraisal and incongruent fall risk appraisal were higher than the previous cohort study (irrational 15.7% vs. 11% and incongruent 24.5% vs. 20%, respectively) (Delbaere, Close, Brodaty, et al., 2010). The percentage of participants with rational fall risk appraisal was higher than the previous study, and the percentage of participants with congruent fall risk appraisal was lower than the previous study (Delbaere, Close, Brodaty, et al., 2010). The differences between the current results and previous studies (Delbaere, Close, Brodaty, et al., 2010; Gunn et al., 2018) can be attributed in part to different measures used to assess physiological fall risk, different study location (Australia vs United States), study design, and different characteristics (e.g., proportion of females to males). A longitudinal study found an association between fear of falling, patterns of personal factors (e.g., gendered patterns), and actual physical performance (Pohl et al., 2015). Gendered patterns are influenced by several factors, such as age, socialization, location, and resources (Calasanti, 2010).

Older adults with irrational fall risk appraisal or who had low physiological fall risk but high perceived fall risk were more likely to be female and 75 and older. This group tends to have depression and decreased function (Delbaere, Close, Brodaty, et al., 2010). Irrational fall risk appraisal may serve as a barrier producing an ir-

TABLE 2

**Statistical Analyses of Gender, Age, History of Fall, and Fear of Falling By Fall Risk Appraisal Group (*N* = 102)**

| Variable | Total (*N*) | Fall Risk Appraisal Group (%) | | | | *p* Value |
|---|---|---|---|---|---|---|
| | | Rational | Congruent | Incongruent | Irrational | |
| *n* (%) | | 46 (45.1) | 15 (14.7) | 25 (24.5) | 16 (15.7) | |
| Gender | | | | | | 0.097* |
| Female | 79 | 80.4 | 86.7 | 60 | 87.5 | |
| Male | 23 | 19.6 | 13.3 | 40 | 12.5 | |
| Age (years) | | | | | | 0.50 |
| 65 to 74 | 36 | 39.1 | 40 | 36 | 18.7 | |
| ≥75 | 66 | 60.9 | 60 | 64 | 81.3 | |
| History of fall | | | | | | 0.006* |
| Yes | 30 | 21.7 | 66.7 | 28 | 18.8 | |
| No | 72 | 78.3 | 33.3 | 72 | 81.2 | |
| Fear of falling | | | | | | 0.006 |
| Yes | 68 | 56.5 | 100 | 56 | 81.3 | |
| No | 34 | 43.5 | 0 | 44 | 18.7 | |

** The cells have expected counts <5; therefore, the Monte Carlo test was used for the Fisher Exact test.*

rational fear that inhibits older adults from staying physically active. Older adults with incongruent fall risk appraisal or who had high physiological fall risk but low perceived fall risk were more likely to be male and reported no fear of falling. Incongruent fall risk appraisal can conversely act as an impediment to older adults' safety by fabricating a sense of well-being when more caution is warranted.

Participants with congruent fall risk appraisal were more likely to report at least one fall in the previous year, which is similar to the cohort study (Delbaere, Close, Brodaty, et al., 2010). It is possible that participants with congruent fall risk appraisal had poor balance and experienced multiple falls that may cause high-perceived fall risk or high fear of falling. All participants in the congruent fall risk appraisal group reported fear of falling. Older adults with high fear of falling have a higher risk for falls, and chronic fear of falling is associated with increased risk of functional decline (Choi et al., 2017).

Fall prevention is best approached from a participant-centered perspective, and findings from the current study can be valuable to target specific fall risk appraisal groups for fall interventions at an individual level. Accurately identifying older adults who require intervention to reduce falls is challenging for health care providers. Because fall risk awareness is low in older adults, it may influence behavior and participation rate (Verghese, 2016). Perceived fall risk should be considered when assessing fall risk and designing fall interventions. The current results highlight the importance of using a combination of the portable BTrackS balance technology (as the objective measure) and the short FES-I (as the subjective measure) to individualize fall risk assessment, especially in older adults with irrational and incongruent fall risk appraisals. The objective measure determines how much fall risk and the subjective measure provides additional insight into individual's perspectives on the risk of falling as part of an in-depth examination (Lusardi et al., 2017). The BTrackS balance system is thus an innovative technology to assess physiological fall risk. The BTrackS balance system provides easy portability for the user and is user-friendly for older adults (Dueñas et al., 2016; Levy et al., 2018). The BTrackS balance system also indicated the potential to identify meaningful changes in balance performance that may warrant fall interventions (Levy et al., 2018).

## LIMITATIONS

The current study had several limitations. First, the cross-sectional research design limited the ability to draw the establishment of causal re-

lationships. Second, the selection of participants was not random, and the sample size was relatively small. Third, perceived fall risk was assessed by the short FES-I English version, and participants were limited to individuals who understand English. Future research should use the FES-I in several languages, such as Spanish. Finally, social desirability may lead participants to under- or over-report their fall risk.

## CONCLUSION

Using a combination of physiological fall risk assessed by the portable BTrackS balance system and perceived fall risk, which was assessed using the short FES-I, provides useful information on screening individuals and findings can be valuable to target fall interventions. In addition, providers are encouraged to use the proposed matrix to assess fall risk and use both measures to attain a more accurate assessment of fall risk appraisal. Identifying individuals who are at high physiological fall risk but possess little perceived fall risk and individuals who are at low physiological fall risk but possess over perceived fall risk is a vital step of fall prevention. Older adults with irrational fall risk appraisal may result in activity disengagement and social isolation, whereas older adults with incongruent fall risk appraisal may result in increasing injurious falls.

This was the first study in the categorization of fall risk appraisal and discrepancy of perceived fall risk and physiological fall risk using innovative technology. Using valid and reliable technology can potentially increase the success of fall risk screening and guide fall interventions to target perceived or physiological components of balance specifically. Further cohort studies are needed to explore the factors and interrelationships of perceived (subjective) fall risk and physiological (objective) fall risk in the prediction of future falls and the mechanisms of older adults' shift from maladaptive to adaptive fall risk appraisal or vice versa.

## REFERENCES


Auais, M., Alvarado, B. E., Curcio, C.-L., Garcia, A., Ylli, A., & Deshpande, N. (2016). Fear of falling as a risk factor of mobility disability in older people at five diverse sites of the IMIAS study. *Archives of Gerontology and Geriatrics, 66,* 147–153. https://doi.org/10.1016/j.archger.2016.05.012 PMID:27327236

Balance Tracking Systems. (2018). *BTrackS™ assess balance.* https://balancetrackingsystems.com/assess-balance

Calasanti, T. (2010). Gender relations and applied research on aging. *The Gerontologist, 50*(6), 720–734. https://doi.org/10.1093/geront/gnq085 PMID:20956798

Choi, K., Jeon, G. S., & Cho, S. I. (2017). Prospective study on the impact of fear of falling on functional decline among community-dwelling elderly women. *International Journal of Environmental Research and Public Health, 14*(5), 469. doi:10.3390/ijerph14050469

Delbaere, K., Close, J. C., Brodaty, H., Sachdev, P., & Lord, S. R. (2010). Determinants of disparities between perceived and physiological risk of falling among elderly people: Cohort study. *BMJ (Clinical Research Ed.), 341*, c4165. https://doi.org/10.1136/bmj.c4165 PMID:20724399

Delbaere, K., Close, J. C., Mikolaizak, A. S., Sachdev, P. S., Brodaty, H., & Lord, S. R. (2010). The Falls Efficacy Scale International (FES-I). A comprehensive longitudinal validation study. *Age & Ageing, 39*(2), 210–216. https://doi.org/ 10.1093/ageing/afp225 PMID:20061508

Dierking, L., Markides, K., Al Snih, S., & Kristen Peek, M. (2016). Fear of falling in older Mexican Americans: A longitudinal study of incidence and predictive factors. *Journal of the American Geriatrics Society, 64*(12), 2560–2565. https://doi.org/10.1111/jgs.14496 PMID:27783403

Dionyssiotis, Y. (2012). Analyzing the problem of falls among older people. *International Journal of General Medicine, 5,* 805–813. https://doi.org/10.2147/IJGM.S32651 PMID:23055770

Dueñas, L., Balasch i Bernat, M., Mena del Horno, S., Aguilar-Rodríguez, M., & Alcántara, E. (2016). Development of predictive models for the estimation of the probability of suffering fear of falling and other fall risk factors based on posturography parameters in community-dwelling older adults. *International Journal of Industrial Ergonomics, 54,* 131–138. https://doi.org/10.1016/j.ergon.2016.05.009

Fletcher, P. C., & Hirdes, J. P. (2004). Restriction in activity associated with fear of falling among community-based seniors using home care services. *Age and Ageing, 33*(3), 273–279. https://doi.org/10.1093/ageing/afh077 PMID:15082433

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12*(3), 189–198. https://doi.org/10.1016/0022-3956(75)90026-6 PMID:1202204

Goble, D. J. (2015). *Validating BTrackS to measure balance.* http://balancetrackingsystems.com/wp-content/uploads/2019/05/Validating-BTrackS-FRA.pdf

Goble, D. J., & Baweja, H. S. (2018). Postural sway normative data across the adult lifespan: Results from 6280 individuals on the Balance Tracking System balance test. *Geriatrics & Gerontology International, 18*(8), 1225–1229. https://doi.org/10.1111/ggi.13452 PMID:29897159

Gunn, H., Cameron, M., Hoang, P., Lord, S., Shaw, S., & Freeman, J. (2018). Relationship between physiological and perceived fall risk in people with multiple sclerosis: Implications for assessment and management. *Archives of Physical Medicine and Rehabilitation, 99*(10), 2022–2029. https://doi.org/10.1016/j.apmr.2018.03.019 PMID:29698641

Houry, D., Florence, C., Baldwin, G., Stevens, J., & McClure, R. (2015). The CDC Injury Center's response to the growing public health problem of falls among older adults. *American Journal of Lifestyle Medicine, 10*(1), 74–77. https://doi.org/10.1177/1559827615600137 PMID:26688674

Kempen, G. I. J., Yardley, L., van Haastregt, J. C. M., Zijlstra, G. A. R., Beyer, N., Hauer, K., & Todd, C. (2008). The Short FES-I: A shortened version of the Falls Efficacy Scale-International to assess fear of falling. *Age and Ageing, 37*(1), 45–50. https://doi.org/10.1093/ageing/afm157 PMID:18032400

Levy, S. S., Thralls, K. J., & Kviatkovsky, S. A. (2018). Validity and reliability of a portable balance tracking system, BTrackS, in older adults. *Journal of Geriatric Physical Therapy, 41*(2), 102–107. https://doi.org/10.1519/JPT.0000000000000111 PMID:27893566

Lusardi, M. M., Fritz, S., Middleton, A., Allison, L., Wingood, M., Phillips, E., Criss, M., Verma, S., Osborne, J., & Chui, K. K. (2017). Determining risk of falls in community dwelling older adults: A systematic review and meta-analysis using posttest probability. *Journal of Geriatric Physical Therapy, 40*(1), 1–36. https://doi.org/10.1519/JPT.0000000000000099 PMID:27537070

Marques-Vieira, C. M. A., Sousa, L. M. M., Severino, S., Sousa, L., & Caldeira, S. (2016). Cross-cultural validation of the Falls Efficacy Scale International in elderly: Systematic literature review. *Journal of Clinical Gerontology and Geriatrics, 7*(3), 72–76. https://doi.org/10.1016/j.jcgg.2015.12.002

Pohl, P., Ahlgren, C., Nordin, E., Lundquist, A., & Lundin-Olsson, L. (2015). Gender per-

spective on fear of falling using the classification of functioning as the model. *Disability and Rehabilitation, 37*(3), 214–222. https://doi.org/10.3109/09638288.2014.914584 PMID:24786969

Sakurai, R., Fujiwara, Y., Yasunaga, M., Suzuki, H., Sakuma, N., Imanaka, K., & Montero-Odasso, M. (2017). Older adults with fear of falling show deficits in motor imagery of gait. *The Journal of Nutrition, Health & Aging, 21*(6), 721–726. https://doi.org/10.1007/s12603-016-0811-1 PMID:28537339

Verghese, J. (2016). Person-centered fall risk awareness perspectives: Clinical correlates and fall risk. *Journal of the American Geriatrics Society, 64*(12), 2528–2532. https://doi.org/10.1111/jgs.14375 PMID:27801936