International Journal of Research in Exercise Physiology

Original Research Article

The Effects of Tempo-Controlled Music Prompts during Task Switching and Multitasking Exercises in Older Adults

Alexis Guthman[1], Maya Brenna[1], Ryan Lahey[1], Taylor Lamon[1], Madeline Moen[1], Saori Braun[1]

[1]Department of Kinesiology, University of Wisconsin-Eau Claire, WI, USA

ABSTRACT

Background/Purpose: Falls are a leading cause of morbidity, mortality, and loss of independence in older adults. Many falls occur while walking and simultaneously performing a physical or cognitive task. The aim of this study was to investigate whether a multitasking exercise program with or without music-based tempo cues could improve gait speed and balance and reduce fall risk indicators in older adults. **Methods:** Sixteen adults aged 50 and older participated in this study. Each participant completed an initial 30-minute assessment evaluating gait speed and balance. Participants were randomly assigned to a group, one utilized music to drive the tempo of the exercise, and another did not utilize music. The intervention consisted of a circuit-based exercise program incorporating simultaneous cognitive and physical tasks. Participants attended two 30-40-minute sessions per week for six weeks. Following the 6-week intervention, all participants completed the same gait and balance assessments. **Results:** A two-way analysis of variance showed no significant differences between music and no-music groups in any of the gait speed or balance protocols. Age was used as a covariate, which showed a decrease in speed as age increased. **Conclusions:** Although no significant differences were found between groups, the age-related decline in gait speed suggests that age plays an important role in gait performance and fall risk. These findings highlight the need for future research to examine age-specific responses to multitasking exercise interventions.

Key Words: Gait, Balance, Posture, Cognitive Function, Secondary Task, Reaction Time, Fall Risk

INTRODUCTION

Falls are among the most common and serious problems that older adults face. Falling is associated with considerable mortality, morbidity, reduced functioning, and premature nursing home admissions[1]. Often, these incidents occur while walking or performing multiple tasks at once, therefore creating a multitasking-based exercise program may be an effective way to reduce the number of falls that occur in an older adult population. Pairing music with exercise may help increase adherence and enjoyment. When adding a musical component, it has been found that cognitive and motor connection areas of the brain can be stemmed and can have a positive correlation between the implementation of a synchronous metrically cued pattern and motor skills[2]. This means that music can potentially be used as a powerful tool to make the exercise program more effective and decrease the risk of falls by a greater margin.

Previous research has been done on the connections of cognitive and motor neural processing for task switching and multitasking with its effects on balance and gait training as individuals age[3-4]. There have also been many studies that delve into utilizing music as an intervention tool for fall prevention[2-3-5-6]. Finding modalities to decrease fall risk demonstrates importance as there is a significant association with increased fall risk over the age of 60, with the highest risk prevalent in those 80 years or older[7]. It is estimated that 35-45% of individuals ages 65 years and older experience one fall per year[1]. Further, increasing age has a direct negative correlation with physical health and independence. This combination increases the prospect of suffering an injury from a fall, therefore displaying the utmost importance of finding a tool to decrease these probabilities.

The importance of fall prevention is essential as it has been shown to impact one's activities of daily living (ADL's) and their quality of life (QOL). As mentioned, older adults experience various changes in cognitive and motor aspects related to fall risk. Proprioception and locomotion are facets of life that are quickly learned as a child; however, they undergo a decline in functionality as an individual ages[5]. Research has shown an evident connection of greater fall risk in older adults compared to that of younger individuals because of lower balance functioning, alongside decreased cognitive execution[4]. Many falls in older adults occur when walking while simultaneously performing another task, which is caused by the inability to switch attention between multiple tasks[8]. As distractions are added to one's environment (multitasking), more cognitive effort is necessary to facilitate a change in activity (task switching). This can impact many areas of an individual's life as an overall decrease in performance presents.

Due to physical and cognitive challenges impacting fall risk, researchers have sought ways to implement a tool that will positively impact this population. Intentional active movement is one way that researchers have explored this topic. It has been found that incorporating a wide range of movements, including atypical movements, to shift the person's weight, can help improve balance[3]. This change in movement may be deviating away from the typical reduced step length, increased double support phase, and increased gait variability that research has commonly seen in older adults. Further, because these physical and cognitive targets go hand-in-hand, aspects of multitasking and task switching should be included. A common way for older adults to train in multitasking or task switching is to have them step or walk while switching tasks[9]. The incorporation of these concepts challenges older adults to both learn and relearn motor skills that will reaffirm the ability to multitask and task switch[9].

Movement or exercise programs alone are not enough to decrease fall risk. Specifically, following the tempo of music during exercise can have an impact on aspects such as one's gait and functionality. When walking to metrically cued music individuals experienced a reduction of fall risk and experience music to be a driving force[5]. When a musical component was added, both motor and cognitive aspects are involved, which allows individuals to improve reaction timing[2]. Aside from enhancing balance, other studies have explored the idea that music can increase motivation, and in turn, increase adherence to exercise. Music can be used to alter individuals' motivation, enjoyment in the activity at hand, and positively impact psychological aspects like anxiety, and is therefore able to impact heart rate, blood pressure, fatiguability, and more[2-5]. Music therapy is a commonly used tool to improve physical activity of all ages. A study done on music therapy and functional fitness in older adults showed that cardiopulmonary fitness levels and flexibility improved at a greater rate compared to the group that did the same exercises without music[2]. A powerful tool like music should be utilized more in a community setting so that the best results can be achieved and adapted to the individual.

With these aspects being presented, there was minimal evidence on the impact of music on the ability to task switch and multitask, which are crucial to various aspects of movement in activities of daily living as individuals age. Studies have found an evident connection between increasing age and fall risk, with a corresponding decreased ability to task switch and multitask[3-4]. However, gaps in the literature denote a need for further research into combining a musical tool as a possible intervention, and whether metrically cued music can increase the positive impact experienced through participating in task switching and multitasking programming.

The purpose of this research study was to explore the impact of metrically cued music when participating in task switching and multitasking exercise circuits, and its impact on fall risk for adults ages 50 and older. Although these aspects of music and multitasking/task switching have been seen to produce positives separately, there was insufficient evidence that using the two together in an exercise circuit format can act as a facilitator to produce decreases in fall risk. It was hypothesized that older adults in the music exercise group will experience improved gait and balance compared to those in the non-music group.

METHODS

Subjects

Participants aged 50 years and older were identified through the University of Wisconsin-Eau Claire's (UWEC) Community Fitness Program (CFP) and the L.E. Phillips Senior Center in Eau Claire via presentation with a successive sign-up sheet. Assessment for exclusion was determined using the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and a health questionnaire to determine eligibility. The exclusion criteria was as follows: the use of an assistive device; individuals under 50 years of age; uncontrolled hypertension; uncontrolled cardiovascular conditions, including coronary artery disease, heart failure, or a diagnosed abnormality of heart rhythm; uncontrolled metabolic disease, including Type I Diabetes, Type II Diabetes, and prediabetes; uncontrolled respiratory disease, including the Chronic Obstructive Pulmonary, Asthma, and Pulmonary High Blood Pressure; and/or if the individual has an intellectual or cognitive disability. Based on these criteria, no individuals were excluded from participation at the CFP and L.E. Phillips Senior Center. An initial 10 participants were recruited from UWEC's CFP and 11 from L.E. Phillips Senior Center, for a total of 21 participants contributing to the study. Refer to Table 1 for additional participant demographics. Further, each participant signed an informed consent, and the UW-Eau Claire Institutional Review Board approved the study.

Table 1. Background Participant Information.

	Male (n = 6)	Female (n = 10)	Total (n= 16)
Age (years)	75.5 ± 9.22	74.8 ± 74.8	75.06 ± 7.13
Moderate Exercise Participation	83%	100%	94%
Balance Specific Exercise Participation	50%	50%	50%
Dominant Foot (Right)	100%	100%	100%
Has fallen in the last 6 months	17%	20%	19%

Note. Values are presented in mean ± standard deviation for continuous variables and in percentage for categorical variable(s).

Control and Experimental Groups

This study consisted of two randomized groups: the control group, which participated in a multitasking-based exercise circuit at a self-paced tempo; and the experimental group, which participated in the same exercise circuit, but with the addition of synchronized music dictating the pace at which the participants would work. The randomization of the groups was done using the participants' I.D. numbers and using a randomization program through a computer generator. This resulted in a total of 10 individuals in the control group and 11 individuals in the experimental group.

Procedures

Data collection began with two days of pre-testing during which participants completed assessments of gait and balance using the Balance Error Scoring System (BESS), the Tinetti Gait and Balance Assessment (TGBA), and a timed gait test using the Brower Timing Gates. To minimize human error and ensure consistency, each researcher learned one specific test and conducted that same test for participants. Each pre-testing session took approximately 30 minutes per participant. The exercise intervention began the week following the pre-testing sessions and lasted six weeks. Participants attended two supervised 45-minute exercise sessions per week, for a total of 12 sessions. The exercise program was designed for adults aged 50 and older. Because physical ability levels vary widely within this population, exercise intensity was self-regulated by participants through their choice of weight resistance.

Exercise Intervention

The exercise sessions consisted of three sets of four exercises, and each exercise was performed for 40-60 seconds. Two of the stations required participants to perform two physical tasks simultaneously: (1) Sidestep squat paired with alternating frontal and lateral raises and (2) bicep curls on an AIREX pad. The other two exercises in the circuit required participants to perform a physical task with a cognitive task: (3) Bench stepping to the beat starting with the non-dominant foot in the first round, paired with the cognitive task of counting down by three’s from a randomly selected number, and (4) single leg forward and lateral foot taps to the beat while performing the Stroop Test. After one round of exercise was completed, participants took a one-to-two-minute break before starting the next round. Adherence to the intervention was monitored using session sign-in sheets, which recorded participant attendance at each class. Attendance rates were used to determine adherence. Following completion of the six-week intervention, participants returned for post-testing, repeating the same gait and balance assessments administered during pre-testing. Because this study used a between-subject design, counterbalancing was not applicable.

Experimental design and Statistical Analysis

The design of this research was an experimental study with pre- and post-testing. The first independent variable was the music that dictates the pace of the exercise being performed for the experimental group; this music consisted of the tempo being 80-100 beats per minute. The second independent variable was the time aspect of how long it takes to perform each exercise before switching stations. The dependent variables are balance, gait, and gait speed, and age was used as a covariate. For the data analysis, the mean and standard deviation of the data will be calculated. Then, the data will be entered into the IBM-SPSS Software: version 29.0 to run a two-way ANOVA with a significance level of .05.

Instrumentation and Baseline Testing

Stroop Test

The Stroop Test is a widely used neuropsychological test, created by John Ridley Stroop, that assesses executive functioning and interference control. This test requires participants to name the color of the ink rather than the name of the color. For example, if the word Green appears on the screen, but it's written in the color Red, the subject would say "Red"[10]. Through recent research of the validity and reliability of the Stroop Test, it has been found to have acceptable internal consistency and high test-retest reliability[11]. The Stroop Test administered in this study was a video displayed on a laptop or tablet; therefore, the only training required for the investigators administering the test was learning how it was performed so that they could instruct the participants. No scores were collected based on correct or incorrect answers; the purpose of the test was to make the participants think while performing another task.

Modified Balance Error Scoring System (BESS)

The Balance Error Scoring System, or BESS, is a widely used and reliable test of static balance. BESS has moderate to good reliability and is a valid resource to use[12]. It requires the subject to stand in three different stances in total on two different surfaces equaling six trial runs total. The participants in this study kept their shoes on as they performed the test on a hard floor and then on an AIREX pad in the following stances: a narrow stance on both legs, single leg stance, and tandem stance. Points are gained by errors committed. Errors include: stepping, stumbling, or falling, lifting heel or forefoot, lifting hands from their hips, further flexion of the hips during single-leg stance trial. If the participant remains out of testing position for more than five seconds, they receive an error score of 10 and the trial is ended[13]. The modified portion, which was also used within this study, takes the same test, but now instead of the participants closing their eyes as they typically would in the second portion of the BESS, they were instructed to keep their eyes open and perform the Stroop Test with the BESS. To document the results of the trial, add each tally from all six trials so that you may compare the pre-test results to the post-test results. It is recommended that those administering the test are trained and that there is a designated person to score participants. To administer this test, an Airex pad, firm flooring, a scoring sheet, a pen, and a stopwatch are required. For the modified portion of BESS, a laptop or tablet is required to play the Stroop Test video.

Tinetti Gait and Balance Assessment (TGBA)

The TGBA is a commonly utilized and easy to use assessment tool that was used to determine balance and gait in this study. It is based on a 28-point scale; 16 potential points designated for balance assessment and 12 potential points for the gait assessment. The balance assessment was performed using a firm armless chair, rating the performance of the following: sitting balance, rises from chair, attempts to rise, immediate standing balance (first five seconds), standing balance, nudged, eyes closed, turning 360 degrees, and sitting down (getting seated). Another component of the TGBA is the gait assessment that requires the evaluator to move with the patient and for the patient to walk across the room (about 25 feet each way) with or without aides at their usual pace and then back at a rapid pace. There are seven domains of gait assessment, totaling 12 points: indication of gait, step length and height, step symmetry, step continuity, path, trunk, and walking stance. It is important to note that there was a spotter present for all tests in this Balance and Gait Assessment. The final scores of both the gait and balance are added together and scored out of 28 points. 18 points or less indicates high risk, 19-23 indicates moderate risk, 24 or more points indicates low risk. For more information on scoring, please refer to Appendix 1.

The TGBA is a reliable source for testing older adults' balance, especially those of the frailer population of older adults[14]. Although this tool is an effective resource to assess fall risk, to increase reliability in this study, consistency was established in the application of the test through routine and the designation of administrators of the test. Those administering the TGBA were trained in recognizing the subcategories within each section, along with the proper force at which they should administer the Nudge Test.

Walking Speed with Brower Timing Gates

Gait speed testing is a very common functional fitness assessment looking at how fast someone walks at a chosen comfortable speed. To accurately measure gait speed, motion sensor equipment was used. The 2024 TCi-System of Brower Timing Gates used in this study are made by Brower Timing Systems based in Draper, UT. It contains a motion start sensor, TCi-PhotoGate A&B sensors to stop the time, and a remote to enter the settings to the sensors and view the times the participant achieves. This timing system removed the factor of human error in the testing results, allowing for more accurate comparison between pre- and post-intervention assessments. Investigators must go through a short training to be qualified to administer this test to ensure the correct mode was selected, and the sensors are functioning properly. In three trials, this test will be measuring the time it takes the subject to walk at their own pace for four meters, giving them two meters to adjust to their normal walking pace[15]. The multitasking aspect comes into play by having the subject carry a laundry basket filled with gator balls as they walk through the gates. This poses a real-life example of multitasking that could cause disruption in balance and is therefore a valid test measure for fall risk in the study's participants. Additional materials needed to administer this test are a tape measure to accurately place the timing gates, start sensor, and the starting place for the participants, and a cone indicating that starting place.

RESULTS

Based on the study criteria, participants who missed greater than three of the 12 sessions were excluded. At both CFP and L.E. Phillips Senior Center, a total of three individuals dropped out of the study, two participants were excluded, leaving 16 participants included within the end results for the study. Inferential statistics revealed that music had no effect on gait speed, BESS, and Tinetti test scores, but age was a covariate. However, age was a significant factor in gait speed with and without a basket. Refer to Table 2 for descriptive statistics on the tests performed by the participants.

Walking Speed with Brower Timing Gates

There was no significant interaction between group (music vs. no-music) and time (pre- vs. post-test) on gait speed without carrying a basket, $F(1,13) = 0.55$, $p = .472$. Further, no significant interaction was found between time and age on gait speed without carrying a basket, $F(1,13) = 0.12$, $p = .738$. There was no significant time effect on gait speed without carrying a basket, $F(1,13) = 0.24$, $p = .631$. Furthermore, there was no group effect on gait speed without carrying a basket, $F(1,13) = 0.09$, $p = .771$. Age was a significant predictor for gait speed without carrying a basket, $F(1,13) = 4.99$, $p = .044$.

For the interaction between group and time on gait speed while carrying a basket, there was no significance found, $F(1,13) = 0.52$, $p = .485$. There was also no significant interaction between time and age on gait speed while carrying a basket, $F(1,13) = 1.475$, $p = .246$. No significant interaction was found between time and gait speed while carrying a basket, $F(1,13) = 1.19$, $p = .296$. There was no group effect on gait speed with carrying a basket, $F(1,13) = 0.45$, $p = .514$. Age was a significant predictor for gait speed with carrying a basket, $F(1,13) = 7.39$, $p = .018$.

Modified Balance Error Scoring System

There was no significant interaction between group and time (pre- vs. post-test) on BESS scores, $F(1,13) = 1.50$, $p = .242$. Furthermore, no significant interaction was found between time and age on BESS scores, $F(1,13) = 0.35$, $p = .567$. No significant time effect on BESS scores, $F(1,13) = 0.36$, $p = .560$ or group effect was found, $F(1,13) = 1.33$, $p = .271$. Age was not a significant predictor for BESS scores, $F(1,13) = 2.15$, $p = .167$.

Tinetti Gait and Balance Assessment

There was no significant interaction between group and time (pre- vs. post-test) on TGBA scores, $F(1,13) = 0.00$, $p = .965$. Further, no significant interaction was found between time and age on TGBA scores, $F(1,13) = 0.04$, $p = .849$. There was no significant time effect on TGBA scores, $F(1,13) = 0.04$, $p = .850$. There was no group effect on TGBA scores, $F(1,13) = 2.11$, $p = .170$. Age was not a significant predictor for BESS scores, $F(1,13) = 0.01$, $p = .934$

Table 2. Descriptive Statistics for Balance and Gait Tests by Group Status.

	Time	Mean	Standard Error	95% Confidence Interval	
				Lower Bound	Upper Bound
GS No Basket					
Music	Pre	3.00	0.20	2.58	3.42
	Post	3.09	0.18	2.70	3.49
No-Music	Pre	3.00	0.25	2.45	3.55
	Post	3.26	0.24	2.75	3.77
GS Basket					
Music	Pre	2.68	0.16	2.33	3.03
	Post	2.87	0.13	2.58	3.15
No-Music	Pre	2.90	0.21	2.45	3.35
	Post	2.95	0.17	2.58	3.32
BESS					
Music	Pre	27.88	9.58	7.18	48.58
	Post	32.32	10.24	10.19	54.45
No-Music	Pre	50.53	12.46	23.63	77.45
	Post	46.80	13.31	18.04	75.57
TGBA					
Music	Pre	26.80	0.58	25.54	28.05
	Post	26.81	0.55	25.62	28.00
No-Music	Pre	25.67	0.76	24.04	27.30
	Post	25.64	0.72	24.09	27.19

Note. BESS = Balance Error Scoring System; CI = confidence interval; GS = gait speed; TGBA = Tinetti Gait Balance Assessment. Covariate of age = 75.06 years.

DISCUSSION

The purpose of this research study was to explore the impact of metrically cued music when participating in task switching and multitasking exercise circuits, and its impact on fall risk for adults ages 50 and older. With the results that were found, no improvements were concluded, with individuals within both the music group and the non-music group not presenting any statistical significance. However, previous research had presented the individual beneficial effects of music and multitasking/task switching, allowing room for exploration of the two combined areas[2-16].

Music-Based Group Exercise and Older Adults

It was hypothesized that older adults in the music exercise group would experience improved gait and balance compared to those in the non-music group. Within this experiment, the same four exercise stations were used for each group, with each individual spending 40-60 seconds at said station. Here, they chose a desired weight, if applicable, and were instructed to follow the beat of the music if in the music group. If in the non-music group, the pace would be self-dictated. Similarly, Trombetti et al. (2011) used a music intervention that consisted of a group exercise program with the implementation of multitasking exercises that were done following the beat of the music, with individuals 65 and older[3]. Differences, however, can be presented in the testing tools with Trombetti et al. (2011) utilizing electronic pressure sensors and a velocity transducer[3]. Further, the study length was longer consisting of a twelve-month assessment. Chan et al. (2020) however, focused on functional fitness results with music therapy (including balance), which had a similar intervention set up with sessions for the two groups being twice a week, with each being 60 minutes[2]. Their program, however, was 24 sessions with a larger participant group of 133 individuals. Overall, recurring differences presented in participant age, the testing methods and tools, and length of the intervention which may have led to the drastic result differences that were found.

Walking Speed with Brower Timing Gates

Our analysis focused on gait and balance differences between groups, but overall, no significant change was found regardless of group affiliation. This was displayed with no significant differences in gait speed both with and without a basket between the music and non-music groups. Trombetti et al. (2011) found that a music-based multitasking intervention showed improvement in gait velocity and stride length[3]. Looking at the data collected in the study and how there was no significance in gait speed; this was contrary to the article, where there was an improvement in gait speed for the intervention group. There was also no significant improvement in gait speed from the beginning to the end of the study. Age was used as a covariate, and there was a decrease in gait speed as age increased. Larson et al. (2023) found that preferred music choice in gait training sessions showed significant improvement in gait velocity. This suggests that music can have a positive association with improving gait speed, once again contrary to our results[6].

Modified BESS

The BESS assessment showed no significant improvement in balance scores between the groups. An article looking at the effects of balance training exercises on balance and posture saw significant increases from beginning to end of the study in balance, and between the groups[17]. Although our exercise intervention wasn't explicitly balance training, some of the exercises in the circuit required good balance to perform them, so an improved balance score was expected. However, our results are contrary to previous research once again. These variables are important because decreased balance can increase the chance of falls occurring. Falls are one of the more common problems an older adult faces, which can lead to reduced functioning, mortality, and morbidity[1].

Tinetti Gait and Balance Assessment

The participants showed no significant differences in Tinetti scores between groups. The Tinetti test measures posture, gait, and balance. Kim & Kim (2023) studied the effects of music-based exercise intervention on posture in younger adults. They found no significant differences in posture, which agrees with our findings[18]. However, this study utilized a different population than our study, and previous research showed that a music intervention with exercise improved balance[17]. The balance aspect from previous research was contrary to our findings from the Tinetti scores because of high participant test scores prior to intervention.

Strengths/Limitations

This study had its strengths. Using the Brower Timing Gates offered a test measure free of human error. Using a control and experimental group at both locations strengthened the legitimacy of the data by taking into consideration the potential differences in the participants from each location. Additionally, the consistency of exercises allowed the participants to gain confidence in the tasks, especially for the music group that had to refine their tempo control skills. The visuals showing how to perform the exercises provided at each station along with verbal corrections by researchers, were in place in effort to help participants with confidence and performance of each exercise. The exercises were carefully chosen to target different muscles and planes of motion, along with testing physical and mental multitasking.

This study also had limitations. The small sample size impacted the validity of this study and reduced the statistical power. To see more progression in the participants, a longer intervention time may be beneficial. Looking at the tests used to obtain baseline and post-intervention scores, the difficulty did not match the skillset of the participants. The TGBA and the gait speed assessment did not challenge the participants enough, making baseline scores high with minor to no difference in the post-intervention results. Instead of using the TGBA and gait speed assessment for an active and mobile population like the one in the present study, a tool such as Community Balance and Mobility Scale (CB&M) would be more fitting. CB&M offers a wide range of skillsets to be graded on a scale of zero to five (lacking basic skills for the task to complete, coordinated execution of the task). This allows for a more inclusive testing tool and thus more accurate representation of the participants and results. The tasks include unilateral stance, tandem walking, 180 degrees tandem pivot, lateral foot scooting, hopping forward, crouch and walk, lateral dodging, walking and looking, running with controlled stop, forward to backward walking, walk and look and carry, descending stairs, and step ups[19]. Due to the length of and the variety of tasks the CB&M includes, testing gait speed can be excluded from the testing regime. A tool that could offer robust data without human error would be the BioDex machine to measure the static balance of participants. Lastly, the study timeframe was confined due to limited access to locations.

CONCLUSION

This study was conducted to bridge the gap in the limited research combining music-based group exercise and balance focused exercise programs that are presently published. There has been minimal evidence on the impact of music on the ability to task switch and multitask, which are crucial to various aspects of movement in activities of daily living as individuals age. This study found no significant difference between the music group and no-music group on gait and balance based on participation in the exercise intervention. However, there was a decrease in gait speed as age increased. Based on participant results of the TGBA, the average score prior and post intervention was 26.38. This demonstrates that the assessment was not an accurate measure for the target population. Further research should include tests of greater difficulty, as outlined within the limitations above, to allow participants the opportunity to improve because of the intervention. Additionally, future studies should look to include further measures for improvement of participants, including surveys to gauge confidence of participants, motivation for adherence, and perceived improvements in fall risk. These measures will allow researchers to establish an exercise intervention focused not only on direct measures of gait and balance, but also indirect contributions to fall risk.

ACKNOWLEDGEMENTS

The authors acknowledge the study participants for donating their time and contributions to the project.

ADDRESS FOR CORRESPONDENCE

Krings, B. University of Wisconsin-Eau Claire, 105 Garfield Ave. Eau Claire, WI, 54702, USA; Phone: 715-836-3033; FAX: 715-836-4074; Email: kringsb@uwec.edu

REFERENCES

1. American Geriatrics Society, British Geriatrics Society, and American Academy of Orthopedic Surgeons Panel on Falls Prevention. (2001). Guideline for the prevention of falls in older persons. *Journal of the American Geriatrics Society (JAGS)*, *49*(5), 664–672. https://doi-org.proxy.uwec.edu/10.1046/j.1532-5415.2001.49115.x
2. Chan, S.-Y., & Chen, C.-F. (2020). Effects of an active music therapy program on functional fitness in community older adults. *The Journal of Nursing Research*, *28*(5),e111–e111. https://doi.org/10.1097/JNR.0000000000000391.
3. Trombetti, A., Hars, M., Herrmann, F. R., Kressig, R. W., Ferrari, S., Rizzoli, R., (2011). Effects of music-based multitask training on gait, balance, and fall risk in elderly people: A randomized controlled trial. *Archives of Internal Medicine, 171*(6),525533. https://doi.org/10.1001/archinternmed.2010.446
4. Ward, N., Menta, A., Ulichney, V., Raileanu, C., Wooten, T., Hussey, E. K., & Marfeo, E. (2022). The Specificity of Cognitive-Motor Dual-Task Interference on Balance in Young and Older Adults. *Frontiers in Aging Neuroscience*, *13*, 804936. https://doi.org/10.3389/fnagi.2021.804936
5. Grant, D. (2018). *Walking to Metrically Cued Music: How It Affects Gait and Balance in Healthy Older Adults*. ProQuest LLC.
6. Larson, C. A., Roth, E. A., Mahon Sterenberg, A. J., Crinion, M, Fischer, K., Yim, S. H., Smith, A. K., (2023). Variable cadence gait training outcomes using rhythmic auditory stimulation embedded in older adults' preferred music. *Journal of Aging and Physical Activity,31*(5),721-732. https://doi.org/10.1123/japa.2021-0516
7. Delbari, A., Azimi, A., Najafi, M., Saatchi, M., Bidkhori, M., Mousavi, M. E., Tabatabaei, F.-S., & Hooshmand, E. (2024). Prevalence, Complications, and Risk Factors of Falls and Fear of Falling Among Older Adults; Based on Ardakan Cohort Study on Aging (ACSA). *Archives of Academic Emergency Medicine*, *12*(1), e9. https://doi.org/10.22037/aaem.v12i1.2084
8. Hawkes, T. D., Siu, K.-C., Silsupadol, P., & Woollacott, M. H. (2012). Why does older adults' balance become less stable when walking and performing a secondary task? Examination of attentional switching abilities. *Gait & Posture*,*35*(1),159–163. https://doi.org/10.1016/j.gaitpost.2011.09.001
9. Kim, K., Deller, L., Vinent, M., & Zijlstra, W. (2024). Age-Related Effects of Immediate and Delayed Task Switching in a Targeted Stepping Task. *Journal of Experimental Psychology. Human Perception and Performance*, *50*(10), 1023–1032. https://doi.org/10.1037/xhp0001237
10. Stroop, J. R., (1992). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology. General*,*121*(1),15–23. https://doi.org/10.1037/0096-3445.121.1.15
11. Emek-Savas, D. D., Yerlikaya, D., Yener, G. G., & Oktem Tanor, O. (2019). Validity, reliability and normative data of the stroop test capa version. *Turkish Journal of Psychiatry*, *31*(1), 9-21. https://doi.org/10.5080/u23549
12. Bell, D. R., Guskiewicz, K. M., Clark, M. A., & Padua, D. A. (2011). Systematic review of the balance error scoring system. *Sports Health: A Multidisciplinary Approach*, *3*(3), 287–295. https://doi.org/10.1177/1941738111403122
13. Iverson, G. L., & Koehle, M. S. (2013). Normative data for the modified balance error scoring system in adults. *Brain Injury*, *27*(5), 596–599. https://doi.org/10.3109/02699052.2013.772237
14. Lin, M., Hwang, H., Hu, M., Wu, H. I., Wang, Y., & Huang, F. (2004). Psychometric comparisons of the timed up and go, one-leg stand, functional reach, and tinetti balance measures in community-dwelling older people. *Journal of the American Geriatrics Society*, *52*(8), 1343–1348. https://doi.org/10.1111/j.1532-5415.2004.52366.x
15. Bohannon, R. W., & Wang, Y. C., (2019) Four-meter gait speed: values and reliability determined for adults participating in the toolbox study. *Archives of Physical Medicine and Rehabilitation, 100*(3), 509-513. https://doi.org/10.1016/j.apmr.2018.06.031

16. MacPherson, S. E., & Gilmour, V. A. W. (2024). The influence of interruptions and planning on serial everyday multitasking in older adults. *Aging, Neuropsychology, and Cognition*, *31*(3), 496–523. https://doi.org/10.1080/13825585.2023.2210814
17. Firoz, A., Azharuddin, M., Usmani, M., Parveen, S., Sehgal, C. A., & Noohu, M. M. (2024). Comparison of effects of balance training exercise and gaze stability exercises on balance and postural control in elderly with fall risk: A randomized controlled trial. *Physical & Occupational Therapy in Geriatrics*, *42*(3),305321. https://doi.org/10.1080/02703181.2024.2317730
18. Kim M-J, Kim D-Y (2023). Effects of a music-based exercise program on the postural balance and emotions of instrumentalists. *Journal of Exercise Rehabilitation,19*(6):339–344. doi: https://doi.org/10.12965/jer.2346494.247
19. Howe, J. A., Inness, E. L., Venturini, A., Williams, J. I., & Verrier, M. C. (2006). The Community Balance and Mobility Scale (CBMS). *Clinical Rehabilitation*, *20*(10), 885–895. https://doi.org/10.1191/0269215506cr1003oa

Appendix 1

This is a copy of the Tinetti Balance and Gait Assessment (TGBA) Tool scoring guide, outlined with instructions to the examiner.

David Geffen School of Medicine

Geriatric Skills *Functional*

Tinetti Gait and Balance Assessment Tool

BALANCE Instructions to Examiner

- Provide overview of what the assessment will consist of and tell them you'll "talk them through it"
- Begin with patient seated in hard, armless, stably positioned chair
- For rising and sitting, ask patient to attempt it without using their arms/hands
- Examiner stands near patient (few feet in front and slightly to the side; "spot" for safety at all times
- Nudge test -> patient stands with feet as close together as possible; examiner presses on sternum with palm of hand (3 trials)

Domain	Evaluation Characteristics	Description of Deficit
Sitting Balance	Leans or slides in chair = 0 Steady, safe = 1	
Rises from chair	Unable to without help = 0 Able, uses arms to help = 1 Able without use of arms = 2	
Attempts to rise	Unable to without help = 0 Able, requires > 1 attempt = 1 Able to rise, 1 attempt = 2	
Immediate standing balance (first 5 sec)	Unsteady (staggers, trunk sway) = 0 Steady but uses walker or other support = 1 Steady without walker or other support = 2	
Standing balance	Unsteady = 0 Steady but wide stance (>4 inches) or uses support = 1 Narrow stance without support = 2	
Nudge	Begins to fall = 0 Staggers, but catches self = 1 Steady = 2	
Nudge, eyes closed	Unsteady = 0 Steady = 1	
Turning 360 degrees ("make a complete circle")	Discontinuous steps = 0 Continuous = 1	
	Unsteady (grabs, staggers) = 0 Steady = 1	
Sitting down	Unsafe (misjudged distance, falls into chair) = 0 Uses arms or not a smooth motion = 1 Safe, smooth motion = 2	
	Balance score	/16

Based on Tinetti ME. Am J Med.1986 (3):429-34.

Page | **1 of 2**

David Geffen School of Medicine **Geriatric Skills** *Functional*

Tinetti Gait and Balance Assessment Tool

GAIT Instructions to Examiner

- Examiner moves along with patient; "spot" for safety at all times
- Patient walks across room (using walking aid if customary for them) for approximately 25 feet each way.
- Provide overview of what assessment will consist of and tell patient you'll "talk them through it" □ On way "out" ask patient to walk at usual pace; on way "back" ask patient to walk at rapid, but safe, pace.
- Instruct patient about the starting cue (go), and that they should stop if they feel unsafe

Definitions of terms used in gait assessment tool

- "Aid" is rated positive if patient is using his/her walking aid or if patient grabs at rails or furniture
- "Stance foot" is the foot that remains on the ground during gait cycle

Domain	Evaluation Characteristics	Description of Deficit
Indication of gait (Immediately after "'go")	Any hesitancy or multiple attempts = 0 No hesitancy = 1	
Step length and height	Right foot swing Does not pass L stance foot = 0 Steps past L foot = 1 Does not clear floor = 0 Clears floor = 1 Left foot swing Does not pass R stance foot = 0 Steps past R foot = 1 Does not clear floor = 0 Clears floor = 1	
Step symmetry	Right and left step length not equal = 0 Right and left step length equal = 1	
Step continuity	Stopping or discontinuity between steps = 0 Steps continuous = 1	
Path	Marked deviation = 0 Mild/moderate deviation or uses aid = 1 Straight without aid = 2	
Trunk	Marked sway or uses aid = 0 No sway but flexed knees or back or spread arms wide = 1 No sway, flexion, widened arms or aid = 2	
Walking stance	Heels apart = 0 Heels almost touching while walking = 1	
	Gait score	/12
	Balance score (prior page)	/16

Total Score	/28

Based on Tinetti ME. Am J Med.1986 (3):429-34.