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Original Study

Supervised Balance Training and Wii Fit–Based Exercises Lower Falls Risk in Older Adults With Type 2 Diabetes

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A B S T R A C T

Objectives: This study examined the benefits of and differences between 12 weeks of thrice-weekly supervised balance training and an unsupervised at-home balance activity (using the Nintendo Wii Fit) for improving balance and reaction time and lowering falls risk in older individuals with type 2 diabetes mellitus (T2DM).
Design: Before-after trial.
Setting: University research laboratory, home environment.
Participants: Sixty-five older adults with type 2 diabetes were recruited for this study. Participants were randomly allocated to either supervised balance training (mean age 67.8 ± 5.2) or unsupervised training using the Nintendo Wii Fit balance board (mean age 66.1 ± 5.6).
Intervention: The training period for both groups lasted for 12 weeks. Individuals were required to complete three 40-minute sessions per week for a total of 36 sessions.
Measurement: The primary outcome measure was falls risk, which was as derived from the physiological profile assessment. In addition, measures of simple reaction time, lower limb proprioception, postural sway, knee flexion, and knee extension strength were also collected. Persons also self-reported any falls in the previous 6 months.
Results: Both training programs resulted in a significant lowering of falls risk ($P < .05$). The reduced risk was attributable to significant changes in reaction times for the hand ($P < .05$), foot ($P < .01$), lower-limb proprioception ($P < .01$), and postural sway ($P < .05$).
Conclusions: Overall, training led to a decrease in falls risk, which was driven by improvements in reaction times, lower limb proprioception, and general balance ability. Interestingly, the reduced falls risk occurred without significant changes in leg strength, suggesting that interventions to reduce falls risk that target intrinsic risk factors related to balance control (over muscle strength) may have positive benefits for the older adult with T2DM at risk for falls.

Falls are the leading cause of fatal and nonfatal injuries for adults older than 65 years, with more than 90% of all hip fractures being linked to falling events. For older adults with type 2 diabetes mellitus (T2DM), the risk of suffering a fall is dramatically increased.[1,2] A key element in preventing falls is to identify the major risk factors that may predispose a person to increased risk and implement appropriate interventions.[3] Although more than 400 risk factors are associated with falls,[4] declines in balance and postural control have been established as the primary mediating factors. Consequently, the design and development of appropriate balance training programs is a viable intervention to address the issue of falls.[3,5] However, although numerous studies have shown the benefits of various balance programs in reducing falls risk and improving postural control in healthy older persons,[3,6–8] few studies have been specifically designed to assess the impact of balance training for reducing falls risk in a population with diabetes.[9,10] Several studies have reported that targeted interventions can reduce falls risk and/or improve balance and walking ability for older adults with T2DM,[11–15] but others have found no changes in balance or strength measures for this population.[16]

Although regular physical activity has been shown to improve balance, reduce the risk of falls, and lead to a general increase in well-

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being,[3,6] there are often barriers to continued participation in supervised exercise programs. For example, travel (to a site for exercise), lack of variety, cost of memberships, and/or equipment are some factors cited as deterrents to consistent physical activity. One solution has been to provide means to be physically active within the home, although adherence has been shown to be an issue, with the level of activity often declining over time because of the lack of variety, limited feedback on overall progress, and demotivation. Arguably, the development of interactive video games can potentially alter levels of physical activity. In particular, the use of the Nintendo Wii Fit system with balance board has the potential to provide an engaging and beneficial tool for exercise/therapy in the home environment.[17,18] This system requires individuals to perform active movements to complete the desired game and so has benefits for maintaining and improving on levels of physical activity. For example, as the games have been designed to be fun and challenging and to provide graded feedback on performance, persons are more likely to be motivated to continue participating for an extended period of time.[18,19] Many of the games have been designed and developed to challenge not just fine muscular control but also general gross motor function, including balance and posture.[19,20] Although relatively new, the Wii Fit balance board has been shown to be a reliable and valid tool to assess posture,[21] and several studies have been performed using this system for training of various clinical and healthy groups.[22–25] However, although the benefits of using the Wii system for improving balance and gait have been advocated for older adults,[18,19,23,24] no comprehensive study has assessed the benefits of this system for reducing falls (or falls risk) in adults with diabetes.

The aim of this study was to assess the benefits of and differences between 12 weeks of thrice-weekly supervised balance training and an at-home unsupervised balance activity (using the Nintendo Wii Fit and balance board system) for improving balance and reaction time and lowering falls risk in older adults with T2DM. It was predicted that both forms of activity would lead to reduced falls risk and improved balance and general physiological function.

Methods

Participants

Sixty-five older adults of both sexes with T2DM were recruited for this study. Subjects were randomly allocated into 2 groups: supervised balance training (mean age 67.8 ± 5.2) or unsupervised, Wii Fit–based balance training (mean age 66.1 ± 5.6). Participants were excluded if they had significant cardiovascular disease, unstable proliferative retinopathy, end-stage renal disease, or uncontrolled hypertension. All participants were screened prior to inclusion to ensure that they had not engaged in balance or resistance training during the previous year, and informed consent was attained prior to testing. Participants provided informed consent prior to inclusion, and all procedures complied with university institutional review board guidelines.

Experimental Design

Initial assessment consisted of a clinical screening that included a complete history and physical examination, evaluation of age, height, body mass index (BMI), percent body fat, and hemoglobin A1c (HbA_{1c}) levels.[12] Further, all persons also underwent a full neurologic evaluation that included assessment for somatic and autonomic neuropathy. A range of sensory modalities were assessed including 128-Hz vibration perception, warm and cold thermal perception and touch, and pressure and prickling pain perception. Neuropathy scores for each lower limb, the total neuropathy score, was also calculated as per our previous research.[26]

Each participant then reported to the laboratory, where assessments of balance, reaction time, and falls risk [(using the Physiological Profile Assessment (PPA)] were completed. The number of falls in the past year was also obtained via self-report. Individuals were also instructed to record the number of falls they had during the 12-week exercise intervention. Following assessment, each participant was assigned to either the supervised or unsupervised training groups. These training components for both groups ran for 12 weeks (3 sessions per week for 36 total sessions). Posttraining assessments were conducted immediately following the respective intervention.

Supervised Exercise Intervention

Each exercise session was completed in 40 minutes, with emphasis placed on balance and postural control. The selected exercise protocol was designed to closely mimic the type of training performed during unsupervised (Wii Fit) training. Training sessions started with a warm-up (lower limb stretching), followed by mostly balance exercises including heel-toe walking (ie, mimicking the tightrope balance exercise on the Wii), calf raises, forward leans, single-leg balance, and basic yoga stretches (the yoga stretches selected were the same as those offered within the Wii program).

Unsupervised (Wii) Exercise Intervention

Participants came in on a separate day from initial testing and were given a 1-hour interactive tutorial on using the Wii Fit Balance System and software program. During this time, participants created their own user (with avatar) and performed many of the available Wii balance exercise activities under supervision of the research team members. Once the participants had demonstrated proficiency in using the Wii Fit balance exercise games, they were permitted to take the device home with them. Wii Fit exercises included aerobics, yoga, strength training, and balance. They were instructed to perform 3 sessions per week, for 40 minutes each. Subjects were instructed to perform stretching warm-up first, followed by the posture and balance categories of exercises only. Prior to beginning the Wii activities, individuals were asked to complete a 5- to 10-minute warm-up period including stretching. After several weeks, when subjects found the balance games easier, they were instructed to increase the difficulty level. The Wii system logged the individual days and time each person trained on the balance board. Every 2 weeks, the Wii participants were contacted by phone to enquire about any difficulties with the training program, ascertain the level of activity, and encourage them to maintain the training program schedule.

Falls Risk, Posture, and Reaction Time Assessment

Physiological Profile Assessment

The risk of falling was determined prior to and after the exercise intervention using the long-form PPA. The PPA has been validated in prospective studies of falls in both community and institutional settings and has been used previously for assessing falls risk in older adults with diabetes.[12,13] The PPA contains physiological assessments of visual function, peripheral sensation, proprioception, lower limb strength, postural sway, postural coordination, and cognitive function. Aggregate scores from these tests were combined to provide an overall falls risk score, with high values reflecting increased risk of falling.[27] The individual measures making up the PPA were also analyzed independently to determine which variables contributed to any observed differences in falls risk.

Reaction Time

All participants completed a simple reaction time (SRT) task where the responses for the upper limb (finger) and lower limb (foot) were assessed. Each person completed 5 practice trials to familiarize themselves with the protocol, followed by 20 trials performed with the