

EXPLORING THE USE OF DANCE THERAPY FOR VESTIBULAR REHABILITATION IN  
ADULTS

By

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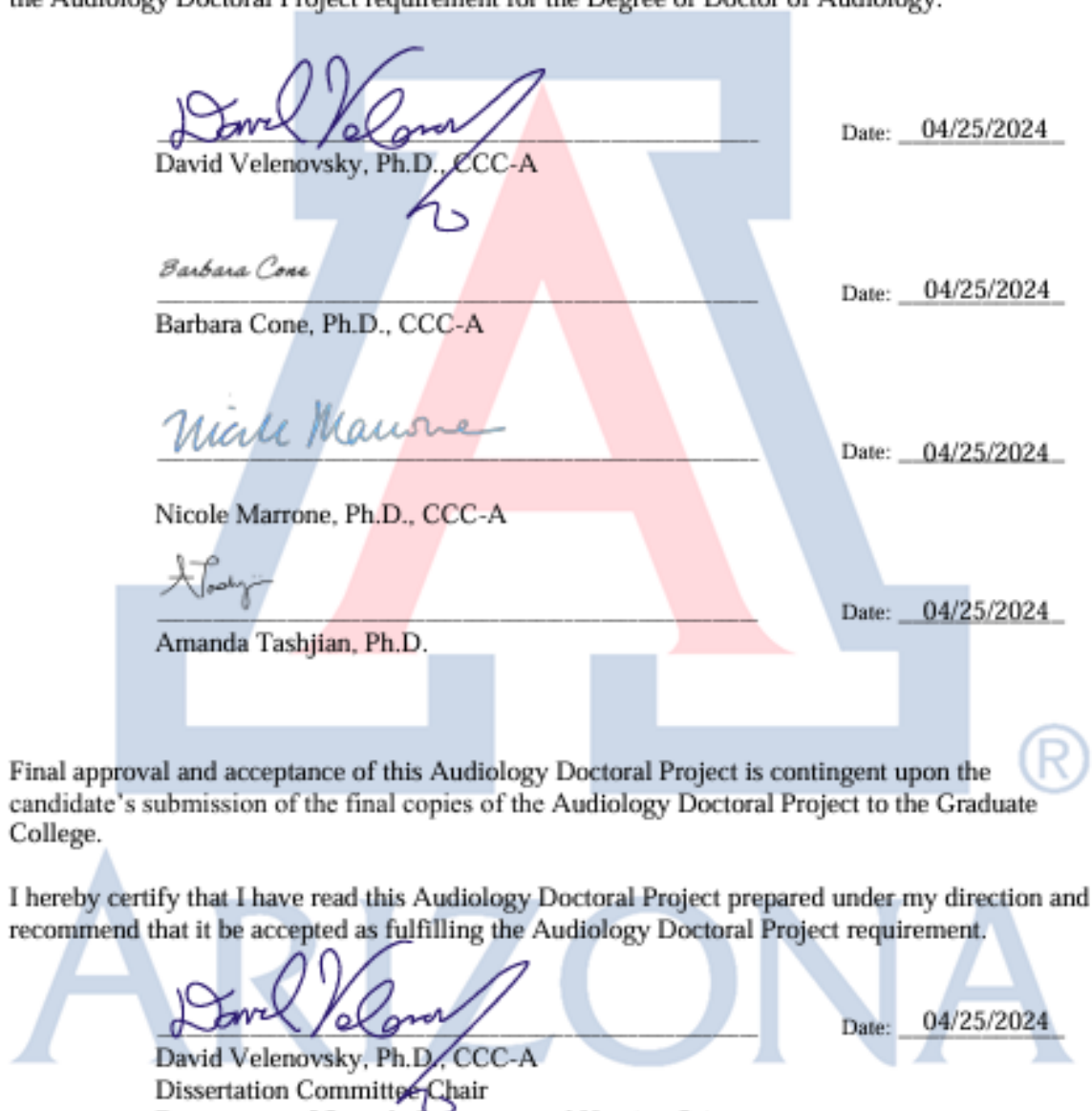
As members of the Audiology Doctoral Project Committee, we certify that we have read the Audiology Doctoral Project prepared by: Emily Walker, titled: "Exploring the Use of Dance Therapy for Vestibular Rehabilitation in Adults", and recommend that it be accepted as fulfilling the Audiology Doctoral Project requirement for the Degree of Doctor of Audiology.

  
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Final approval and acceptance of this Audiology Doctoral Project is contingent upon the candidate's submission of the final copies of the Audiology Doctoral Project to the Graduate College. 

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**Table of Contents**

Abstract .....4

Introduction .....5

Methods .....10

Results of the Literature Search .....11

How Findings Relate to Balance Disorders .....17

Discussion .....18

Conclusion .....21

References .....23

Abstract

*Background:* Balance disorders impact people in all stages of their life. Individuals can experience unsteadiness, fear of movement, dizziness, nausea, and vertigo. Assessments are completed by medical professionals to determine the cause of the balance disorder, then treatments are prescribed. For peripheral balance disorders, rehabilitation can include physical therapy and movements performed by the individual at home to allow for the brain to compensate for the disorder. Adherence to such rehabilitation programs is not high, therefore other rehabilitation options must be explored. Dance is a movement form that utilizes and strengthens aspects of balance.

*Methods:* A literature review was conducted to determine how dance has been used as a rehabilitation method for movement disorders. The search included various combinations of the following terms: “dance”, “rehabilitation”, “adults”, “therapy”, “treatment” and “balance”. Research articles that have been published in the last 25 years were included.

*Results:* 35 articles remained following the literature search. The articles discussed various dance styles used for rehabilitation, various lengths and intensities of programs, and improvements in balance and movement measures. The articles were reviewed to determine if similarities exist between the movement disorders discussed and peripheral balance disorders.

*Conclusion:* While no direct similarities were found between the movement disorders and balance disorders, it is hypothesized that aspects of dance can be incorporated into peripheral balance disorder rehabilitation methods to improve balance and movement measures for individuals. Further research must be conducted to determine the impacts of a dance-based rehabilitation specifically on peripheral balance disorders.

## Introduction

Balance is an important part of everyday life; however, we don't typically think about our balance system and balance abilities unless they are impacted in some way. Our balance functions from input of three different sensory systems of the body: the inner ear vestibular system/organ, the visual system (including the oculomotor reflex- VOR), and the proprioception (touch) system (Herdman & Clendaniel, 2014; Jacobson, et al., 2021). The inner ear vestibular system is comprised of the following sensory structures: the utricle, saccule, and the three semicircular canals (horizontal, anterior vertical, and posterior vertical). The utricle and saccule encode our orientation to gravity and linear acceleration in the horizontal and vertical planes, respectively. The semicircular canals encode rotational acceleration in the vertical, horizontal, and diagonal planes. When linear or angular (or both) acceleration occurs, fluid is displaced within the vestibule (utricle and saccule) and in the semicircular canals and displaces stereocilia of the hair cells. When the hair cell stereocilia are displaced, depending on the movement direction, the result is activation or suppression of afferent vestibular nerve fibers that project from these sensory structures, ultimately sending information to the brain. The oculomotor reflex (VOR), which is controlled by the vestibular periphery, allows us to keep objects of interest in focus as we move. The visual system provides extremely helpful information regarding where objects are in our environment that allows us to navigate safely. The proprioception system provides inputs as to where we are in the environment and how our movements influence objects around us (Herdman & Clendaniel, 2014; Jacobson, et al., 2021). When the inputs from these three systems function correctly, we are able to maintain our center of gravity, walk normally, etc. If the input from at least one of these systems is compromised, our balance can be negatively impacted, resulting in balance insecurity when in motion, or in extreme cases, the inability to

ambulate. Balance disorders can impact individuals at any stage of life. Common symptoms experienced include dizziness, unsteadiness, fear of movement, nausea, and vertigo (perception of spinning when not in motion, or perception of the environment spinning). When someone experiences one or all of these symptoms, they typically seek a professional's help. This process, however, can take time as symptoms can be dismissed, or it can be difficult to pinpoint the balance system as the primary concern. Many people will see multiple physicians and specialists, and go through a battery of tests before a balance disorder is the resulting diagnosis. The physician then determines the most appropriate course of treatment to help manage the symptoms. The treatment will depend upon whether the balance disorder is related to the peripheral components (the inner ear vestibular system, the vestibular nerves) or central components (the brain, neural pathways). Common peripheral balance disorders include benign paroxysmal positional vertigo (BPPV), Meniere's Disease, vestibular labyrinthitis (inflammation of the peripheral vestibular organs), and a vestibular weakness (unilateral or bilateral). Central balance disorders include vestibular migraine, cerebellar ataxia, Mal de Debarquement disorder, persistent postural perceptual dizziness (PPPD), or any lesion in the pathways of the sensory or central structures that inform us of acceleration, sustained movement, or positions (Herdman & Clendaniel, 2014; Jacobson, et al., 2021).

A common management strategy for balance insecurity is to have the individual complete a series of exercises that train the brain and body to compensate for the balance disorder (central compensation). These exercises may be completed at home by the individual and typically involve repetition of specific movements in different variations. For instance, an individual may keep their gaze focused on a fixed point on a wall and shake their head back and fourth. Another exercise may be keeping their head still but moving their eyes up and down or side to side

quickly. These are examples of Cawthorne-Cooksey exercises that can be given to patients with a unilateral peripheral balance weakness, or balance hypofunction (Herdman & Clendaniel, 2014). Individuals may also work with a physical therapist who will determine what types of exercises and rehabilitation the individual will complete. There are a variety of factors that influence the physical therapist's decisions, such as the patient's medical diagnosis, standardized balance assessments (objective measures), and subjective measures that come with experience working with individuals. Standardized balance assessments are not performed with every individual who attends physical therapy. For instance, in a retrospective chart study performed by Gervaise and colleagues (2014) it was determined that 182 out of 250 (73%) patients performed a standardized balance measure. The Timed Up and Go (TUG) test and Berg Balance Scale were the most commonly used measures within this study and were used for all groups of balance patients (a variety of medical diagnoses were present). While 73% of the charts reviewed discussed the use of a standardized balance assessment, all of the charts described at least one other physical therapy assessment related to balance, such as observations of gait, transfer assessments, assessments of active range of motion, and distance walked assessments (Gervais, et al., 2014). McGinnis and colleagues (2009) assessed that physical therapists also use their academic knowledge, as well as their experience working with patients over time and identifying patterns of how patients move. Eleven physical therapists who work with individuals with balance disorders participated in interviews to determine how they make decisions during the examination/initial assessment with a patient, what methods of assessment they choose, and why they choose such methods. Five of the eleven therapists discussed in their interviews how their academic education influenced how they chose their balance assessments. Three of these therapists described their academic education as a significant factor they considered, whereas the

other two described it as a foundation to base their clinical experience upon and build off of. Movement observation was a large factor used in each of the therapist's initial assessments. The therapists utilized standardized balance measures, but it was discussed that the purpose of using such measures was to provide quantitative data for documentation purposes. Documentation purposes included for insurance, to identify expected outcomes, to report on patient progress, and to determine if a patient was ready for discharge if in an inpatient facility. The Berg Balance Scale and the Timed Up and Go test were identified as being quick, easy to administer measures that were used by each of the therapists. Movement observation was also used by each of the physical therapists with their patients. Through experience, recognizing patterns of movement problems became easier for the therapists and helped determine the types of exercises they would be using during the rehabilitation training with their patients (McGinnis, et al., 2009).

After an initial assessment, the physical therapist may have the patient start with basic exercises and work their way up to more difficult exercises. For instance, the patient may start by standing in place with both feet on the ground (a firm surface) with their eyes closed. Once able to do this, the patient may stand in place with both feet on a firm cushion that moves slightly when the patient's feet move. The next progression can be to a soft foam pad that moves much more with the patient's movements. These progressions are examples of dynamic posturography. Dynamic posturography (with a computerized program or without) can help determine which of the three inputs for vestibular function are not working correctly, or if multiple inputs are providing inaccurate information. For instance, by standing on a firm flat surface with the eyes open, but then having the patient close their eyes, the patient must rely on the inputs of their vestibular system and proprioceptive system. By standing on a soft foam pad, the patient's proprioceptive inputs are disrupted and they must rely on their vestibular inputs and visual inputs

if their eyes are open (Smith-Wheelock, et al., 1991). Physical therapists can then work with patients on exercises for the specific input(s), as well as use the same dynamic posturography measures to determine if improvement is being made during the rehabilitative program. Another progression of exercises can be the patient walking down a hallway while focusing on a non-moving focal point or object at the end of the hallway. After being able to complete this, the patient will walk down the hallway again while slowly turning their head side to side. The speed of the head turns progress until the patient is able to walk down the hallway without dizziness occurring while shaking their head side-to-side quickly (A. Guerrero, personal communication, April 20, 2022; Smith-Wheelock, et al., 1991). A common warning from physicians to their patients is, “You may feel worse before you feel better”, as these movements can cause dizziness or vertigo when performing the exercises. When the individual can complete the prescribed repetitions without feeling dizzy or triggering vertigo, the exercises are helping, central compensation has occurred. However, getting to this point can take time and the individual must be dedicated to performing the exercises multiple times a day, every day. From personal experience within an Ear Nose and Throat office, when individuals with peripheral balance disorders return for follow-ups after a home exercise regimen has been recommended, it is common for them to report that they did not complete the exercise regimen each day or to the full extent. Some of the reasons they give for not performing the exercises consistently include not being able to mentally push past the dizziness they experience at the beginning of the exercises (before central compensation occurs), finding the exercises boring or time consuming, or feeling like they were completing the exercises but not experiencing any perceptual difference/benefit. Determining if other rehabilitation methods are available that are perceived as

enjoyable may help increase adherence to such regimens, thus increasing the likelihood that the regimen will be successful in diminishing the individual's balance insecurity.

One group of people that depend upon and often think about balance specifically are dancers. From a very young age until about thirteen years old I was enrolled in dance classes. One of the first concepts learned as a new dancer is how to maintain balance and manipulate it when changing movements. An exercise that is completed in many dance classes is maintaining balance in different conditions with eyes open and eyes closed. Dancers, regardless of the style of dance they practice, are known for their exceptional balance. Dancing itself is known to help improve people's mood, lift their spirits, and can be an enjoyable pastime for many individuals. Rokka, Mavridis, and Kouli (2010) determined that even a single session of a dance aerobic program of moderate- or high-intensity is influential and can significantly increase energy while decreasing tension, depression, aggressiveness, and confusion in healthy adults. Participating in dance can positively impact an individual's mood and psychological state in the short-term (immediately after participation) and long-term. A high-intensity class can increase these quality of life aspects more significantly than a moderate-intensity class (Rokka, et al., 2010). Based on this, and the aforementioned struggles related to adherence to balance exercise regimens, the purpose of this study is to answer three questions: *1) Has dance been used as a rehabilitation technique? 2) What aspects of dance make it a successful rehabilitation technique? 3) Can aspects of dance be incorporated into vestibular rehabilitation exercises for vestibular disorders?*

## Methods

A literature review is the chosen method to identify and explore the use of dance as a rehabilitation method. PubMed was the main database used to identify and explore peer reviewed

articles pertaining to my research questions. Searches were conducted using various combinations of the following terms: “dance”, “rehabilitation”, “adults”, “therapy”, “treatment” and “balance”. Research articles that have been published within the last twenty-five years were included for review. Research articles discussing the use of dance for movement disorders were included. As peripheral vestibular disabilities are the focus of this project, research articles discussing the use of dance for psychological and social disorders (ex: depression, schizophrenia, anxiety, etc.) were rejected. Additionally, articles concerning children and adolescent subjects were rejected as the current population of interest is adults (age 18+). Finally, articles published in a language other than English that did not have a reputable translation available were rejected.

#### Results of the Literature Search

An initial search of the PubMed database using the terms “dance”, “rehabilitation”, and “therapy” and/or “treatment” yielded 1,764 results. Including the term “balance” in the search reduced the number to 349 items and adding the term “adults” further reduced the count to 227 items. The remaining items were filtered with the publishing date criteria mentioned above. Titles and abstracts were reviewed to determine if the articles met the inclusion criteria. Once the literature search was complete and articles were rejected or included, thirty-five articles remained. Of these articles, thirteen were randomized controlled trials (including single- and double-blinded studies), three were single-subject trials, seven were pilot studies, and twelve were systematic reviews and meta-analyses. Also included was one article from the results of a survey and one informational guide for how to implement a dance-based rehabilitation program. Most of the articles (30/35) discussed dance as a rehabilitation method for Parkinson’s disease (PD). Other populations of interest that were discussed included Alzheimer’s, dementia, stroke,

fibromyalgia, Huntington's disease, spinal cord injuries, older adults who are at risk for falls, and healthy older adults.

The randomized controlled trials focused on a control group versus at least one experimental group that was involved in a dance class. Some of the studies had a control group, an experimental group that was involved in a dance class, and an experimental group involved in a different form of exercise. Additionally, some of the articles had different experimental groups to see if there were specific aspects of dance (style, partnered versus non-partnered, etc.) that changed the outcomes for the participants. Dance had to be utilized as one of the experimental groups for articles to be included in this review. If an article discussed movement to music but did not specify that dance was the form of movement, the article was not included.

The most common form of dance used in the studies was Tango, specifically Argentine Tango, and this form was used most in the studies related to Parkinson's disease. The reasoning for choosing Argentine Tango (or Tango in general) was due to the use of quick movements, stopping and starting, and quick changes in the movement or direction of movement (Albani, et al., 2019; Allen, et al., 2017; Berti, et al., 2020; Duncan & Earhart, 2012; Duncan & Earhart, 2014; Hackney, et al., 2007; Hackney & Earhart, 2010<sup>a</sup>; Hackney & Earhart, 2010<sup>b</sup>; Hackney, et al., 2012; Hackney & McKee, 2014; McNeely, et al., 2015; Roments, et al., 2015). Freezing of gait is a common motor impairment experienced by individuals with Parkinson's disease. Freezing of gait occurs when there is a small period of time when an individual attempts to move, but their body freezes momentarily before the movement commences (Heremens, et al., 2013). This can lead to many falls for individuals and is a large motor concern in individuals with Parkinson's disease. Tango was chosen as the dance style in many of the studies to potentially help reduce freezing of gait occurrence (Earhart, 2009; Hackney & Earhart, 2009;

Hackney & McKee, 2014). Other styles of dance that were studied included Cha-Cha (Li, et al., 2022), Irish set dancing (Volpe, et al., 2013), Salsa (Abreu & Hartley, 2013), Greek style dancing (Elpidoforou, et al., 2022), Belly dancing (Baptista, et al., 2012), Waltz or Foxtrot (Hackney & Earhart, 2009), and dance rehabilitation that was not a specified style (Bek, et al., 2022; Dos Santos Duarte, et al., 2023; Franco, et al., 2020; Hashimoto, et al., 2015; Kalyani, et al., 2020; Marchant, et al., 2010; McKee & Hackney, 2013; Westheimer, et al., 2015).

While different dance styles were explored across the articles, differences in dance rehabilitation programs were also found regarding timing. The duration of the individuals' participation in programs varied, as well as the number of classes attended and duration of each class. For example, McKee and Hackney (2013) had the shortest overall participation length in their study in which participants were enrolled in two weeks of Tango based classes. The participants completed ten classes, each 90 minutes long, within the two-week period. The longest overall study length was by Duncan and Earhart (2012) in which participants were enrolled in a community-based Tango program for one year. The participants attended two one-hour sessions per week for the year. The average study length ranged from eight weeks to twelve weeks, with one to two sessions per week. The average session length across studies for each class attended was 75 minutes.

Many of the studies discussed the effects of dance on different outcomes for the experimental groups, such as cognitive abilities, movement and balance abilities, neuromuscular effects, social effects, effects on behavior and mood, and effects on confidence. Improvements in balance and movement abilities were the main outcomes this review focused on. The most common measures used for balance and movement abilities in the articles included the Berg Balance Scale (BBS), the Timed Up and Go (TUG) test, Dual-task TUG test, the Freezing of

Gait (original and modified) Questionnaire, the Mini Balance Evaluation Systems Test (Mini-BESTest), Fullerton Advanced Balance (FAB) Scale, six-minute walk test (6MWT), and the 30-second chair stand test. Other measures included functional reach tests, gait tests, backwards walking tests, and single-leg stance tests. The Berg Balance Scale focuses on static and dynamic standing/balance abilities in adults that consists of fourteen items (situations). The maximum score that can be achieved is 56. A lower score indicates the individual has a greater risk for falling at some point in the six months following testing (Abreu, 2013; Shirley Ryan AbilityLab, 2020). The Timed Up and Go test (TUG) evaluates how quickly an individual can stand up from a chair, walk ten feet, turn around, walk back to the chair, and sit back down. The TUG can also be completed as a dual task in which individuals are asked to complete a secondary task while completing the motions. Secondary tasks can include counting backwards by threes from a randomly selected number between 20 and 100 or walking while holding a cup full of water. If an older adult takes twelve seconds or longer to complete the task (single or dual) they are at risk for falling. (Abreu, 2013; CDC 2017; Shirley Ryan AbilityLab, 2014). The Mini-BESTest tests anticipatory postural adjustments, reactive postural control, sensory orientation, and dynamic gait through fourteen items (Duncan & Earhart, 2014; Shirley Ryan AbilityLab, 2013; Simpkins & Yang, 2023). The Fullerton Advanced Balance scale also focuses on static and dynamic balance for adults under a total of ten different conditions (Shirley Ryan AbilityLab, 2012; Simpkins & Yang, 2023). The Six-minute walk test evaluates how far an individual can walk over the course of six minutes. While the test examines aerobic capacity and endurance, it has been documented that a lower distance walked can be correlated to a greater fall risk in adults (Duncan & Earhart, 2012; Shirley Ryan AbilityLab- 6 minute walk test, 2013).

The majority of the articles discussed how individuals involved in a dance rehabilitation program improved in at least one measure of balance compared to pre-test measures. The most common measures of balance and movement in which improvement were seen (in a small or a significant amount) were in measures of gait (Abrea & Hartley, 2013; Albani, et al., 2019; Allen, et al., 2017; Ares-Benitez, et al., 2022; Bek, et al., 2020; Dos Santos Duarte, et al., 2023; Earhart, 2009; Li, et al., 2022; McNeely, Duncan, & Earhart, 2015; Patterson, et al., 2018; Pereira, et al., 2019; Sharp & Hewitt, 2014; Westheimer, et al., 2015), the Berg Balance Scale (Abreu & Hartley, 2013; Allen, et al., 2017; Earhart, 2009; Elpidoforou, et al., 2022; Hackney, et al., 2007; Hackney & Earhart, 2009; Hackney & Earhart, 2010<sup>a</sup>; Hackney & Earhart, 2010<sup>b</sup>; Hackney, et al., 2012; Hasan, et al., 2022; Hashimoto, et al., 2015; Kalyani, et al., 2020; Li, et al., 2022; Marchant, et al., 2010; Westheimer, et al., 2015), the Fullerton Advanced Balance Scale (Allen, et al., 2017; McKee & Hackney, 2013), the Timed Up and Go test (Abreu & Hartley, 2013; Allen, et al., 2017; Ares-Benitez, et al., 2022; Earhart, 2009; Hackney, et al., 2007; Hackney, et al., 2012; Hasan, et al., 2022; Hashimoto, et al., 2015; Li, et al., 2022; McNeely, et al., 2015; Patterson, et al., 2018; Roments, et al., 2015; Volpe, et al., 2013), the Mini-BESTest (Ares-Benitez, et al., 2022; Duncan & Earhart, 2012; Duncan & Earhart, 2014; Hasan, et al., 2022; Roments, et al., 2015), and the Six-Minute Walk Test (Allen, et al., 2017; Baptista, et al., 2012; Duncan & Earhart, 2012; Duncan & Earhart, 2014; Earhart, 2009; Hackney & Earhart, 2009; Hackney & Earhart, 2010<sup>a</sup>; Hackney, et al., 2012; Patterson, et al., 2018). Baptista and colleagues (2012) reported that women with fibromyalgia who completed two belly dance classes a week for sixteen weeks achieved significant improvements in the six-minute walk test compared to the control group. Duncan and Earhart (2021) discussed how participants involved in a twelve-month community-based tango program improved upon balance measures. The tango

participants improved scores on the miniBESTest. The control group in this study had a decrease in distance walked during the six-minute walk test, while the tango group maintained their distance walked. In another study by Duncan and Earhart (2014), participants were assigned to an Argentine tango group or a control group. Participants in the Argentine tango group improved in balance measures using the miniBESTest and improved upon a dual task TUG test compared to the control group after two years of sessions. Improvements in measures on the Berg Balance Scale and an upward trend on scores for the Timed Up and Go test were seen in participants who were enrolled in a tango class compared to a traditional exercise class for individuals with Parkinson's disease (Hackney, et al., 2007). Hackney and Earhart (2009) studied the effects of participating in a tango class or a waltz/foxtrot class compared to a control group. Both the tango and waltz/foxtrot groups improved in balance measures such as the Berg Balance Scale and six minute walk test compared to the control group. Greater improvements were seen for the participants in the tango group compared to the waltz/foxtrot group. In a different study Hackney and Earhart (2010) determined that both partnered and non-partnered dance can improve Berg Balance Scale scores significantly and be maintained at least one month after dance classes ended. Involvement in Cha-Cha classes three times a week for twelve weeks resulted in participant improvement in dynamic and static balance of older adults compared to a control group in a study conducted by Li and colleagues (2022). Significant improvement in miniBESTest scores and dual task Timed Up and Go scores were also shown by Roments and colleagues (2015) after participants completed twenty four tango classes within twelve weeks. It is important to note that not all studies within this literature review reported improvements in balance and movement measures. Some studies reported no improvement or improvements that

were not clinically significant. This may be due to small sample sizes and the fact that a large number of studies did not have a control group to compare interventions with.

Motivation and the adherence and dropout rates for the dance classes and control groups were mentioned in various studies. Adherence rates and motivation for the variety of dance classes were reported by Ares-Benitez and colleagues (2022) who completed a systematic search of the use of dance therapy for individuals who suffered a stroke. Their search consisted of a total of eight studies. Of these, five studies reported a mean dropout rate of 18%. The various studies used exit questionnaires, the Intrinsic Motivation Inventory (IMI) scale, or subjective questions to determine patient satisfaction and perception of the dance therapy. The majority of the participants across the studies reported that they had a positive experience within the dance therapy classes and they felt more confident after the studies ended. It was also reported that some of the participants expressed interest in continuing to participate in dance-based therapy or that they wished the study had a longer duration. In another study, the adherence rate to participating in a Dance for Parkinson's Disease (DfPD) course was 93% and it was reported that adherence ranged from 78-90% for other studies that used dance as a rehabilitation method for individuals with Parkinson's disease (Elpidoforou, et al., 2022).

#### How Findings Relate to Balance Disorders

There are no direct correlations between the physiologic aspects of the movement disorders discussed in the literature search and peripheral or central balance disorders, nor have any studies been conducted specifically regarding dance as a rehabilitation method for balance disorders. However, improvement in balance and gait measures can potentially help to improve confidence in individuals with balance disorders. Improvements in balance confidence following participation in the dance sessions were mentioned for individuals in various studies (Bek, et al.,

2020; Bek, et al., 2022; Hackney and Earhart, 2010; McNeely, Duncan, and Earhart, 2015).

Additionally, it was discussed that neurological changes occur when individuals participated in the different dance courses and that movement partnered with music/an auditory stimulus can produce a positive effect on such changes (De Dreu, et al., 2012; Dos Santos Duarte, et al., 2023; Earhart, 2009; Hackney and Earhart, 2009) This could be beneficial for individuals with balance disorders, such as with a unilateral peripheral weakness or PPPD, as the exercises that can be recommended for rehabilitation help with brain compensation (Jacobson, et al., 2021).

Additionally, the high adherence rates to dance courses for individuals with other balance and movement disorders is indicative that dance can be an enjoyable experience for adults. It is hypothesized that including dance aspects into vestibular rehabilitation can make completing exercises more enjoyable for patients, therefore increasing adherence.

## Discussion

Based upon the findings of the studies included in this review, it is hypothesized that incorporating aspects of dance into vestibular rehabilitation for individuals with peripheral vestibular disorders would result in improvement in balance and gait measures. However, there is no current literature regarding dance and the population of interest (adults with balance disorders). Future research would need to be conducted to determine if improvements in gait and balance measures would occur in adults with peripheral and central vestibular disorders following participation in a dance course. While Argentine Tango was found to be an effective style of dance for individuals with Parkinson's disease, it is unknown whether this style would be effective for this population of interest, or if another style may be more effective. Studies would need to be conducted using different dance styles, as well as comparing dance to different rehabilitation methods (physical therapy programs and exercises currently used). Many of the

studies included in this review discussed how Argentine Tango was used not only for its quick steps, weight transitions, and coordinated movements, but also as it utilizes a partner. The partner can be a physical support for the individual and can provide immediate feedback. Studies would also need to be completed to determine how long the classes should be per session, how many sessions should be conducted per week, and the overall duration of participation (i.e. weeks, months, a year, etc.) that would be most effective in eliciting positive changes in gait and balance measures, as well as maintaining these changes. Earhart (2009) discusses how the CDC recommends at least 150 minutes of moderate exercise per week for a program to be effective. Additionally, Earhart comments that a 60-minute session may be the best duration for a single session. Longer sessions may induce fatigue faster in participants and require more breaks within the session. Based upon the findings in Duncan (2012) it is hypothesized that individuals would benefit more from participation in dance course that is at least three months long for improvements to be seen, but improvements can continue at six and twelve months. Duncan and Earhart (2014) found that improvements in the miniBESTest occurred within 12 months after participants participated in an Argentine Tango course twice a week for one hour each. The participants continued to participate for an additional year. No further improvements were made in the MiniBestest measures between the 12 and 24 months, however the improvement seen in the first 12 months was maintained (Duncan and Earhart, 2014). The findings can help indicate that longer participation in dance courses may not mean improvement for the entire duration, but that improvements in balance and movement measures can be maintained. I would propose a study for individuals who are eighteen years of age and older with a diagnosed balance disorder. The individuals would be randomly allocated to a dance group or to a control group. The dance group would participate in a 60-minute group tango-based class twice weekly and would be

given exercises to practice for at least 30 minutes on their own each week. Chairs and supports would be available during the dance classes for participants who cannot stand for the entire class, and modifications for exercises would be given by the instructor. The instructor would be knowledgeable in tango and would be assisted by a physical therapist who has knowledge and experience in working with patients with balance disorders. The control group would go about their lives as usual, with instructions to not participate in any dance-based activity for the duration of the study. The participants in the control group would be given the option to participate in a dance-based rehabilitation program following the end of the study. I would propose a study duration of twelve months. Pre-test measures of balance and movement would be conducted and would include computerized dynamic posturography, the Berg Balance Scale (BBS), the six-minute walk test, and a dual task Timed Up and Go (TUG) test. Measures would be re-tested at the six month mark and at the twelve month mark when dance class participation has ended to determine if changes (positive or negative) in balance and movement abilities have occurred. Additionally, I would propose that the measures be re-tested a year after the conclusion of the study to determine if any positive changes in balance and movement abilities that occurred have been maintained. I would also utilize a questionnaire or survey to determine if changes in mood and confidence occurred after participation in the dance classes, such as the Profile of Mood States (POMS) survey utilized by Rokka, Mavridis, and Kouli (2010).

If dance is found to be an effective rehabilitation modality, implementing dance as a rehabilitation method would begin. Discussion should be initiated with clinicians and physicians who diagnose balance disorders, as well as with professionals who currently work with patients for vestibular rehabilitation. Small steps could be taken to start implementing different moves or aspects of dance into regular physical therapy sessions or at home exercises. Next steps would

include the formation of dance classes that are specifically for adults with balance disorders and taught by professionals who are knowledgeable in dance and in working with adults with balance difficulties. A large-scale nationwide effort could be made to create a dance program that is easy to follow, as well as easy to implement in virtually any setting, similar to the Dance for Parkinson's Disease (DfPD) program (Kalyani, 2020).

### Conclusion

Balance disorders can impact individuals throughout the course of their life. These disorders can be accompanied by symptoms such as dizziness, nausea, and vertigo and can take time to correctly diagnose. Once diagnosed by a medical professional, individuals may go through a series of rehabilitative exercises promoting central compensation to reduce the negative impact of their symptoms. People are told that their dizziness and related symptoms may worsen with the initiation of the rehabilitative exercises. Not all people complete the exercises as they do not enjoy the exacerbated symptoms. Finding a rehabilitation program that helps reduce the negative impact of balance disorders and improve balance and movement symptoms while also being enjoyable for the individual is of high importance. Dance has successfully been used as a rehabilitation method to improve balance and movement measures for individuals with Parkinson's disease, stroke, Huntington's Disease, and other disorders. No research has been conducted thus far to determine if improvement can be seen in adults with peripheral balance disorders after completing a dance-based rehabilitation program. Studies must be conducted to determine if this population of interest could benefit from such a program, what aspects of dance would improve balance measures, and how long the individual would participate in rehabilitation for improvements to be seen and maintained. If dance can be incorporated into rehabilitation for adults with balance disorders, adherence to completing

exercises and the entire regimen may also increase. Additionally, the use of dance in rehabilitation can help reduce the risk for falls in adults. Dance could not only be used for individuals with peripheral balance disorders, but individuals who are at-risk for falls in general or have balance insecurity.

References

- Abreu, M., and Hartley, G. (2013). The effects of salsa dance on balance, gait, and fall risk in a sedentary patient with Alzheimer's Dementia, multiple comorbidities, and recurrent falls, *Journal of Geriatric Physical Therapy*, 36(2), 100-108, doi: 10.1519/JPT.0b013e318267aa54.
- Albani, G., Veneziano, G., Lunardon, C., Vinci, C., Daniele, A., Cossa, F., and Mauro, A. (2019). Feasibility of home exercises to enhance the benefits of tango dancing in people with Parkinson's disease, *Complementary Therapies in Medicine*, 42, 233-239, doi: 10.1016/j.ctim.2018.10.02.
- Allen, J. L., McKay, J. L., Sawers, A., Hackney, M. E., and Ting, L. H. (2017) Increased neuromuscular consistency in gait and balance after partnered, dance-based rehabilitation in Parkinson's disease, *Journal of Neurophysiology*, 118(1), 363-373, doi: 10.1152/jn.00813.2016.
- Ares-Benitez, I., Billot, M., Rigoard, P., Cano-Bravo, F., David, R., and Luque-Moreno, C. (2022) Feasibility, acceptability and effects of dance therapy in stroke patients: A systematic review, *Complementary Therapies in Clinical Practice*, 49(1), 1-10, doi: 10.1016/j.ctcp.2022.101662.
- Baptista, A. S., Villela, A. L., Jones, A., and Natour, J. (2012). Effectiveness of dance in patients with fibromyalgia: a randomised, single-blind, controlled study, *Clinical and Experimental Rheumatology*, 30, 18-23, retrieved from: <https://pubmed.ncbi.nlm.nih.gov/23020850>.
- Bek, J., Arakaki, A. I., Lawrence, A., Sullivan, M., Ganapathy, G., and Poliakoff, E. (2020). Dance and Parkinson's: A review and exploration of the role of cognitive representations

- of action, *Neuroscience and Biobehavioral Review*, *109*, 16-28, doi:  
10.1016/j.neubiorev.2019.12.023.
- Bek, J., Leventhal, D., Groves, M., Growcott, C., and Pollakoff, E. (2022). Moving online: Experiences and potential benefits of digital dance for older adults and people with Parkinson's disease, *PLoS One*, *17(11)*, 1-17, doi: 10.1371/journal.pone.0277645.
- Berti, A., Pini, M., Ferrarello, F. (2020). Argentine tango in the care of Parkinson's disease: A systematic review and analysis of the intervention, *Complementary Therapies in Medicine*, *52*, 1-9, doi: 10.1016/j.ctim.2020.102474.
- Center for Disease Control and Prevention. (2017). Timed Up and Go (TUG), retrieved from:  
[https://www.cdc.gov/steady/pdf/TUG\\_test-print.pdf](https://www.cdc.gov/steady/pdf/TUG_test-print.pdf).
- De Dreu, M.J., Van Der Wilk, A.S.D., Poppe, E., Kwakkel, G., and Van Wegen, E.E.H. (2012). Rehabilitation, exercise therapy and music in patients with Parkinson's disease: A meta-analysis of the effects of music-based movement therapy on walking ability, balance and quality of life, *Parkinsonism and Related Disorders*, *18*, 114-119, doi: 10.1016/S1353-8020(11)70036-0.
- Dos Santos Duarte, J., Alcantara, W. A., Brito, J. S., Santiago Barbosa, L. C., Machado, I. P. R., Furtado, V. K. T., Lopes dos Santos-Lobato, B., Pinto, D. S., Krejcova, L. V., and Bahia, C. P. (2023). Physical activity based on dance movements as complementary therapy for Parkinson's disease: Effects on movement, executive functions, depressive symptoms, and quality of life, *PLoS One*, *18(2)*, 1-16, doi: 10.1371/journal.pone.0281204.
- Duncan, R. P., and Earhart, G. M. (2012). Randomized controlled trial of community-based dancing to modify disease progression in parkinson disease, *Neurorehabilitation and Neural Repair*, *26(2)*, 132-143, doi: 10.1177/1545968311421614.

- Duncan, R. P., and Earhart, G. M. (2014). Are the effects of community-based dance on Parkinson disease severity, balance, and functional mobility reduced with time? A 2-year prospective pilot study, *Journal of Alternative and Complementary Medicine*, 20(10), 757-763, doi: 10.1089/acm.2012.0774757.
- Earhart, G. M. (2009). Dance as therapy for individuals with Parkinson disease, *European Journal of Physical Rehabilitation Medicine*, 45(2), 231-238, retrieved from: <https://pubmed.ncbi.nlm.nih.gov/19532110/>.
- Elpidoforou, M., Bakalidou, D., Drakopoulou, M., Kavga, A., Chrysovitsanou, C., and Stefanis, L. (2022). Effects of a structured dance program in Parkinson's disease. A Greek pilot study, *Complementary Therapies in Clinical Practice*, 46, 1-5, doi: 10.1016/j.ctcp.2021.101528.
- Fernandez-Arguelles, E. L., Rodriguez-Mansilla, J., Antunez, L. E., Garrido-Ardila, E. M., and Munoz, R. P. (2015). Effects of dancing on the risk of falling related factors of healthy older adults: A systematic review, *Archives of Gerontology and Geriatrics*, 60(1), 1-8, doi: 10.1016/j.archger.2014.10.003.
- Franco, M. R., Sherrington, C., Tiedemann, A., Pereira, L. S., Perracini, M. R., Faria, C. S. G., Negrao-Filho, R. F., Pinto, R. Z., and Pastre, C. M. (2020). Effect of senior dance (DanSE) on fall risk factors in older adults: A randomized controlled trial, *Physical Therapy*, 100(4), 600-608, doi: 10.1093/ptj/pzz187.
- Gervais, T., Burling, N., Krull, J., Lugg, C., Lung, M., Straus, S., Jaglal, S., and Sibley, K. M., (2014). Understanding approaches to balance assessment in physical therapy practice for elderly inpatients of a rehabilitation hospital, *Physiotherapy Canada*, 66(1), 6-14, doi:10.3138/ptc.2012-57.

Hackney, M. E., Kantorovich, S., Levin, R., and Earhart, G. M., (2007), Effects of tango on functional mobility in Parkinson's disease: A preliminary study, *Journal of Neurologic Physical Therapy*, 31, 173-179, doi: 10.1097/NPT.0b013e31815ce78b.

Hackney, M. E., and Earhart, G. M. (2009). Effects of dance on movement control in Parkinson's disease: A comparison of Argentine tango and American ballroom, *Journal of Rehabilitative Medicine*, 41(6), 475-481, doi:10.2340/16501977-0362.

Hackney, M. E., and Earhart, G. M. (2010). Effects of dance on balance and gait in severe Parkinson disease: A case study, *Disability and Rehabilitation*, 32(8), 679-684, doi:10.3109/09638280903247905.

Hackney, M. E., and Earhart, G. M. (2010). Effects of dance on gait and balance in Parkinson disease: A comparison of partnered and non-partnered dance movement, *Neurorehabilitation and Neural Repair*, 24(4), 384-392, doi:10.1177/1545968309353329.

Hackney, M. E., Hall, C. D., Echt, K. V., and Wolf, S. L. (2012). Application of adapted tango as therapeutic intervention for patients with chronic stroke, *Journal of Geriatric Physical Therapy*, 35(4), 206-217, doi: 10.1519/JPT.0b013e31823ae6ea.

Hackney, M. E. and McKee, K. (2014). Community-based adapted tango dancing for individuals with Parkinson's disease and older adults, *Journal of Visualized Experiments*, 94, 1-12, doi:10.3791/52066.

Hasan, S. M., Alshafie, S., Hasabo, E. A., Saleh, M., Elnaiem, W., Qasem, A., Alzu'bi, Y. O., Khaled, A., Zaazouee, M. S., Ragab, K. M., Nourelden, A. Z., and Doheim, M. F. (2022). Efficacy of dance for Parkinson's disease: A pooled analysis of 372 patients, *Journal of Neurology*, 269(3), 1195-1208, doi: 10.1007/s00415-021-10589-4.

- Hashimoto, H., Takabatake, S., Miyaguchi, H., Nakanishi, H., and Naitou, Y. (2015). Effects of dance on motor functions, cognitive functions, and mental symptoms of Parkinson's disease: A quasi-randomized pilot trial, *Complementary Therapies in Medicine*, 23(2), 210-219, doi: 10.1016/j.ctim.2015.01.010.
- Herdman, S. J. and Clendaniel, R. A. (2014). *Vestibular Rehabilitation: Fourth edition*. F.A. Davis Company
- Heremans, E., Nieuwboer, A., and Vercrucysse, S. (2013). Freezing of gait in Parkinson's Disease: Where are we now? *Current Neurology and Neuroscience Reports*, 13(6), 350-359, doi: 10.1007/s11910-013-0350-7.
- Jacobson, G. P., Shepard, N. T., Barin, K., Burkard, R. F., Janky, K., and McCaslin, D. L. (2021). *Balance function assessment and management: Third edition*. Plural Publishing Incorporated.
- Kalyani, H. H., Sullivan, K. A., Moyle, G. M., Brauer, S. G., Jeffrey, E. R., and Kerr, G. K. (2020). Dance improves symptoms, functional mobility and fine manual dexterity in people with Parkinson's disease: A quasi-experimental controlled efficacy study, *European Journal of Physical and Rehabilitation Medicine*, 56(5), 563-574, doi: 10.23736/S1973-9087.20.06069-4.
- Li, F., Wang, D., Ba, X., Liu, Z., and Zhang, M. (2022). The comparative effects of exercise type on motor function of patients with Parkinson's disease: A three-arm randomized trial, *Frontiers in Human Neuroscience*, 16, 1-11, doi: 10.3389/fnhum.2022.1033289.
- Li, H., Qiu, X., Yang, Z., Zhang, Z., Wang, G., Kim, Y. and Kim, S. (2022). Effects of Cha-Cha dance training on the balance ability of the healthy elderly, *International Journal of Environmental Research and Public Health*, 19(20), 1-11, doi: 10.3390/ijerph192013535.

Marchant, D., Sylvester, J. L., and Earhart, G. M. (2010). Effects of a short duration, high dose contact improvisation dance workshop on Parkinson Disease: A pilot study,

*Complementary Therapies in Medicine*, 18(5), 184-190, doi:10.1016/j.ctim.2010.07.004.

McGinnis, P. Q., Hack, L. M., Nixon-Cave, K., and Michlovitz, S. L. (2009). Factors that influence the clinical decision making of physical therapists in choosing a balance assessment approach, *Physical Therapy*, 89(3), 233-247, retrieved from:

<https://academic.oup.com/ptj/article/89/3/233/2737704>.

McKee, K. E., and Hackney M. E. (2013). The effects of adapted tango on spatial cognition and disease severity in Parkinson's disease, *Journal of Motor Behavior*, 45(6), 519-529, doi: 10.1080/00222895.2013.834288.

McNeely, M. E., Duncan, R. P., and Earhart, G. E., (2015). A comparison of dance interventions in people with Parkinson disease and older adults, *Maturitas*, 81(1), 10-16, doi: 10.1016/j.maturitas.2015.02.007.

Patterson, K. K., Wong, J. S., Prout, E. C., and Brooks, D. (2018). Dance for the rehabilitation of balance and gait in adults with neurological conditions other than Parkinson's disease: A systematic review, *Heliyon*, 4(3), 1-25, doi: 10.1016/j.heliyon.2018.e00584.

Pereira, A.P. S., Marinho, V., Gupta, D., Magalhaes, F., Ayres, C., and Teixeira, S. (2019), Music therapy and dance as gait rehabilitation in patients with Parkinson disease: A review of evidence, *Journal of Geriatric Psychiatry and Neurology*, 32(1), 49-56, doi:10.1177/0891988718819858.

Rokka, S., Mavridis, G., and Kouli (2010). The impact of exercise intensity on mood state of participants in dance aerobics programs, *Studies in Physical Culture and Tourism*, 17(3), 241-245, retrieved from: <https://www.semanticscholar.org/paper/The-impact-of-exercise->

intensity-on-mood-state-of-Rokka-

Mavridis/d50d234c0178d3b2f948f2f2794d4b94a5d3ddf3.

Roments, S. R., Anang, J., Fereshtehnejad, S-M., Pelletier, A., and Postuma, R. (2015). Tango for treatment of motor and non-motor manifestations in Parkinson's disease: A randomized control study, *Complementary Therapies in Medicine*, 23(2), 175-84, doi: 10.1016/j.ctim.2015.01.015.

Sharp, K., and Hewitt, J. (2014). Dance as an intervention for people with Parkinson's disease: A systematic review and meta-analysis, *Neuroscience and Biobehavioral Reviews*, 47, 445-456, doi: 10.1016/j.neubiorev.2014.09.009.

Shirley Ryan AbilityLab. (2012). Fullerton advanced balance scale.

<https://www.sralab.org/rehabilitation-measures/fullerton-advanced-balance-scale>.

Shirley Ryan AbilityLab. (2013). 6 minute walk test. <https://www.sralab.org/rehabilitation-measures/6-minute-walk-test>.

Shirley Ryan AbilityLab. (2013). Mini balance evaluation systems test.

<https://www.sralab.org/rehabilitation-measures/mini-balance-evaluation-systems-test>.

Shirley Ryan AbilityLab. (2014). Timed up and go dual task; Timed up and go (cognitive); Timed up and go (motor); Timed up and go (manual).

<https://www.sralab.org/rehabilitation-measures/timed-and-go-dual-task-timed-and-go-cognitive-timed-and-go-motor-timed-and-go-manual>.

Shirley Ryan AbilityLab. (2020). Berg balance scale. <https://www.sralab.org/rehabilitation-measures/berg-balance-scale>.

- Simpkins, C., and Yang, F. (2023). Do dance style and intervention duration matter in improving balance among people with Parkinson's disease? A systematic review with meta-analysis, *Parkinsonism and Related Disorders*, 106, 1-10, doi: 10.1016/j.parkreldis.2022.105231.
- Smith-Wheelock, M., Shepard, N. T., and Telian, S. A. (1991). Physical therapy program for vestibular rehabilitation, *The American Journal of Otology*, 12(3), 218-225, retrieved from: <https://pubmed.ncbi.nlm.nih.gov/1882973/>.
- Volpe, D., Signorini, M., Marchetto, A., Lynch, T., and Morris, M. E. (2013). A comparison of Irish set dancing and exercises for people with Parkinson's disease: A phase II feasibility study, *BMC Geriatrics*, 13(54), 1-6, doi: 10.1186/1471-2318-13-54.
- Westheimer, O., McRae, C., Henchcliffe, C., Fesharaki, A., Glazman, S., Ene, H., and Bodis-Wollner, I. (2015). Dance for PD: A preliminary investigation of effects on motor function and quality of life among persons with Parkinson's disease (PD), *Journal of Neural Transmission*, 122(9), 1263-1270, doi: 10.1007/s00702-015-1380-x.