The Effect of Ten-week Ballroom Dance Therapy on Cognitive Abilities, Balance, and Perceived Stress Among Individuals over-60s

Lilla Barna[1], József Márton Pucsok[1*], László Rátgéber[2], Kata Németh[3], Eszter Bíró[1], László Balogh[1]

Abstract

Nowadays, aging is a popular research topic. Several articles describe the positive effects of dance and music therapies on older individuals' cognitive and physical abilities. Our research examined the effects of ten-week dance therapy on senior participants over 60s. We also assessed their cognitive abilities, physical endurance, and perceived stress levels. The Vienna Test System**,** Determination Test (VTS DT) was performed to assess the cognitive stress for 12 minutes. We measured a significant increase in the effect of the training program. We observed an elevation in mean pre-training values. After the intensive ballroom dance program, there was also a significant improvement, in mean score. We also examined the acute effect of a single dance class. We observed a significant improvement in acute values. Participants completed the Perceived Stress Questionnaire (PSS-14) and a Flamingo balance test before and after the dance program. We used a paired T-test to determine the effect of dance therapy on participants' perceived stress. The results indicated a significantly improved ability to balance after completing the dance program. We may conclude that the dance program has improved the current cognitive abilities of the elderly. Practical implications of our study includes improvement the quality of life, and support healthy lifespan of the elderly. Future studies, with higher number of participants, involving various physical activities,would be helpful to support our hypothesis.

Keywords: healthy aging, dance therapy, stress, cognitive abilities, falls prevention

Introduction

Regular exercise, physical activity, and sports are essential for physical, mental, and social well-being. Numerous studies have investigated the relationship between dance and cognitive abilities. Two components impact our performance and quality of life regardless of gender, age, or education.

Healthy aging: WHO defines healthy aging as "the process of developing and maintaining the functional ability that enables wellbeing in older age." "Healthy aging is the focus of WHO's work on aging between 2015 – 2030. Healthy aging replaces the World Health Organization's previous focus on active aging, a policy framework developed in 2002. Healthy aging, like active aging, emphasizes the need for action across multiple sectors and enabling older people to remain a resource to their families, communities, and economies." (WHO, 2020).

First, in 1936 Hans Selye described the new concept of general adaptaion syndrome, Selye wrote "Stress is the spice of life" (Rochette, Dogon, & Vergely, 2023)

Cognitive abilities are defined as principal abilities involving attention, memory (short -and long term), argumentation, auditive and visual processing, processing speed and thinking. Cognitive abilities may provide help in processing informations necessary in everyday life. Impaired cognitive abilities may result in decreased information processing capacity, which may lead to incorrect execution of tasks (Kiely, 2014).

Review of the Related Literature

The number of studies examining the effect of dancing activities and music therapy on cognitive abilities among the elderly population with dementia is limited. Dancing requires a high level of physical and mental abilities (Douka et al., 2019). A decline in cognitive abilities associated with aging is supported in the related literature, suggesting that physical activity significantly affects the quality of life. Numerous studies have demonstrated that physical activity is a lifestyle factor that positively influences older adults' cognitive abilities and mental health (Blair, Kohl, & Gordon, 1992; Hillman, Erickson, & Kramer, 2008). A sedentary lifestyle can lead to various functional disorders, malfunctions in the locomotor, nervous and cardiovascular systems, and metabolism. The extent of social interactions and loneliness significantly affects cognitive and emotional functioning (Haustein et al., 2011) - aging decreases sensorimotor, mental, and physical performance. Dancing has a complex effect on several cognitive abilities and activates proprioceptive memory; it can

[1] University of Debrecen, Hungary.
[2] University of Pécs, Hungary.
[3] University of Pécs, Hungary.
*Corresponding Author Email: pucsok.jozsef@sport.unideb.hu

effectively treat the elderly with dementia (Carcel et al., 2012). Dancing may improve an individual's coordination and balancing abilities by executing complex movements involving the entire neuromuscular system. Related literature demonstrated that dancing has a beneficial effect on preserving mental health by stabilizing the status of dementia (Barna & Balogh, 2020a; Kiepe, Stöckigt, & Keil, 2012). Rehfeld et al. (2018) developed a dancing routine in which participants (63–80 years old) must master increasingly complex movements. The routine lasted six months and was compared with a traditional fitness exercise. At the end of the study, it was concluded that both forms of physical activity positively affected mental health. Researchers suggested regular dancing increased volume in several brain areas, including the cingulate and sensorimotor cortex. Other studies concluded that dancing activates plasma brain-derived neurotrophic factor (BDNF). Both groups demonstrated increased activation of memory functions (Rehfeld et al., 2018). We may conclude that dancing is beneficial for mental health by alleviating the adverse effects of the aging brain.

Vienna Test System

Chen et al. (2012) investigated the quality of selective attention on elderly population living in care facilities. They conducted specific sensorimotor tests on the participants using the Vienna Test System COG-S9 device. There are a number of studies – using VTS DT device - reported the beneficial effect of physical activity including specific balance training on the cognitive functions of the elderly (Rodziewicz-Flis et al., 2022; Taheri & Irandoust, 2017). Stress and anxiety are popular research topics among researchers, however the effect of ballroom dancing is scarcely investigated (Alves, 2013; Badave et al., 2020).

The Significance of the Study

During elderly years, it is critical to improve the status of health through preserving mental and physical state. We used valid measuring devices (VTS) for the entire investigation. We found several research examining the improvement of quality of life in the elderly. Only a limited number of investigations were primarily focusing on the relationship between mental-cognitive state and ballroom dance therapies (Subramanian, Patel, & Mahalakshmi, 2023). Mishra and Shukla (2022) investigated the effect of six-week Indian folk-dance therapy in elderly population. The researchers experienced a significant improvement in static and dynamic balance, and a significant decrease in the occurance of falls, (in Fullerton advanced balance scale ($Z = -2.91$, $p < 0.01$). Alpert et al. (2009) examined elderly population over sixty performing jazz dance movements. The researchers were focusing on the effect of dancing program on mood and balance. They utilized the Folstein Mini Mental Status Examination (MMSE) and the Geriatric Depression Scale (GDS) tests. The relatively low number of participants resulted no significant changes on mood state and mental status; however, results of the tests measured by the NeuroCom Smart Balance Master device demonstrated a significant ($p < 0.001$) in balance scores. We found a number of studies examining the status of balance in active and non-active dancer population (Kilroy et al., 2016); however, there is a lack of findings among elderly participants. We conducted a ballroom dancing program involving elderly over sixty population, which provides the significance of our research.

The Purpose of the Study.

Our primary aim was to improve overall quality of life: cognitive abilities, stress tolerance among senior individuals with a ten-week, carefully planned dancing program. Our secondary purpose was to improve static balancing ability to avoid life-threatening falls.

Methodology

Participants of the Study

Twenty participants enrolled in a dance therapy program ($n = 20$; male = 3, female = 17). The mean age of the participants was 71.65 years. Participants with documented high blood pressure were excluded from the study. Subjects were asked not to participate in any physical activity program besides dancing.

Testing Procedures

Preliminary testing sessions were performed before the ten-week ballroom dance therapy program. Each session was conducted once a week for 60 minutes. The dance therapy sessions consisted of standard and Latin American dances. A professional dancer, certified instructor, conducted all dancing sessions. Each classes consisted of a five-minute warm-up, dancing and five minutes of cool-down sessions. Individual classes were carefully planned, intensity, complexity of movements were gradually increased especially focusing on the basic steps, turns, formations and rhythmic components of each dances. A constant methodology was followed throughout the entire classes regardless of the types of dance (Cha- cha- cha, Slow Waltz, Samba, Tango, Rumba, Viennese Waltz, Blues, Slow Fox, Jive etc.) performed. First, the basic steps were introduced, after more complicated movements were performed in slow and normal tempo music. The basic steps and the combination of steps were performed individually; constant corrections were made throughout the classes. After participants successfully performed the basic movements, they performed the movements in pairs. After participants repeatedly performed the movements, we instructed them to

change partners. All participants were instructed accordingly at the beginning of classes.

Vienna Test System - Determination Test

First, the subjects performed the (VTS-DT); the test was performed using a neurometer. The VTS-DT module (Schuhfried Gmbh, Austria) assessed reactive stress tolerance for 12 minutes. "This test is an enhanced version of the Vienna Determination Unit (D-Unit)." However, the color and acoustic stimuli are presented via the monitor and the Test System interface, respectively. The subject reacts by pressing the appropriate buttons on the panel. Despite these differences, studies demonstrate that the results of DT and D-Unit coincide essentially (Karner & Biehl, 2001). "Stimulus presentation occurs in three different ways, namely in the adaptive mode (the presentation speed adjusts to the performance level of the respondent), in the action mode (no time limit) and in the reaction mode (fixed time limit). The headsets supplied guarantee an undisturbed stimulus presentation" (Schuhfried, 2022). The test was performed before and after the ten-week intervention program; an acute measurement was performed before and after a single dance class. VTS-DT evaluates reactive stress tolerance and reactivity under complex stimulus conditions. VTS-DT is an internationally recognized and applied test examining cognitive abilities and reaction time during decision-making (Amado et al., 2015).

Perceived Stress Questionnaire

"The Perceived Stress Scale (Cohen, 1986) is a measure of the degree to which situations in one's life are appraised as stressful. The items are designed to tap how unpredictable, uncontrollable, and overloaded participants find their lives. In each of 14 questions, participants were asked to estimate how often they felt a certain way during the previous month using a scale of 0 to 4, with 0 indicating "never" and 4 indicating "very often". An overall score was obtained by reversing responses to the four positively stated items (items and then summing across all scale items. High scores indicated high stress levels" (Alves, 2013). The PSS has been translated to Hungarian and has been specifically validated for elderly subjects. The subjects completed the questionnaire (PSS-14) immediately before and after the ten-week program (Jiang, Geertman, & Witte, 2021).

Balance Test

All participants performed the Flamingo one-legged (unipedal) balance test. The subject standing on one leg with eyes open for one minute performed the task. The goal is to remain in a one-legged position as long as possible without touching the ground with the other foot. The tests were performed before and after the ten-week intervention program. We selected the Flamingo balance test because it provides a valid measurement of the static balance. Dancing is a very effective way of improving both static and dynamic balance. Participants dancing in pairs required to maintain stable through providing a joint axis of equilibrium. Developing balance may help to avoid injuries and risk of falls in everyday life. Increased balance may result an increased overall feeling of confidence for participants. This way dancing provides not only physical but also mental benefit as well.

Statistical Analysis

Statistica software (StatSoft Europe, Hamburg, Germany) was used to analyze all data. First, a normality test was performed on the Determination test data. The normality test results demonstrated that for variables including Reaction time, Reactions, Stimuli, Delayed responses, On time responses, and Correct responses, a parametric paired t-test was used to analyze data (Table 1).

Table 1

Parametric paired t-test

Variable	T-test For Dependent Samples Marked Differences are significant at p <.05									
	Mean	Std. Dv.	N.	Diff.	Std. Dv. Diff	t	df	p	Confidence -0.95	Confidence 0.95
Reaction Time (pre)	449.00	0.06								
Reaction Time (post)	0.98	0.10	11.00	0.08	0.11	2.423	10.00	0.03	0.00	0.16
Reactions (pre)	357.29	49.542								
Reactions (post)	398.52	70.677	17.00	-41.24	78.435	-2.16	16.00	0.04	-81.56	-0.90
Stimuli (pre)	372.35	36.18								
Stimuli (post)	412.58	55.87	17.00	-40.24	61.72	-2.68	16.00	0.01	-71.97	-8.50
Delayed (pre)	83.58	21.51								
Delayed (post)	105.23	33.78	17.00	-21.64	38.19	-2.33	16.00	0.032	-41.28	-2.00
On time (pre)	247.41	26.88								
On time (post)	274.47	41.43	17.00	-27.30	49.30	-2.26	16.00	0.03	-52.40	-1.70
Correct (pre)	331.00	40.88								
Correct (post)	379.70	65.60	17.00	-48.70	73.58	-2.72	16.00	0.01	-86.54	-10.87

For variables including Omitted responses, incorrect responses, and Sum incorrect omitted responses, the non-parametric paired samples sign test was used (Table 2).

Table 2

Non-parametric paired samples sign test

Pair of Variables	Sign Test Marked tests are significant at p <.05			
	No. of non-ties	Percent v<V	Z	p-value
Omitted (pre) & Omitted (post)	16.00	37.50	0.75	0.45
Incorrect (pre) & (post)	15.00	26.66	1.54	0.12
Sum incorrect omitted (pre) & Sum incorrect omitted (post)	17.00	29.41	1.45	0.14

The normality test was also performed on the Perceived stress scale data. A parametric, paired t-test was performed on the normally distributed data (Table 3).

Table 3

Parametric paired t-test

Variable	T-test For Dependent Samples Marked Differences are significant at p <.05									
	Mean	Std. Dv.	N.	Diff.	Std. Dv. Diff	t	df	p	Confidence -95.00%	Confidence 95.00%
PS (pre)	3.43	1.06								
PS (post)	3.07	1.07	266.00	0.36	0.81	7.27	265.00	0.00	0.26	0.46

Finally, we analyzed the Balance test data. According to the normality test results, a non-parametric paired samples sign test was performed (Table 4).

Table 4

Non-parametric paired samples sign test

Pair of Variables	Sign Test Marked tests are significant at p <.05			
	No. Of non-ties	Percent v<V	Z	p-value
Flamingo test (pre) & (post)	11.00	0.00	3.01	0.00

Results

First, we demonstrate the results obtained from the Vienna Test System (VTS) device. In terms of omitted responses, we experienced a significant decrease in the acute effect of the dance therapy program. The mean number of omitted responses was (32.23; SD=10.09) before the ten-week exercise program. We observed no significant (p=0.45) but marked improvement (27.82; SD=15.94) after the ten-week exercise program.

The value of incorrect responses was also examined immediately before, after a single dancing class, and after completing the ten-week exercise program. First, we examined the acute effect of the exercise; we observed a marked but no significant (p=0.546) improvement from (26.29; SD= 26.86 to 22.54; SD= 20.28), the completion of the ten-week exercise program also resulted in improved values (18.82; SD= 19.61); however, the changes were not significant (p=0.12).

We also evaluated the reaction time of the participants. The mean reaction time before the exercise program was (1.07; SD= 0.05 seconds). Immediately after the dance class, we experienced no significant (p=0.46) decrease (0.97; SD= 0.09 seconds) in reaction time values. The ten-week dance therapy program resulted in a significant (p = 0.03) decrease (0.97; SD= 0.09 seconds) in reaction time values.

Before the exercise program, the mean total reactions were (357.29; SD=49.54). Immediately after a single dance class (acute effect), the complete responses significantly (p=0.02) increased to (399.72; SD= 42.29). After completing the entire ten-week intervention, the mean number of total reactions also increased to (398.52; SD= 70.67), which is a significant (p = 0.04) improvement compared to the initial value.

We also examined the late but correct responses. The mean value of the pre-exercise measurements was (83.58; SD= 21.52). Immediately after the dance class, we observed a significant (p=0.00) increase (108.54; SD= 15.45). This increase was significant (p = 0.00). We also found significant (p = 0.03) improvement (105.23; SD= 33.78) after the ten-week intervention.

The correct responses received on time demonstrate a significant increase in acute and post-exercise values. The mean pre-exercise value was (247.41; SD= 26.88), which increased to (268.63; SD= 26.87) immediately after the dance class. The changes were statistically significant (p = 0.018). After the completion of the entire exercise program, we also experienced an improvement in mean (274.47; SD= 41.43) values. All changes were statistically significant (p=0.01 and p = 0.03, respectively).

The number of total correct responses were also evaluated. Mean pre-exercise values (331.00; SD= 40.87) significantly (p=0.00) increased to (377.18; SD= 32.95) after the completion of the ten-week intervention. Compared to the pre-exercise values, acute values (379.70; SD= 65.61) also significantly improved (p = 0.01).

Perceived stress questionnaire

Perceived stress questionnaire data were evaluated separately before and after the ten-week dance therapy program. We analyzed the data using paired T-test (p = 0.00). We experienced a positive impact of dance therapy on participants' perceived stress. We suggested that the perceived stress experienced in the month before the start of the dance program is more harmful than the stress experienced during the program. Therefore, physical activity such as dancing, social occasions, time spent active, and listening to music while dancing helped the individual to experience a more positive feeling of stress.

We observed an improvement in perceived stress scores (Figure 1). The mean value 3.23 decreased to 2.89. Overall, we experienced an improvement for all participants except for two; their values remained the same on the effect of the dance therapy program.

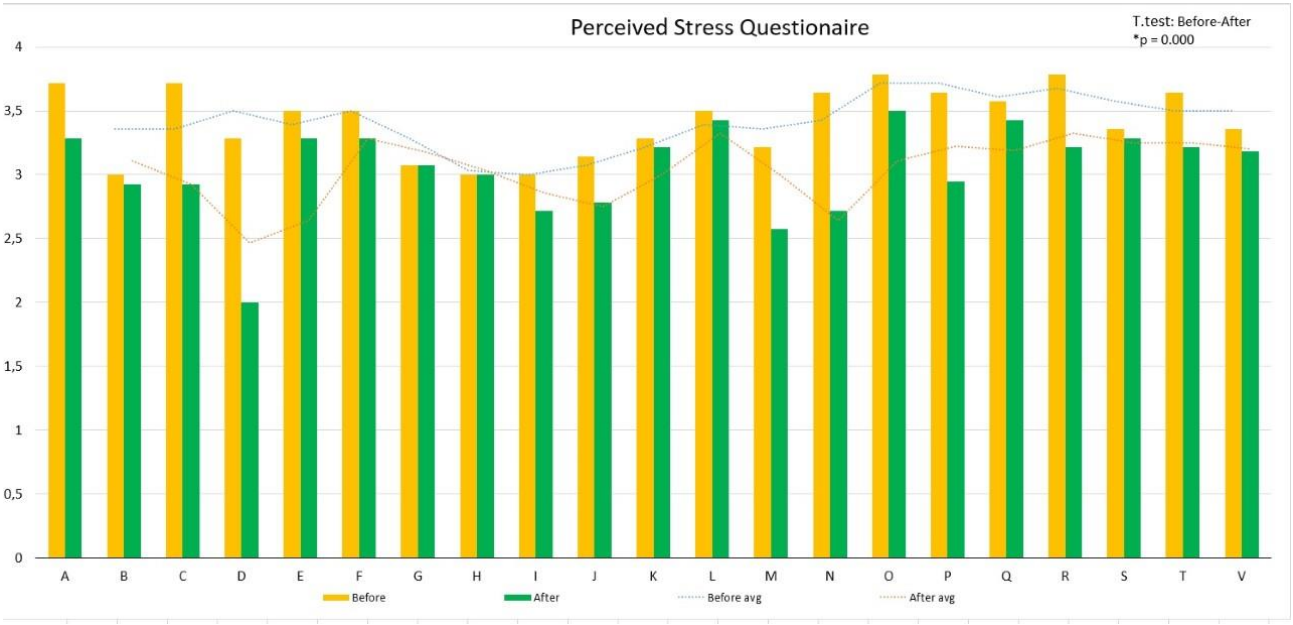

Figure 1. Perceived stress score of the participants

Flamingo balance test

We also analyzed the results of the flamingo balance test. We experienced a positive change in test scores after completing the dance therapy program. Participants who had successfully - with a low number of errors - performed the first test and committed no errors during the second test. Those who had a high number of errors (7, 6, 5) demonstrated an improved performance (3, 1, 1) on the effect of the dance therapy program.

Examining the mean number of errors, we observed an improvement from 1.0 to 0.5 error score on the effect of the dance therapy program. The results suggested that the improvement in flamingo balance test performance was significant (p = 0.00). The ten-week dance therapy program was successful for participant's over-60s in balance development.

Discussion

In addition to motor skills, developing emotional (affective) and cognitive abilities essential for coordinated, conscious, and planned performance enhancement. Factors influencing physical performance include hereditary factors, physique, gender, age, environment, and status of fitness (Barna & Balogh, 2020a).

Dance improves an individual's coordination skills, such as balance. Dancing requires a coordinated musculoskeletal system while using the strength of the body and actively activating the memory, which creates the ability to mimic

movement. Thus, several types of research prove that dance has a beneficial effect in stagnating the dementia condition, at least not worsening it (Barna & Balogh, 2020b). Physical activity has a positive impact on the decline of cognitive function. Indeed, it does not impair the activation processes of brain function during aging. Earlier researchers have examined the neurological processes in the brain during participation in dancing. The plasticity of brain is highly active in such cases. They found that learning and dancing strongly influence brain activity as the gray and white matter structure changes. The relationship between dancing and brain activity are considered essential in neuroscience (Karpati et al., 2015).

Examining prior studies on this topic, we may suggest that our research is novel in presenting the practical components of dance therapy. Related literature needs more methodological issues; they describe the measuring device, the results, and the protocol. Our research aimed to broaden our perspective in the area of sport psychology. Our research methodology is also novel incorporating the assessment of perceived stress and psychophysiological parameters via VTS-DT. Kattenstroth et al. (2013) conducted a similar study. The researchers examined inactive controls and adult females participating in a dance class once a week for six months. Their study incorporated a complex protocol measuring cognition, intelligence, perception, reaction time, well-being and motor learning, and cardiovascular capacity. They concluded that the group participating in a dance program demonstrated significantly better results; the beneficial effect was even more significant with a lower initial score. Out of 220 volunteers, thirty-five females participated in this study without prior dancing experience. The active group completed a particular routine once a week for 24 weeks. The dancing classes incorporated a 20 minutes warm-up, followed by a 40 minutes dancing session. The great advantage of this dancing program is that it is suitable for solo dancers. At the same time, according to a 2009 study, 73 percent of European women above 60 are single (Haustein et al., 2011). Solo participants may be involved in these programs without any difficulties. We designed our dance therapy program not only for groups but for solo participants too. Earlier studies supported our results involving inactive controls and senior fourth category (age 60-94) professional dancers (Kattenstroth et al., 2011).

Regarding cognitive abilities, balance tests, and cognitive flexibility, professional dancers with the same age, gender, and educational background demonstrated outstanding results compared to their inactive counterparts. The positive effect of regular physical activity involving a dancing program starting at an early age may provide long-term benefits. This beneficial effect of traditional dancing is primarily manifested in unique dancing-related routines (Kattenstroth et al., 2011).

Conclusion

Our results demonstrated that a pre-planned, organized movement therapy program involving dancing routines may improve cognitive abilities and the ability to cope with stress among individuals over 60s. Among the examined parameters, the reaction time, total reactions, late but correct responses, correct responses, total correct responses, and static balance improved significantly.

Review of related literature suggest that physical activity has a positive impact on the ability to cope with stress, cognitive abilities. The results of the VTS-DT and PSS-14 demonstrates, that ballroom dancing may be as much effective as other forms of fitness activities in terms of improving cognitive abilities, stress management, and static balance. The combined effect of physical activity (dancing) and musical therapies are very promising (Mello et al., 2018). Our study examining the effect of a dancing program on cognitive abilities, coordination, and perceived stress is unique, at least in Hungary. It would be beneficial in the future to conduct studies with a higher number of participants especially with people suffering mental illnesses or cognitive decline to support our hypothesis.

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