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The Effect Of Two Intervention Programs On The Development Of Balance In Young Adults With Down Syndrome

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Abstract:
Background*: Children with Down syndrome (DS) have delayed motor development. This delay affects both fine motor skills, such as the ability to grasp objects or use various devices, and gross motor skills, such as being able to walk, run, and play football or dance. The delay in the development of postural control affects not only the development of balance but also many other skills. Thus, people with DS must be constantly dependent on people in their environment or professional caregivers to carry out these tasks. The aim of the study was to investigate the effect of two interventional programs - Greek traditional dance and motor games - on the balance of people with Down syndrome.*
Materials and Methods*: The sample of the survey consisted of 42 people with Down syndrome, aged 20-30 years, from the Vlach Association of Efkarpia "The Holy Spirit". Two interventional programs were implemented, the first of which included Greek traditional dance and the second one was based on motor games. The programme lasted 12 weeks and 36 lessons of 60 minutes each were carried out. The research data was collected with the Four-Square Step Test. The statistical analysis of the data included a) Descriptive statistics, b) t-test for independent samples, c) Repeated Measures Anova analysis.*
Results*: The statistical analysis of the data shows: a) there is a statistically significant difference from measurement to measurement for the factor "balance", b) there is no statistically significant interaction between the two programs applied.*
Conclusion: *From the results of the study the authors conclude that a) a program of traditional Greek dance has a positive effect on the balance of patients with DS, b) a program of kinetic games has a positive effect on the balance of patients with DS.*
Key Word*: Greek traditional dance; Motor games; Gross motor skills; Muscle hypotonia.*

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I. Introduction

Children with Down syndrome (DS), compared to typically developing children, have delayed motor development. This delay affects both fine motor skills, such as the ability to grasp objects or use various devices, and gross motor skills, such as being able to walk, run, and play football or dance. This delay, although its appearance and degree is not the same for all patients, results in a negative impact on the person's relationships with the social environment they come into contact with.

And while the age of onset of gross basic motor skills - such as rolling, crawling, sitting and walking - in the vast majority of typically developing children is around the first year of life, this is not the case for children with DS. In these individuals, the onset of these basic motor skills is placed at the age of 2 to 2.5 years[1,2,3]. This delayed motor development is detrimental to an individual's development and in the long term since motor activity in the early months of life is crucial for later development.

There are many factors that contribute to gross basic motor skills starting with a long delay. However, three main factors account for this delayed onset. These factors are muscle hypotonia, joint hypermobility, and delayed motor control[4]. Muscle hypotonia, i.e. low levels of muscle tone, is one of the most consistent characteristics exhibited by individuals with DS. This trait is responsible for the lack of stability and strength which, in turn, contribute to the lack of development of motor skills[5]. On the other hand, joint hypermobility is responsible for further aggravating the problem since it contributes to the instability observed in the joints and

therefore making it even more difficult to maintain the appropriate posture and perform coordinated movements[6].

However, the observed motor delays have serious implications for the cognitive and social development of the individual. Delayed acquisition of basic motor skills excludes people with DS from their social environment and as a result they have far fewer opportunities, compared to their typically developing peers, to interact with their peers and to interact with each other. The lack of interaction with peers and the social environment significantly affects the cognitive and social development of individuals with DS, resulting in the individual being deficient in school readiness and socialization, two of the most crucial aspects of early childhood[7].

As already mentioned, muscle hypotonia is a symptom, and one of the most common symptoms, of people with DS. It plays an important role in the development of the individual since it affects, among other things, both gross and fine motor skills of the individual. It is a medical term for reduced muscle tone as a result of various pathological conditions in the presence of which there is reduced resistance to passive joint movements. The muscles are more than normally relaxed and weak which prevents voluntary movements from occurring with the end result that the individual is unable to perform even simple routines such as standing upright, controlling posture, or being able to sit[2,8]. All of this leads the individual to be dependent on the help of people in their environment since without their help they cannot perform the simplest or smallest movement[9].

The problems caused by hypotonia in motor development are exacerbated by joint instability and loose ligaments. A person who has muscle atonia is unable to perceive their position in space, their motor coordination is at very low levels and therefore they lack the ability to control their body movements[10]. These weaknesses ultimately result in individuals with DS encountering great difficulties in performing motor skills that require strength and balance.

One of the most basic elements of motor development is balance, which plays a key role in everyday activities. People with DS have a balance deficit due to the observed interaction between muscle tone, motor control and sensory processing. Essentially, the balance deficit is the result of the dysfunction of the two - vestibular and proprioceptive - sensory systems. More specifically, the vestibular system processes information about motion, gravity and balance and helps to perceive our body in space during movement. The proprioceptive system relates to stimuli from the muscles and joints. It provides information about the movement and position of our body parts in space.

The term "posture" refers to the way the body is positioned in both the sitting and standing positions. The term "postural control" refers to the ability of the person to maintain a vertical body position either when standing, sitting or moving. According to Nahla, El-Sayed, Ragaa, and El Ghafar (2022), children with DS need help from their environment when engaging in activities that require postural control such as sitting for long periods of time[11]. This is because in individuals with DS, postural control occurs quite late which means that these individuals encounter difficulties in keeping their body stable in different positions.

The delay in the development of postural control affects not only the development of balance but also many other skills. According to Malak et al. (2019), when the system related to postural control is not fully developed, difficulties in coordinating upper body and lower body movements are observed, resulting in the impairment of basic and necessary functions such as walking or carrying objects[8]. Thus, people with DS must be constantly dependent on people in their environment or professional caregivers to carry out these tasks.

As already mentioned above, the vestibular system is responsible for the function of balance and orientation in space, while the proprioceptive system is the system responsible for giving information about the movement and position of our body parts in space. According to Schott, Holfelder and Mousouli (2014) and Jain, Nayak, Karnad, and Doctor (2022), it is common for people with DS to have both of these sensory systems under-function or even dysfunction, resulting in a significant impact on their ability to be able to adjust their body posture when it changes position or when it is subjected to external forces[4,12].

According to Capio, Mak, Tse and Masters (2018), the dysfunctions present in the proprioceptive system of people with DS result in reduced body awareness, contributing to problematic coordination and impaired balance control[6]. According to Shumway-Cook and Woollacott (1985) and Watson-Scales et al. (2018), the problems, observed in sensory integration, bring about even greater to insurmountable difficulties in both maintaining dynamic balance and static balance. For this reason, people with DS encounter major problems both when walking and when standing or sitting[13,14].

The motor development and balance impairments mentioned above negatively affect the participation of people with DS in exercise activities which negatively affects many areas of their development. Areas that are negatively affected by reduced participation in physical activities, in addition to physical health, are the individual's cognitive, emotional and social development. It follows that people with DS, individuals with motor skill and balance impairments, may be reluctant or even avoid participating in activities in which coordination and strength are necessary, further limiting opportunities for socialization and physical activity[15].

Arslan, Dogan, Canaloglu, Baysal, Buyukavci and Buyukavci (2022) write that people with DS, because of their motor system dysfunction and balance deficit, hesitate or even avoid participating in physical activities because they are afraid of falling and getting hurt or of receiving ironic comments from other participants[16]. Not participating in physical activities, however, puts individuals with DS at risk of leading an inactive and sedentary lifestyle, thereby increasing the risks of obesity and cardiovascular disease[17].

However, the absence of physical activity from a person's life has a negative impact not only on physical health but, according to Vandoni, Giuriato, Pirazzi, Zanelli, Gaboardi, Carnevale Pellino, Gazzarri, Baldassarre, Zuccotti and Calcaterra (2023), also on the socialisation of the individual since through participation in organised physical activities, especially group activities, they will develop their social relationships[5]. People with DS will thus be able to join a group, develop their interaction with other members, improve their self-esteem and gain confidence in their abilities.

Dance, of any kind, apart from being an art form, has been recognized by many scientists from different fields as a medium that has the potential to bring many physical, mental and spiritual benefits to the participant[18]. In the following, the role of dance in improving the balance levels and overall motor function of people with DS will be examined. This is because it is a structured physical activity in which rhythmic movements, coordination and proprioceptive feedback coexist. Three elements that are key components of balance training. Participation in organized dance activities offers the potential for a) stimulation of the vestibular system, b) improvement of muscle strength and c) improvement of motor function. Particularly for people with DS, dance is a multi-sensory experience activity that has the potential to provide solutions to problems such as balance deficit.

The aim of the study by Gutiérrez-Vilahú, Massó-Ortigosa, Costa-Tutusaus, Guerra-Balic, & Rey-Abella (2016) was to investigate the effect of a dance program on postural control during static balance in closed- and open-eye adult youth with and without DS[21]. The study involved 22 adult youth with DS who were randomly assigned to two groups. Participants were randomly assigned to two groups. The first group, M of age 20.5±1.37 years, consisted of 11 DS adult youth and the second group, M of age 20.2±2 years, consisted of 11 adult youth without DS. The program was of 18 weeks duration with a frequency of 2 times per week. Each session lasted 90 min and consisted of warm-up activities (5-10 min), core strength and ballet barre exercises (15 min), proprioception exercises and balance with EO and EC (20 min), choreography (20 min), improvisational exercises and image recognition in a mirror (15 min), and relaxation (5-10 min).The types of dance that were used were classical, contemporary and creative dance. From the analysis of the data, the authors concluded that a) adult youth with DS, compared to subjects without DS, during static standing have a different extent of center of gravity displacement while not differentiating in their sway. Individuals with DS have a higher amplitude of displacement, b) visual condition (eyes open or closed) does not differentiate the behavior of the center of gravity.

The aim of the pilot study by McGuire, Long, Esbensen and Bailes (2019) was to investigate the effect of an interventional dance programme on the motor skills of people with DS[22]. The study involved 14 children with DS, aged 4 - 7 years, of whom only 6 completed the programme. Twenty sessions, once a week, of 60 minutes each, of Ballet Moves aimed at eliciting creativity in the participants were conducted.The Canadian Occupational Performance Measure (COPM) and Gross Motor Function Measure (GMFM) Dimensions D and E were used to collect the data. From the data analysis, the authors found significant improvements in the children's motor skills that enabled them to argue that a Ballet Moves program has the potential to bring about positive changes in the motor skills of individuals with DS.

Dipasquale, Canter and Roberts (2020) investigated the effect of a 12-week Integrative Dance program on postural stability of seven, 5 men and 2 women, adult individuals with DS[23]. The results found an improvement in postural stability and therefore a reduction in the risk of falling as well as a possible improvement in motor function. From the results of the study, the authors concluded that dance - Integrative Dance- has the potential to be a tool for restoring postural stability in people with DS.

The aim of the study by Raghupathy, Divya and Karthikbabu (2021) was to investigate the effect of two intervention programs on motor skills and balance in children with DS[24]. The 1stintervention program included Indian dances like Bharatanatyam, Kuchipudi and Kathak while the 2ndimplemented a neuromuscular training program. The study included 36 children aged 6-10 years whose Beighton's hypermobility test score was <5. By random selection, participants were assigned to the two groups equally, 18 subjects in each group. The program was 6 weeks in duration with a frequency of 3 times per week. The duration of each session was 60 minutes. The instruments used to collect the data for the study were Test of Gross Motor Development-2, Four Square Step Test and pediatric balance scale. From the statistical analysis of the data, the authors concluded that the children who were taught Indian traditional dance improved their motor skills statistically significantly while the children who participated in the neuromuscular training program did not. Furthermore, it was found that balance ability improved in both groups.

Aleksander-Szymanowicz, Filar-Mierzwa, and Skiba (2023), considering that participation in organised dance activities can have a positive effect on balance and therefore reduce the risk of falling, conducted a study to evaluate the effect of a dance therapy programme on improving the balance of people with DS to reduce the risk of falling[25]. 23 people aged 26-49 years took part in the study. The programme lasted for 3 months with a frequency of 2 classes of 45 minutes per week. The program included basic steps of traditional dance, ballroom dance, integration dance, and foreign dances. The indicators assessed were a) postural stability, limits of stability, and c) M-CTSIB fall risk). From the results of the study the authors concluded that participation in dance activities partially improves the balance of people with DS since only the limits of stability indicator showed a statistically significant improvement.

From what has been cited above, it can be seen that there is a lack of research that aims to investigate the effect of a Greek traditional dance programme on improving the balance of people with DS. So, the aim of the study was to investigate the effect of two interventional programs - Greek traditional dance and motor games - on the balance (dynamic and static) of people with Down syndrome.

II. Material And Methods

The sample of the survey consisted of 42 people with Down syndrome, aged 20-30 years, from the Vlach Association of Evkarpia "The Holy Spirit". Of these, 21 were men and 21 were women. All individuals in the sample belong to type T21 (Typical Trisomy 21), with mild mental retardation. The participants were randomly divided into two equal groups. The first group - experimental group 1- implemented an interventional program of Greek traditional dance, while the second - experimental group 2- implemented a program of motor games.

Study Duration: October 2024 to January 2025.

Sample size: 42 people with Down syndrome.

Inclusion criteria:
1. Young adults with Down syndrome.
2. Either sex.
3. Aged 20 to 30 years.
4. Participants with mild mental retardation.

Exclusion criteria:
1. Participants with multiple disabilities.
2. Participants who participate at the same time in other dance programs.
3. Participants who know the dances that will be taught in the program.

Procedure methodology

For the individuals in the sample from the Vlach Association of Efkarpia "The Holy Spirit", permission to participate in the program was requested and obtained from the administrators of the Association. Also, signed permission was requested and obtained from the parents and guardians of the individuals.

The administrators of the Vlach Association of Efkarpia and the parents were assured that the data collected will be used exclusively for scientific purposes. In addition, they were informed that they could withdraw from the program at any time if they felt that the program did not correspond to what they were initially told. Finally, permission to conduct the research was sought and obtained from the Ethics Committee of the Democritus University of Thrace, Greece.

Intervention programme

The programme lasted 12 weeks. There were 3 lessons per week of 60 minutes each. That is, 36 lessons of Greek traditional dance for the first experimental group and 36 lessons of movement games for the second experimental group. The choice of dances and movement games was made taking into account the guidelines of the curriculum for students with moderate mental retardation (Ministry of Education, 2004). The dances taught were chosen based on simplicity, not having complex and complicated movements, alternating lower limb supports and alternating hand movements. As for the movement toys, balls, hoops, cones and various other educational materials were used.

Measurement instrument

The Four-Square Step Test (FSST) by Duncan, Weiner, Chandler and Studenski (1990) was used to assess balance. The test has the ability to assess both dynamic balance and functional mobility of the subject. The test is commonly used in people who have balance problems such as those with neurological disorders.

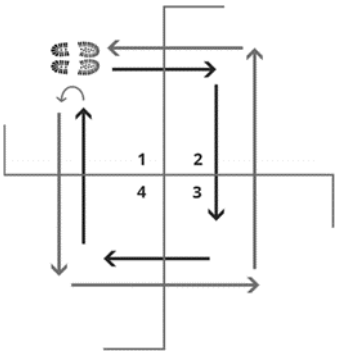

Figure no 1: Four Square Step Test

Statistical analysis

Data was analyzed using SPSS version 26 (SPSS Inc., Chicago, IL). The following statistical analyses were performed:

a) Descriptive and inferential statistics,
b) t-test for independent samples,
c) Repeated Measures Anova analysis

III. Result

Firstly, a t-test for independent samples was performed to test whether there were statistically significant differences in the balance factor at the beginning between the group that participated in the dance program and the group that participated in the movement games. The results (Table) show that there are no statistically significant differences in the balance factor between the two groups. Therefore, it was assumed that the two groups have the same starting point before the start of the intervention program.

Table no 1: Means - standard deviation and t-test values for the factor "balance" at the initial measurement.

	Total		**Dance**		**kinetic games**				
Balance	**M**	**SD**	**M**	**SD**	**M**	**SD**	**t**	**df**	**Sig.**
	13.86	.48	13.88	.48	13.84	.49	2.49	40	.805

Two-way Repeated Measures ANOVA was applied to examine whether there were statistically significant differences in the factor "balance" between the measurements (initial, final & re-measurement) and the intervention groups (1 = dance, 2 = motor games). The results show that there was no statistically significant interaction between the measurements and the intervention groups ($F_{2,80}$ = .959, p = .387). In contrast, statistically significant differences in the "balance" factor were observed between initial, final and re-measurement ($F_{2,80}$ = 3699.37, p < .001) for both experimental groups.

The LSD multiple comparison test was applied to identify statistically significant differences between the levels of the repeated measures factor "balance" and found statistically significant differences between the initial, final and re-measurement. More specifically:

a) 1st experimental group/Greek traditional dance: as shown in Table 2, the participants in the 1st experimental group, i.e. the group that participated in Greek traditional dance classes, improved their initial performance since they reduced the time of the test during the final measurement. A statistically significant difference was observed between the final and the re-measurement. In this case, the participants performed worse. However, this performance is statistically significantly different from the performance of the initial measurement.

b) 2nd experimental group/moving games: As shown in Table 2, the participants in the 2nd experimental group, i.e., the group that participated in the motor games program, improved their initial performance since they reduced the test performance time at the final measurement. A statistically significant difference was also observed between the final and re-measurement. In this case, participants performed worse. However, this performance is statistically significantly different from the performance of the initial measurement.

Table no 2: Means-Standard deviation and interaction for the two experimental groups at initial, final measurement andre-measurement.

		Measurement						
		Initial		**Final**		**Re-measurement**		Interaction
Factor	Group	M	S.D.	M	S.D.	M	S.D.	
Balance	Dance	13.88	.48	8.37	.49	8.87	.64	$F_{(2,80)}$=3699.37, $p<.001$, $\eta^2=.574$
	Motor games	13.84	.49	8.50	.43	9.00	.56	

IV. Discussion

One of the most important problems faced by people with DS is the delayed onset of gross motor skills since in people with DS the onset of gross motor skills is at the age of 2 to 2.5 years, where as in typically developing children the onset is in the first year of life. The delayed onset has long-term implications for motor development since motor activity in the first months of life is crucial for later development and adulthood.

Considering the above, the aim of this study was to investigate the impact of two intervention programs on the balance of adults with DS. The content of the first intervention program was Greek traditional dance. The reason why Greek dance was chosen, as accepted by researchers, it is because Greek dance is a physical activity that can positively contribute to the improvement of patients' motor status[28]. The content of the second intervention was various movement games according to the guidelines of the curriculum for people with mild mental retardation.

The programme was 12 weeks long with a frequency of 3 lessons per week, each lasting 60 minutes. That is, 36 lessons were conducted for the first intervention group and 36 for the second. 42 young adults took part in the study. All of them were included in the final evaluation since none of them missed the lessons more than once. The assessment of balance was carried out with "The Four Square Step Test" (FSST) by Duncan, Weiner, Chandler and Studenski (1990)[27].

Data collection was carried out in three phases. In the first phase - initial measurement - data were collected both to provide a measure of the effectiveness of the two programs and to determine whether the two groups start the programme from the same levels. The second phase involved the collection of data from the main survey, the statistical analysis of which would establish the effectiveness of the two programs. Data collection took place immediately after the end of the programme. Finally, it was considered appropriate to collect data one month after the end of the programme in order to be able to check whether the potential positive effects of the programme were maintained.

Firstly, a t-test for independent samples was performed to test whether there are statistically significant differences in the "balance" factor between the two intervention groups. From the value obtained for the t-index it is found that there are no statistically significant differences between the group that implemented the programme with Greek traditional dance and the group that implemented the programme with movement games. This means that the two groups start from the same starting point, therefore the results obtained from the implementation of the program will be entirely due to the program.

From the results of the Repeated Measures Anova Analysis and multiple comparison test LSD it is found that both groups showed statistically significant differences from the initial to the final and re-measurement measurement. Both the first experimental group and the second group statistically significantly improved their performance on the "balance" factor while significantly decreasing their performance on the test. And because members of both groups did not take part in other physical activities during the implementation of the program, it is assumed that the improvement in balance is a result of the implementation of the program.

The results of the study agree with the results of other studies according to which participation in organised dancing activities contributes positively to the improvement of the mobility status of patients with mobility problems. More specifically, the results of the present study agree with the results of Giazitzioglou's (2022) research according to which participation in dance activities, especially Greek traditional dance, contributes positively to the improvement of the motor status of patients with Parkinson's disease[18]. The results of the present study are in agreement with the results of Aleksander-Szymanowicz, Filar-Mierzwa, and Skiba (2023) according to which participation in dance activities improves the balance of people with DS since the index of limits of stability showed a statistically significant improvement[25]. However, the results of the study are also in agreement with the results of the study by Raghupathy, Divya and Karthikbabu (2021) according to which participation in Indian traditional dance classes improves both motor status and balance of children with DS[24]. Finally, the results of the study are in agreement with the results of the research by Dipasquale, Canter and Roberts (2020) since the authors concluded that dance - Integrative Dance- has the potential to be a tool for restoring postural stability of people with DS[23].

However, the results of the 2nd experimental group are also in line with the results of other studies that participation in organised sports activities contribute to improving the balance of people with DS. More specifically, and from a review study conducted by Maïano et al. (2019), which included surveys conducted from 2010 to 2017, it is found that participation in sports activities contributes to the improvement of both static and dynamic balance levels of adolescents and adult adolescents with DS[9]. Again, from a review study, that of Rodríguez-Grande, Vargas-Pinilla, Torres-Narvaez, & Rodríguez-Malagón, (2022), which involved studies investigating the effect of exercise on the balance, muscle strength and flexibility of children aged 6 - 12 years and adolescents aged 13 - 18 years with DS, it is evident that it contributes to the improvement of balance in individuals over the age of 8 years[29]. Finally, from a literature review, this time covering the time period 2010 - 2022 and including a meta-analysis of a random sample, we are informed that participation in organized exercise contributes to both improving balance and preventing falls in adolescents with DS[30].

As mentioned above, there was data recording and analysis one month after the end of the project. The purpose of this recording was to investigate the effect of the program on balance. From the results it was found that there was an increase in the performance of the participants. This means that balance decreased in both experimental groups. Despite this decrease there was still a statistically significant difference between the initial measurement and the re-measurement. That is, one month after the end of the program and without the sample participating in any other physical activity, the positive effect of both intervention programs on balance continues.

From the results of the Repeated Measures Anova Analysis it was found that there was no interaction between the two intervention programs since no statistically significant differences were observed. This means that the two programs had the same positive effect on the balance factor.

V. Conclusion

From the results of the research and the discussion that followed, the authors conclude that a) an appropriately designed Greek traditional dance program has a positive effect on the balance of patients with DS, b) an appropriately designed movement games program has a positive effect on the balance of patients with DS.

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