

THE IMPACT OF PHYSICAL EXERCISE ON THE DEVELOPMENT OF COORDINATION SKILLS IN PEOPLE WITH INTELLECTUAL DISABILITIES

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Abstract: The aim of the research was to present the steps of evaluation and to validate an original physical exercises programme adapted to individual possibilities and abilities of people with Down syndrome in order to intervene with objective stimuli on the improvement of their physical condition.

Designing and implementing of a programme based on coordination and balance physical exercises can help to improve the physical condition of adults with Down syndrome. This type of exercises can be applied to people with Down syndrome positively influencing some components of functionality and quality of life. In this research we presented a case study of a 43-year-old male subject with Langdon Down syndrome from an urban environment living with his family. The subject participate for 6 month to a special program, 3 times/week, the applied exercise concentrate on balance, coordination and strength. The subject was tested pre and post intervention, our results showing improvements on shoulder mobility, lower limbs strength and balance.

Keywords: adult Down syndrome, coordination, balance, physical exercises

Introduction

Physiotherapists have an important role in the therapy of children with intellectual disabilities by being involved in their learning of gross and fine motor skills, gait, endurance and muscle strength or joint integrity. They are becoming less and less involved in exercise programs for adults mainly due to funding difficulties and difficulties in accessing specialized care (Kageleiry et al., 2017, Friedman & Feldner 2018).

For people with intellectual disabilities, the need in the health care sector is great for the treatment of chronic diseases, but interventions that address the subject of intellectual disability or Down syndrome are also needed to avoid this stage of chronic disease. The intervention through individualized physical education programs targeting the need of the disabled subject for health promotion, as a unitary whole, has not been documented by many extensive studies in Romania on adults.

Programs designed to promote physical exercise must specifically address these problem areas, but also rely on the

development of a comprehensive complement of movement skills that can be developed and practiced.

The adults with Down syndrome (aDS) can present many chronic conditions, especially since we are talking today about a population with the same life expectancy as those related to them. In addition to physical therapy and medical treatments, they needs exercise programs to maintain an optimal functional level and well-being.

Methods

In this research, we present a case study of a 43-year-old male subject, normal weight, from an urban environment living with his elderly parents. The family rely on the support of another daughter without DS. His parents describe him as extremely lively and generous in feelings and attitude. He has the ability to bring joy and warmth into the lives of those around him and is open to interpersonal relationships. He is loving and empathetic, offering affection and support to loved ones. He is always a bright presence in

the lives of others and often brings a smile to the faces of others.

The medical diagnosis Langdon Down syndrome was established at birth, his mother was 27 years old at birth. Subject was diagnosed with keratoconus and underwent successful corneal crosslinking surgery to slow down the progression of the disease. In addition, he had problems with varicose veins in his lower limbs, which caused discomfort and swelling sometimes. Consequently, surgical intervention using the sclerotherapy method was performed to treat the varicose veins.

All those medical problems (vision, problems in lower limbs) can disturb balance and coordination, in the future the subject is at risk of falling.

The testing session and the intervention program took place at a Romanian clinique. At the beginning of the testing session, the participant's guardian provided information about their health history by completing a informed consent.

Initial testing identified problems with the execution of certain tests. Subsequently, measurements from the test battery were carried out and were interpreted, analysed and an individualized exercise program was chosen.

In order to become familiar with the test requirements, including unfamiliar objects, several pre-tests were conducted prior to the final test, which were designed to help the subject adapt to the environment. During testing, verbal encouragement and explanation were used to set expectations, and external support was provided through hand-holding in the familiarization process before performing independently. the aim was to provide a minimum level of external support. Only data that met the testing criteria were considered in subsequent analyses.

Examples of specific approaches included the use of visual markers (such as a tape) to indicate where the foot should be placed, the use of visual metaphors (e.g. "stand still like a statue") and giving verbal cues (such as "get ready... 3, 2, 1. Start") to mark the start of a test.

Used test to identify the functional level

The tests used identify the impact of a 6-month, three time a week physical exercise program on coordinative abilities were the Hurdle Step Test and the Shoulder Mobility Test (part of Functional Movement Screen or FMS) that assess functionality, the Y BALANCE TEST, the vertical jump.

These tests were chosen because they are easy to apply and to perform by the participants and help us to identify, without errors, functional changes that impact the quality of coordinative abilities.

The hurdle step test can identify disfunctions in an integral part of locomotion and gait acceleration. This movement challenges the mechanics of the body's, step and stride, also stability and control in a one-legged stance. Overcoming obstacles requires bilateral mobility and stability in the hips, knees and ankles. The test also assesses the ability to maintain stability and control of the pelvis and abdominal girdle, providing an opportunity to observe functional symmetry.

The shoulder mobility test can identify the complementary natural rhythm of the scapulothoracic region, thoracic spine and rib cage during reciprocal shoulder movements at the upper extremity. In addition, this test assesses bilateral shoulder range of motion, integrating extension, internal rotation and adduction at one end and flexion, external rotation and abduction at the other.

Y BALANCE TEST (YBT) is a dynamic test is a thorough but easy way to test a person's risk of injury as well as demonstrate functional symmetry. It is performed in a one-legged stance that requires strength, flexibility, core control and proprioception.

For this test it was used a Y Balance Test assessment kit consists of a central platform on which one of the subject's legs is placed. Three pieces of PVC pipe are attached to this central plate, appropriately marked in centimetres forming the anterior posteromedial and posterolateral touch directions. The posterior directions are each positioned at 135 degrees to the anterior and 90 degrees to each other.

The vertical jump was evaluated with **OPTOJUMP** (Microgate, Bolzano, Italy), an

optical measuring system consisting of a transmitting and receiving bar.

The subject was initially assessed in December 2022. From January 2023, he was included in a special training programme with physical exercises three times a week, focusing on the development of his strength, coordination and balance skills. Each training session lasts 120 minutes and includes exercises aimed at developing balance, segmental coordination and spatial and temporal orientation, which were carried out in the first part of the session.

The working programme was based on 3 concepts that are fundamentals to the optimal functionality of the aDS in order to reduce the risk of injury according to the prognosis of this pathology in adult and older age.

Therefore, the program was created in three parts, each with 15 exercises of an average

duration of 60 minutes. Each part contains a well-defined balance route (lasting 30 minutes) aimed at increasing joint stability. The programme concludes with 30 minutes of cardiovascular endurance, which includes both lower and upper limb cycling.

Therapeutic physical exercise programme

One objective of the basic research was to develop and implement a physical exercises programme adapted to the needs of adult with Down syndrome. This organised programme will allow them to access physical exercise not only like therapy (physical therapy).

The physical exercise programme was developed according to the rules of physical exercise, with warm-up, cool-down, and the actual exercises. The objectives for each part are presented in table 1.

Tabel 1. Therapeutic programme for people with intellectual disabilities

<i>The warm-up programme included 3 exercises</i>	<i>The programme</i>	<i>The cool-down at the end of the working programme included 4 exercises</i>
Objectives: - Warm-up. - Enhancing mobility and flexibility in the spine	Objectives: - Developing balance. - Improving dynamic balance, enhancing coordination skills, and spatial-temporal orientation.	Objectives: -Protecting cardiovascular health, improving balance and coordination, strengthening the joints.

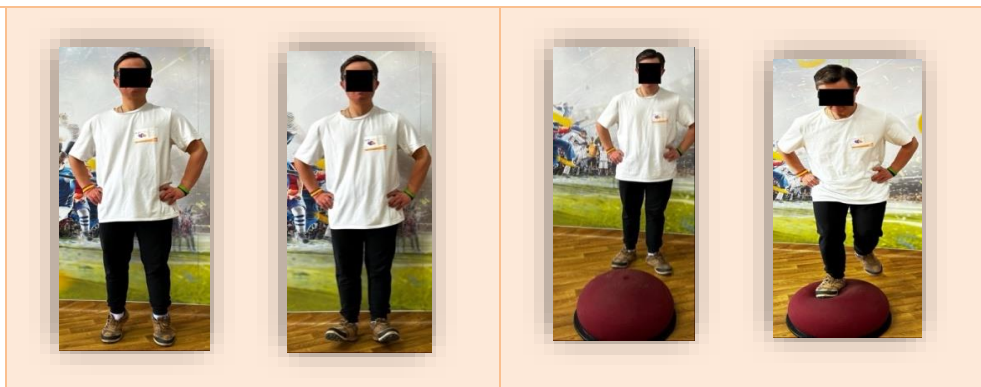
The exercises that made up the applied program.

Exercise 1

<i>Objective</i>	Development of balance
<i>I.P.</i>	Standing with hands on hips, lifts on toes, then heels;
<i>Dosage</i>	3x (15 repeats);
<i>Directions</i>	Back straight, knees bent.

Exercise 2

<i>Objective</i>	Development of balance
<i>I.P.</i>	Sitting behind the balance cushion, getting on the cushion and getting off;
<i>Dosage</i>	3x (15 repeats);
<i>Directions</i>	Maintaining balance during the execution of the movement.

Image**Exercise 3****Exercise 4**

<i>Objective</i>	Development of balance	Development of balance
<i>I.P.</i>	Sitting on the balance cushion with knees slightly bent, arms stretched forward, perform the left arm overhead carry and return, then the right arm;	Sitting on the chair, hands resting on hips, standing up, then back down;
<i>Dosage</i>	3x (15 repeats);	3x (20 repeats);
<i>Directions</i>	Maintaining balance during the execution of the movement. Your gaze follows the working arm.	Keep your back straight and aim to keep your knees in the correct position.
<i>Image</i>		

Exercise 5**Exercise 6**

<i>Obiectiv</i>	Development of lower limb strength	Development of lower limb strength
<i>P.I.</i>	Sitting on the chair, hands by your side, extend your left knee;	Sitting, hands on hips, left-footed lunge;
<i>Dozare</i>	3x (20 repeats);	3x (15 repeats);
<i>Indicații</i>	Same with the right leg. Keep your back straight.	Same with the right leg. Keep your back straight.

Imagine**Exercise 7****Exercise 8**

<i>Objective</i>	Development of lower limb strength	Development of lower limb strength
<i>I.P.</i>	Sitting, hands on hips, perform abduction of the left lower limb;	Sitting on the balance sponge, arms stretched forward.
<i>Dosage</i>	3x (20 repeats);	5x (30 seconds);
<i>Directions</i>	Idem with the right leg. Holds the position with right spine.	Holds the position and with right spine.
<i>Image</i>		

The balance trail (table 2) aimed to improve dynamic balance, develop coordination skills and spatial and temporal orientation. Dosage: The trail is repeated 10 times.

Table 2. The applied balance trail

✓ The trail begins by instructing the subjects to take small and controlled steps along a line drawn on the floor. ✓ Walking among the cones over a distance of 4 meters. ✓ Ankle game on the coordination ladder. ✓ Stepping onto the Bosu balance pad with the left foot, followed by 5 half squats. ✓ Stepping onto the Bosu balance pad with the right foot, followed by 5 half squats. ✓ Walking on balance sponges over a distance of 4 meters. ✓ Stepping onto the plyometric box with the left foot, then descending forward. ✓ Stepping onto the next plyometric box with the right foot, then descending backward. ✓ Walking on balance cushions one foot at a time, alternating, over a distance of 4 meters. ✓ Sideways walking with the left foot over small hurdles over a distance of 2 meters. ✓ Sideways walking with the right foot over small hurdles over a distance of 2

- ✓ meters.
- ✓ Jumping over an obstacle.
- ✓ Grabbing the medicine ball and throwing it into a circle positioned 2 meters away from the subject.
- ✓ Resuming the trail.

Obtained results

Shoulder Mobility Test (SMT) results are presented in table 3. Subject scored 29 cm on the right arm up test in the first evaluation (It) and 11 cm on the final test (Ft.) Subject progress was 62.06%, which means an increase in shoulder joint mobility. Also, for this test but with the left arm up, subject obtained a value of 35 cm at the It and 11 cm in the Ft. Subject progress was 68.57%, which means an improvement in shoulder joint mobility.

Table 3. Shoulder Mobility Test (SMT) and Hurdle Step Test (HST) results

	SMT Right arm up (cm)	SMT Left arm up (cm)	SMT final Score	HST Score right foot	HST Score left foot
Initial test (It)	29cm	35cm	1	1	1
Final test (Ft)	11cm	11cm	3	2	2
Diff It.-Ft.	18	24			
Diff. It.-Ft.=%	62,06%	68,57%			

The Hurdle Step Test (HST) results after the first and second evaluation are presented in also in table 3. The first assesment (It) assessment shows a score of 1, indicating that the subject was unable to perform the movement even with compensations. At the final assessment (Ft), the subject managed to obtain a score of 2, showing progress, namely that the movement was performed, but with small compensatory patterns.

Figure 1 present the scores after 6 month physical exercises recorder by the subject with DS.

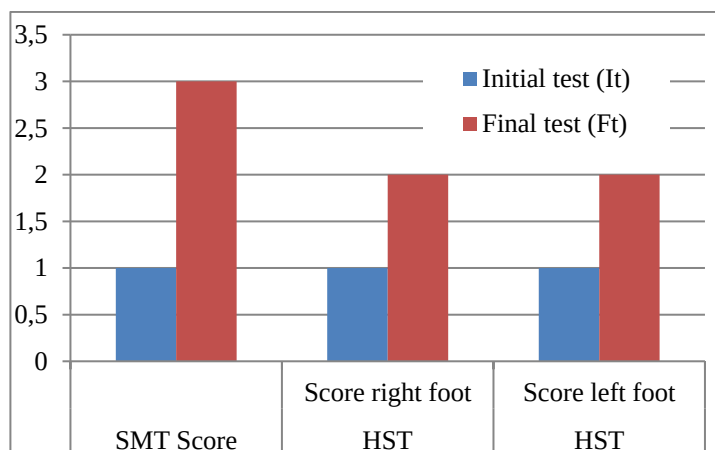


Figure 1. The progression of scores recorder by the subject

After the applied exercises program, the Y BALANCE TEST record also improvements that are presented in table 4.

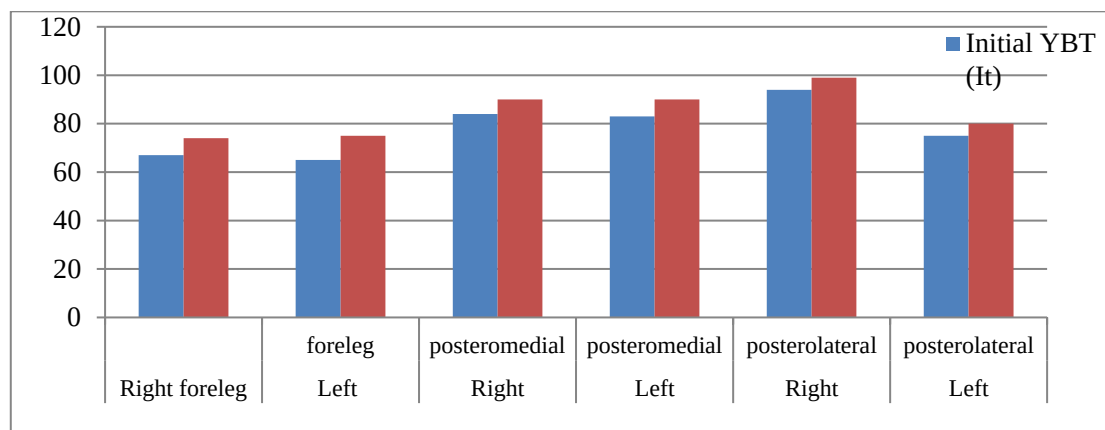
Table 4. Y Balance Test results

	Right foreleg	Left foreleg	Right posteromedial	Left posteromedial	Right posterolateral	Left posterolateral
Initial YBT (It)	67	65	84	83	94	75
Final YBT (Ft)	74	75	90	90	99	80
Dif. YBT Ft.-It.	7	10	6	7	5	5
Diff. Ft.-It. = %	9,45%	13,33%	6,66%	7,77%	5,05%	6,25%

In the Tabel 4 are presented the results at the Y Balance Test. At the initial test, the subject achieved 67 cm with the right foot in the forward (anterior) direction, subsequently progressing by 7 cm (an improvement of 9.45%) resulting in better stabilisation ability. With the left foot in the forward (anterior) direction, the subject initially recorded 65 cm, and at the final test (Ft.) had an increase of 10 cm (a 13.33% improvement), thus improving stabilisation ability.

On the posteromedial direction, the initial value with the right leg was 84 cm, subsequently progressing by 6 cm (a progress of 6.66%), resulting in improved stabilisation ability. With the left leg in the posteromedial direction, the subject had an initial value of 83 cm, increasing by 7 cm (a 7.77% improvement), which improved stabilisation ability.

In the posterolateral direction, the subject achieved an initial value of 94 cm with the right leg, subsequently increasing by 5 cm (5.05% progress), improving stabilisation ability. With the left leg in the posterolateral direction, the subject achieved an initial value of 75 cm, subsequently achieving an increase of 5 cm (a progress of 6.25%), which improved stabilisation ability.

*Figure 2. The progression of YTB scores recorded by the subject*

The vertical jump was recorded with OptoJump Testing system (OptoJump test). The subject performance is presented in figure 3, also the result recorded by the soft in table 5.

At the initial assessment the subject recorded a jump value of 10.8 cm. At the final test, this parameter improves by 5.5cm.

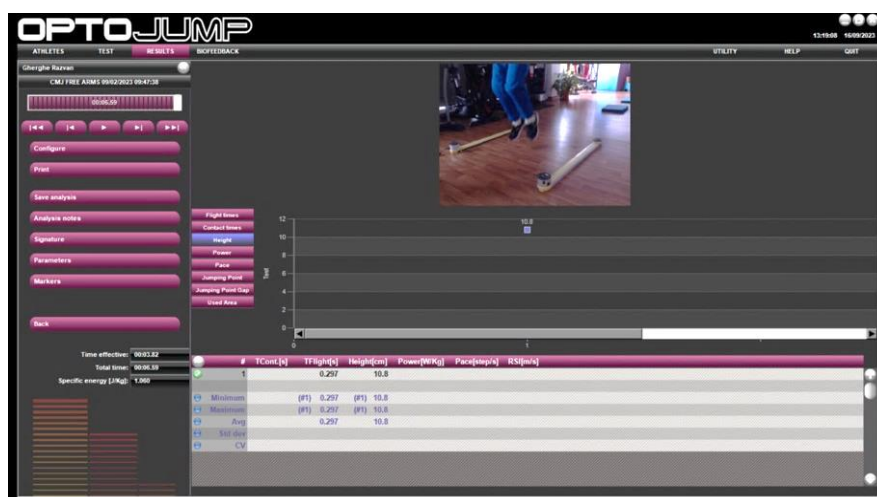


Figure 3. The capture motion for the vertical jump of the subject

This is an innovative measurement platform that introduces a revolutionary approach to performance assessment especially for people with Down syndrome taking into account their physical and psychological particularities. They can react to an unfamiliar environment and perform with very low scores, so their functionality can be considered bad. It was used to develop a personalised and specific training programme based entirely on accurate objective data.

Tabel 5. Results of the OptoJump Test - vertical jump, subject assessed

Initial test	Final test	Ft.-It.
10,8 cm	16,3 cm	5,5 cm

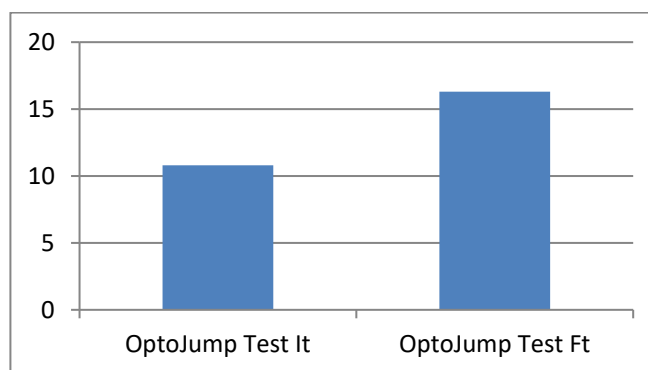


Figure 4. The progression of Optojump scores recorded by the subject

Discussions

Physical activity and movement in children with and without Down syndrome is an essential facilitator of learning, according to Ulrich & Ulrich, 1995, Sydoruk et al. 2021. The effects of learning the correct patterns of movement will have an effect in the life of a young person and then as an adult, with consequences in particular on sedentary behaviors and on some conditions that are associated with sedentarism and can shorten their lives. The health risks posed by

sedentary behaviors in the global population are not fully known (Park et al. 2020), and subjects with intellectual disabilities or Down syndrome are no exception.

Adults with DS show lower motor skills compared to people with typical motor development, but at the individual level possible individual strengths or abilities of adults with DS can be identified (Quinzi et al., 2022).

Therefore, motor actions should be undertaken in adults with DS that stimulate

them to develop and maintain any motor skill similar to interventions applied to their typically developing peers, even in adulthood. Physical activity has been identified as a form of "therapy" that involves active engagement of the patient, either in a collaborative relationship with a specialized professional or independently, with an emphasis on recognizing personal and individual characteristics related to the medical diagnosis, age, and motor difficulties.

The recommendations for maintaining health aim for each individual to engage in at least 30 minutes of physical activity per day, of moderate to high intensity, at least 5 days a week. It is emphasized that it is beneficial for every person to engage in regular exercise.

Therefore, educating the individual (with or without an individual disability) for an active lifestyle should primarily address the beliefs that the individual develops from childhood, under the influence of their family nucleus and then in the social environment.

At the same time, it is important to provide information on how individuals with intellectual disabilities can anticipate the impact of physical exercises on their body and symptoms, as well as to discuss the risks related to physical activity, inactivity, and the consequences of sedentary behavior.

Because people with secondary disabilities and other health problems present in higher percentages than the general population, they need more specialized care, exercise and physical education programs than the rest of the community (Moore, G. et al., 2016).

In recent years, there has been a move away from single exercise programs such as strength, aerobics, muscular endurance and flexibility in favor of more complex and personalized programs for people with intellectual disabilities. These integrated programs include various elements such as strength, balance, aerobic training and other types of exercise to achieve more effective results.

Given the fact that performing a dual task (dual task) involves an increased cognitive involvement, this indicates a greater complexity in what is identified as cognitive

engagement and a possible reduction in performance (Horvat et al., 2013).

Practicing adapted sports and implementing them in groups trains children to communicate, become more sociable and overcome their psychological barriers. This adds to their quality of life (Barbu et al., 2021) and can help them create a circle of teammates-friends with the same concerns that improve their perception of quality of life. Components of physical fitness have been shown to have a significant positive relationship with improved outcomes in physical activity, including participation in various sports (Farley et al. 2020).

This education could also support the patient in acquiring new motor skills or honing those already acquired, in order to estimate the barriers and facilitators of physical activity, or to plan physical activity or exercises in a rational manner in their daily life. Education for an active lifestyle will contribute to this: from passive, the patient will then become active (with their body and self-care) with the possibility of increasing independence or the need for care from parents or family.

It is recognized that physical activity, sports, and physical exercises have a positive impact on individuals with mental health issues to alleviate, improve, or maintain an optimal level for the health of individuals with intellectual disabilities (ID).

The competency demonstrated by family members regarding physical activity, exercises, and movement represents the essential starting point for the involvement and long-term maintenance of an active and healthy lifestyle among adults with ID and SD. The detailed presentation of an exercise program, accompanied by strong, evidence-based arguments regarding its benefits, is of great value both for researchers and for the general public, including caregivers, families, and teachers. Therefore, it is possible to reduce and address the fears related to involvement in sports activities for individuals facing multiple conditions associated with chromosome 21 changes.

Through this work programme, it was developed a deeper understanding of how to test and adapted exercise for people with

intellectual disabilities that can influence key aspects of health.

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