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Modulation of Balance and Gait in Children with Down Syndrome via Gravity Force Stimulation Program Training

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ABSTRACT

Background and purpose: Down Syndrome (DS) is one of genetic disorders characterized by some common clinical and functional features. Most children with Down syndrome have deficits in balance, co-ordination, and gait throughout childhood and adulthood. So, it is essential to seek an ideal physical therapy program to help in solving such widespread problem. The purpose of this study was to examine the effects of twelve-week Gravity Force Stimulation (GFS) program on balance and gait in children with Down syndrome. ***Subjects:*** *Thirty children with DS from both sexes, ranging in age from eight to ten years represented the sample of this study. They were divided randomly into two groups of equal number A (control) and B (study).* ***Procedures:*** *Evaluation before and after three months of treatment for each child of the two groups was conducted via using Biodex stability system to evaluate balance and using foot print method to evaluate selected gait variables (stride length and step width). Group A received a selected exercise program, while group B received GFS program training in addition to the same exercise program given to group A.* ***Results:*** *The results revealed no significant differences in all the measured variables when comparing the pre-treatment results of the two groups, while significant improvement was observed in the two groups when comparing their pre and post-treatment mean values. Significant difference was also observed when comparing the post-treatment results of the two groups in favor of group B.* ***Discussion and Conclusion:*** *Gravity Force Stimulation program utilization provides sensory feedback and may be used as a therapeutic intervention for improving balance and gait in children with DS.*
Key words: *Down Syndrome, Gravity Force Stimulation, Balance, Gait Parameters.*

INTRODUCTION

Down Syndrome (DS) is the most commonly inherited form of developmental disability[2]. It is one of the chromosomal disorders characterized by muscular hypotonia, ligament laxity, obesity and mental retardation. DS is caused by trisomy of chromosome 21 and is associated with a number of signs and symptoms including learning disabilities, heart defects and craniofacial dysmorphia. Physical activity patterns of DS are influenced by ligaments' laxity and reduced muscle strength and tone[40]. Trisomy 21 results in a constellation of dysfunctions, spanning several physiological systems. Individuals with DS have poor balance, poor coordination, slow reaction time, reduced visual-motor control and sensory acuity, gross and fine motor skill dysfunction, and overall greater movement variability[38]. Gait disorder is common, they tend to progressively worsen as the clinical picture advances, severely limiting the patients' quality of life[6]. Motor dysfunction in persons with DS prevents successful completion of many activities of daily living, and contributes to low physical work capacity. This ultimately results in increased dependence on others and assisted living[10].

It takes several years for a mature gait pattern to evolve. Characteristics of a mature gait pattern include a narrow base of support; smooth movements with minimal oscillations of the center of gravity and reciprocal arm swing[33]. Infants with DS begin to walk, on average, about one year later than infants who are nondisabled. This is a part of the sequence of delayed and diminished motor abilities; the gap between infants with and without DS grows wider with age. Walking is a particularly silent skill for young children because its impact is multidimensional; affecting cognitive, social, as well as subsequent motor development[37]. The development of gross motor skills is quite variable. Some children will begin walking at around 2 years of age, while others will not walk until age of four[3]. Toddlers with DS shows shorter stride length, slower velocity and a trend towards wider step width

compared to their peers with typical development[17]. While for preadolescents with DS, merely increasing step width as compared to their peers with typical development seems adequate to provide stability for walking overground at their self-selected speed[32,36].

Postural stability or balance is the ability to maintain the body in equilibrium. It is also defined as the ability to maintain or control the center of mass in relation to the base of support to prevent falls and complete desired movements in order to maintain a stable stance position. One can either relocate the center of mass through movement of the different body segments or adjust the size of the base of support, as taking a step[4].

Gravity is a force that pulls downward. More specifically, gravity is the force caused by the mutual attraction between all physical matter (the direction of the force of gravity is downward. The force that gravity exerts on the subject is the weight of him[22]. Gravity is an absolute environment to which the upright spine and posture of humans must develop and relate. Since gravity is an absolute, there has to be an absolute optimum position for the upright spine and posture. The spine functions are best when it is in its optimum position relative to gravity[12]. Gravity Force Stimulation (GFS) program is not working on tone or positioning directly, but tone, movement and body posture improve when doing these exercises as GFS has a strong impact on the child's sensory system helping to normalize the system through exercises that send strong messages to the brain to regulate the tactile, proprioceptive and vestibular components[7].

Biodex stability system is an important balance assessment and training system. This unique device is designed to stimulate joint mechanoreceptors. It can assess neuro-muscular control by quantifying the ability to maintain dynamic posture stability on an unstable surface, as well as dynamic limits of stability. This system, also acts as a valuable training device to enhance the kinesthetic ability[27].

It would be of interest to know whether Gravity Force Stimulation program might help to improve deviation of balance and gait in children with Down Syndrome.

SUBJECTS INSTRUMENTATION AND PROCEDURES

Subjects

Thirty children from both sexes with DS ranged in age from 8 to 10 years (X` 8.9 ± 0.73 years) participated in this study .Their height ranged between 110 and 131 cm (X` 120 ± 0.09 cm). Inclusion criteria was only that the children had to be able to understand commands; they were able to stand and walk independently, non significant visual or hearing deficits and no operative procedures in both lower limbs.

Children were suffering from balance problems and abnormal walking pattern. They were selected from the out-patient clinic, Faculty of Physical Therapy, Cairo University. Children were randomly assigned into two groups of equal number (A and B), by asking each child to pick up an index card out of a box which contains 30 cards (15 card for each group) to determine which group he/she would be in. Participants came to the evaluation laboratory where the Biodex balance system exists and gait evaluation procedures took place twice; pre and post study period.

Evaluation was conducted for each child of two groups by measuring of standing dynamic balance and the selected gait variables including (stride length and step width).

Group A received a selected exercise program, while group B received GFS program training in addition to the same exercise program given to group A.

Instrumentation
For evaluation
1-Biodex Balance System:

It is a dynamic postural control assessment and training system (Biodex medical system, Shirley, New York). It consists of a movable balance platform which can be set at variable degrees of instability and safety support rails. This system is interfaced with computer software monitored through the control panel screen. During postural stability testing, the patient's ability to control the platform's angle of tilt is quantified as a variance from center. A large variance is

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indicative of poor neuromuscular control. When the system is on, the first displayed screen will show the main menu to choose testing. Determine the test parameters including test duration, weight, height of child, and the stability level was chosen.

2-Kalk paper:

A straight white kalk paper, (16 meters in length and 50 cm in width), was used to record distance (stride length and step width) gait parameters.

3-Weight and height scale:

A valid and reliable weight and height scales were used.

4- Ruler.

For treatment

1-Physical therapy tools of different shapes in the form of:

Mat, wedges, rolls, medical balls, standing bar, parallel bars, tilting board, stepper, wooden blocks and large mirror were used in conducting the exercise program.

2- Gravity Force System:

Two wooden boxes: made of strong wood that was able to withstand the child's weight, with equal measures of (30cm length X 30cm width X 15cm height). The two boxes may be connected together by two beams of equal measures of (75cm length X 10cm width X 2cm height) or connected together by one beam (Fig. 1):
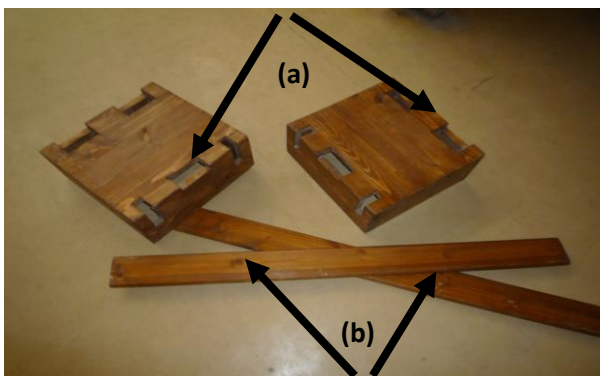

Fig. (1): Illustrating the Gravity Force System; (a) Two wooden boxes, (b) Two beams.

Procedures

For evaluation

All parents had been informed of all study procedures and objectives for their children with the absence of any risk. After signing a written consent form, instructions about evaluative procedures were explained

for each child before the testing session to make sure that all children understood the steps of evaluation and are familiar with the device. Evaluation for each child in the two groups was conducted before and after three months of treatment.

1-Standing dynamic balance testing procedure

This test was performed to test the child's ability to control the platform angle of tilt. Each child in both groups was asked to stand on the center of the locked platform with two legs stance. Safety support handrails and biofeedback display were adjusted for each child to ensure comfort and safety. The display screen was adjusted so that each child can look straight at it. At first, certain parameters were fed to the device including: child's weight, height, age and stability level (platform firmness).

Centering aiming to position the center of gravity over the point of the vertical group reaction force, was achieved by asking the child to stand on both feet while grasping the handrails. The child was then instructed to achieve a centered position on a slightly unstable platform by shifting his feet position until it is easy to keep the cursor (which represents the center of the platform) centered on the screen grid while standing in a comfortable, upright position. Once centering was achieved and the cursor was in the center of the display target, instruction was given to the child to maintain his feet position till stabilizing the platform. This was followed by recording heels coordinate and feet angles from the platform. The child's heels coordinates were measured from the center of the back of the heel, and foot angle was determined by finding a parallel line on the platform to the center line of the foot. After introducing feet angles and heels coordinates into the Biodex system, the test then began. As the platform advanced to an unstable state, the child was instructed to focus on the visually feedback screen directly in front of him (while standing with both arms at the side of the body without grasping handrails) and attempt to maintain the cursor in the middle of the screen. Duration of the test was 30 seconds for each child and the mean of three repetitions was determined. At the end of each test trial, a print out report was obtained. This report

included information as regard overall stability index, medio-lateral stability index, and antero-posterior stability index.

Overall stability index: Represents the child's ability to control his balance in all directions. Antero-posterior index: Represents the child's ability to control his balance from front to back directions. Medio-lateral index: Represent the child's ability to control his balance from side to side. (The high values mean that the child had balance difficulty). This test procedure was carried out for each child in the two groups before and after three months of treatment programs.

2-Gait evaluation

The kalk sheet, 16 meters in length, was positioned on the floor and fastened on both ends with adhesive taps to prevent their slipping. Each child was asked to put his/her bare feet in a bowel filled with water then place them in the colored powder and to walk as normal as he /she used to, from the beginning to the end of the walk way, but evaluation was conducted in the middle 8 meters only. Stride length and step width were recorded by ruler as follows:

Stride length (cm): Measured between two successive contacts of the same foot (two steps).

Step width (cm): Mediolateral distance between the heels in double support[16].

Three successive trials were allowed for testing each parameter and the mean values were obtained for each child of the two groups, before and after three months of treatment.

For treatment

Treatment protocol:

The two groups attended one hour, three times/week for 12-week training program which included supervised exercise sessions.

For the control group:
- Facilitation of trunk control to improve postural control from different positions (prone, supine, sitting).
- Balance training was carried from different positions (quadruped, kneeling, half kneeling and standing) on tilting board.
- Facilitation of righting, protective and equilibrium reactions: These exercises were carried through tilting from different

positions (forward, backward, and sideways) in order to improve postural mechanisms via variety of exercises applied on medical ball and tilting board.
- Facilitation of standing: These exercises were conducted from different positions (supine, prone and standing on single limb while facing the stand bar) helped by the therapist and by using wooden blocks.
- Gait training activities: These exercises also were important elements for balance training including: sideway, forward and backward walking between the parallel bars in front of a large mirror and walking training using stepper. Training of walking in open environment by placing obstacles across walking tract as rolls of different diameters and wedges of different heights. Training of walking on different floor surfaces (spongy and hard surfaces) on mat, on the floor.
- Climbing stairs up and down[20].
- Selected exercises included:
1) Stand up against the wall without letting your heels touch it, bend at your knees to 90° as if you were about to sit down, then slowly return to the upright position.
2) Stand up against the wall and then alternately lift your toes upwards.
3) From a standing position, raise yourself up onto your toes and then slowly lower your heels back to the ground.
4) Walk on your heels at a comfortable speed and don't let the rest of your feet touch the floor.

For exercises 1, 2 and 3 patients were asked to complete 3 sets of 15 repetitions each. For exercise 4, patients were asked to walk approximately 4 meters and then repeat the task 10 times with a rest in-between[5].

For the study group:

All the exercises given for the control group in addition to:

Gravity Force System:

The Gravity Force Stimulation program was used as a suggestion to improve balance. In using GFS, a lot of vestibular and righting reflexes are used to promote movement. When child stands on the surface of beams, he has to balance his body as he receives strong

gravitational signals through the vestibular system while his ankles are challenged to find a secure position due to the narrow support[7].

Prerequisites for training on GFS:

- The child must be motivated and had sufficient desire and motivation to learn how to use the GFS.
- Training with GFS program requires active participation and cooperation of the child.

Preparation of the child:

- The therapist explained to the child and his parents the rational for the treatment and emphasizing its harmless effect.
- The child was placed in erect standing position on GFS.
- The child was learned the way of walking on the beams and how to protect himself from falling down.

The Gravity force stimulation program sessions took place at the outpatient clinic of Faculty of Physical Therapy, Cairo University.

Each child in this group received the Gravity Force Stimulation program in which he was asked to maintain balance during each of the following positions:

- Walking on two beams connecting the two boxes.
- Standing crossly on the surface of one beam with minimal support at the level of knees then at ankles then finally independently.
- The child was trained on side walking on the surface of one beam with manual help and walking on the surface of one beam without manual help.
- Walking on the edge of only one beam (most difficult).
- All exercises were done at first with manual support then that support was gradually decreased.
- All exercises were done in front of mirror to allow the child to correct the abnormal

movement during walking as a source of feedback.

RESULTS

The raw data were analyzed using the SPSS program to determine the mean± standard deviation for each measuring variables of the two groups before and after three months of treatment. Tests included in this study were independent t-test and paired t-test.

Stability Indices

The collected data from this study represent the statistical analysis of the stability indices including overall stability index, antero-posterior (A/P) stability index and medio-lateral (M/L) stability index of the dynamic balance test at the level 8 stability (more stable platform) were measured before and after three months of treatment for the two groups. Student t-test was then applied to examine the significance of the treatment conducted for each group. The obtained results in this study revealed no significant differences when comparing the pre-treatment mean values of the two groups. Significant improvement was observed in all the measuring variables of the two groups when comparing their pre and post-treatment mean values. After treatment, significant difference was observed when comparing the post-treatment results of the two groups in favor of the study group.

As revealed from table (1) and Figure (2), significant reduction was observed in the mean values of stability indices for the control group at the end of treatment as compared with the corresponding mean values before treatment.

Table (1): Pre and post-treatment mean values of the stability indices for the control group.

	Stability indices					
	Over all SI		Antero-posterior SI		Medio-lateral SI	
	Pre	Post	Pre	Post	Pre	Post
X	2.226	1.980	1.206	1.113	1.660	1.480
±SD	0.2374	0.1656	0.1506	0.220	0.1639	0.2651
t-Test	2.961		2.941		2.418	
P-value	0<0.05		0<0.05		0<0.05	
Sig.	Significance		Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance, SI: Stability index.
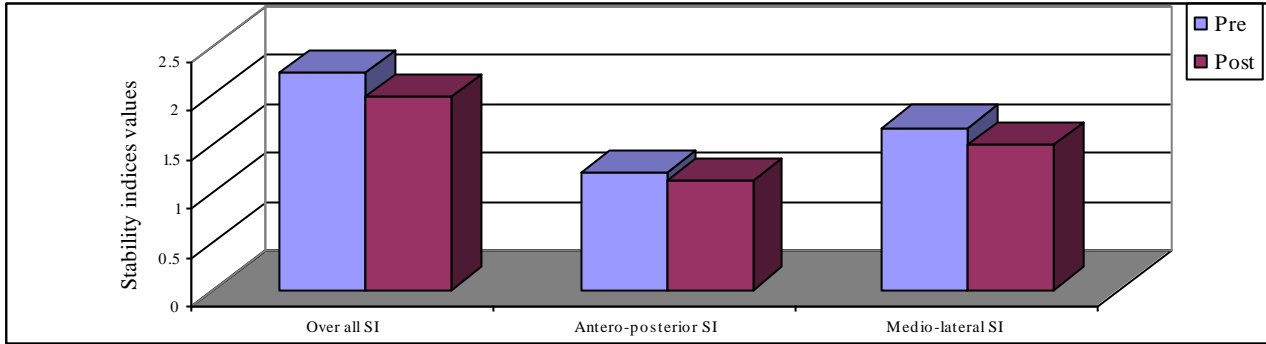
Fig. (2): Demonstrating the pre and post-treatment mean values of the stability indices of the control group.

Also, Table (2) and Figure (3), showed a significant reduction in the mean values of stability indices for the study group at the end of treatment as compared with the corresponding mean values before treatment.

Significant improvement was also observed when comparing the post-treatment mean values of the stability indices of the two groups in favor of the study group (P < 0.05).

Table (2): Pre and post-treatment mean values of the stability indices for the study group.

	Stability indices					
	Over all SI		Antero-posterior SI		Medio-lateral SI	
	Pre	Post	Pre	Post	Pre	Post
X	2.273	1.7200	1.300	0.946	1.693	1.260
±SD	0.3035	0.2918	0.136	0.199	0.240	0.284
t-Test	4.300		5.596		5.139	
P-value	0<0.05		0<0.05		0<0.05	
Sig.	Significance		Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance, SI: Stability index.
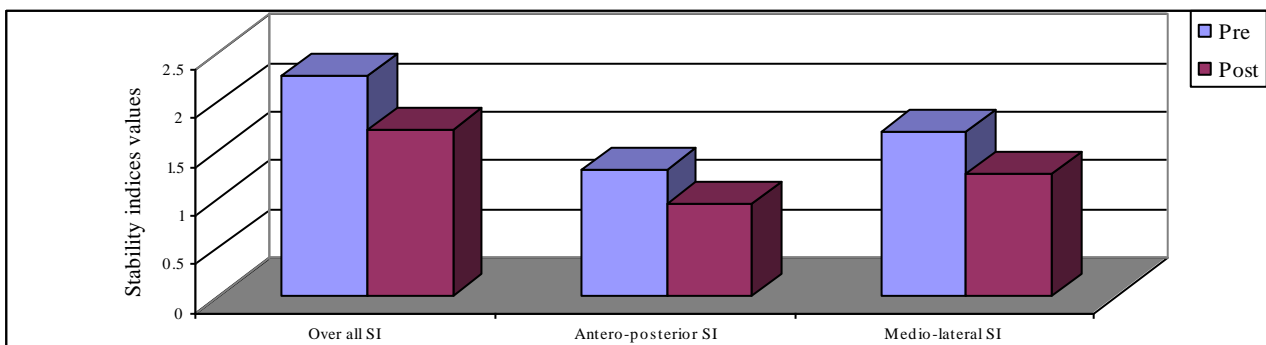

Fig. (3): Demonstrating the pre and post-treatment mean values of the stability indices of the study group.

Gait variables

1-Stride length

As shown in Table (3) and demonstrated in Figure (4) pre and post-treatment mean values of stride length for the control group were 61.6 ± 4.938 cm. and 66.8± 4.539 cm.

respectively (P <0.05), which was statistically significant. Also significant improvement was observed when comparing pre and post-treatment mean values of stride length for the study group which were 60.9± 6.123 cm. and 70.7± 5.035   cm. respectively (P <0.05).

Table (3): Pre and post-treatment mean values of stride length (cm)for the control and the study group.

	Control group		Study group	
	Pre	Post	Pre	Post
X	61.6	66.8	60.9	70.7
±SD	4.938	4.539	6.123	5.035
t-Test	3.539		4.583	
P-value	0<0.05		0<0.05	
Sig.	Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance.
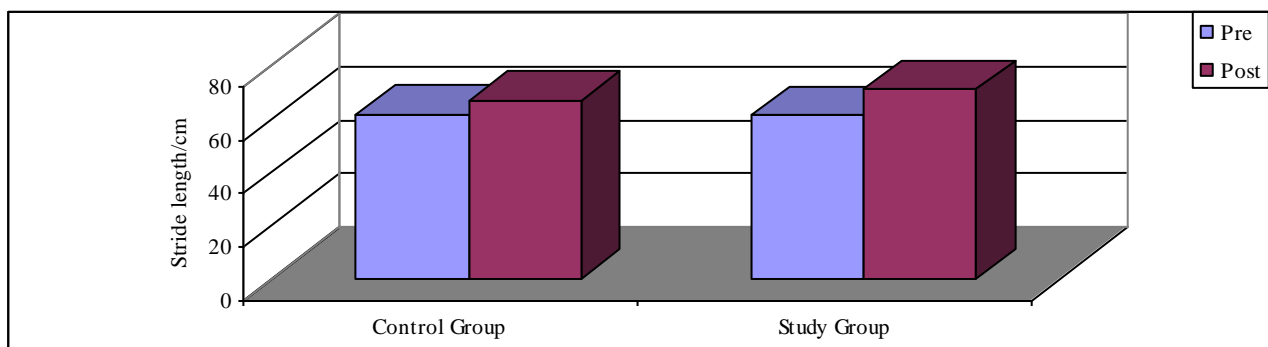

Fig. (4): Illustrating the pre and post-treatment mean values of stride length(cm) for the control and the study group.

2-Step width

As shown in Table (4) and demonstrated in Figure (5), the mean values of step width for the control group were 19.4± 1.187 cm. pre-treatment and 17.9±1.033 cm. post- treatment, (P <0.05), which was statistically significant.

While significant improvement was observed when comparing pre and post-treatment mean values of step width for the study group which were 19.4±.1352cm. And 16.66 ±1.404 cm. respectively (P <0.05).

Table (4): Pre and post-treatment mean values of step width (cm) for the control and the study group.

	Control group		Study group	
	Pre	Post	Pre	Post
X	19.4	17.9	19.4	16.66
±SD	1.187	1.033	1.352	1.404
t-Test	3.151		5.310	
P-value	0<0.05		0<0.05	
Sig.	Significance		Significance	

X: Mean, SD: Standard deviation, P-value: Level of Significance, Sig.: Significance.
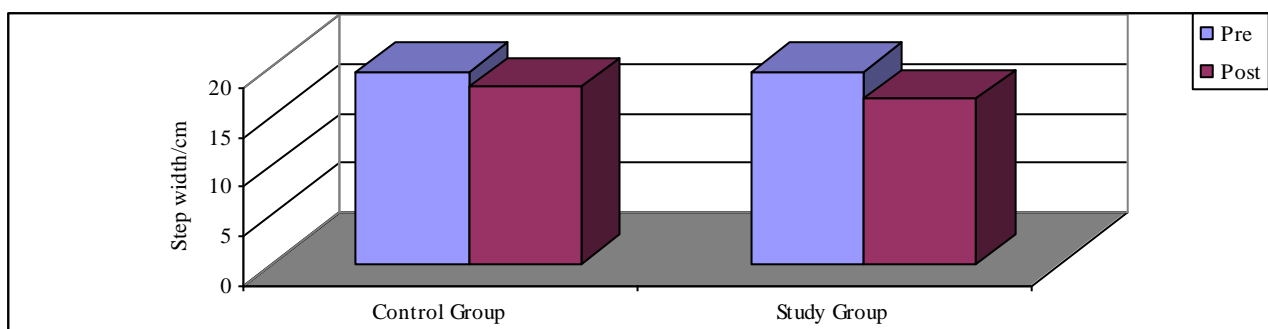

Fig. (5): Illustrating the pre and post-treatment mean values of step width (cm) for the control and the study group.

DISCUSSION

Impaired balance, gait disturbances are common problems in children with DS. They demonstrate deficits in postural control system that may provide a partial explanation for balance problems that are common in these subjects[11]. Structurally, individuals with DS have reduced volume in the cerebellum, cerebral gray matter and white matter of the frontal cortex compared with age-matched non-DS peers[35]. Cerebellar alteration has been suggested to be the most prominent structural aberration underlying neuromotor impairment in DS[18].

Choosing the measured variables (balance parameters and selected gait variables including stride length and step width) for evaluation come in agreement with Ulrich et al.,[36] who concluded that DS children have ligamentous laxity, weakness of muscles and less stability and inefficient gait patterns. DS children perform poorly in measures of running speed, balance, visual motor control, strength and overall gross motor and fine motor skills in comparison to children with typical development at the same age; also they have shorter step length, shorter stride length, high cadence and slower velocity than normal children. This also confirmed by Leclair[19] who reveled that although most DS children walk independently, they continue to evidence deficits in balance and gait through childhood and adulthood.

The main objective of this study is to reveal the differences in balance and gait control under condition of Gravity Force Stimulation program between two groups with Down syndrome. A total of 30 children participated voluntarily, divided into control and study groups.

Conducting the study on children aged from 8 to 10 years may be attributed to the fact that, patients with DS between 7 and 14 years show defect in agility and balance tasks[14]. The chosen age's bracket in this study was parallel to Sutherland et al.,[34] who reported that there is a complete maturation of gait at this age and the pattern of gait at this age is very similar to the adult's pattern, so the developmental factor as a factor affecting the gait in these children

can be excluded. This also come in agreement with Evans-Martin[9] who reveled that Down syndrome children have a number of problems that affect the muscular and skeletal systems. Loose joints and low muscle tone affect about 44% of children between ages 6 and 10 with Down syndrome.

Balance is vital for all the activities of human performance. It refers to the ability to keep the center of gravity within the base of support in various positions[24]. Concerning the pre-treatment findings of the present study were matching with those reported by Rose et al.,[25] who speculated that high stability indices on the biodex balance system indicate a lot of movements during the test (greater platform motion) and therefore less stability. This pretreatment data agreed with the findings of Shumway-Cook and Woollacott[30] who reported that neuromuscular problem that is proposed for movement initiation included inadequate force generation (inability to overcome gravity, inertia, or antagonist muscle restraint), decreased rate of force generation, to allow movement, reduced motivation, and abnormal postural control.

Statistical analysis of the post treatment results of the two groups revealed significant improvement in postural stability and functional ability which is represented by keeping the body segments properly aligned in upright posture, and was expressed by a reduction of biodex dynamic balance test values.

The significant improvement obtained in the post-treatment mean values of the measuring variables of the control group may be attributed to the effect of treatment activities and a specially selected exercise program which was directed toward facilitating normal patterns of postural control (righting and equilibrium reactions) and developing a greater variety of normal movement patterns particularly in the trunk and lower extremities. This agree with Lord et al.,[21] who observed that the balance training program is one of the intrinsic part of motor skills because it facilitates the normal weight shift, mobility and provide the balance mechanisms when center of gravity is disturbed. Also improvement fulfilled in the

control group may be attributed to the development of proper alignment of posture provided by the different exercises for facilitation of normal erect posture as stated by Horak and Macpherson[15].

Improvement in the post treatment mean values of study group may be attributed to the increase of the activity of antigravity muscles which counteract the force of gravity and leads to modulation of postural control and maintenance of good alignment with least expenditure of energy.

The significant improvement achieved by the GFS program that is applied in this study come in agreement with findings of Wernig et al.,[39] who found that proprioceptive awareness of postures and movements is most required during the learning of new skills. He added that, with slower movements, the proprioceptive system can monitor and adjust the movement as it occurs. This system is able to trigger immediate, rapid and precisely tailored compensatory muscular contractions reflexively in response to unexpected changes in external or internal forces.

Training with GFS to maximize the functional outcome is confirmed by the study of Cuevas[7] which concluded that central nervous system produce new antigravity postural control reactions, by providing the less possible external support. It poses a physical challenge to the child's brain, which would create the appropriate internal response. It has a strong impact on the sensory system of the child helping normalize the system through exercises that send strong messages to the brain to regulate the tactile, proprioceptive and vestibular components.

The results of study group were also confirmed by the findings of Hedberg and Carlberg[13] who stated that normal postural control requires the organization of sensory information from visual, somatosensory, and vestibular systems which provide information about the body's position and movement with respect to the environment, and coordination of sensory information with motor actions. This was achieved by the use of Gravity Force Stimulation program which helped the DS children to organize sensory information (sensory strategies) for postural control thus

creating internal neural representation which is necessary for coordinated postural abilities[7].

Deviation in some selected gait parameters were evaluated, they were chosen to be the main representative parameters for delayed gross motor development and to determine the effect of the treatment program on functional abilities. This selection in this study come in agreement with the findings of Galli et al.,[11] who stated that DS children need to compensate for their muscle and ligament dysfunction in order to cope with daily activities and maintain function. Gait becomes unsteady, and the increased cautiousness during walking may lead to low velocity and short strides.

The significant improvement in control group was supported by Akerstrom and Sanner[1]; who reported that balance and gait problems don't result only from the hypotonia but rather from defects within the high level postural control mechanisms, so improvement in these postural control mechanisms leads to improvement in gait pattern. Also, we can explain the improvement in selected evaluated gait variables from developmental point of view, that sufficient strength and balance are two critical requests for the onset of independent balanced walking[8].

The significant improvement detected in the selected gait variables in the results of study group may be attributed to, improvement of the child ability to combine a pattern of stability and mobility because gravity-force stimulation provide postural stability with security so enable the child to improve balance and gait.

The exercises on two beams or one beam of measures (75cm length X 10cm width X 2cm height) of the GFS therapy program can drive the child's recovery potential to the maximum functional improvement, because in each exercise the child experiences new sensations through new postures and movements as stated by Cuevas[7].

The post treatment result in the form of increase values of stride length and decrease values of step width due to regular schedule training program mainly affect the capacity of the child's brain to assimilate, integrate and to reproduce adjustment of his postural, also integrates range of motion exercises into the

global functional maneuver. This explanation come in agreement with Rowe et al.,[26] who revealed that postural adjustments are necessary for all motor tasks and need to be integrated within voluntary movements. They support the head and the body against gravity and other external forces, and maintain the center of body mass aligned and balanced over the base of support also they stabilize supporting parts of the body during movement. Postural adjustments are achieved by means of anticipatory and feedback mechanism.

This result might be attributed to better postural control which may be improved by task condition that spark new interest and direct the attention of the child to its consequence of walking on GFS. This result confirmed by Shumway-Cook and Woollacott[29] who stated that postural muscles are activated in the advanced skilled movement or task and body had to be adjusted in order to maintain balance.

The post-treatment results of this study reinforced the effectiveness of training program in improving balance and gait by adopting suitable program for DS children. This come in agreement with Provost et al.,[23] who reported that, improvements in performance occur as a result of practice, appropriate sequencing of movement components, reduced effort and concentration, improved timing and speed control.

Significant improvement was also noticed when comparing the post-treatment results of the two groups in favor of the study group. These results might be attributed to automatic control of balance, improvement in anticipatory postural response and increase of motor control, this come in agreement with the findings of Shumway-Cook and Woollacott[29] who described that the development of antigravity movement is strongly associated with the development of higher levels of postural control, balance and movement. Also, confirmed with Sackley et al.,[28] who concluded that re-educating symmetrical stance is important for improving balance control.

Vision is also vital to normal walking. It is particularly important when other sensory input is reduced. Vision gives information about the movement of head and body relative to the surroundings and is important for the automatic balance responses to changes in surface conditions. Other sensory systems that are important are the vestibular, auditory and sensorimotor systems[31].

The significant improvement in the results of the study group, clearly demonstrated the effect of a combination of the selected exercise program and the Gravity Force Stimulation program which improves the child's ability to balance.

In conclusion Gravity Force Stimulation program could be used as an additional modality to the regularly scheduled therapeutic exercises training program for children with Down syndrome in the purpose of assisting those children in their function outcome.

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الملخص العربي

تعديل الاتزان و المشي لدي أطفال متلازمة داون عن طريق برنامج تنبيه قوه الجاذبية

خلفيه البحث والهدف : متلازمة داون واحد من الأمراض الوراثية التي تضم مجموعة من الصفات العيادية والوظائفية . معظم أطفال متلازمة داون يعانون من مشاكل في الاتزان ، التنظيم ، والمشية في مرحلة الطفولة والكبر . لذلك من الضروري إيجاد برنامج علاج طبيعي لحل هذه المشكلة واسعة الانتشار . الهدف من هذه الدراسة اختبار تأثير اثني عشر أسبوعاً من التدريب علي جهاز تنبيه قوه الجاذبي ة علي الاتزان والمشي في أطفال متلازمة داون . **عينة البحث :** ثلاثون طفلا من الجنسين تتراوح أعمارهم بين الثمانية والعاشرة ، تم تقسيمهم إلى مجموعتين المجموعة الحاكمة (أ) ومجموعة الدراسة (ب) . **طريقة البحث :** تم تقييم قياسات الاتزان باستخدام جهاز البيودكس و قياسات المشي باستخدام طريقه أثار الأقدام قبل وبعد ثلاثة شهور من الدراسة . المجموعة الحاكمة (أ) أخذت برنامج تمرينات مستحدث بينما مجموعه الدراسة (ب) أخذت بالإضافة إلى هذه التمرينات برنامج تمرينات علي جهاز التنبيه بقوه الجاذبية . **النتائج :** أظهرت نتائج البحث عدم وجود فروق ذات دلاله إحصائية بين جميع المتغيرات عند مقارنتها قبل العلاج في المجموعتين بينما كان هناك تحسن ملحوظ في كل المتغيرات في المجموعتين عند مقارنه النتائج قبل وبعد العلاج . كما وجد فروق ذات دلاله إحصائية عند مقارنه نتائج المجموعتين بعد العلاج لصالح مجموعه الدراسة (ب) . **المناقشة والاستنتاج :** استخدام جهاز التنبيه بقوه الجاذبية يمنح استجابة حسية ويمكن استخدامه في تحسين الاتزان والمشي عند أطفال متلازمة داون .

الكلمات الدالة : متلازمة داون ، التنبيه بقوه الجاذبية ، الاتزان ، قياسات المشي .