EFFECT OF BRAIN GYM EXERCISES ON POSTURAL STABILITY IN CHILDREN WITH DOWN SYNDROME

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Abstract

Background: Children with Down Syndrome experience delayed development, mainly influence their postural stability, where Brain Gym is an easily intentional approach involves simple and enjoyable series of twenty-six movement activities that promotes whole child brain learning that thought to improve Down syndrome children postural control and related quality of life.

Purpose: To investigate the effect of Brain Gym exercises on postural stability in children with Down syndrome.

Material&Methods: A single prospective clinical, randomized control trial. It involved thirty-two children with Down syndrome, their age range was 6-12 years old, they were randomly assigned into two equal groups Group (A): received Brain Gym (Midline movement, Energy exercises, Deeping attitudes, Lengthening activities) exercises and traditional balance program. Group (B): received traditional balance (static, dynamic and functional) program. All children were trained one hour per day, three times a week, and pre and post interventional values were measured and analyzed.

Results: No significant differences in both groups age, height, weight, and sex distribution (>0.05). Significant increase in group A in terms of single leg stance test by 245%, time up and go test by 34.8%, and paediatric balance scale by 8%, while group B were 158%, 14.2%, and 4%, respectively.

Conclusions: It can be concluded that BG exercises are effective in immediate improving postural stability in children aged 6-12 years old with Down syndrome .

Keywords: Brain Gym Exercises**.** Down syndrome**.** Postural stability

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Introduction

Children with Down Syndrome (DS) are addressed as one of commonest neurodevelopmental disorders than typically developing children of the same gender and age (Thurman & del Hoyo Soriano, 2021). DS children demonstrated deficits in muscular strength, muscular endurance, and motor skill development, also greater instability in both postural and voluntary control.(Driscoll et al., 2014).

DS leads to obvious deficits in balance either static or dynamic that significantly noted through having a wide base of support, elevated falling accidents, limited daily living i.e., walking, stairs climbing, while dynamic balance was massively influences that addressed as an integral DS features. Where, normal children have normal postural sway, and stable stance those are required for developing adequate postural control system, and adjusting satisfactory response to changes within postural task requirements. (Bieć et al., 2014).

Postural control has been described as the individual`s ability to control the body`s position in a standing , recover a stable position following an unexpected perturbation .Satisfactory postural control requires a seamless integration and regulation of sensory systems. (Gallahue et al., 2013).

Brain Gym (Brain Gym, 2014) involves simple and enjoyable series of twenty-six movement activities that promotes whole child brain learning across integrative movements focusing on particular sensory stimuli those facilitate functioning throughout body mid-line.(AL HERBAWI, 2018).

The main BG feature is a simple activity that easily could be conducted routinely, especially effective for enhancing children to cross physical their human-body midline to facilitate adjusting their posture and both gross and fine motor motion with maintaining their attention and balance, plus recognizing spatial relations across surrounding environment. (Shear, 2019).

BG could be addressed a beneficial modality, even for educational kinesiology program, which was defined operationally as a set of twenty-six exercises performed as a protocol for various physical challenges, also gym idea was primary developed by educator specialist Dr. Paul E. Dennison, Dr Gail E Den in 1970s.(AL HERBAWI, 2018).(Ocampo et al., 2017).

BG is possibly implemented in children with developmental disabilities. BG activities enhances DS children's capabilities through facilitate balance control, and stimulate neurological repatterning that promote overall brain learning. (Nagarkar et al., 2018).

Recently, BG is a series of twenty-six exercises that are valuable for all ages. BG helps into boosting self-esteem, and releasing stress, plus maximizing creativity, and communication skills. A recent quasi-experimental study conducted by Ismayenti and his colleagues on fifty-three participants performed BG therapeutic modality. There was significant decrease in musculoskeletal complaints per part body was found on the left wrist, left hand, and left knee. The percentage of musculoskeletal complaints severity decreased in all parts of the body, except the right shoulder, left elbow, and right thigh. (Ismayenti et al., 2021). (Andrea & Ginger, 2014).

BG is an educational kinesiology program that is promoted and implemented internationally, as well BG have been translated into over 40 languages.(Jernth & Velayudhan, 2017).

However, few trials have been conducted to evaluate creative rehabilitation protocols based on brain plasticity as a new trend approach to improve postural and function among children with DS. No study yet has been performed to evaluate BG effect of postural control and stability in children with DS. Thus, the main objective of this study was to investigate the effect of BG exercises on postural stability in children with DS.

Material and Methods

A single prospective clinical, randomized control trial was conducted on thirty-two children with DS were selected from legitimacy assembly at Kafr-Elsheikh governorate, speech centers at Kafr-Elsheikh, and Sharkia governorate from May to November 2023 Prior to initiating the study, each children parents were signed a consent form before participation in the study. The investigation was carried out in accordance with the ethical standards specified in the 1964 Declaration of Helsinki and received approval from the Research Ethical Committee at the Faculty of Physical Therapy, Kafrelsheikh University, Egypt (No. P.T.REC/ PED /1/2023/27). This trial was registered at Pan African clinical trials registry (No. NCT05769556).

Participants

Based on pilot testing conducted over 3 participants per group, G*power was used to conduct this analysis where $\alpha = 0.05$, $p = 0.001$, $d = 0.01$, $\sigma = 0.03$. The proposed sample size equal to 32 (16 in each group), adding 10% to account for dropout.

Microsoft Excel 2010 was used to produce an automated random number list, from which the subject allocation sequence was derived. The therapist who performed the assessments as an evaluator visited with the patients. The group assignment was hidden from the therapist. The patients were randomly assigned to either the control or study groups after completing their exams. Thus, neither the evaluator therapist nor the statistician knew who belonged in

which group, so the study adopted double blinding approach.

Total analyzed sample size was 32 subjects with 16 subjects in each group allocated randomly. Patients were randomly assigned to two equal groups. Group A received BG (Midline movement, Energy exercises, Deeping attitudes, Lengthening activities) exercises and traditional balance program. Group B received traditional balance (static, dynamic and functional) program.

Control Group B was given traditional balance program only

The eligible participants met the following inclusion criteria: age between 6 and 12 years old of both genders, clinical diagnosis of DS, and their IQ level was in average range 60-70.

Patients were excluded if they had any of the following criteria: obese with body mass index (BMI) >30 kg/m2; neuropathy and Orthopaedic disorders; mental deficiency; receiving medical drugs those might cause confusion or make child less alert; and/ or any surgical interference in any part of child body that might hamper child performance during activities (Figure 1).

At the beginning, all demographic data including age, weight, height, and gender were documented, along with screening balance deficits.

Romberg test with examined child remained standing up, barefoot with feet parallel together feet, and arms beside with eyes closed along one minute, Sharpened/ Tandem Romberg test, where child placed feet in heel-to-toe position with one foot in front, and crossed arms over chest with open palm rested over opposite shoulder. Romberg test has been shown to be a valid and a reliable method. (Cohen & H, 2019).(Agrawal et al., 2011).

Child underwent SLS test remained standing up, barefoot with unipedal support, standing up on dominant leg, with closed eyes for thirty seconds. In case of child was unable to remain in unipedal support along SLS test time that would classify as a positive sign of altered static balance (Mani et al., 2019). the single-leg stance balance test proposed is a valid and reliable method to assess balance, especially when performed in a static position, with the eyes opened and using the best result of six attempts as reference, independently of the stance leg.(Ponce et al., 2014).

It involves a series of movements i.e., sitting, standing, walking, and postural control. Initially, Child underwent TUG test was sat on a chair, then has received verbal order 'RUN' thus, child raised up and walked for three meters in a straight line, after that turned back and returned to initially chair, and sat down. Where, the researcher has calculated time consumed, the TUG test has been shown to be valid and reliable for the functional mobility assessment of children with (DS). (Beerse et al., 2019).

The pediatric balance scale is a modified version of Berg balance scale that is reliable and valid for evaluating functional balance skills among children. It is

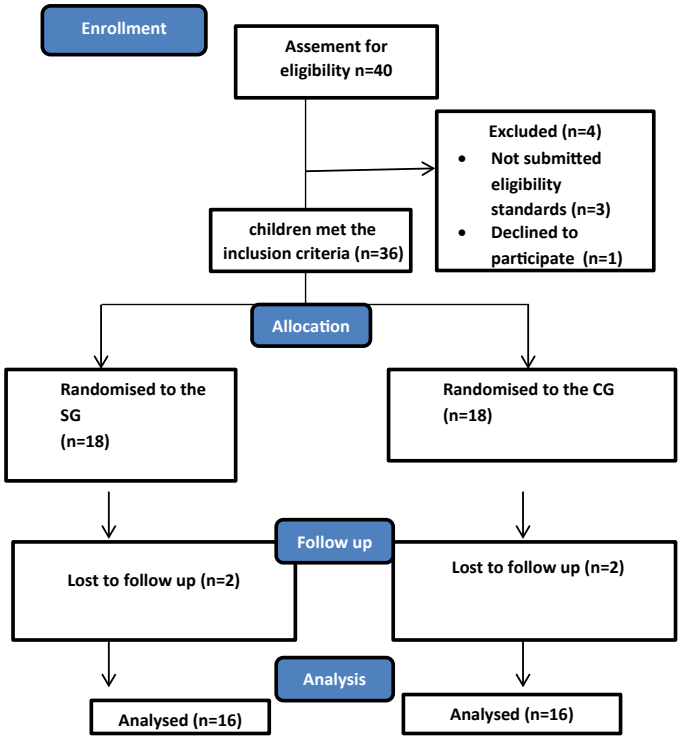

Figure 1. Flowchart of the current study.

fourteen items maximum score value is fifty-six. The researcher has evaluated each child participated, and tabulated. (Malak et al., 2015)

Each child in group (A), has received BG exercises chosen to represent one movement activity from each category: energy exercise (drinking water) ; midline movements (cross crawl,belly breathing,elephant,lazy eight, and rocker); deeping attitudes (hook ups) ; lengthening activities (calf pump and gravity glider) in addition to traditional balance program. The sessions were held in a confined room away from noise ,each exercise continued until the child stopped moving ,request to stop ,or 30 sec had passed. the program lasted one hour per day, three times a week, and pre and post interventional values were measured and analyzed.

Drinking water that helps child brain to stay alert and thinking, where all biochemical and bioelectrical activities of central nervous system depend on good electrical conductivity. (Brain Gym, 2014). Cross crawl, where child alternatively moved own arm with other side leg in a march-past, that repeated for three minutes. (Panse et al., 2018).Elephant exercise, where child stood straight, one hand beyond and the other above head as in reaching ear. (Brain Gym, 2014).(Panse et al., 2018).Belly breath exercise, initially child cleaned own lungs through extended inhalation through the nose, then released in short puffs across pursed lips as in feathering a float. All conducted while kept child hands rested on own abdomen, with counting till three for inhalation and same for exhalation and hold along four sets (Brain Gym, 2014; Panse et al., 2018). Lazy eights where participating child arms were straightened out with same shoulders` level and thumbs pointing up, then slowly in a smooth manner traced shape of large figure eight while focusing sight on thumbs (Brain Gym, 2014; Panse et al., 2018).Rocker exercise where child sat on comfortable yet firm while leaning back on arms, and bent knees up with crossed ankles, where kept sacrum on ground, then gently rock own sacrum in a circular motion, with stabilized pelvis in order to improve child`s focusing capabilities. (Brain Gym, 2014).(Panse et al., 2018).Hook ups exercise, where child initially do crossing one ankle over the other in order to feel comfortable. Then crossed own hands, clasped and inverted, through stretching arms out while hands` back facing together and thumbs pointed down, then facing palms and interlock own fingers then moved to rest on own chest with elbows down. (Panse et al., 2018).(N. E. M. Barakat et al., 2016).Calf pump where child stood facing a wall, then leaned forward while placing own hands on the facing wall, and tried having own toes balls in contact to the ground, and putting own weight on left leg while inhaling the exhaling in eight counts, then brought the right heel down to the ground and felt stretching in calf in a comfortable manner, after that relax and brought heel back off the floor and repeated as a circulatory and breathing exercise form. (Panse et al., 2018). (N. E. M. Barakat et al., 2016). Gravity glider exercise with child sat in a chair while leaning forward, and brought legs out in front and crossing right one over left ankle. While taking deep breaths while counting up to eight with leaning forward, stretching arms toward feet, and repeated. (Malak et al., 2015).

Each child in group (B) has received the following program exercises one hour per day, three times a week, and pre and post interventional values were measured and analyzed.

Static balance exercises involving Kneeling, half kneeling, single leg stance, both anteroposterior and lateral balance, standing on wedge, standing on heel and on toes, heel-toes standing, step standing on block, and finally standing on high block exercises, where all of mentioned static balance exercises, where supervised by the researcher herself. Dynamic balance exercises including half kneeling from kneel, stand from kneel, throw and pick up a ball from standing, stand up on block, ascending and descending wedge, walking in a straight line, side walking in a straight line, walking backward, forward and backward walking on a stepper, also hopping exercises, where all of mentioned dynamic balance exercises, where supervised by the researcher herself. Functional balance exercises involving walking, ascending and descending stairs, time up and go exercises, also pick up a thing and walk to put in a basket, as well kicking a ball exercises, where all of mentioned functional balance exercises, where supervised by the researcher herself. the physical therapy modalities(Alsakhawi et al., 2019)in conjunction with traditional physical therapy programs improves the balance in children DS.(Alsakhawi et al., 2019).

Statistical analysis

Data were screened for missed data visually, then outliers were checked using interquartile range in excel and boxplot in SPSS, For normality test of data, Shapiro-Wilk test was performed to ensure data normality.

Descriptive statistics in form of mean and standard deviation and unpaired t test were conducted for comparison of age, height, and weight between the two groups and pre treatment and post treatment measurements of Single Leg Stance test, Timed Up and Go test, and Pediatric Balance Scale between the two groups. Chi square test was conducted for comparison of sex between the two groups.

Paired t test was conducted for comparison between pre and post treatment

measurements of Single Leg Stance test, Timed Up and Go test, and Pediatric Balance Scale for each group.

The level of significance for all statistical tests was set < 0.05.

All statistical measures were performed through the statistical package for social studies (SPSS) version 27 for windows (Abu-Bader, 2021).

Results

Analysis of demographic data showed no statistical significance differences between groups in the mean values of age, sex, weight, height and gender distribution (p>0.05), as summarized in Table-1. Results regarding Single leg stance test, Time up and go test and Pediatric balance scale were presented in table (2).

Discussion

According to current study`s findings, when compared to baseline evaluation, there was a significant improvement in BG group regarding all measured variables (SLS and TUG tests and pediatric balance scale), as there was a significant decrease in TUG test pretreatment compared with posttreatment with improvement percentage 34.8% (p <0.05), there was a significant increase in SLS test and pediatric balance scale compared with posttreatment with improvements percentage 245% and8% , respectively (p <0.05). While regarding group B that showed limited improvements in terms of SLS and TUG tests, also pediatric balance scale among whom received traditional balance rehabilitation program

Postural instability in children with DS is a consequence of their delayed gross motor skills development, limited their sensory-motor control 'somatosensory, visual, and vestibular' system, inherent joints laxity, as well inverted feet those restricts their dynamic balance that leads to variable gait pattern, and elevated energetic cost for any physical exertion, which agreed with Barakat et al.(N. E. M. Barakat et al., 2016).

BG exercises are an enjoyable educational kinesiology program that consists of 26 simple movements those are effective in improving postural control and health related quality of life in children with DS, as well in whom suffering from hearing impairments that concluded recently by Barakat et al.(Barakat et al., 2021).

Current study findings are most closely related to the results reported by Elbanna and her colleagues whom had investigated BG exercises on preschool children static and dynamic balance, and they ensured efficacy of BG with no clear training parameters, and unprecise determination of balance performance improvements. (Elbanna et al., 2023).Therefore, we could explain current study findings based on that BG training protocol has facilitated inter-brain hemisphere communication that is believed to maximize perceptual and reasoning capabilities across neural remodeling.

The results of this study are most closely related to the results reported by Dawood et al. who had examined sixty participants in a quasi-experimental clinical trial in El-Hadara Traumatology and Orthopedic University Hospital, Alexandria University, Egypt in line to determine BG efficacy in terms of cognitive performance, and they had stated that BG training for one month revealed significant improvements. (Fathy Ahmed et al., 2022).Where the mean issue directs the current study researcher is that almost children with DS almost exhausted because of huge energetic cost for any physical activities than well-developed children.

One of the more interesting facts regarding BG training could be advised as a potential beneficial physical therapeutic approach for enhancing brain functioning, which supported findings of current study that conducted mainly to provide administrators, educators, caregivers, and parents, who are seeking additional effective classroom management strategies and enhanced focus skills for children with DS. That was the main drive to evaluate the previously stated benefits of BG in terms of both physical issues, and pediatric balance scale for determining level of postural control efficacy among whom suffering from DS.(Aslan et al., 2016).

No doubt that adaptation and creating adequate circumstances for DS children permits them to develop motor skills and makes it easier to perform better, which was ensured by Sharma et al. who conducted a recent clinical trial in line to assess BG program benefits in terms of postural stability on 180 children along eight weeks, unless they used New York posture rating scale as an outcome measure for evaluation. Sharma et al. had reported that postural alignment significantly improved following BG as compared to their control group. (Sharma K., 2023).

The results of this study are most closely related to the results reported by Cancela et al. as the current study also found improvements in postural stability in eighty-five participants through the use of BG program on four training groups, whom shown an increase in participants` physical fitness, and performance level.(Cancela et al., 2015).

Fortunately, numerous published studies had advised involving BG activities in isolation or combined with other training protocols maximize DS children`s postural control, in addition BG exercises enhance their stress release, as well permits then a satisfactory relaxation, plus gaining adequate intellectual engagement.(Shear, 2019).(Nagarkar et al., 2018).(Ismayenti et al., 2021).

Although usage of BG entire process settled to consume around 3-5 minutes, also could be categorized into activate 'move, learn, connect ..,' that require actually motor planning, adequate vestibular stimuli, visual tracking, these protocols require regrouping into sections using rhythm, deep, pressure, respiration, vision breaks, and stretching, also calming in order to ensures satisfactory collaboration of both brain hemispheres. (Schmalle et al., 2015)

A recent published systematic review that was conducted by Reffat and Abdelazeim whom focus on enhancing development of motor functioning among children with DS had ensured moderate evidence for physical therapy regarding balance, in the same line the present study had stated that specified BG training program for each DS participant based on detailed evaluation. (Reffat et al., 2022).

This study was not designed to completely revealing BG system efficacy, unless we could explain current study revealed improvements in postural stability among participating children with DS through the use of BG that conducted routinely on daily bases, with no doubt that BG training protocol is not a time consuming program that permits both brain hemispheres collaborating with each other at the same time thus assist DS children to have better attention and engagement, plus facilitating completion of required tasks maximize therapeutic benefits on both short- and long-term memory, also aggravates self-awareness skills helps into boosting self-esteem, minimizes stress and enhances behavioral support, even increases creativity and develops additional communication skills.BG might add extra activation for concentration and focus, and memory, also physical coordination, relationship self-responsibility, organization skills, as well attitude areas of children`s brain.

(Shear, 2019). (Yildirim et al., 2022).(Corballis & M, 2014).(Hannaford, 1995).

Our finding is in consistence with finding of a study conducted by Fyfe et al. who stated that minimal therapeutic exercise with lower session volumes than traditional is recommended to improve musculoskeletal mass, strength, also functional capacity.(Fyfe et al., 2022).

Selection of the children age of the present study respects conclusion of Siroya and his colleagues whom summarized general benefits of BG exercises. BG exercises activate numerous brain areas, mainly emphasis corpus callosum, also facilitate inter-brain hemisphere communication, also BG is believed to maximize perceptual and reasoning capabilities across neural remodeling. (Siroya et al., 2020).

Thus BG was an effective intervention to improve quality of life in children suffering from DS.

The study's limitations include a relatively small sample size of 32 participants, potentially restricting the generalizability of the findings to a broader population. Focusing exclusively on children with Down Syndrome (DS) from specific locations in Egypt may limit the relevance of the results to a more diverse or global context. The single-center design introduces a risk of bias, and caution is needed in extending the findings to children with DS from different regions or cultural backgrounds. Exclusion criteria, such as omitting children with obesity, neuropathy, orthopedic disorders, and those on specific medications, may constrain the study's applicability to the broader Down Syndrome population. Additionally, the reliance on performance-based measures without considering subjective outcomes or the perspectives of the children and their families is a noteworthy limitation. Furthermore, the absence of a long-term follow-up to evaluate sustained intervention effects beyond the immediate post-treatment period is a critical aspect that warrants consideration in interpreting the study's findings.

Conclusion

In conclusion, the incorporation of BG exercises has proven to be effective in immediately enhancing postural stability in children aged 6-12 years old with Down Syndrome (DS). The study's findings offer valuable insights for individuals seeking additional and effective classroom management strategies. To further expand our understanding of BG exercises, we recommend conducting additional studies to explore their potential applications and benefits in diverse contexts beyond postural stability enhancement.

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