A COMPARATIVE STUDY TO FIND OUT THE EFFECT OF TASK ORIENTED TRAINING ALONG WITH SPECIALLY DEVELOPED SERIOUS GAMES AND TASK ORIENTED TRAINING ALONE ON LOWER EXTREMITY FUNCTION IN DIPLEGIC CEREBRAL PALSY

REGISTER NO: 271620304

ELECTIVE: PHYSIOTHERAPY IN NEUROLOGY

A DISSERTATION SUBMITTED TO THE TAMILNADU

Dr. M. G. R MEDICAL UNIVERSITY, CHENNAI.

AS PARTIAL FULFILLMENT OF THE

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CERTIFICATE

Certified that this is the bonafide work of **Mr. SETHURAMAN. S** of K.G. College of Physiotherapy, Coimbatore submitted in partial fulfilment of the requirements for Master of Physiotherapy Degree course from the Tamil Nadu Dr. M. G. R Medical University under the **Registration No: 271620304** for the May 2018 Examination.

Date:

Place: Principal

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Internal Examiner External Examiner

ACKNOWLEDGEMENT

First of all, I praise **GOD**, the almighty, merciful and passionate, for providing me this opportunity and granting me the capability to proceed successfully.

At the very outset, I express my deepest sense of gratitude to our respected Chairman **Padmashree Dr.G.Bakthavathsalam,** Chairman K. G. Hospital, Coimbatore for allowing me to use facilities of the hospital and institution for this study.

I would like to express my deep thanks to our madam **Mrs. Vaijayanthi Mohandas,** CEO - Education, K. G. College of Health Sciences for her concern for the betterment of students.

I humbly express my sincere gratitude and special thanks to our Principal **Dr.B.Arun, MPT, Ph D,** for his support, encouragement, valuable suggestions and guidance.

My special and sincere thanks to **Dr.K. Mohan Raj, MPT,Ph D,** Vice Principal and guide for rendering valuable suggestions, constant guidance and support for the progress of my work and fruitful outcome of this study.

I express my sincere gratitude to **Prof .V. Mohan Gandhi, M.P.T,** Chief Physiotherapist, K.G. Hospital, Coimbatore for his valuable support and guidance.

I extend my sense of gratitude to **Prof. R. K. Punitha Kumar, M.P.T.,** all other **Faculty Members, Librarian** of K.G. College Of Physiotherapy and **Physiotherapists** in the Department Of Physiotherapy, K.G. Hospital for their priceless contribution in cultivating education and special skills in me which stands significant for my career.

I am obliged to offer my sincere thanks to all **my subjects** for having consented to participate in this study forgoing all suffering.

My deep humble sense of gratitude to **My Father, Mother and Sister** for their unwarranted and conditional love and courage they have given me.

Last but not least, I submit my thanks to **My Friends** for their unwavering support, encouragement and love which helped me in doing my project and my studies as well.

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I INTRODUCTION

Cerebral palsy is considered a neurological disorder caused by non-progressive brain injury or malformation that occurs while the child's brain is under development. Cerebral palsy primarily affects body movement and muscle coordination. Cerebral palsy is the most common cause of physical disability in childhood, with an estimated incidence of 2.11 per 1000 live births (Bax M et al., 2005).

While cerebral palsy is a blanket term commonly referred to as "CP" and described by loss or impairment of motor function, cerebral palsy is actually caused by brain damage .The brain damage is caused by brain injury or abnormal development of the brain that occurs while a child's brain still developing – before birth, during birth, or immediately after birth. Current research suggest, that the majority of cerebral palsy cases results from abnormal brain development or brain injury prior to birth or during labor and delivery. Accidents, abuse, medical malpractice, negligence, infection, and injury are some known risk factors that may lead to cerebral palsy.

Cerebral palsy affects body movements, muscle control, muscle coordination, muscle tone, reflex, posture, and balance. It can also impact fine motor skills and oral motor functioning. The injury and damage to the brain is permanent. The brain does not "heal" as other parts of body might. Because of this the cerebral palsy itself will not change for better or worse during a person's lifetime. On the other hand associative conditions may improve or worsen over time.

The effects of cerebral palsy are long term not temporary. The impairment caused by cerebral palsy is manageable, in other words treatment, therapy, surgery, medications, assistive technology can help to maximize the independence, reduce barrios and thus lead to enhanced quality of life.

Diplegic CP patient's exhibits weak postural balance control ability and less standing stability compared with hemiplegic cerebral palsy (Rojas VG et al., 2013). Patients population based study indicates that people with cerebral palsy have proprioception deficits in all limbs (Wingert, et al., 2009). Stiff knee in swing, equinus, and intoeing were all seen in more than 50% of the subjects of the Diplegic groups. Increased hip flexion and crouch were also present in more than 50% of the subjects in the Diplegic (Wren TA et al., 2005). The large majorities of children with CP have difficulty in walking, demonstrate poor balance control; that leads to poor gait and reaching movements the maintenance of stability is critical to all movements (Shumway cook A et al., 2001). There are various strategies to improve balance and the postural control and thus to improving lower extremity function.

Task-oriented training is defined as a repetitive training of significant, functional activities or element of such activities, to acquire well-organized and effective motor skill (Horak FB et al., 1990). The task-oriented Training approach is based on a systems model of motor control and contemporary motor learning theories. This approach focuses on interactions between the sensorimotor system components of strength, endurance, range of motion, coordination, sensory awareness, postural control, and perceptual skills, and uses the concepts of degrees of freedom and control parameters (Flinn N et al., 1995). With the emergence of the task-oriented approach, the focus of therapy in rehabilitation has shifted from eliminating deficits to enhancing function across all performance domains by emphasizing fitness, function, participation, and quality of life (Rensink M et al.,2009).

A game for which the primary purpose is not pure entertainment one sub-category is healthy gaming- also called as “exer-games”. Which are made specifically to improve physical ability and health. In order to maximize benefits of the rehabilitation session it is advised to patients to perform supplementary exercises at home, it is estimated that only 30% of the patients perform home exercises regularly (Ryan RM et al.,1995). One of the most frequent reasons reported for patient dropout is related to a lack of patient motivation (Sluis EM et al., 1993).

Integration of rehabilitation schemes and exercises into video game interfaces has been previously suggested to increase patient compliance to planned exercises and to prevent patients’ demotivation.

Specially developed serious video games (e.g. Nintendo Wii Fit_) have been recently tested as a supplementary treatment for CP children with encouraging results on balance and motivation (Jelsma et al., 2013). However, these games were primary designed for fun and not for rehabilitation, therefore for some heavily disabled patients it is not obvious to integrate them into rehabilitation (e.g. because of the speed required from the patient to play or the visual complexity disturbing many CP patients suffering from visual impairment). Therefore, specific patient games must be developed from real clinical specifications including rehabilitation schemes and therapists' expectations; only such integration can answer the practical rehabilitation field constraints (Christensen et al., 2012).

Hence the study is to compare the effect of task-oriented training alone and task oriented training along with specially developed serious games to improve lower extremity function in Diplegic cerebral palsy.

1.1 NEED FOR THE STUDY

There are several approaches was used for rehabilitation of cerebral palsy patients to improve their quality of life. Task oriented training and specially developed serious games are one of them.

Several researches had proven the technique of task oriented training in improving balance and gait parameter of the lower extremity function. Research evidence suggests some form of recreational activities such as video games can be influence the motor abilities in patient with cerebral palsy. The lack of research evidence in combination of task oriented training technique along with specially developed serious games in improving motor abilities of lower extremity function in cerebral palsy child. Hence, the prospective of this study is to find out better treatment strategy in which task oriented training along with specially developed serious games to improve lower extremity function of cerebral palsy child.

1.2 AIM OF THE STUDY

The aim of the study is to compare the effect of task oriented training alone and task oriented training along with specially developed serious games on balance and gait in Diplegic cerebral palsy children.

1.3 OBJECTIVE OF THE STUDY

- To find out the effectiveness of task oriented training on balance and gait in Diplegic cerebral palsy children.
- To find out the effectiveness task oriented training along with specially developed serious games on balance and gait in Diplegic cerebral palsy children.
- To compare the effect of task oriented training alone and task oriented training along with specially developed serious games on balance and gait in the Diplegic cerebral palsy children.

1.4 HYPOTHESIS

1.4.1 NULL HYPOTHESIS

There is no significant improvement in task oriented training alone and task oriented training along with specially developed serious games on balance and gait in Diplegic cerebral palsy children.

1.4.2 ALTERNATE HYPOTHEIS

There is a significant improvement in task oriented training alone and task oriented training along with specially developed serious games on balance and gait in Diplegic cerebral palsy children.

1.5 KEY WORDS

- Cerebral palsy
- Task oriented training
- specially developed serious games
- paediatric berg balance scale
- Gait parameters
- Balance and gait

II REVIEW OF LITERATURE

CEREBRAL PALSY

Angelina Kakooza-Mwesige et al., (2017)

The study was aimed to examine cerebral palsy prevalence and subtypes, functional impairments, and presumed time of injury in children in Uganda. In this population-based study, they used a nested, three-stage, cross-sectional method to screen for cerebral palsy. They used data from the March 1, 2015, to June 30, 2015, surveillance round of the Iganga-Mayuge HDSS. 31 756 children were screened for cerebral palsy, which was confirmed in 86 (19%) of 442 children who screened positive in the first screening stage. The crude cerebral palsy prevalence was 2·7 per 1000 children, and prevalence increased to 2·9 (2·4–3·6) per 1000 children after adjustment for attrition. The prevalence was lower in older (8–17 years) than in younger (<8 years) children. Spastic unilateral cerebral palsy was the most common subtype (45 [46%] of 97 children) followed by bilateral cerebral palsy (39 [40%] of 97 children).14 (27%) of 51 children aged 2–7 years had severe cerebral palsy (GMFCS levels 4–5) compared with only five (12%) of 42 children aged 8–17 years. Few children (two [2%] of 97) diagnosed with cerebral palsy were born preterm. Post-neonatal events were the probable cause of cerebral palsy in 24 (25%) of 97 children.

Kim Van Naarden Braun et al., (2015)

This study was to examine trends in the birth prevalence of congenital spastic CP by birth weight, gestational age, and race/ethnicity in a heterogeneous US metropolitan area. Children with CP were identified by a population-based surveillance system for developmental disabilities (DDs). Birth weight, gestational age, and race/ethnicity sub analyses were restricted to children with spastic CP. Trends were examined by CP subtype, gender, race/ethnicity, co-occurring DDs, birth weight, and gestational age. Birth prevalence of spastic CP per 1000 1-year survivors was stable from 1985 to 2002 (1.9 in 1985 to 1.8 in 2002; 0.3% annual average prevalence; 95% confidence interval [CI] −1.1 to 1.8). Whereas no significant trends were observed by gender, subtype, birth weight, or gestational age overall, CP prevalence with co-occurring moderate to severe intellectual disability significantly decreased (−2.6% [95% CI −4.3 to −0.8]). Racial disparities persisted over time between non-Hispanic black and non-Hispanic white children (prevalence ratio 1.8 [95% CI 1.5 to 2.1]). Different patterns emerged for non-Hispanic white and non-Hispanic black children by birth weight and gestational age.

Ruth morris bakwin, M.D. et al., (2012)

Cerebral palsy is "essentially a neuromuscular disease, caused by faulty development in, or damage to, the part of the brain which has to do with the control of motor function. The widely used term "crippled child" is much more inclusive. According to the New York City Survey in 1941 a crippled child is "an individual under 21 years of age who is so handicapped through congenital or acquired defects in the use of his limbs and body musculature as to be unable to compete on terms of equality with a normal individual of the same age." Included among crippled children are victims of poliomyelitis, tuberculosis of bones and joints, trauma, osteomyelitis, cerebral damage, tumour’s and, in some surveys, even cardiac and nutritional disorders.

Dinah, et al., (2011)

Cerebral palsy is the most common cause of physical disability in childhood. While some children have only a motor disorder, others have a range of problems and associated health issues. The importance of multidisciplinary assessment and treatment in enabling children to achieve their optimal potential and independence is highlighted. Disability is a life-long problem which impacts on the child, their parents and their siblings. After transition to adult services, the GP may be the only health professional that has known the young person over an extended period, providing important continuity of care.

Bole et al., (1971)

According to the Little Club Memorandum (1959), 'Cerebral palsy is a persisting qualitative motor disorder appearing before three years due to non-progressive interference with the development of the brain.' The disorders such as microcephaly, mental retardation and convulsions have been considered as associated manifestations. The high incidence of this type of cases reflects the chronicity and the magnitude of the difficult problem. In a developing country like India which is saturated with various socio-economic problems, a large number of children are born each year with various physical and mental disorders. As the etiology of this disease is still not proved, no definite preventive measures can be taken to check it.

TASK ORIENTED TRAINING IN CEREBRAL PALSY

Hyun-kyung Han, yijung chung et al., (2016)

The study was to investigate the effect of task oriented training for gross motor function measure, gait and balance function in cerebral palsy. Twenty four subjects were included and divided in to task oriented group and conventional group for 4 weeks of treatment. They suggested that the task oriented training for gross motor function, gait and balance be effective on the cerebral palsy.

Kim Y, et al., (2013)

This study was conducted in order to investigate the effects of child-centred task oriented training on balance ability in patients with cerebral palsy. 26 subjects were recruited. The child-centered task oriented training given a period of 15 weeks. The paediatric berg balance scale (PBS) was used for measurement of the child-centered task oriented training. They prove that the balance ability showed a significant change after the intervention in age groups younger than nine, between 10 and 12 and older than 13. The studies showed improve balance ability in cerebral palsy by using child-centered task oriented training.

Sehneiberg S, et al., (2010)

The goal of the study was to contribute evidence towards the effectiveness of task oriented training with or without restrictions of trunk movements on the quality of upper limb movement in children with cerebral palsy. They used a prospective, single-subject research design in 12 children's with di- hemi-quadriplegia. They use Melbourne assessment of unilateral upper limb function. They divide 12 children's in to two groups 6 of each group for three months of treatment program. The study showed that greater improvement in the quality of upper limb movement in children with CP, including less compensatory trunk use and better carry-over effects was achieved by training with trunk restraint.

Salem Y, et al., (2009)

The study was to evaluate the effects of task oriented strength training on mobility function in children's with cerebral palsy. Single blind, randomized control trail. 10 children's with CP (GMFCS level 1-3) were assigned in to two groups 5 of each group. Mobility function was assessed by using Gross Motor

Function Measure (GMFM) and Timed "Up and Go" (TUG) test with 5 weeks of interventions. They concluded that the task oriented strength training program is linked to positive functional outcomes. The result suggests that the children's with cerebral palsy may benefit from a task oriented strength training program

Katz- Leurer M, et al., (2009)

The study was to evaluate the effect of a "home based" task oriented exercise program on motor and balance performance in children's with spastic cerebral palsy and severe traumatic brain injury. A randomized clinical trail.20 children's are included and divided in to two group 10 children's in each group. Regular daily activities for control group and regular daily activities plus home based task oriented exercise program for 6 weeks. Timed Up and Go test, and Functional Reach Test were used as functional balance test. The positive change in balance performance in the experimental group was noted after a 6 week follow up period. They concluded that a home based task oriented exercise can improve balance performance in children's with spastic cerebral palsy or severe traumatic brain injury.

SPECIALLY DEVELOPED SERIOUS GAMES ON CEREBRAL PALSY

Tarakci D, et al., (2016)

This study was to compare the effect of Nintendo Wii-Fit balance based video games and conventional balance training in children with mild cerebral palsy. 30 ambulatory paediatric patients with CP. 15 patients receive the conventional balance training and another 15 patients receives the Wii-Fit balance based video games training, both the group receives the neuro developmental treatment. The primary outcomes were Functional Reach Test, Sit to Stand test, and Timed Up and Go test. They prove that the Wii-Fit balance based video games are better at improving both static and performance related balance parameters when combined with NDT treatment in children with mild CP.

Jaume-i-capo A, et al., (2014)

The study covers a new experimental system, designed to improve the balance and postural control of adults with cerebral palsy. This system is based on a serious game for balance rehabilitation therapy. A 24 week of physiotherapy intervention program was conducted with the 9 adults from a cerebral palsy centre. They used Tinetti scale for risk of fall. Findings demonstrated a significant increase in balance and gait function scores. They prove that the experimental system is feasible for balance rehabilitation therapy.

Chen PY, et al., (2012)

The study states that lower limb muscle power training is currently an emerging concept in rehabilitation on individuals with decreased balance and mobility. In this prospective, controlled study, they used a human- computer interactive video-game-based rehabilitation device for training of lower limb muscle power in elderly. 40 patients were selected divided into two groups 20 patients for each group. 20 patients receive the strengthening exercises, whereas another 20 patients receives video game based rehabilitation. They used Modified Fall Efficacy Scale (MFES), Tinetti Performance Oriented Mobility Assessment (POMA), Functional Reach Test, Five times Sit to Stand test and Timed “Up and Go” test (TUG) were administered. They prove that the sit to stand movement in video game based training mimic real life situations which may help to transfer the training effects in to daily activities.

Ramstrand N, et al., (2012)

This study aimed to evaluate if use an activity promoting computer game, used in the home could influences balance related outcome measures in children with cerebral palsy. 18 children’s with hemiplegic or diplegic cerebral palsy were recruited for the study design was used with after 5 weeks of playing Wii-Fit games and after 5 weeks without intervention. Outcome measures are modified sensory organisation test, reactive balance test, and rhythmic weight shift test. They suggest that the use of Nintendo Wii- Fit software is effective as a balance training tool in children with cerebral palsy.

Szturm T, et al., (2011)

The purpose of this study was to examine the feasibility and benefits of physical therapy based on a task oriented approach delivered via an engaging, interactive video game paradigm. The intervention focused on performing targeted dynamic tasks, which included reactive balance control and environmental interaction. 30 subjects are taken and divided in to control and experimental group. Control group gets typical rehabilitation program consisting of strengthening and balance exercises. The experimental group gets dynamic balance exercises coupled with video game play. Berg Balance Scale, Timed Up and Go test, Activity Specific Balance Scale, Modified clinical test of sensory integration and balance, and spatiotemporal gait variables assessed in an instrumented carpet system test are used. They concluded that the greater improvement in dynamic standing balance control compared with the typical exercise program.

PEDIATRIC BERG BALANCE SCALE

Natalia de A.C, et al., (2014)

The purpose of the study is to investigate the correlation of functional balance with the functional performance of the children with cerebral palsy.

They conduct a cross-sectional study of children with cerebral palsy with mild to moderate impairment. Children's were divided in to three groups based on their motor impairment. The evaluation consists of the administration of the paediatric berg balance scale and the paediatric evaluation disability inventory. They concluded that the PBS proved to be good auxiliary tool for the evaluation of functional performance with regard to mobility.

Franjoine, et al., (2013)

The purpose of the Paediatric Balance Scale (PBS), a modification of Berg's Balance Scale, was developed as a balance measure for school-age children with mild to moderate motor impairments. The study was to determine the test-retest and interrater reliability of the PBS. 20 children (aged five to 15 years) with known balance impairments were tested by one examiner on the PBS. Ten paediatric physical therapists independently scored 10 randomly selected videotaped test sessions. They concluded that The PBS has been demonstrated to have good test-retest and interrater reliability when used with school-age children with mild to moderate motor impairment.

Chia-lingChen, et al., (2013)

This study examined criterion-related validity and clinometric properties of the paediatric balance scale (*PBS*) in children with cerebral palsy (CP). 45 children with CP (age range: 19–77 months) and their parents participated in this study. At baseline and at follow up, Pearson correlation coefficients were used to determine criterion-related validity by analysing the correlation between the PBS, including PBS-static, PBS-dynamic, and PBS-total, and criterion measures, including the Gross Motor Function Measure-66 items (*GMFM-66)* and Functional Independence Measures for Children *(*WeeFIM*).* They concluded that the PBS with GMFM-66 and WeeFIM showed fair-to-excellent concurrent validity.

Kembhavi Gayatri, et al., (2002)

This study was designed to evaluate the use of the Berg Balance Scale (BBS) to assess the balance abilities of children with cerebral palsy. Thirty-six ambulatory children with cerebral palsy and 14 children with no motor impairment (ages eight to 12 years) were assessed on the BBS and the Gross Motor Function Measure (GMFM). Participants with cerebral palsy comprised three groups based on diagnosis (spastic hemiplegia, spastic diplegia who ambulated without aids, and spastic diplegia who ambulated with aids). A fourth group consisted of control subjects with no motor impairment. It was hypothesized that these four groups demonstrated a hierarchy of balance abilities. A one-way ANOVA was used to detect significant differences in test scores among the four groups. The analysis was repeated categorizing children on the Gross Motor Function Classification System (GMFCS) instead of diagnosis. They suggest that the BBS can be considered as a clinical measure of balance for children with cerebral palsy.

GAIT PARAMETERS: (STRIDE LENGTH, CADENCE, GAIT VELOCITY)

Sun-Hye Jung, et al., (2016)

The purpose of the study is to find out the effects of kinesio taping on the gait parameters of children with cerebral palsy. A pilot study, Four children with spastic Diplegia participated in this study. The participants' gait parameters while walking 10 m with and without kinesio taping were recorded. Gait parameters including gait velocity, cadence, step length, stride length, single support time, and double support time were evaluated using the GAITRite. They concluded that kinesio taping may have a positive effect for improving gait parameters of children with spastic Diplegia.

Chang Ju Kim, et al., (2014)

The purpose of this study was to determine the differences in spatiotemporal gait parameters between children with spastic Diplegic CP and children with normal development (ND). Sixteen children were recruited for participation as volunteers in this study. The children with CP had a Gross Motor Function Classification (GMFC) System level of between I and II. Walking velocity, cadence, stride length, and step width of children with CP with a GMFC of between I and II were a level of 60%, 77%, 73%, and 160%, respectively, of those of ND children. The percentages of right and left double-limb support were 188% and 179% higher, respectively, and the proportion of single limb support was shorter by 83% and 82%. They concluded that theobjective evidence of distinct differences in spatiotemporal gait parameters between children with spastic diplegic CP with a GMFC level I or II and ND children and would be helpful to persons involved in the care of these children.

Sun Jong Choi et al., (2011)

The goal of the study was to investigate the clinical relevance of hip kinematic and kinetic parameters, and 3D modelled psoas length in terms of discriminant validity, convergent validity, and responsiveness. Twenty-four patients with cerebral palsy (mean age 6.9 years) and 28 normal children (mean age 7.6 years) were included. Kinematic and kinetic data were obtained by three dimensional gait analyses, and psoas lengths were determined using a musculoskeletal modelling technique. Validity of the hip parameters was evaluated. They concluded that Maximum pelvic tilt, maximum psoas length, hip flexor index, and maximum hip extension in stance were found to be clinically relevant parameters in evaluating hip flexor contracture.

Jeong-Yi Kwon, et al., (2011)

The purpose of the study was to evaluate the effects of Hippotherapy on temporospatial parameters and pelvic and hip kinematics of gait in children with bilateral spastic cerebral palsy.32 Children with bilateral spastic cerebral palsy, Gross Motor Function Classification System level 1 or 2 are included in this study. The main outcome is Temporospatial parameters and pelvic and hip kinematic parameters in 3-dimensional motion analysis, Gross Motor Function Measure (GMFM)-88, and score for dimensions D (standing) and E (walking, running, jumping) of the GMFM, GMFM-66, and Paediatric Balance Scale (PBS). They concluded that Hippotherapy significantly improved walking speed, stride length, and pelvic kinematics.

Susan Klejman, et al., (2010)

The purpose of the study is to Test-retest reliability of discrete gait parameters in children with cerebral palsy. 28 Ambulatory children with CP are recruited. The primary outcome is Intraclass correlation coefficients (ICCs), standard error of measurement, and MDC of discrete gait parameters. They concluded that select discrete gait parameters measured using computerized gait analysis are reliable and potentially responsive measures of performance and can be used as outcome measures in intervention studies.

III METHODOLOGY

3.1 Study design:

Pre-test and post-test experimental study design

3.2 Study setting:

Department of Physiotherapy, K.G Hospital, Coimbatore.

3.3 Study duration:

The study was conducted over a period of 6 months. Each patient underwent treatment duration of 4 weeks.

3.4 Study samples:

A total 20 patients were selected based on the selection criteria and divided into two groups. 10 subjects in each group, sample selection was done using simple random sampling method. The participants are allocated into two groups, Group A and Group B.

3.5 Criteria for selection of samples:

3.5.1 Inclusion criteria

- Children diagnosed as spastic Diplegic cerebral palsy
- Age between 5–12 years
- Both sexes were included.
- Having spasticity range between 1 and 1+ grade according Modified Ashworth Scale.

- Able to perform sit-to-stand task and walking with or without walking devices.
- GMFCS I–III and having sufficient cognitive level to understand.
- They were having sufficient co-operation and cognitive understanding to participate
- Able to communicate and follow the instructions

3.5.2 Exclusion criteria:

- Unstable seizures.
- Receiving any treatment for spasticity or surgical procedures
- Children were suffering from other diseases that interfered with training.
- Presence of shortening or deformities of the ankle, knee and/or hip joints that prevented the children from keeping their feet on the ground.
- Hindered them from maintaining the standing position, or made it impossible for them to independently perform an STS movement.
- Having difficulty maintaining an upright position without support for more than 30 seconds.
- Showing behavioural disorders.

3.6 Variables:

3.6.1 Independent variables:

Task oriented training

Specially developed serious games.

3.6.2 Dependent variables:

- Balance
- Gait

3.7 Outcome measures:

- Paediatric berg balance scale
- Gait parameters:
  - Stride length (cm),
  - Cadence (steps/min),
  - Velocity (m/min)

3.8 Operation tool:

- Nintendo Wii Balance Board (WBB)
- Data Collection Sheet
- Consent Form
- Mattress
- Stop Watch
- Inch tape
- Chair
- Ink Pad and Stools.

3.9 Orientation of the subjects

Before treatment, all children's and their parents were explained about the study and procedure to be applied and were asked to inform if they felt any discomfort during the course of the treatment. All the children with cerebral palsy and parents who were interested to participate in the study were asked to sign the consent form before the treatment.

3.10 Procedure:

Twenty subjects based on the inclusion criteria were randomly allocated in to two groups, Group A (Task Oriented Training) and Group B (task oriented training along with specially developed serious games), with 10 subjects in each. Each child was evaluated for their functional ability using the Paediatric Berg Balance Scale, and Gait parameters such as cadence, gait velocity, stride length prior to commencement of training.

GROUP A

Receives task oriented training alone for one hour for 6 days/ week.

GROUP B

The children's in this group also receives task oriented training for 45 minutes 6 days/week, along with 15 minutes of playing specially developed serious games.

3.11 STATISTICAL TOOLS

Paired ‘t’ test:

Paired ‘t’ test was conducted to compare the pre-test and post-test values of paediatric berg balance scale for balance and gait parameters.

Formula of paired ‘t’ test:

$$S = \sqrt{\frac{\sum d^2 - \frac{(\sum d)^2}{n}}{n-1}}$$

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

d = difference between the pre-test versus post test

$\bar{d}$ = mean difference

n = total number of subjects

S = standard deviation

$\sum d^2$ = sum of the squared deviation

Unpaired’ test:

The Unpaired' test was used to compare the pre-test and post-test values of group A and group B for paediatric berg balance scale for balance and gait parameters.

Formula of Unpaired't' test:

$$S = \sqrt{\frac{\sum(x1-\overline{x1})^2+\sum(x2-\overline{x2})^2}{n1+n2-2}}$$

$$t = \frac{\overline{x1-x2}}{S}\sqrt{\frac{n1n2}{n1+n2}}$$

n1 = total number of subjects in group A

n2 = total number of subjects in group B

$x1$ = difference between pretest Vs posttest of group A

$\overline{x1}$ = mean difference between pretest Vs posttest of group A

$x2$ = difference between pre-test Vs post-test of group B

$\overline{x2}$ = mean difference between pretest Vs posttest of group B

S = combined standard deviation

Level of significance = 5%

IV DATA ANALYSIS AND INTERPRETATION

TABLE I

PAEDIATRIC BERG BALANCE SCALE

PAIRED ‘t’ TEST OF GROUP A – (TASK ORIENTED TRAINING)

S.NO	PBS	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	37.180	0.842	3.12	3.70
2.	Post test	40.300			

The table I shows the analysis of paediatric berg balance scale in Group A. Using paired‘t’ test with 9 degrees of freedom and 0.05% as a level of significance, the table ‘t’ value is 2.262 which was lesser than the calculated ‘t’ value 3.70. The result shows that there was significant difference between pre-test and post-test values.

GRAPH I

PAEDIATRIC BERG BALANCE SCALE

PAIRED 't' TEST OF GROUP A – (TASK ORIENTED TRAINING)

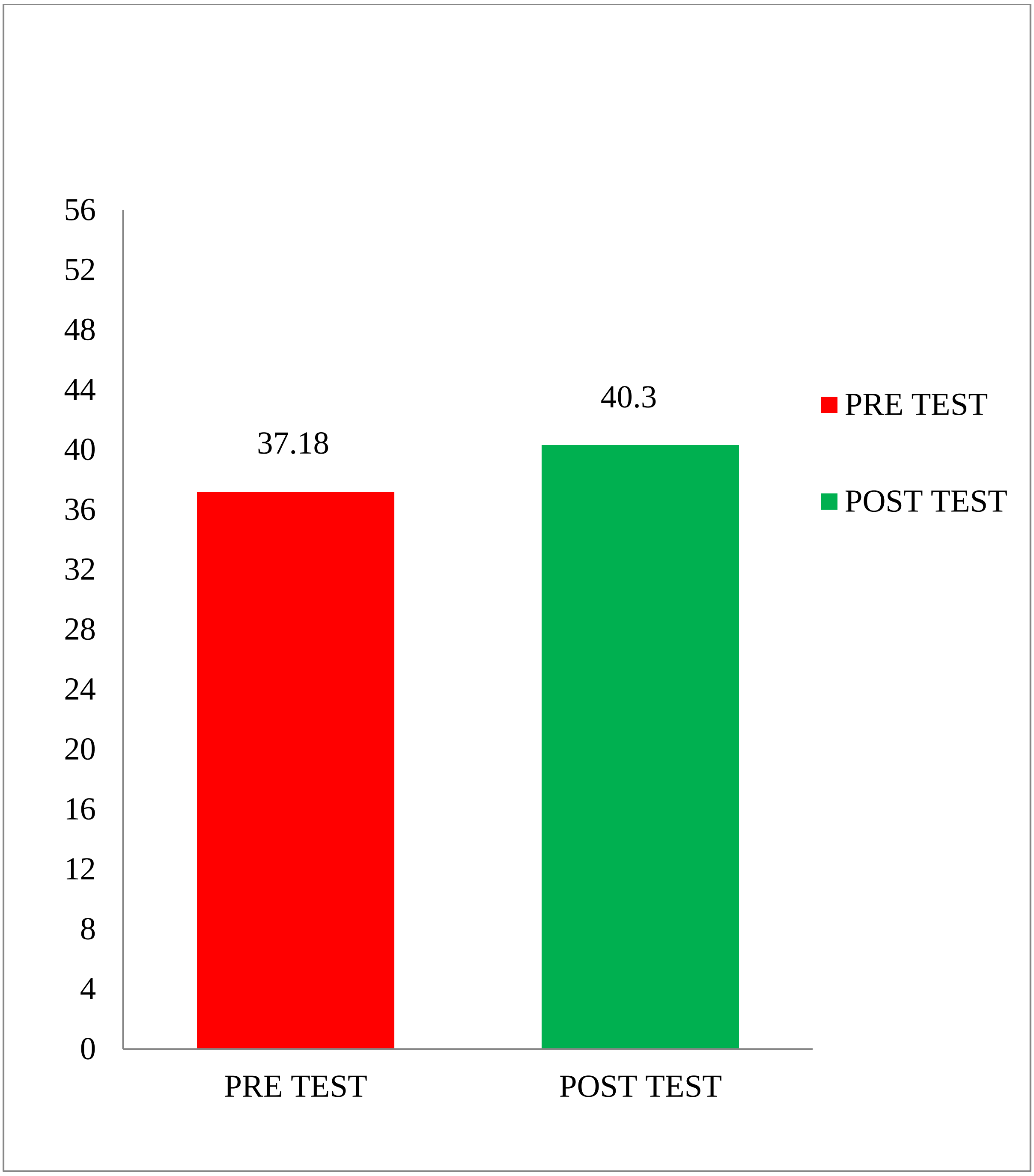


TABLE II

PAEDIATRIC BERG BALANCE SCALE

PAIRED 't' TEST OF GROUP B – (TASK ORIENTED TRAINING WITH SPECIALLY DEVELOPED SERIOUS GAMES)

S.NO	PBS	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	37.44	0.912	6.4	7.02
2.	Post test	43.84			

The table II shows the analysis of paediatric berg balance scale in Group B. Using paired 't' test with 9 degrees of freedom and 0.05% as a level of significance, the table 't' value is 2.145 which was lesser than the calculated 't' value 7.02. The result shows that there was significant difference between pre-test and post-test values.

GRAPH II

PAEDIATRIC BERG BALANCE SCALE

PAIRED 't' TEST OF GROUP B – (TASK ORIENTED TRAINING WITH SPECIALLY DEVELOPED SERIOUS GAMES

TABLE III

UNPAIRED'T' TEST-POST TEST VALUES OF PAEDIATRIC BERG BALANCE SCALE FOR GROUP A Vs GROUP B

GROUPS	MEANS	S.D	t VALUE
A	40.300	0.694.	5.09
B	43.84		

Post-test values of group A and B is analysed by unpaired 't' test. The calculated 't' value is 5.09, which is greater than the table 't' value is 2.048 at 5% level of significance and 18 degrees of freedom. This test showed that there was significant difference in balance in between the effect of group A and group B.

GRAPH III

PAEDIATRIC BERG BALANCE SCALE

UNPAIRED 't' TEST OF GROUP A AND GROUP B

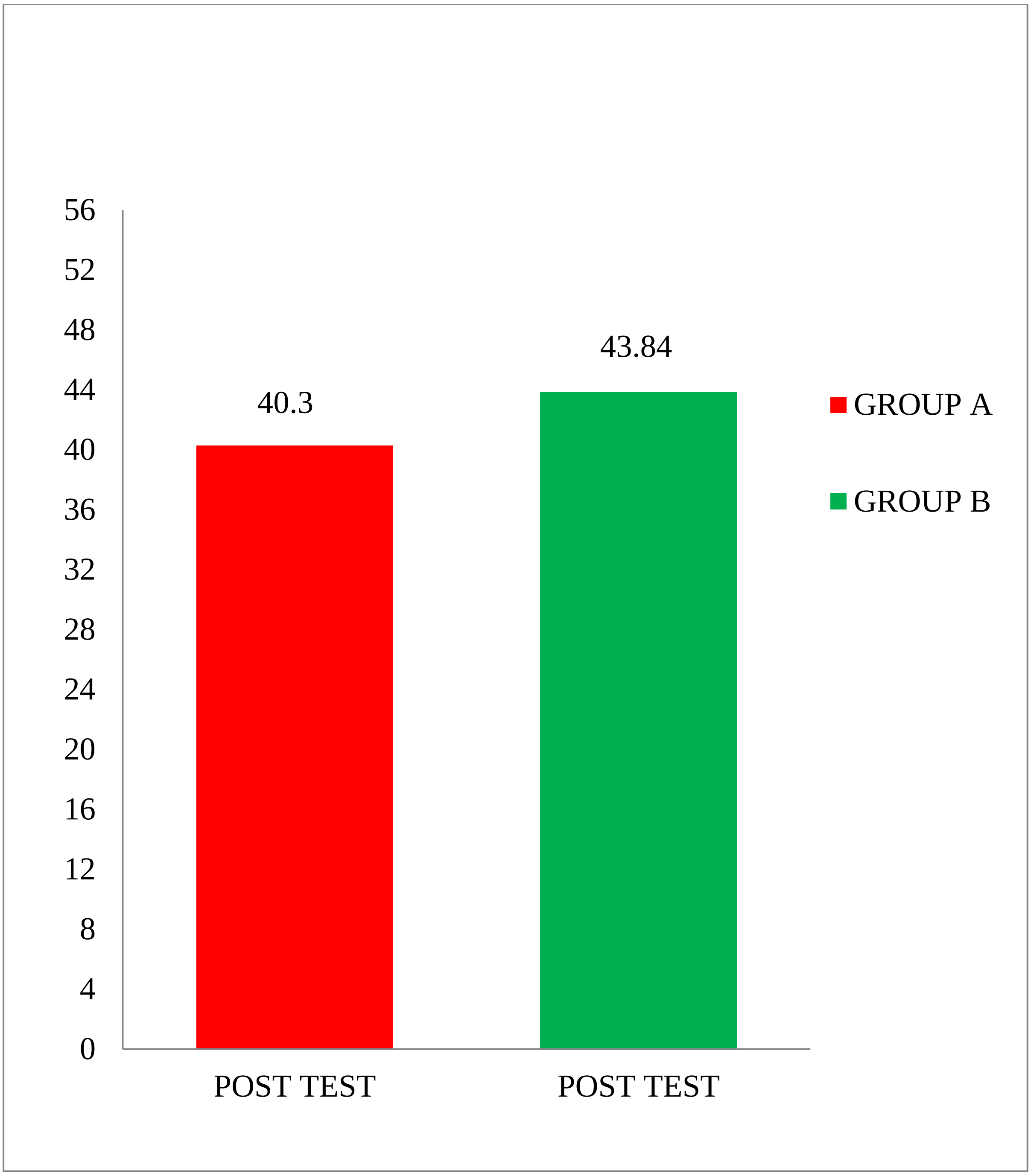


TABLE IV

GAIT PARAMETER (STRIDE LENGTH)

PAIRED 't' TEST OF GROUP A – (TASK ORIENTED TRAINING)

S.NO	STRIDE LENGTH	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	65.730	0.549	3.17	5.7725
2.	Post test	68.900			

The table IV shows the analysis of 10 meter walk test for gait parameter stride length in Group A. Using paired 't' test with 9 degrees of freedom and 0.05% as a level of significance, the table 't' value is 2.262 which was lesser than the calculated 't' value 5.7725. The result shows that there was significant difference between pre-test and post-test values.

GRAPH IV

10 METER WALK TEST - GAIT PARAMETER (STRIDE LENGTH)

PAIRED ‘t’ TEST OF GROUP A – (TASK ORIENTED TRAINING)

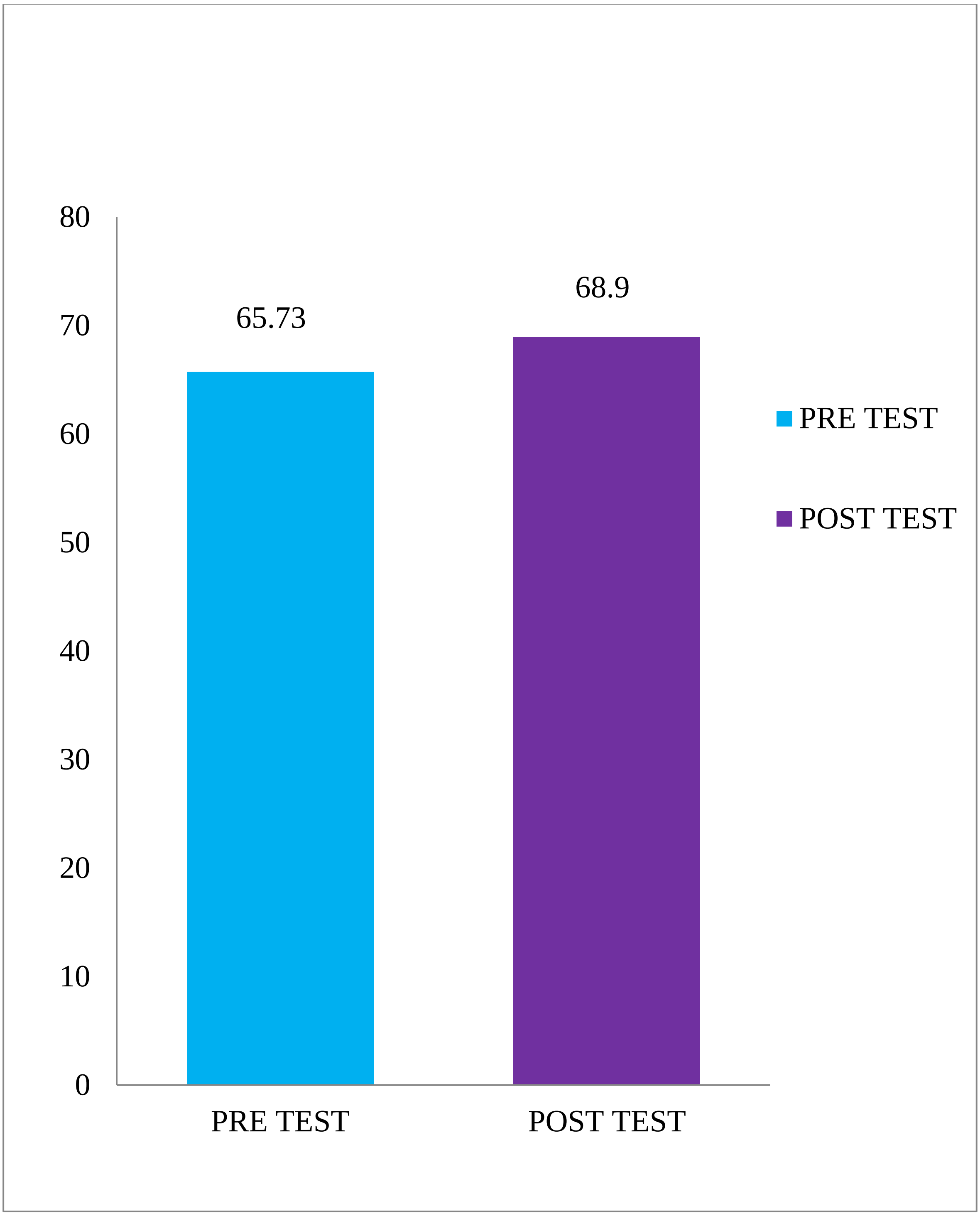


TABLE V

GAIT PARAMETER (STRIDE LENGTH)

PAIRED 't' TEST OF GROUP B – (TASK ORIENTED TRAINING AND SPECIALLY DEVELOPED SERIOUS GAMES)

S.NO	STRIDE LENGTH	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	65.110	0.705	8.2	11.6276
2.	Post test	73.310			

The table V shows the analysis of 10 meter walk test for gait parameter stride length in Group B. Using paired't' test with 9 degrees of freedom and 0.05% as a level of significance, the table 't' value is 2.262 which was lesser than the calculated 't' value 11.6276. The result shows that there was significant difference between pre-test and post-test values.

GRAPH V

GAIT PARAMETER (STRIDE LENGTH)

PAIRED ‘t’ TEST OF GROUP B – (TASK ORIENTED TRAINING AND SPECIALLY DEVELOPED SERIOUS GAMES

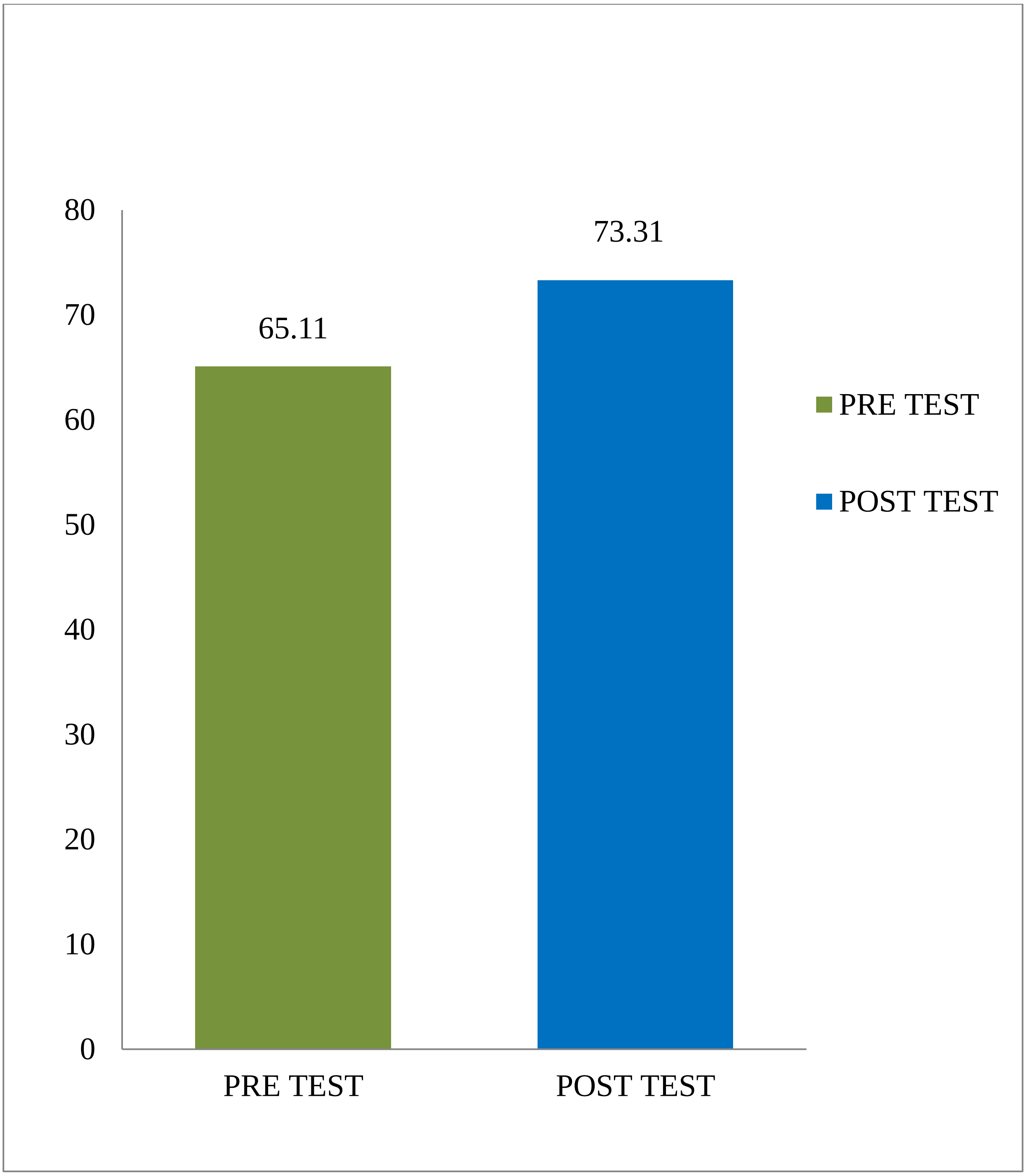


TABLE VI

UNPAIRED'T' TEST-POST TEST VALUES OF GAIT PARAMETER (STRIDE LENGTH)

FOR GROUP A Vs GROUP B

GROUPS	MEANS	S.D	t VALUE
A	68.900	0.635	6.9469
B	73.310		

Post-test values of group A and B is analysed by unpaired 't' test. The calculated 't' value is 6.9469, which is greater than the table 't' value is 2.101 at 5% level of significance and 18 degrees of freedom. This test showed that there was significant difference in stride length in between the effect of group A and group B.

GRAPH VI

UNPAIRED'T' TEST-POST TEST VALUES OF GAIT PARAMETER

(STRIDE LENGTH)

FOR GROUP A Vs GROUP B

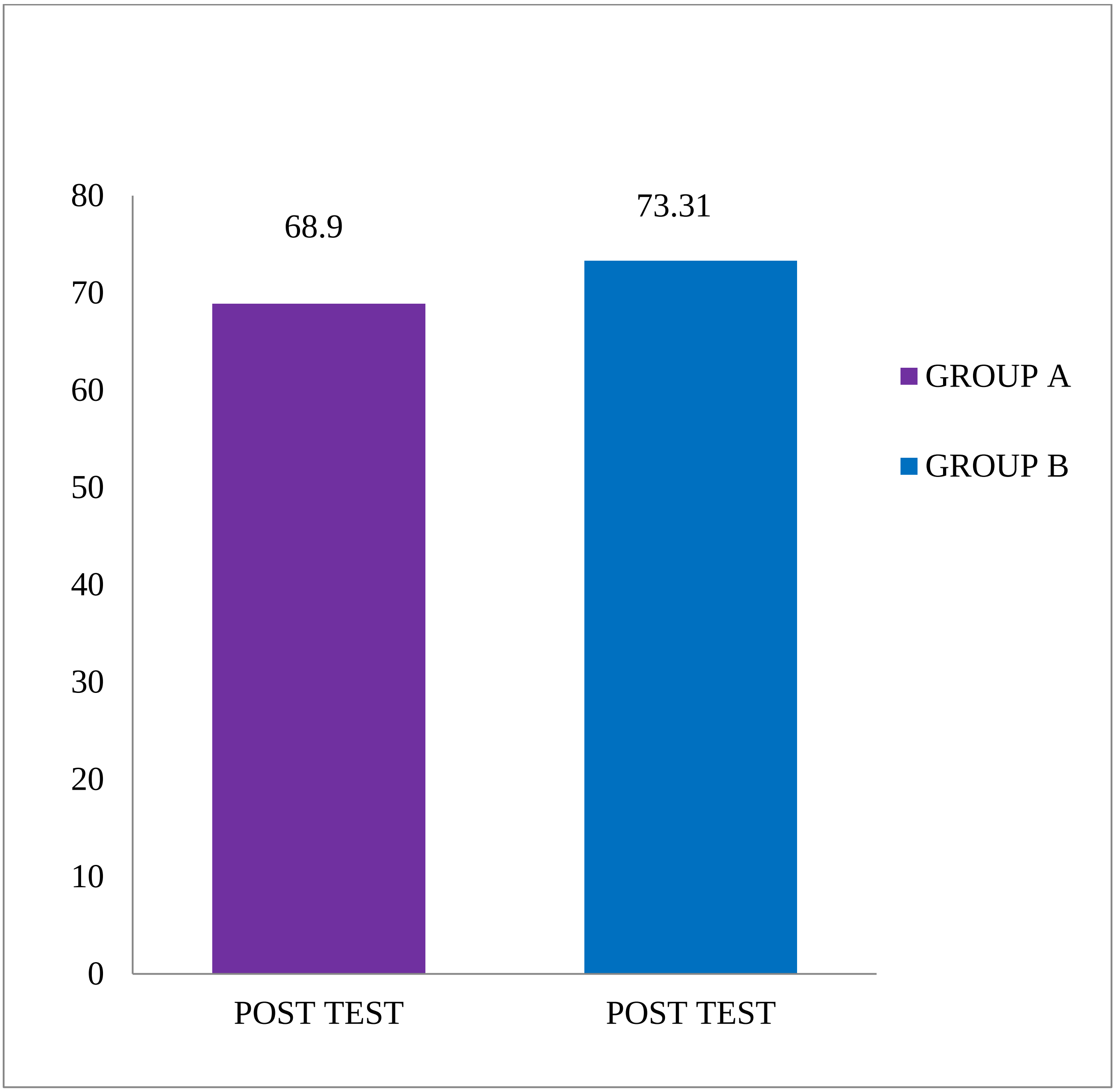


TABLE VII

GAIT PARAMETER (CADANCE)

PAIRED ‘t’ TEST OF GROUP A – (TASK ORIENTED TRAINING)

S.NO	CADANCE	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	85.0900	0.619	9.7	15.6709
2.	Post test	94.7900			

The table VII shows the analysis of 10 meter walk test for gait parameter cadence in Group A. Using paired ‘t’ test with 9 degrees of freedom and 0.05% as a level of significance, the table ‘t’ value is 2.262 which was lesser than the calculated ‘t’ value 15.6709. The result shows that there was significant difference between pre-test and post-test values.

GRAPH VII

GAIT PARAMETER (CADANCE)

PAIRED ‘t’ TEST OF GROUP A – (TASK ORIENTED TRAINING)

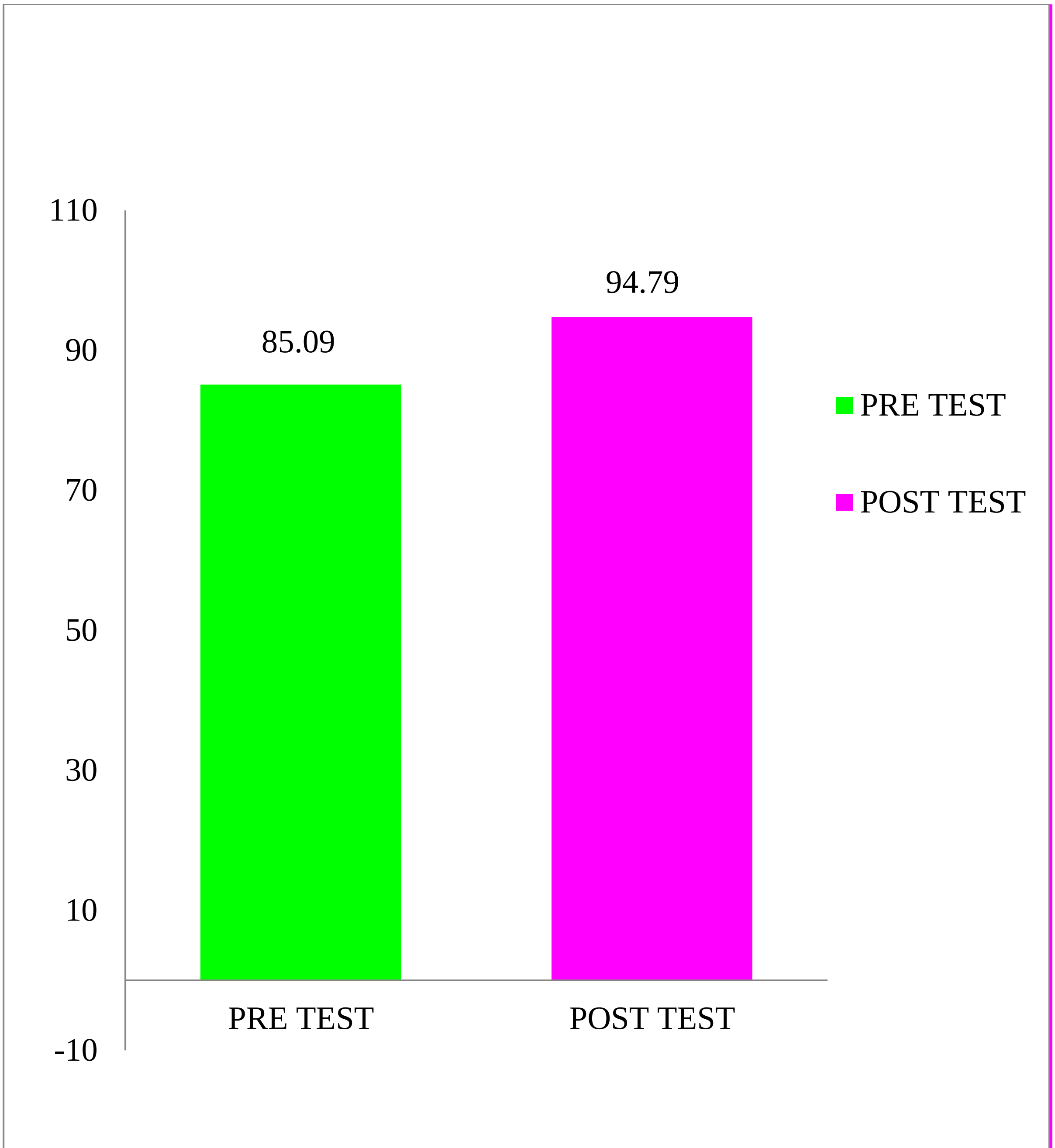


TABLE VIII

GAIT PARAMETER (CADANCE)

PAIRED 't' TEST OF GROUP B – (TASK ORIENTED TRAINING AND SPECIALLY DEVELOPED SERIOUS GAMES)

S.NO	CADANCE	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	85.720	0.487	14.45	29.6577
2.	Post test	100.170			

The table VIII shows the analysis of 10 meter walk test for gait parameter stride length in Group B. Using paired't' test with 9 degrees of freedom and 0.05% as a level of significance, the table 't' value is 2.262. Which was lesser than the calculated't' value 29.6577. The result shows that there was significant difference between pre-test and post-test values.

GRAPH VIII

GAIT PARAMETER (CADANCE)

PAIRED 't' TEST OF GROUP B – (TASK ORIENTED TRAINING AND SPECIALLY DEVELOPED SERIOUS GAMES)

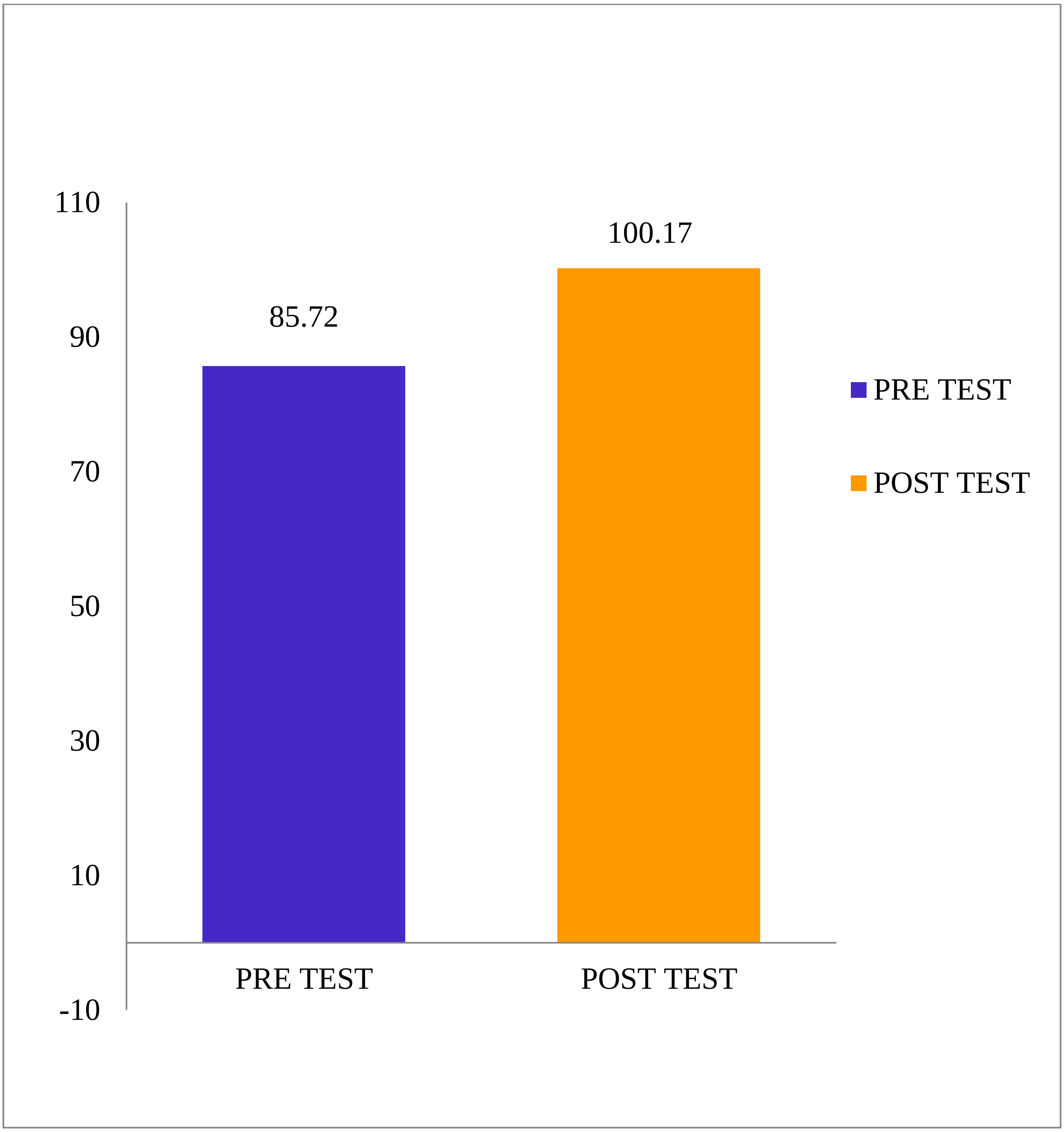


TABLE IX

UNPAIRED'T' TEST-POST TEST VALUES OF GAIT PARAMETER

(CADANCE)

FOR GROUP A Vs GROUP B

GROPUS	MEANS	S.D	t VALUE
A	94.7900	0.460	11.6877
B	100.170		

Post-test values of group A and B is analysed by unpaired 't' test. The calculated 't' value is 11.6877, which is greater than the table 't' value is 2.101 at 5% level of significance and 18 degrees of freedom. This test showed that there was significant difference in cadence in between the effect of group A and group B.

GRAPH IX

UNPAIRED'T' TEST-POST TEST VALUES OF GAIT PARAMETER

(CADANCE)

FOR GROUP A Vs GROUP

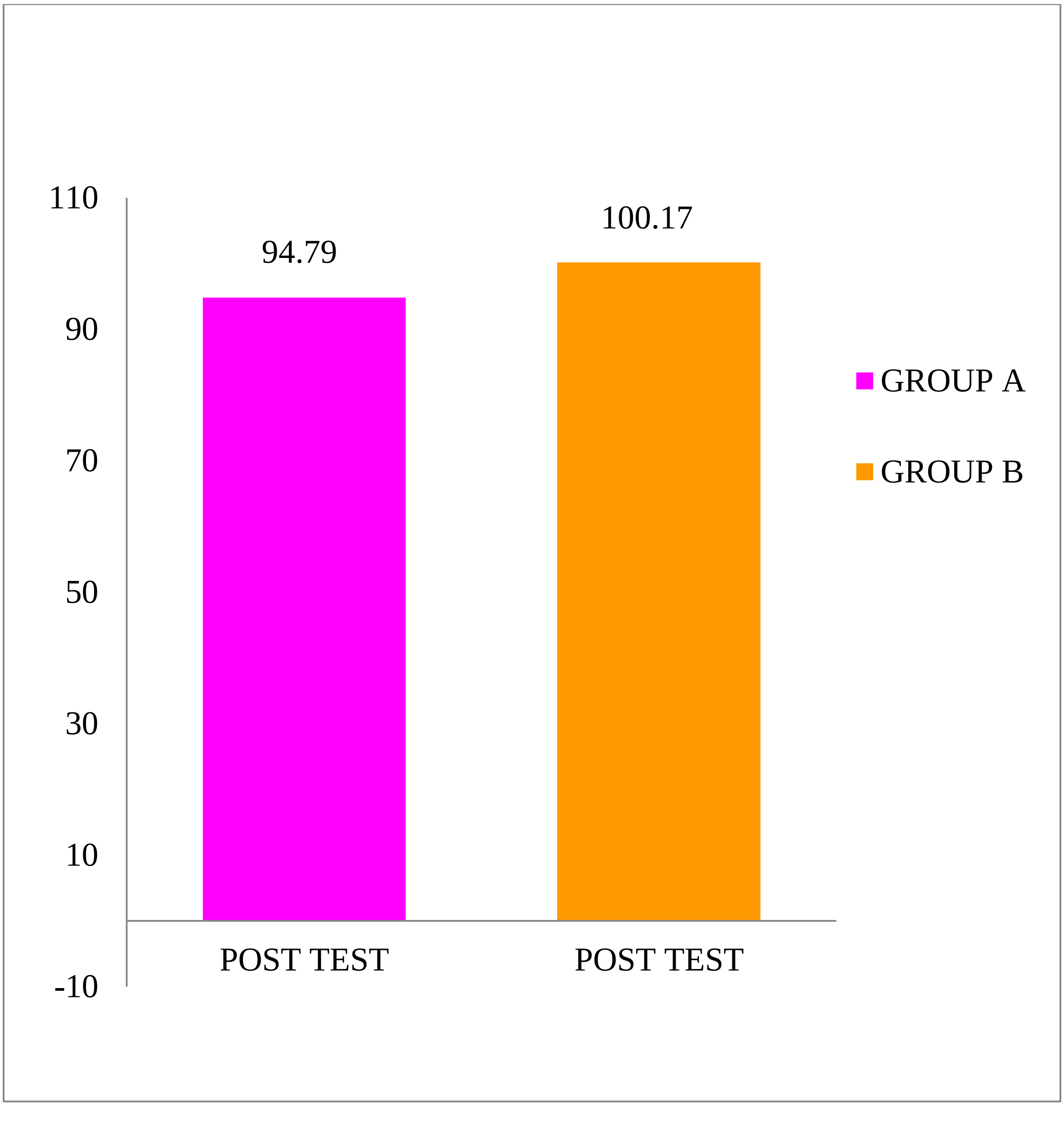


TABLE X

GAIT PARAMETER (GAIT VELOCITY)

PAIRED ‘t’ TEST OF GROUP A – (TASK ORIENTED TRAINING)

S.NO	GAIT VELOCITY	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	55.810	0.327	3.32	10.1673
2.	Post test	59.130			

The table X shows the analysis of 10 meter walk test for gait parameter gait velocity in Group A. Using paired ‘t’ test with 9 degrees of freedom and 0.05% as a level of significance, the table ‘t’ value is 2.262 which was lesser than the calculated ‘t’ value 10.1673. The result shows that there was significant difference between pre-test and post-test values.

GRAPH X

GAIT PARAMETER (GAIT VELOCITY)

PAIRED ‘t’ TEST OF GROUP A – (TASK ORIENTED TRAINING)

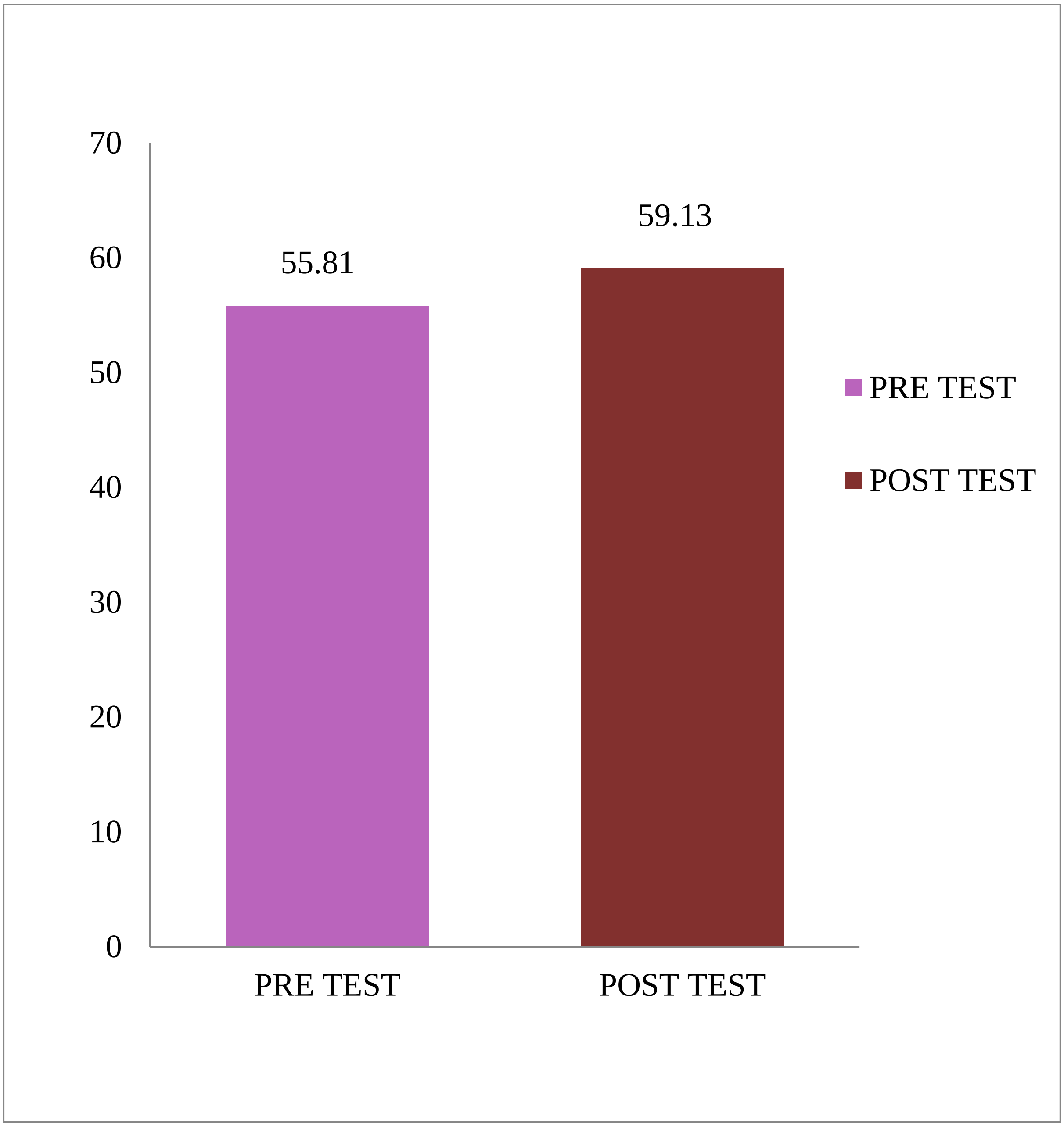


TABLE XI

GAIT PARAMETER (GAIT VELOCITY)

PAIRED ‘t’ TEST OF GROUP B – (TASK ORIENTED TRAINING AND SPECIALLY DEVELOPED SERIOUS GAMES)

S.NO	GAIT VELOCITY	MEAN	S.D	MEAN DIFFERENCE	PAIRED t TEST
1.	Pre test	54.930	0.545	6.92	12.7059
2.	Post test	61.850			

The table XI shows the analysis of 10 meter walk test for gait parameter gait velocity in Group B. Using paired ‘t’ test with 9 degrees of freedom and 0.05% as a level of significance, the table ‘t’ value is 2.262. Which was lesser than the calculated ‘t’ value 12.7059. The result shows that there was significant difference between pre-test and post-test values.

GRAPH XI

GAIT PARAMETER (GAIT VELOCITY)

PAIRED ‘t’ TEST OF GROUP B – (TASK ORIENTED TRAINING AND SPECIALLY DEVELOPED SERIOUD GAMES)

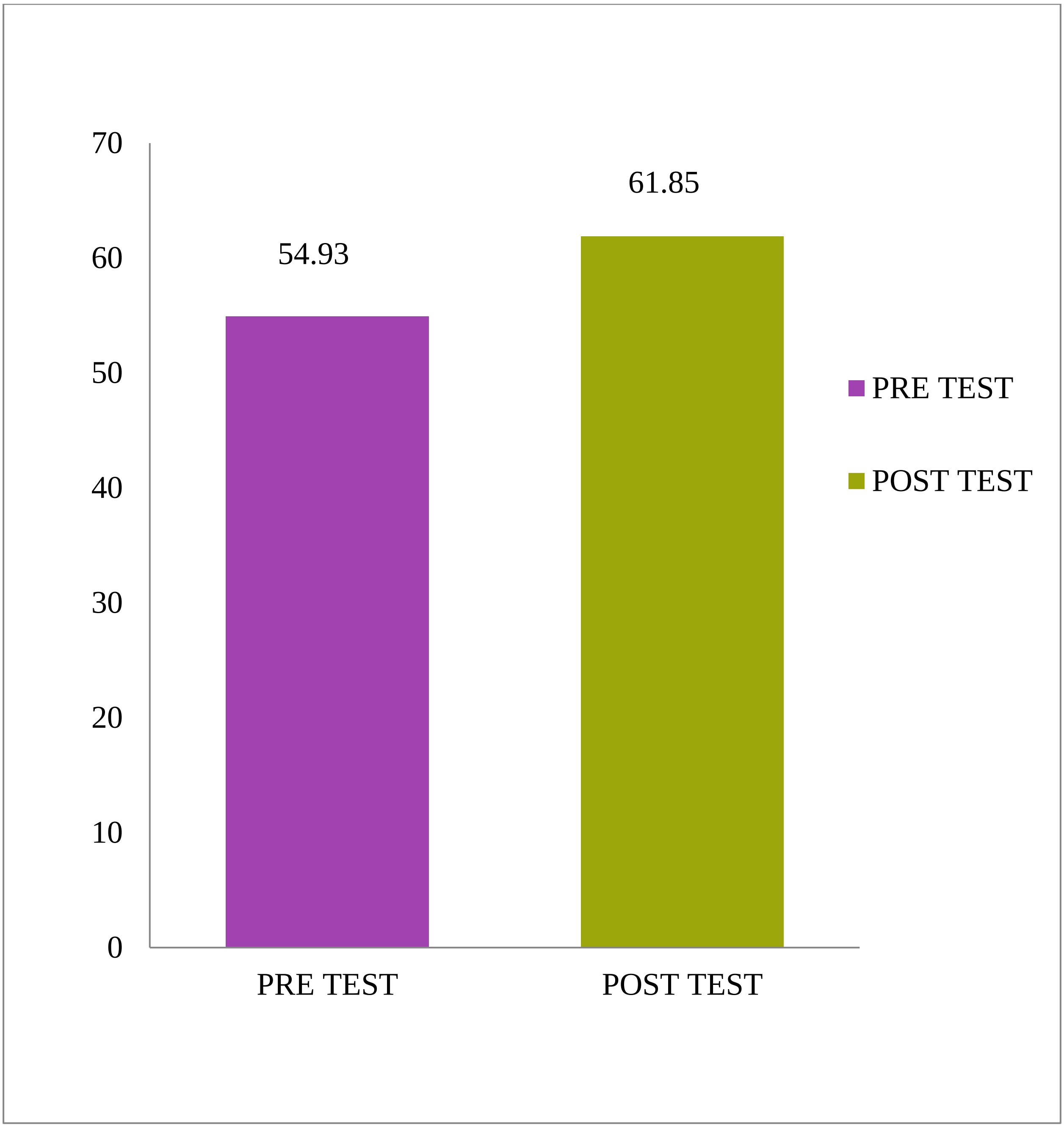


TABLE XII

UNPAIRED'T' TEST-POST TEST VALUES OF GAIT PARAMETER

(GAIT VELOCITY)

FOR GROUP A Vs GROUP B

<table>
<tr><th>GROPUS</th><th>MEANS</th><th>S.D</th><th>t VALUE</th></tr>
<tr><td>A</td><td>59.130</td><td rowspan="2">0.304</td><td rowspan="2">8.9535</td></tr>
<tr><td>B</td><td>61.850</td></tr>
</table>

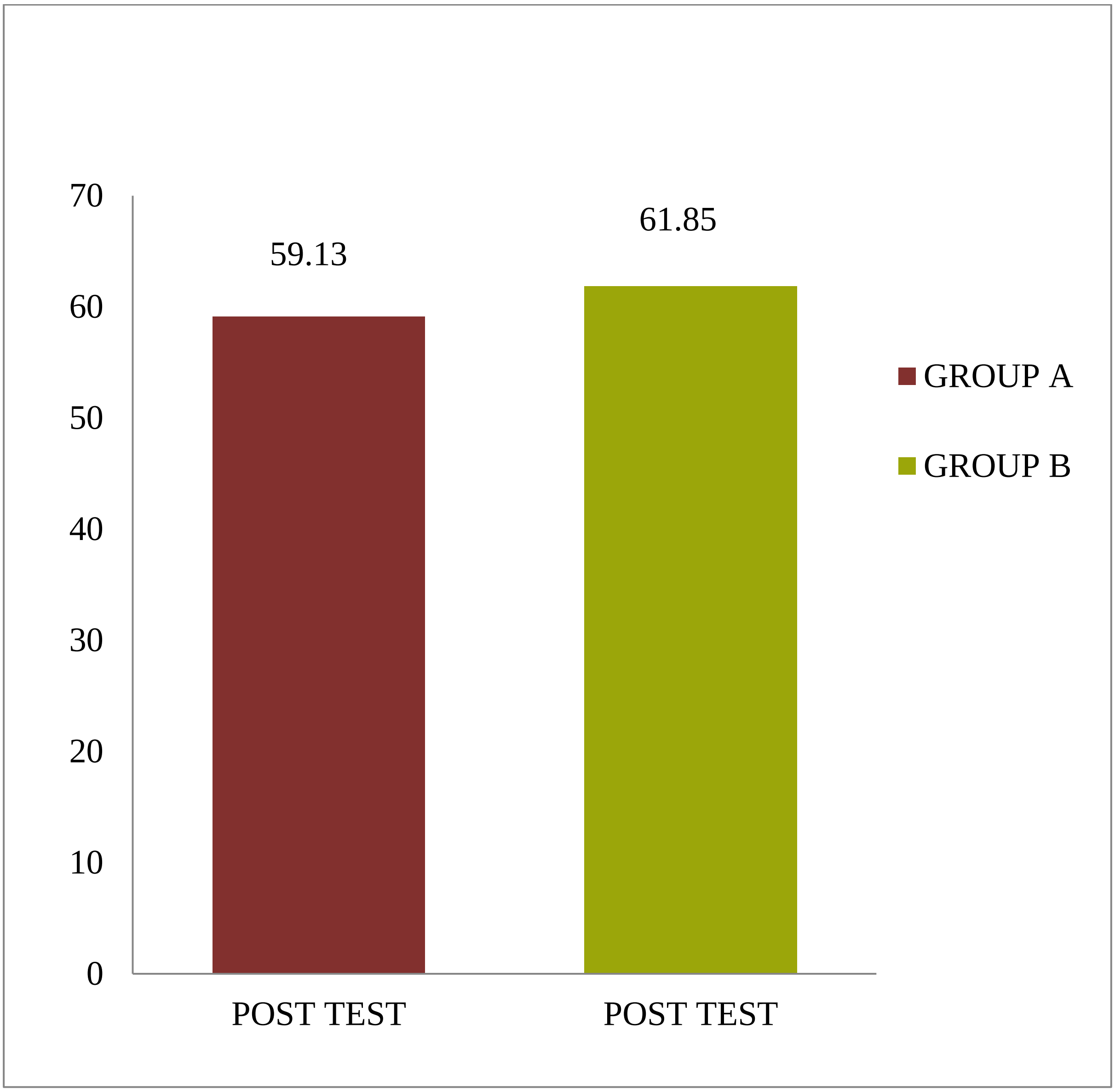
Post-test values of group A and B is analysed by unpaired 't' test. The calculated 't' value is 8.9535, which is greater than the table 't' value is 2.101 at 5% level of significance and 18 degrees of freedom. This test showed that there was significant difference in gait velocity in between the effect of group A and group B.

GRAPH XII

UNPAIRED'T' TEST-POST TEST VALUES OF GAIT PARAMETER

(GAIT VELOCITY)

FOR GROUP A Vs GROUP B



V DISCUSSION

The purpose of the study was to find out the effect of task oriented training alone and task oriented training along with specially developed serious games on lower extremity function in Diplegic cerebral palsy.

In this study 20 patients were selected according to inclusion and exclusion criteria and it divided in to two groups Group A and Group B by simple random sampling method. Group A receives the treatment of task oriented training alone and Group B receives task oriented training along with specially developed serious games.

Statistical data analysis shows in Group B which receives task oriented training along with specially developed serious games have significant improvement in lower extremity function which includes of balance and gait parameter than Group A which receives the task oriented training alone.

Balance and gait parameter consisting of stride length, cadence and gait velocity of lower extremity function of Diplegic spastic cerebral palsy children has improved markedly in both the group which receives the treatment of task oriented training approach. Statistical analysis shows there were significant improvement in lower extremity function of cerebral palsy children of Group B which receives the combination of specially developed serious games with task oriented training have more influence in the motor abilities than Group A.

Task oriented exercises have efficiency in improve balance, strength, and functional mobility (kumar et al 2013).The efficacy of task related circuit training on functional mobility and balance in children with Spastic Diplegic type of cerebral palsy (Bo Hyun Kim et al. 2012). This study suggest that task oriented circuit training is more effective as compared to the conventional training for functional mobility and balance in spastic Diplegic cerebral palsy children

This may be because of task specific training in rehabilitation focuses on improvement of performance in functional task through goal directed practice and repetition. The focus is on training of functional tasks rather than impairment, such as with muscle strengthening and muscle weakness is a primary limiting factor in ambulation in children with cerebral palsy.

In the treatment of specially developed serious games cerebral palsy children training centre of pressure displacement is in a range more similar that those achieved during the static sitting testing than the dynamic one. Indeed most of the previous studies related to specially developed serious games for balance training of cerebral palsy children were about the use of commercial video games (e.g. Nintendo Wii for balance board). Although those games are designed for balance training, they are also- and especially- designed for gaming purpose of healthy players. Therefore; those games are not adapted at all for disabled patients.

This study mainly focused on find out the combined effect of task oriented training with specially developed serious games on lower extremity function in Diplegic cerebral palsy.

Based on these data the study accepts alternate hypothesis and reject null hypothesis.

Hence combination of task oriented training with specially developed serious games shows significant improvement in balance and gait on lower extremity function in Diplegic cerebral palsy children.

VI SUMMARY AND CONCLUSION

The purpose of the study was to find out the effect of task oriented training alone and task oriented training with specially developed serious games on lower extremity function in Diplegic cerebral palsy.

Based on the statistical analysis Group B subjects shows a significant improvement than Group A. The task oriented training was proved to improve balance and gait whereas the task oriented training along with specially developed serious games gives much more improvement of balance and gait in lower extremity function in Diplegic cerebral palsy.

Thus the study was concluded that task oriented training with specially developed serious games helps to improve the balance and gait in children with Diplegic cerebral palsy.

VII LIMITATION AND RECOMMENDATION

LIMITATION

- The study is small sample size.
- This study is short duration i.e only for 4 weeks.
- There was no follow up after 4weeks of intervention.
- Repetition of each task was not fixed, progression was considered according to each child’s capacity.

RECOMMENDATION

- Study with more patients is recommended.
- Further analysis in balance and gait could be done by using EMG biofeedback.
- Study can be done in subjects with different age groups.
- The study can be extended to all other types of cerebral palsy.
- Follow up study can be done to know the long term effects.

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IX APPENDIX

APPENDIX-I

Gross Motor Function Classification System (GMFCS)

The gross motor function of children and young people with cerebral palsy can be categorised into 5 different levels using a tool called the Gross Motor Function Classification System

GMFCS looks at movements such as sitting, walking and use of mobility devices. It is helpful because it provides families and clinicians with:

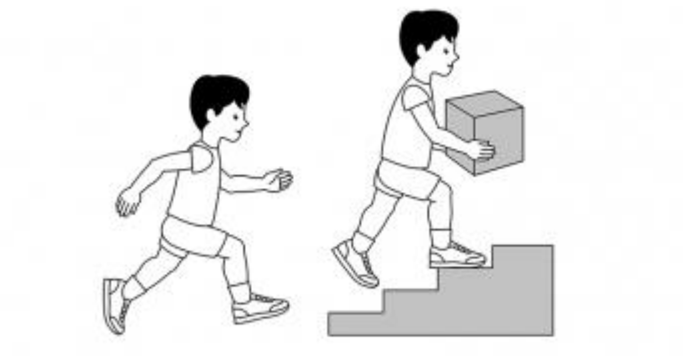
1. A clear description of a child's current motor function, and
2. An idea of what equipment or mobility aids a child may need in the future, e.g. crutches, walking frames or wheelchairs.

Generally, a child or young person over the age of 5 years will not improve their GMFCS-E&R level so, if for example, a child is classified at a Level IV at the age of 6 then it is likely that they will need to use a mobility device throughout their life.

GMFCS SCALE

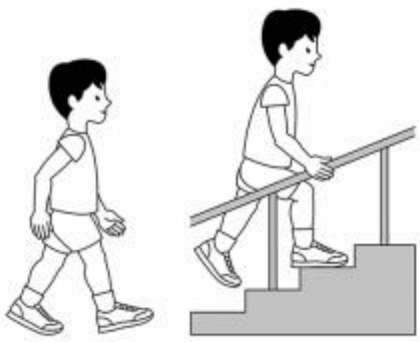
GMFCS Level I

Children walk at home, school, outdoors and in the community. They can climb stairs without the use of a railing. Children perform gross motor skills such as running and jumping, but speed, balance and coordination are limited.



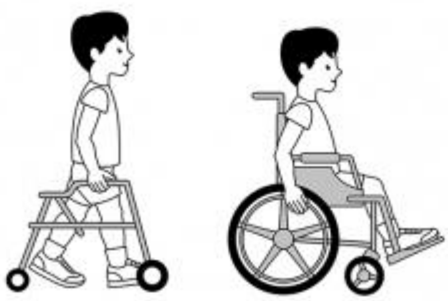
GMFCS Level II

Children walk in most settings and climb stairs holding onto a railing. They may experience difficulty walking long distances and balancing on uneven terrain, inclines, in crowded areas or confined spaces.
Children may walk with physical assistance, a handheld mobility device or used wheeled mobility over long distances. Children have only minimal ability to perform gross motor skills such as running and jumping.



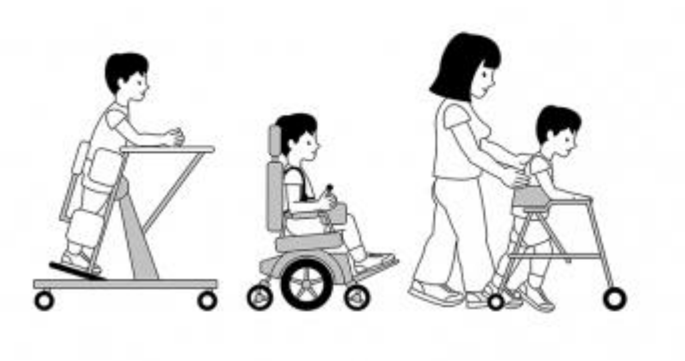
GMFCS Level III

Children walk using a hand-held mobility device in most indoor settings. They may climb stairs holding onto a railing with supervision or assistance. Children use wheeled mobility when traveling long distances and may self-propel for shorter distances.



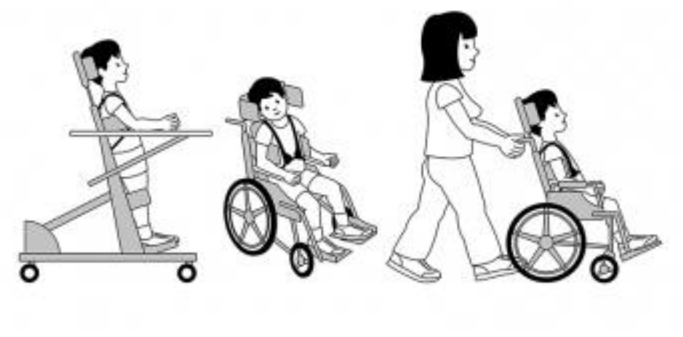
GMFCS Level IV

Children use methods of mobility that require physical assistance or powered mobility in most settings. They may walk for short distances at home with physical assistance or use powered mobility or a body support walker when positioned. At school, outdoors and in the community children are transported in a manual wheelchair or use powered mobility.



GMFCS Level V

Children are transported in a manual wheelchair in all settings. Children are limited in their ability to maintain antigravity head and trunk postures and control leg and arm movements.



APPENDIX-II

Modified Ashworth Scale

The Modified Ashworth Scale (MAS) better measures muscle hypertonia instead of spasticity. The Ashworth scale is one of the most widely used methods of measuring spasticity, due in a large part to the simplicity and reproducible method. The MAS better measures muscle hypertonia instead of spasticity.

Grade Description

- 0 -No increase in muscle tone
- 1 -Slight increase in muscle tone, manifested by a catch and release or by 3minimal resistance at the end of the range of motion when the affected part(s) is moved in flexion or extension
- 1+ -Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
- 2 -More marked increase in muscle tone through most of the ROM, but affected part(s) easily moved
- 3 -Considerable increase in muscle tone, passive movement difficult
- 4 -Affected part(s) rigid in flexion or extension.

APPENDIX-III

PEDIATRIC BALANCE SCALE

Description:

14-item scale designed to measure balance of the children's in a clinical setting.

Equipment needed:

Ruler, two standard chairs (one with arm rests, one without), footstool or step, stopwatch or wristwatch, 15 ft walkway

Scoring: A five-point scale, ranging from 0-4. "0" indicates the lowest level of function and "4" the highest level of function. Total Score = 56

Interpretation: 41-56 = low fall risk

21-40 = medium fall risk

0 –20 = high fall risk

GENERAL INSTRUCTIONS:

Document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item. In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

• The time or distance requirements are not met

• The subject's performance warrants supervision

• The subject touches an external support or receives assistance from the examiner.

Subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring. Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.

Name:

Location:

Examiner:

		Date:	**Date:**	**Date:**
		Score 0-4 (time-optional)	Score 0-4 (time-optional)	Score 0-4 (time-optional)
1.	Sitting to standing **“ Hold your arms up and stand up”** 4- able to stand without using hands and stabilize independently			

	3- able to stand independently using hands 2- able to stand using hands after several tries 1- needs minimal assist to stand or to stabilize 0- needs moderate or maximal assist to stand			
2.	Standing to sitting **“Sit down slowly without using your hands”** 4- sits safely with minimal use of hands 3- controls descent by using hands 2- uses back of legs against chair to control descent 1- sits independently, but has uncontrolled descent 0- needs assistance to sit			

4.	Standing unsupported 4- able to stand safely 30 seconds 3- able to stand 30 seconds with supervision (spotting) 2- able to stand 15 seconds unsupported 1- needs several tries to stand 10 seconds unsupported 0- unable to stand 10 seconds unassisted	(___ sec.)	(___ sec.)	(___ sec.)
5.	Sitting unsupported "**Sit with your arms folded on your chest for 30 seconds**" 4- able to sit safely and securely 30 seconds 3- able to sit 30 seconds under supervision (spotting) or may require definite use of upper extremities to maintain sitting position 2- able to sit 15 seconds	(___ sec.)	(___ sec.)	(___ sec.)

	1- able to sit 10 seconds 0- unable to sit 10 seconds without support			
7.	Standing with feet together 4- able to place feet together independently and stand 30 seconds safely 3- able to place feet together independently and stand for 30 seconds with supervision (spotting) 2- able to place feet together independently but unable to hold for 30 seconds 1- needs help to attain position but able to stand 30 seconds with feet together 0- needs help to attain position and/or unable to hold for 30 seconds	(___ sec.)	(___ sec.)	(___ sec.)
8.	Standing with one foot in front 4- able to place feet tandem independently and hold 30 seconds	(___ sec.)	(___ sec.)	(___ sec.)

	3- able to place foot ahead of other independently and hold 30 seconds 2- able to take small step independently and hold 30 seconds, or required assistance to place foot in front, but can stand for 30 seconds 1- needs help to step, but can hold 15 seconds 0- loses balance while stepping or standing			
9.	Standing on one foot 4- able to lift leg independently and hold 10 seconds 3- able to lift leg independently and hold 5-9 seconds 2- able to lift leg independently and hold 3-4 seconds 1- tries to lift leg; unable to hold 3 seconds but remains standing 0- unable to try or needs assist to prevent fall	(___ sec.)	(___ sec.)	(___ sec.)

10.	Turning 360 degrees **" Turn completely around in a full circle, STOP, and then turn a full circle in the other direction"** 4- able to turn 360 degrees safely in 4 seconds or less each way 3- able to turn 360 degrees safely in one direction only in 4 seconds or less 2- able to turn 360 degrees safely but slowly 1- needs close supervision (spotting) or constant verbal cuing 0- needs assistance while turning	(___ sec.)	(___ sec.)	(___ sec.)
11.	Turning to look behind **" Follow this object as I move it. Keep watching it as I move it, but don't move your feet."** 4- looks behind/over each shoulder; weight shifts include trunk rotation 3- looks behind/over one shoulder with trunk rotation			

	2- turns head to look to level of shoulders, no trunk rotation 1- needs supervision (spotting) when turning; the chin moves greater than half the distance to the shoulder 0- needs assistance to keep from losing balance or falling; movement of the chin is less than half the distance to the shoulder			
12.	Retrieving object from floor 4- able to pick up chalk board eraser safely and easily 3- able to pick up eraser but needs supervision (spotting) 2- unable to pick up eraser but reaches 1-2 inches from eraser and keeps balance independently 1- unable to pick up eraser; needs spotting while attempting 0- unable to try, needs assist to keep from losing balance or falling			

13.	Placing alternate foot on stool 4- stands independently and safely and completes 8 steps in 20 seconds 3- able to stand independently and complete 8 steps >20 seconds 2- able to complete 4 steps without assistance, but requires close supervision (spotting) 1- able to complete 2 steps; needs minimal assistance 0- needs assistance to maintain balance or keep from falling, unable to try	(___ sec.)	(___ sec.)	(___ sec.)
14.	Reaching forward with outstretched arm **“ Stretch out your fingers, make a fist, and reach forward as far as you can without moving your feet”** 4- reaches forward confidently >10 inches 3- reaches forward >5 inches, safely 2- reaches forward >2 inches, safely	(___ in.)	(___ in.)	(___ in.)

	1- reaches forward but needs supervision (spotting) 0- loses balance while trying, requires external support			
	TOTAL SCORE			

APPENDIX-IV

GAIT PARAMETERS

During the pre-assessment session foot prints of all the children were taken with the help of ink on chart paper. The ink was put on the feet of child with the help of a piece of cloth and child was asked to walk on the chart paper fixed on the floor. For the measurement of stride length 2 footprints of affected legs from the middle portion of each walking trial were analysed.

Stride length

The stride length was measured from the heel of the affected foot to the heel of the same foot when it again contacts the ground with the help of a measuring tape/scale.

Cadence

The number of steps per minutes was counted with the help of stop watch.

Gait velocity

Gait velocity was studied at comfortable walking speeds. The mean of 3 repeated walking speed measurements was calculated in order to reduce measurement error.

APPENDIX-V

TASK ORIENTED TRAINING

Task-oriented training involves practicing real-life tasks with the intention of acquiring or reacquiring a skill. The tasks should be challenging and progressively adapted and should involve active participation. It is important to note that it differs from repetitive training, where a task is usually divided into component parts and then reassembled into an overall task once each component is learned. Repetitive training is usually considered a bottom-up approach, and is missing the end-goal of acquiring a skill. Task-oriented training can involve the use of a technological aid as long as the technology allows the patient to be actively involved. Task-oriented training is also sometimes called task-specific training, goal-directed training, and functional task practice.

INTERVENTIONS

(1) Standing and reaching in different directions for objects located beyond arm's length to promote loading of the lower limbs and activation of lower limb muscles;

(2) Sit-to-stand from various chair heights to strengthen the lower limb extensor muscles;

(3) Stepping forward and backward onto blocks of various heights to strengthen the lower limb muscles;

(4) Stepping sideways onto blocks of various heights to strengthen the lower limb Muscles;

(5) Forward step-up onto blocks of various heights to strengthen the lower limb muscles;

(6) Heel raise and lower while maintaining in a standing posture to strengthen the plantar flexor muscles.

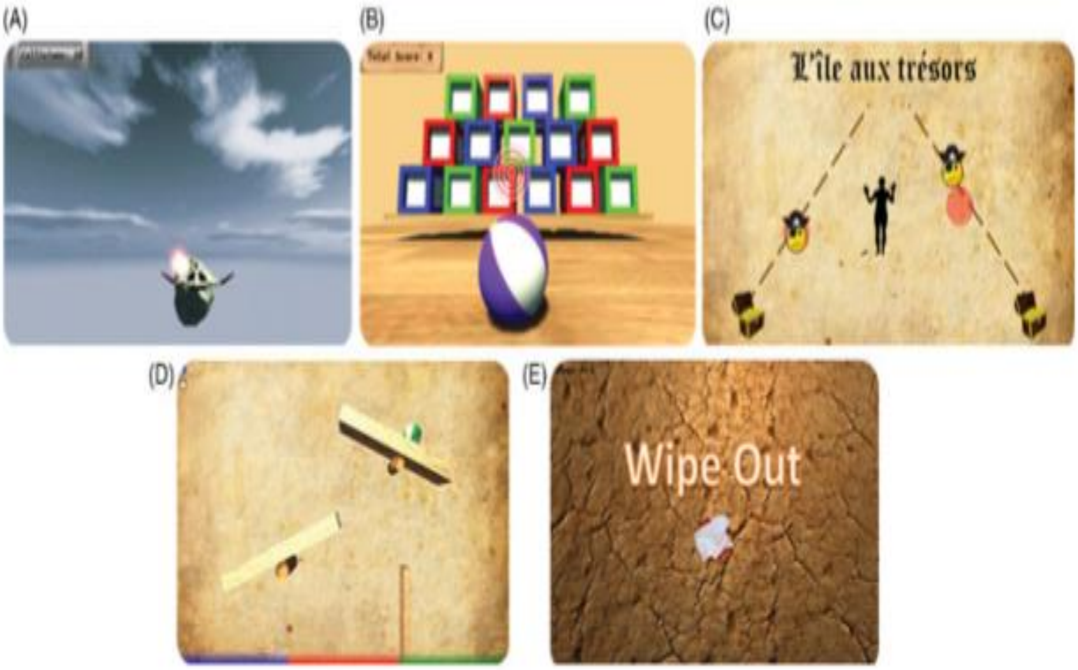
Each task was given 5 min in duration for each exercise class. Children were being encouraged to work as hard as possible at each workstation and were also be given verbal feedback and instructions aimed at improving performance. The progression of the task was considered according to each child’s ability. Progressions were include increasing the number of repetitions completed within 5 min at a workstation and increasing complexity of the exercise performed at each workstation, such as the distance reached in standing, reducing the height of the chair during sit-to stand, and the height of the blocks.

APPENDIX-VI

SPECIALLY DEVELOPED SERIOUS GAMES

However, these games were primary designed for fun and not for rehabilitation, therefore for some heavily disabled patients it is not obvious to integrate them into rehabilitation (e.g. because of the speed required from the patient to play or the visual complexity disturbing many CP patients suffering from visual impairment). Therefore, specific patient games must be developed from real clinical specifications including rehabilitation schemes and therapists' expectations; only such integration can answer the practical rehabilitation field constraints.

A series of mini-games seems to be an interesting supplementary method to be added in the PT treatment of CP children. Patients enjoyed playing and did not experience any difficulties to play the games because those games are specially adapted for this pathology and are highly configurable and therefore adapted for each patient and each pathology.



INTERVENTIONS

SPECIALLY DEVELOPED SERIOUS GAMES.

(A) Flight simulator (lateral translation of CoP),

(B) Hit the boxes (lateral translation of CoP),

(C) Follow me (oblique translation of CoP),

(D) Balls (lateral translation of CoP),

(E) Wipe out (translation in all directions of CoP).

Five specific games have been developed (snapshots of the games are presented in Figure. Movies of the games can be seen from http://www.youtube.com/ict4rehab). Within this study, all games were controlled with a Nintendo Wii Balance Board (WBB) linked to a computer via Bluetooth. One game (Balls see Figure 1D) was controlled with a WBB and a Kinect sensor, simultaneously. Because some of the patients could not stand alone and/or for a sufficiently long period of time, all patients were seated on the middle of the WBB when playing. Different potential used of the WBB during the control and play the games [e.g. the center of pressure (CoP) displacement required to control the game can be easily modified from almost 0 in case of highly disabled patients to an important displacement in case of light handicap.

APPENDIX-VI

CONSENT FORM

This is to certify that I -- freely and voluntarily agree to participate in the study “**A COMPARITIVE STUDY TO FIND OUT THE EFFECT OF TASK ORIENTED TRAINING ALONG WITH SPECIALLY DEVELOPED SERIOUS GAMES AND TASK ORIENTED TRAINING ALONE ON LOWER EXTREMITY FUNCTION IN DIPLEGIC CEREBRAL PALSY”**

I have explained about the procedure and the risks that would occur during the study.

Participant:

Witness:

Date:

I have explained and defined the procedure to which the subject has consented to participate.

Researcher:

Date: