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Effect of Motor Skill Training on Balance and Hand – Eye Coordination in Children with Attention Deficit Hyperactivity Disorder (ADHD)

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ABSTRACT

Background: ADHD or Attention Deficit Hyperactive disorder is one of the most common condition affecting children. It is a neuro behavioural disorder affecting boys more than girls with a ratio of 3:1 and it affects almost 3 to 6 percentage of school children. There are limited number of studies on motor skill training to improve attention, balance and hand eye coordination.

Methodology: Quasi Experimental, Convenient sampling, sample size was 30. The Participants for the study were selected based on the inclusion and exclusion criteria and experimental group followed 6 weeks of motor skill training exercise along with conventional physiotherapy.

Conclusion: The results of this study showed post-test values of paediatric balance scale, nine-hole peg board test and gross motor functional measure of experimental and control group has a p value < 0.05 which is statistically significant. The study concludes that, motor skill training on attention deficit hyperactivity disorder shows significant improvement in balance and hand eye coordination.

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Introduction

ADHD or Attention Deficit Hyperactive disorder is one of the most common condition affecting children [1]. It is a neuro behavioural disorder affecting boys more than girls with a ratio of 3:1 and it affects almost 3 to 6 percentage of school children. There are three main characteristics that define ADHD which are inattention, impulsivity and hyperactivity. The DSM-IV classification classifies it into three subtypes which are inattentive, hyperactive-impulsive and a combined subtype [2].

Based on two behavioural patterns, ADHD is further divided in to 3 subtypes which are predominantly inattentive subtype, hyperactive subtype and impulsive subtype. The former being more common among girls and the latter being more common among boys [3,4]. The inattentive subtype usually has difficulty in attention, organisation, lack of persistence and repeated distractions. The hyperactive or impulsive type involves excessive motor activity and impulsive behaviour or response [5].

The aetiology of ADHD is multifactorial. Genetic and neurological factors play a major role in determining the occurrence of this condition. Extrinsic factors like environment might contribute to aggravating the symptoms and the prevalence of associated deficits [6].

The male gender has a higher rate of occurrence than the female with the ratio of 3:1. The prevalence varies with age, 11.4% for the age group 6–12 years, 8% in 13–18 years and 5% for 19 years [4]. In tamilnadu, the prevalence of attention deficit hyperactivity disorder was found to be 8.8%. The subtypes of ADHD were classified as 43.3% for inattentive type and hyperactive type, and 13.2% for combined type of ADHD [7,8].

Children with ADHD have problems associated with a wide range of tasks, especially the ones that involve sustained attention [9]. They have problem concentrating on everyday tasks like lectures, conversations, reading, playing etc. They also forget things easily, fail to meet deadlines and do not like to participate actively in groups which require a lot of mental effort.

Niedermeyer and Naidu suggest that frontal-motor cortex disconnections appear in the motor activity and attention disturbances is seen in children with ADHD. Basal ganglia

functional abnormalities and smaller cerebellum in children with ADHD have been investigated with neuro imaging studies, both basal ganglia and cerebellum plays a major role in maintaining motor control activity and balance. Limited number of studies evident that ADHD have balance dysfunctions, so we are not sensible to any studies on balance function in children with ADHD [10].

ADHD is caused due to dysfunction in dopamine branches and impaired non-dopaminergic signal transmission [11]. A malfunctioning meso-limbo-cortical dopamine branch will lead to altered reinforcements and extinction of processes which will eventually result in hyperactivity, lesser attention span, behaviour changes, motor and cognitive changes. A malfunctioning nigro-striatal dopamine branch will cause poor motor control [12].

ADHD is also associated with motor problems [13].Research has stated that almost 30-50% of ADHD children suffer from motor problems [12]. It can be identified when a pre-schooler or kindergartener has difficulty in performing skills of his/her age such as playing or writing. The poor motor coordination trait is attributed to the child's lack of attention span and repeated distractions while doing a specific task [14].

Motor skills are actions which involve the precise involvement of muscles that involve combined action of brain and nervous system to execute the activity in an appropriate manner [6].

It is classified into two types which are gross motor skills and fine motor skills. As the name indicates, gross motor skills involve activities that require a larger group of muscle to work, for example: swimming, running, walking etc., These activities require coordinated movements of the arms and legs. Fine motor skills on the contrary are activities that involve smaller movements especially those that occur in hand, wrist, thumb, fingers etc. Impaired fine motor skills can result in poor academic performance as it requires a lot of fine motor skills like writing, playing etc [9,15].

Motor skills play a very important role, especially on how a child functions in a social or emotional aspect or surrounding. Motor skills and social or emotional functioning has indirect relationships with each other. Inadequate motor skills may result in reduced performance in individual and team games, which in turn impact child's sense of competence [16].

Motor problems prevalence in children with ADHD vary from 30% to 52%. Pitcher et al. says that 58% of children with ADHD inattentive subtype, 49% with ADHD combined and 47% with ADHD hyperactivity and impulsiveness had motor problems. Not much of focus is being directed towards motor skill deficit in ADHD children in clinical settings [11].

The type of motor deficits that are found in ADHD vary according to the subtypes that were discussed earlier [17]. Pieck et al. concludes inattentive type have poor fine motor activities whereas children with combined type experiences difficulty in gross motor activities [6,7].

Poor motor skills can put ADHD children at the risk of developing high anxiety, weak confidence levels, lack of physical fitness and poor social function. Kaiser et al. argue that individuals with ADHD may fall or knock things over this may be due to motor impairment[12]. Most oftenly, attention deficit hyperactivity disorder children show consistent motor skill impairment. Since the motor skill training on ADHD children will also enhance attention and focus, there are limited number of studies on motor skill training to improve attention, balance and hand eye coordination. Hence, this study is focused to find out the effects of motor skill training on balance and hand eye coordination in children with attention deficit hyperactivity disorders.

Materials and Methods

This study was conducted in order to explore the effects of motor skill training on balance and hand-eye coordination in children with attention deficit hyperactivity disorder (ADHD). The Participants for the study were selected based on the inclusion and exclusion criteria. The inclusion criteria include: Age group 6 -10 years, According to SWAN Neck Rating Scale for ADHD children more than 6, Both boys and girls, Pediatric balance scale ranges from 21- 40. Exclusion criteria include: Pediatric balance scale range greater than 40, less than 21, Any orthopedic surgery in legs and hand, Visual problems, Hearing problem, Mental retardation children, Any cardiovascular problem.

All Children and their parents were explained about the procedure of the study and the parental/guardian informed consent was obtained before the start of the study. The selected children were divided into two groups, Group A as experimental group and Group B as control group. A diagnostic test of swan neck rating scale, was used to suspect ADHD with the help of scoring and it was done for both the groups. The paediatric balance scale, gross motor functional measure and nine-hole peg board test as a Pre and Post-test outcome measure.

GROUP A-Experimental group (n=15) was given with an exercise intervention program of motor skill training along with conventional physiotherapy. GROUP B-Control group(n=15) was given with conventional physiotherapy of fine motor and coordination exercises. The exercise directions for experimental group include warm up for 5 min with deep breathing exercise, jogging on same place, motor skill exercise for 20 min which includes hand skill, balance, strength and ball skill exercises, cool down for 5 min which includes deep breathing exercise, stretching for upper and lower limb. Separate exercise protocol for each week duration of 30min/day -3 days per week for 6 weeks. After the completion of 6 weeks program, post-test was assessed to check the improvement for motor skills in children with ADHD. The data collected from the individuals were tabulated and entered in MS – Excel spread sheet. The pre and post mean values of nine-hole peg board test, paediatric balance scale and gross motor functional measure score is calculated, assessed and tabulated. The data analysis was done by using IBM SPSS Version 20[18].

Group a – Experimental Group
WEEK 1-2
Hand skills
Finger tips touching with eye open and closed
Posting coins (both hands)
Colouring the shapes
Balance
Sitting to Standing
Standing to Sitting
Standing with eyes closed
Standing with feet together
Standing on one foot
Strength
Jumping over a small obstacle
Strength and Balance
Alternate jump (forward, backward)

Horizontal jump
Foot tapping
WEEK 3-4
Hand skills:
Placing dots in the grid pattern
Puzzle maze
Balance
Turning to 360 degree
Retrieving objects from floor
High knee march
Strength
Hop on one leg and pull the object on the string
Ball skills
Ball catching
Ball throwing
Ball kicking
WEEK 5-6
Hand skills
Cutting the paper into different shapes
Threading the beads
Worksheet
Balance
Placing alternate foot on the stool
Stance on the right leg and jump over the obstacles, then left leg
Jumping on mats
Strength
Hopscotch hop and jump in the number
Ball skills
Move the balloon with knees
Catch and clap off the wall
Jump with ball squeezed in your leg

Outcome Measures
1.Paediatric balance scale: It has reliability value of ICC > 0.99 [19].

2.Gross motor functional measure: Here, I have taken 2 domains D and E for assessing gross motor skills. It has highly reliable >0.98[20].
3.Nine-hole peg board test: It has test-retest reliability ICC = 0.95 for right hand, ICC = 0.92 for left hand[21].

Results and Discussion
The result of this study proved that the group A - experimental group which received 6-week motor skill training program showed an improvement in the nine-hole peg board test, paediatric balance scale and gross motor functional measure. The statistical analysis showed significant improvement in the nine-hole peg board test, paediatric balance scale and gross motor functional measure in both control and experimental groups, but clinically significant improvement was higher in experimental group when assessed using paediatric balance scale, nine-hole peg board test, gross motor functional measure.

30 children were selected according to the swan neck rating scale, in which 15 were experimental group and 15 were control group. Both the group were assessed by paediatric balance scale, gross motor functional measure and nine-hole peg board test as a pre- test measure. Experimental group was given a motor skill training in combination with conventional physiotherapy and control group was given a conventional physiotherapy. The study was carried out for a duration of 6 weeks. The post-test for both the groups was done using the paediatric balance scale, gross motor functional measure and nine-hole peg board test. The study was done to find out the effectiveness of motor skill training on balance and hand eye coordination in children with attention deficit hyperactivity disorder (ADHD). Statistical analysis shows significant improvement in balance, hand eye coordination and attention when treated using motor skill training protocol.

Motor skill training is one of the best interventions in children which improves the attention, concentration, listening skills and also improve the social participation. Motor skill mainly focused to improve daily activities and increase their quality of life [9]. It also helps children to control their bodies, manipulate their environment, complex movements that involved in sports and other recreational activity [11]. Jayanthi et al. in her study concluded that variety of exercise programme that improve the motor skill, attention, hyper behaviour, physical fitness and structured exercise programmes also improve the cognition and behavioural problems in children with ADHD [22]. Maria Mokopane Basil J et al. in her study concluded that fine motor skills mainly affect inattentive and combined types of attention deficit hyperactivity disorder [7]. So, this study is focused to find out the effect of balance and hand eye coordination in children with ADHD. E. Fliers et al. concluded that motor coordination equally affects both boys and girls in younger and older children [2].

The Paediatric balance scale experimental group and control group post-test values are 47.40 and 39.80 mean respectively. According to the obtained results both the treatment methods showed a significant improvement in paediatric balance scale in ADHD children, but when considering the mean values of post-test, a clinically significant improvement is noticed in the experimental group. Kim et al. study found that children with ADHD had a problem in balance [23]. Amira H. Mohammed et al. has concluded that ADHD has balance disorders when assessed using paediatric balance scale, similar to which this study uses paediatric balance scale to improve static and dynamic balance in children with ADHD [14].

The Gross motor functional measure experimental group and control group post-test values are 82.04 (Domain D), 84.62(Domain E) and 75.17(Domain D), 77.21(Domain E) mean respectively. According to the obtained results both the treatment methods showed a significant improvement in gross motor functional measure in attention deficit hyperactivity disorder children, but when considering the mean values of post-test, a clinically significant improvement is noticed in the experimental group. Nakesha Arumugam et al. has concluded that ADHD children has reduced gross motor skills, fine motor skills and reduced physical fitness compared to normal children24. Marzieh et al. concluded that motor performance exercise shows improvement in locomotion and total motor skill scores [25].

Similar to which, this study proves that when is trained using Motor skill training program there is clinically significant improvement in gross motor activities and physical fitness in children with ADHD. The Nine-hole peg board test experimental group and control group post-test values are 37.72 (Right), 46.69(Left) and 49.17(Right) 55.21(Left) mean respectively. According to the obtained results both the treatment methods shows a significant improvement in nine-hole peg board test in attention deficit hyperactivity disorder children, but when considering the mean values of post-test, a clinically significant improvement is noticed in the experimental group. Jayanthi et al. in their case study concluded that 6-week combination of structural exercise and neurolinguistics programming improve the fine motor skills, gross motor skills and

overall fitness level in children with ADHD [26].

Caroline Frederika Kamp et al. in their study concluded that designed exercise intervention reduced the symptoms of ADHD in children and improvement in attention, motor skills, strength and social behaviour in children with ADHD [27].

This study was mainly intended to evaluate the motor skill training effectiveness in children with ADHD. Since there are only limited number of studies supporting the effectiveness of motor skill training program on balance and hand eye coordination in children with ADHD, this study unambiguously evaluates these factors. The major limitation of this study is the constrain in the study duration due to Covid pandemic. At first it was targeted to have 8-week study duration but the study was done within a 6-week duration. Future recommendations of the study: Parental involvement in exercise intervention program can be implemented, The relationship between parental analysis and therapist analysis can be compared, Large sample size can be selected to obtain accurate result.

This study concludes that there is an improvement in the balance and hand eye coordination after the 6 weeks motor skill training on children with ADHD which can improve their academic performance, attention, concentration and social participation.

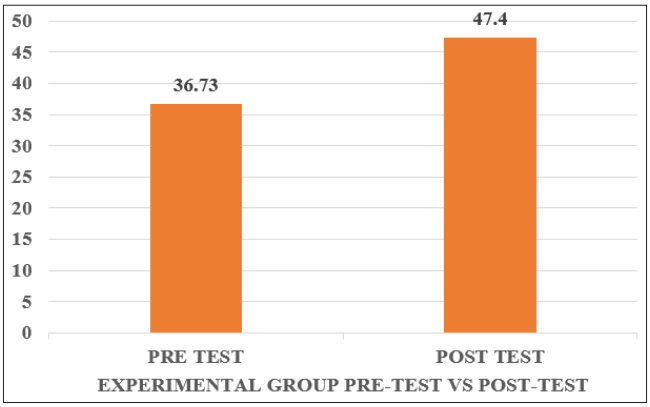

Figure 1: Pre and Post Test Values of Paediatric Balance Scale In Experimental Group

Experimental group shows an increased value in the post-test of paediatric balance scale after training with motor skill exercises. On average values of paediatric balance scale pre-test value are 36.73 whereas the post-test value is 47.40.

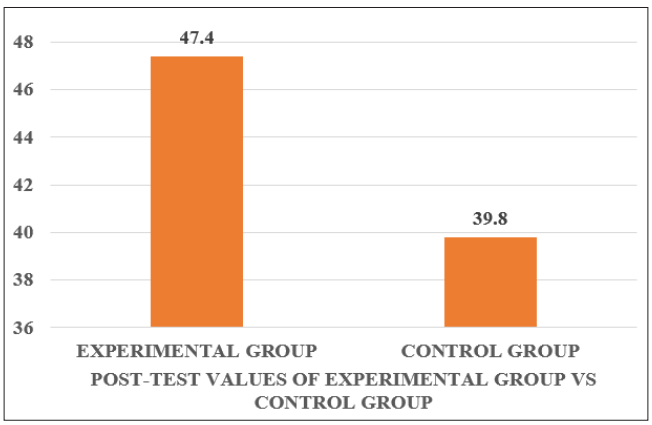

Figure 2: Comparing the Post Test Values of Experimental Group Vs Control Group in Paediatric Balance Test

The post-test values of experimental group show a marked increase than a control group in paediatric balance scale. The post-test values of experimental group are 47.40 and control group is 39.80.

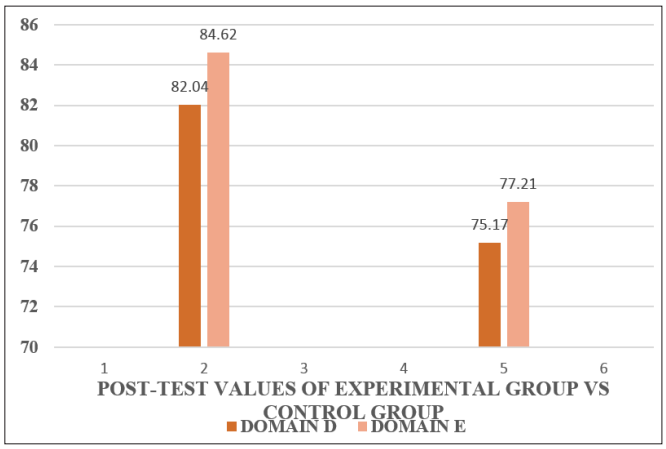

Figure 3: Comparing the Post Test Values of Experimental Group Vs Control Group in Gross Motor Functional Measure

The post-test values of experimental group show a marked increase than a control group in gross motor functional measure. The post-test experimental group is 82.04(Domain D),84.62(Domain E) and control group is 75.17 (Domain D), 77.21(Domain E).

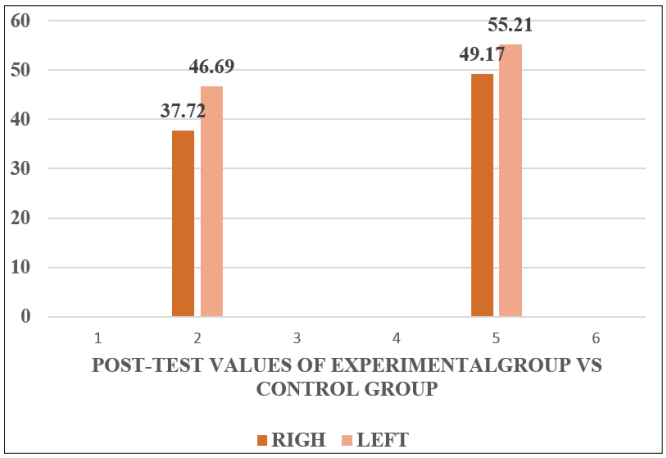

Figure 4: Comparing the Post Test Values of Experimental Group Vs Control Group in Nine Hole Peg Board Test

The post-test values of experimental group show a marked increase than a control group in nine-hole peg board test. The post-test values of experimental group are 37.72(Right), 46.69(Left) and control group is 49.17(Right), 55.21(Left).

Conclusion

This study concludes that, motor skill training on attention deficit hyperactivity disorder shows significant improvement in balance and hand eye coordination. Simultaneous application of motor skill training protocol and regular exercise should be considered when designing a rehabilitation program to improve attention, balance and hand eye coordination in attention deficit hyperactivity disorder [28, 29].

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Ethical Clearance: Departmental ethical committee clearance was obtained before conducting the study.

Conflict of Interest: Nil

Source of Funding: Self

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