

# Influence of Structured Aquatic Training Program on Endurance and Tone of Children with Cerebral palsy

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**Abstract:** This study is pursued to find the effectiveness of Structured Aquatic Training Program for children with Cerebral Palsy. Sensory profile was used to assess the effectiveness of endurance and tone, of 14 Children with CP average of age nine years, purposively selected from Asha AWWA school at Delhi, India. Participants were divided into Experimental and Control groups. Result of Two Way ANOVA reflects positive accelerated transformation only in experimental group, showing moderate to considerable benefits through the 9 weeks training program. In addition, individualized scale of improvement was also studied, which resulted into minor to major enhancement of endurance and tone among all the experimental group participants. Hence a prolonged Structured Aquatic Training Program (intervention) is off paramount to get the best results. These findings also enhance the preceding research work based on aquatic intervention.

**Keywords:** Cerebral palsy, structured aquatic training program.

## I. INTRODUCTION

Cerebral palsy (CP) is a permanent movement disorder. They face both physical and intellectual problems, with poor coordination, stiff and weak muscles resulting into poor functional efficiency and other difficulties in sensation, vision, speaking, thinking and reasoning (NINDS, 2013). It occurs in early childhood, by abnormal development or damage to the brain or CNS, that controls movement, balance, and posture (NINDS, 2013) (NIH, 2017) and results in abnormal sensory processing (Iliana, 2013) (Sultana, 2018). Researchers advocates that children with CP lack in endurance, muscle strength, tone and physical activity (MN Eek, 2011) (SLCarlson, 2013), reduced physical ability signifies the risk of negative health outcomes and early mortality (MD Peterson, 2012) (M Peterson, 2015). Endurance and tone indicates how much and how long the individual can work, as these are related to muscular abilities which are connected with CNS and motor neuron system. Smooth physical activity can only be executed, with good control over the sensory processing allowing full functional efficiency (Hillary A. Reinhold, 2014; Maria A. Fragala Pinkham, August 2011). It is evident that regular exercise

from an early age helps to gain physical abilities (Benda, 2015) (Haak Peterson, 2009). However, land based activities are difficult for a person with movement limitations (Lidija Dimitrijevic, 2012). Hence in such a case aquatic activity can be a doorway to reduce their difficulties and improve quality of life (Ki-Hyeon Kim, 2018). The buoyancy of water relieves them from pain and makes them comfortable to float and choose their locomotion, which becomes difficult on land. Also, aquatic activity is helpful to improve motor skills which reduce disabilities and sensory impairments as well (Aleksandrovic, 2016) (Hall J. J., 2013). Density, hydrostatic pressure, buoyancy, viscosity, and thermodynamics the physical principles of water are helpful for CP children in various ways. Therefore, Aquatic programs can be effective and beneficial for children with physical and intellectual disorders (Gerter JW, 2011). With this understanding, the author prepared structured aquatic training program to evaluate its influence on endurance and tone processing of children with CP.

## II. METHODOLOGY

### Participants

A total of 14 children with CP were selected as participants for the study from Asha AWWA School, Delhi Cant, India in summer 2018. School allowed students with CP to be part this study those who were following in the category of non-clinical requirement and age range between 7 to 11 (average age nine years). On the basis Sensory Profile Questionnaire's scores filled by their caregiver/ teacher/ parents, students were categorized and only the students falling in definite difference were selected for this study. The selected participants were randomly divided into two groups of 7 participants each in experimental group and control group.

### Criterion measure

- ❖ Sensory Profile Questionnaire developed by Winnie Duun, 1999, to be filled by parents/ teachers/ caregivers was used to measure the sensory performances.
- ❖ The summary score-sheet provides the range of scores for understanding the students' performance at three scales i.e.
  - Typical Performance: indicating the child's performance as good condition and requiring no intervention,
  - Probable Difference: it indicates that the child's performance is improvable and

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- **Definite Difference:** it directs that the child is definitely in need of intervention and has a lot of scope for improvement.

### Preparation of training program

The training program was purposively designed with the selected exercises to improve endurance and tone. According to (O. VerschuAdaen, 2011) (Lidija Dimitrijevic, 2012 ) coalition of both aerobic and strength exercise are highly gainful for children with CP to improve endurance, muscle strength and tone. So the current study's aerobic activities were directly related to endurance and resistance offered by water. Also, own body weight along with verity of exercises along with assisted in muscle strengthening and toning. Program intensity was gradually increased and variations were introduced after every two weeks. Training program was finalized after discussion and feedback, of the experts and supervisor. The finalized program consists of three phases, namely, familiarization with new environment, acclimatization with water and water activities and advanced activities.

- ❖ The *first phase* included land warm up for the first week - activities like walking and running in different patterns on land and in water, and splashing in hands and legs in water.
- ❖ The *second phase* was constructed to develop participant's water balance, confidence to perform activity, strength and endurance to resistance of water and fear removal drills. It included only water activities like Walking and Jumping in water, Squatting holding railing, Bubbling and Floating.
- ❖ The *third phase* of the training consists of advanced activities which included Walk and squat, Squatting independently, Prone/supine float, Kicking holding pool side/rode/reeling, Floating with wall push, Catching and throwing, Floating and kicking (with kick board). Every week, advanced and novel activities were introduced to the participants. Some fun activities targeting sensory development like putting the floating animals in bucket, putting rings in a pipe, collecting different coloured ball, Squatting with open eyes inside water as a number game, Balancing on the tube, etc. were also incorporated in every session.

### Administration of the Structured Aquatic Training Program

The current Structured Aquatic Training Program was administered for nine weeks three days in a week and each session lasted for 40 minutes. It was planned as alternate days training provides adequate recovery and increase strength and endurance (Faigenbaum A. D., 2009) (Lidija Dimitrijevic, 2012 ). For the smooth and effective administration of the training, the students were divided into two segments of 3 and 4 participants for alternate days (Group 1: Mon, Wed, Fri; Group 2: Tues, Thurs, Sat) in each session there were two participants and two coaches.

In case, participants were not able to follow the given instructions, the instructor provided vocal prompt paired with a manual guidance. Manual guidance was faded as soon as the participant began to engage in the task independently (which usually took 2 to 3 sessions for each activity or more depending upon the severity of the participants and activity). If the participant did not engage in the task even after manual guidance, it is considered that the participant is not willing to

perform or is scared of that particular activity. In this condition, the participants were instructed to execute the next activity listed in the program for every session. The session is only considered complete when the participant finishes all activities mentioned for one session. After completion of each activity, vocal praise was given to encourage the participants and once participants completed the activities for the session, they were encouraged by tapping on shoulder or shaking hands or high-five or different claps.

### Safety precautions

It was examined in advance through verification and physical visit that:

1. No participants were in need of any clinical assistance (low severity level).
2. Depth of the pool was 2.5 feet's initially for water familiarization, and gradually increased till 3.5 throughout the duration to increase the resistance.
3. The pool had stairs as well as two railings to avoid any unforeseen happening.
4. Every participant was assisted by an elder person outside the pool and even in changing rooms
5. A ratio of one coach to one participant was maintained to get more attention of the subjects.

### Collection of Data

Pre data - before starting the training program, the questionnaire was distributed among the concerned parents or teachers. All questions were explained to them for receiving accurate responses. After pre data assessment, subjects were identified on the basis of their sensory profiling, having a need of sensory intervention in terms of endurance and tone and hence, selected for the study.

Training program - During nine weeks training program, after every session a recording sheet was maintained to record the performance of participants separately. It maintained the record of scores earn by the participants for all the activities planned for the session, rated on the scale of 0 - 5 as per the desired level of each activity. Post data - After completion of the training program, the questionnaire was again filed by the class Teachers/ Parents/ Caregiver for evaluation of post-performance of all selected participants for evaluation of endurance and tone.

## III. RESULTS

The current study presents the statistical analysis and its interpretation of the effect of Structured Aquatic Training Program on Endurance and Tone, on the basis of pre and post test conducted Two Way ANOVA and Syntax calculations of SPSS was employed to test the effect of intervention on and among the groups. Further, the Sensory questionnaire assisted the analyzer to understand the effect elaborately.

**Table I: Descriptive statistics of total Vestibular Processing Score of Sensory Profile**

Groups	Performances	Mean	Std. Deviation	N
Experimental Group	Pre	21.42	5.85	7
	Post	34.28	7.88	7
	Total	27.85	9.43	14
Control Group	Pre	21.00	4.20	7
	Post	22.00	2.82	7
	Total	21.50	3.48	14
Total	Pre	21.21	4.90	14
	Post	28.14	8.54	14
	Total	24.67	7.69	28

The descriptive analysis shows the mean results between experimental and control group of the selected participants. Mean score of pretest of experimental group was 21.42 (SD 5.85) and posttest was 34.28 (SD 7.88). Among the control group, pre and post scores were 21.00 (SD 4.20) and 22.00 (SD 4.90) respectively. Further, the two way analysis was computed to check whether there was any significant difference in performances, the results shown below in table 2:

**Table 2: Analysis of Two Way ANOVA of Endurance and Tone among pre and post performances between Experimental and Control Group**

Source	Sum of Square	Df	Mean Square	F	Sig.
Groups	282.89	1	282.89	9.26	.01*
Performance	336.03	1	336.03	11.0	.00*
				0	
Groups*Performances	246.03	1	246.03	8.05	.01*

\*p<0.05

Experimental and control groups were found significantly different with the scores as f (Df =1) 9.26, p<0.01. Both pre and post performances were significantly different with f (Df =1) 11.00, p<0.05. The interaction between groups and performances were also found to have significant difference with f (Df =1) 8.05, p<0.01. Thus, training program has some effect over endurance and tone of sensory processing as the scores are showing significant difference. To check the exact effect of training on the experimental and control groups, of control and experimental groups, Syntax of SPSS was further computed. Findings are represented in table below.

Table III: Pairwise Comparisons of Pre and Post of both the groups in Endurance and Tone Performance

Performance	(I) Groups	(J) Groups	Mean Difference (I - J)	Std. Error	Sig. <sup>a</sup>	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Pre	Experimental	Control	0.42	2.95	0.88	-5.66	6.52
	Post	Experimental	Control	12.28	2.95	.00*	6.18
Groups	Performance	Performance					
Experimental	Post	Pre	12.85	2.95	.00*	6.76	18.95
Control	Post	Pre	1.00	2.95	0.73	-5.09	7.09

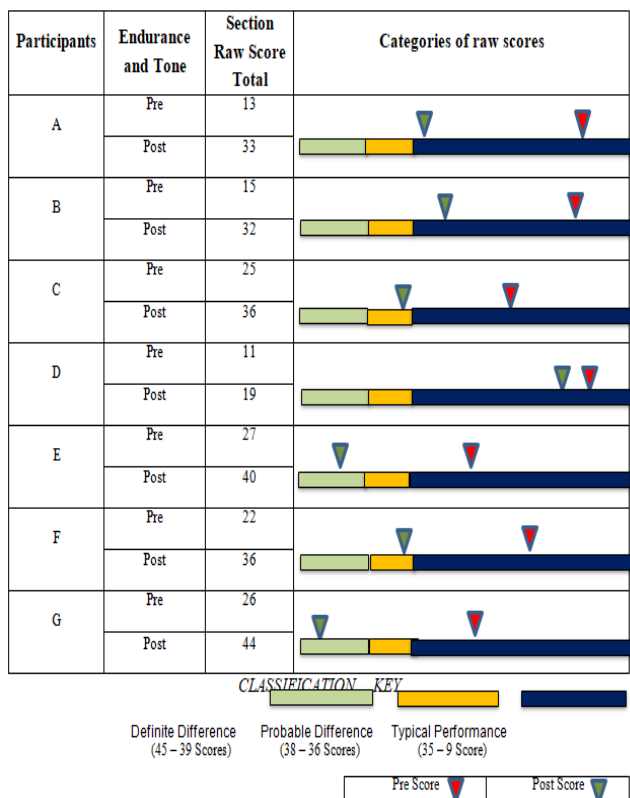
\*P< 0.05

The table reveals that pre performance of experimental and control groups have no significant difference p>0.05 (0.88), it can also be understood by the mean scores of pre performances of experimental (21.42) and control group (21.00). While, when post training performances was compared within experimental and control group, significant difference was found as p<0.05 (0.00). When pre and post performances of experimental group was compared, it shows significant difference p<0.05 (0.00). However no significant difference was found in comparison of pre and post performances control group (p = 0.73). In post-performance is experimental group stood statistically higher (M = 34.28) in comparison with the control group (M = 22.49). Conclusively, the pre performances of experimental and control group was statistically insignificant but post training performances of experimental group has shown a significant improvement, which indicates a positive effect of training on endurance and tone of children with CP. To have a clear glance on the change in performances, the below table of Sensory Profiling of the subjects is reflected as per their performance on the, Questionnaire [summary score sheet].

**Table 5: Endurance and Tone Performance Scores before and after the Structured Aquatic Training Program of Nine Weeks.**

Groups	Performances	Typical Performance	Probable Difference	Definite Difference
		Good Condition (45 - 39 Scores)	Moderate (38 - 36 Scores)	Poor Condition (35 - 9 Score)
Experimental Group	Pre	0	0	7
	Post	2	2	3
Control Group	Pre	0	0	7
	Post	0	0	7

The table indicates effect of nine weeks training on endurance and tone of the subjects. It shows that, only the experimental group participants have moved toward progress by showing improvement in scores and profiling. While all 7 subjects of control group remained in definite difference in pre and post performances trials.



**Fig 1: Detailed description of improvement in Experimental Group**

For further understanding, the case wise improvement is described only for experimental group participants. A positive acceleration from pre to post performances of the experimental group participants, on three scales of sensory profiling (Definite Difference Probable Difference. Typical Performance) is reflected in fig 1.

The above figure depicture that in experimental group, total 57% of participants i.e.; 4 students have shown tremendous improvement, among them 2 participants i.e.; E and G have shown a shift from typical performance to definite difference which is biggest improvement among all. Other two participants C and F have also shown enhanced performance, by shifting from typical performance to Probable difference. Remaining 43% of the participants i.e. participants A, B and D have also improved in their scores, but remained in the same scale of Typical Performance in both pre and post training performances.

The Typical Performance Score range from (9 - 35) which is maximum in comparison to other two categories, where Probable Deference range from (36 - 38) and Definite Difference (39 - 45). As the range of Typical Performance is high, the participant may not jump into the next superior category, but travelling within the Typical Performance from a low score to high will have a positive sign of endurance and tone improvement. Hence, it is evident that A, B and D have improved in their scores but remained in Typical Performance which is not ignorable.

**Discussion of findings**

Several studies (Weaver, 2013), (İlker Yılmaz, 2009) have found improvement through aquatic training program in aspect like walking gait, gross motor, social aspect, etc. the aquatic activities are kind of physical activity, in addition to that water is considered as a more suitable environment than land for children to exercise freely (M. Kelly and J.Darrah,

2005). After understanding the deficit of the identified subjects, present aquatic training program was deliberately designed with set of exercises to improve endurance and tone related to sensory parameters for CP population (Faigenbaum A. D., 2009) (GorterJ.W., 2011). Considering the above facts, set of endurance exercises like walking, jumping, squatting, catching & throwing, etc along with water resistance and own body weight to benefit toning. A gradual increment in intensity level was maintained throughout the program; moreover no participants were forced to perform beyond their abilities. And the structured training was imparted for three sessions per week for nine weeks, which facilitated sufficient recovery after each session and escalates strength and endurance as well (Lidija Dimitrijevic, 2012 ) (Faigenbaum A. D., 2009).

According to the selection process all identified subjects were almost identical. The mean scores of pre performances were similar for both the groups, i.e. experimental group 21.42 and control group 21.00. The pairwise comparison the pre performances were similar for both experimental and control groups. Hence, post-performance of Structured Aquatic Activities for all the participants of experimental group has turned up with an improvement in the scores of endurance and tone. The degree of improvement among these participants varied from minor to major changes. Based on the three scales of Sensory Profiling, improvement can further be understood better by presenting in two different perspectives of, improvement in score with no shift; and improvement in score with shift in higher profile.

Participants G and E (28.50 %) exhibited maximum improvement and shifted to superior category of sensory profiling, i.e. from typical performance to definite difference with a score improvement of 14 and 18 respectively. While another 28.50% of participants i.e. F and C have shown a moderate improvement and shifted one category upward, i.e. from typical performance to probable difference with a score improvement of 14 and 11 respectively. From the above results it can be noticed that participant G and F have taken a leap of 14 scores but their landing in post performances is determined by their pre performance scores. Hence, they have reached in the different profiles, even if having the same improved range of scores.

In addition to that, other three participants A, B and D composing 43 % of the experimental group population showing improvement in scores still remained in the same category i.e. typical performance of Sensory Profile. Though the initial scores of these three participants were almost same, but among them participant “A” showed maximum improvement among all seven experimental group population with an improvement of 20 scores, whereas participant B showed an improvement of 17 scores and D improved with 8 scores only. Participant A and B might have shown a shift to superior category, if structured training was continued for some more weeks. It was observed that participant D, had lowest improvement in scores, as he was facing problems in following instructions and was able to accomplish only 50 - 60% of target repetition. There with, caregivers also reported that he had interest towards sedentary play and also showed negative attitude towards any outdoor play. But it was clearly evident through the improvement in the scores of endurance and tone, that the participants in experimental group had



achieved a better functional ability.

On the other hand these participants were arranged according to their rate of improvement in ascending order of A, E, B, G & F, C and D, where G and F have equal scores of improvement. variations among the improvements is due to the pre score positioning and along with that literature says that it might happened due to many factors like individual differences, regularity in attendance, activeness and keen interest of an individual (Čoh M, 2004), liking/disliking towards the activity, understanding and executing the activity, existing muscle strength and power (Faigenbaum A. D., 2009), acclimatization with water environment.

Some studies describe that the effects and importance of individualized aquatic program (M. Kelly and J.Darrah, 2005) is beneficiary, especially for children with CP (Bax M, 2005). The result of the present study also illustrates significant positive effect on the participant's endurance and tone with differences in rate of improvement among the participants through a structured program which ensured the scope of flexibility while imparting the training program considering the situation and individualized needs of the participants. Some studies have shown that six weeks aquatic program had also started showing some improvement (Lidija Dimitrijević, 2012), but in present study the Structured Aquatic program was imparted for nine weeks, which resulted into noticeable significant changes among participants of experimental group. Another positive aspect of this training program is flexibility of repetitions and rigidness of activity's nature. Hence this type of aquatic training program may suit a vast range of C.P population to improve the quality of life and achieve better functional efficiency through improving endurance and tone (Anttila H, 2008) (M. Kelly and J.Darrah, 2005) and (Maria A. Fragala Pinkham, August 2011)

In nutshell, even the smallest change in the functional efficiency of participants towards betterment is inevitable. CP causes a permanent disorder of movement and posture (Rosenbaum P., 2007) (Maria A. Fragala Pinkham, August 2011) hence the effect of training reduces with time after completion of a short term program. So it is required that continuous program to maintain and improve the skill should be implemented for long-term to achieve permanent benefits (Lidija Dimitrijevic, 2012 ) (O. VerschuAdaen, 2011). As water based skills are life time retainable though their efficiency may decreases with time if not in regular performances (Lidija Dimitrijevic, 2012 ).

#### IV. CONCLUSION

This program is beneficial and easy to execute so it is strongly recommended to special school for children with CP, which can be imparted by teachers, therapist and assistant teachers who are comfortable in water, longer duration of training can ensure permanent change. The ratio should be one instructor to one participant for the purpose of safety and better results.

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