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Aerobic Capacity in Contemporary Children and Children with Cerebral Palsy

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Abstract

Aim: To assess the aerobic capacity in contemporary children and children with cerebral palsy. Method: The study is a comparative study between two groups where one group children have developed with normal developmental milestones where as other group consist of children diagnosed Cerebral palsy (GMFCS E&R Level 1). The study aimed to assess the aerobic capacity by submaximal exercise testing method using the six-minute walk test. The participants demographic data and diagnosis was noted and they performed the six minute walk test. The comparison between both the group was analyzed using descriptive statistics.

Result: The results show that the children with Cerebral palsy have reduced level of cardiovascular endurance compared to their peer groups. The children with Cerebral palsy showed reduced level of aerobic capacity.

Conclusion: Children aged between 6-12 years diagnosed with Cerebral palsy showed reduced level of VO2 max as compared to the contemporary children of their same age group. The results also show that there is a significant rise in the Blood Pressure and Rate of perceived exertion faced by children with cerebral palsy following the six-minute walk test.

Keywords: Aerobic capacity, Cerebral palsy, Exercise, Submaximal exercise test, Cardiovascular endurance.

Introduction

Cerebral palsy refers to permanent, non-progressive and occasionally evolving, disorders of tone, movement or posture, caused by an insult to the developing brain. It is the most common chronic motor disability in childhood, affecting 2-3 infants per 1000 live births. While perinatal asphyxia was considered the most common cause, it accounts for less than 10% of cases [(1).] Injury to the brain typically results in impairments in motor function, such as muscle weakness and spasticity, spinal deformity, muscle/tendons, contractures, persistent neonatal reflexes, hyperreflexia, gait disturbances and decreased selective motor control [(2)]

Etiology of cerebral palsy [(3)]

PRENATAL CAUSES	PERINATAL CAUSES	POSTNATAL CAUSES
-Structural malformations of nervous system -Congenital / intrauterine infections -Maternal/obstetric complications -Teratogens	-Birth asphyxia -Prematurity; low birth weight -Birth trauma -Intracranial haemorrhage -Hyperbilirubinemia -Hypoglycaemia -Central nervous system (CNS) infection	-CNS infection -Hypoxia -Trauma -Toxins

Classification of CP [3] :- 1)Spastic CP (65%)
2)Hypotonic
3)Extrapyramidal CP
4)CP with cerebellar involvement
5)Mixed type CP

In general, a diagnosis of cerebral palsy suggests that the individual has a lesion within the motor control system with a residual disorder of posture and movement control [1]

Varying degrees of associated components are seen with this disorder that further define the category that a child may fall into: severity of motor abnormalities, anatomical and magnetic resonance imaging findings, extent of associated impairments, and the timing of the neurological injury. [1]

In addition, the labelling process often identifies the parts of the body that are primarily involved. Diplegia, hemiplegia, and quadriplegia, respectively, indicate that the lower extremities, one side of the body, or all four extremities are affected. [1]

The clinician must be aware that the categorization of cerebral palsy is based on descriptions of observable characteristics; thus, it is a symptomatic description. The hyper tonus of spasticity prevents a smooth exchange between mobility and stability of the body. [1] Hypotonicity is another category of cerebral palsy, but it may also mask undiagnosed degenerative conditions. Hypotonia in a young infant may also be a precursor of a dyskinetic syndrome. Often, athetoid movements or spasticity are not noticed until the infant is attempting antigravity postures, although there may be some disorganization apparent to the careful observer. Generalized hypotonia often masks some specific areas of deep muscle tension with accompanying local immobility. [1]

According to WHO, the peak oxygen uptake attained during graded maximal exercise to volitional exhaustion is considered as the single best indicator for aerobic physical fitness. [4] VO_2 max can be expressed in milliliters of oxygen per kilogram of body weight per minute(ml/kg/min) [4] .Maximal volume of oxygen consumed per unit time (O2max) is accepted as the criterion measure of CRF. This variable is typically expressed clinically in relative (Ml/ kg/min) as opposed to absolute (mL · min −1) terms, allowing for meaningful comparisons between/among individuals with differing body weight. O2max is the product of the maximal cardiac output. [5]

When direct measurement of O2max is not feasible, a variety of maximal and submaximal exercise tests can be used to estimate O2max. These tests have been validated by examining (a) the correlation between

directly measured O2max and the O2max estimated from physiologic responses to submaximal exercise (e.g., HR at a specified power output) or (b) the correlation between directly measured O2max and field test performance [6]

The decision to use a maximal or submaximal exercise test depends largely on the reasons for the test, risk level of the client, and availability of appropriate equipment and personnel. Maximal tests require participants to exercise to the point of volitional fatigue, which may be inappropriate for some individuals and may require the need for emergency equipment. [6]

Aerobic Capacity can be assessed using: -1) Maximal exercise testing

2)Submaximal exercise test

The peak oxygen uptake (VO2peak) attained during graded maximal exercise to volitional exhaustion is considered by the World Health Organization as the single best indicator of aerobic physical fitness. [5]

Exercise professionals often rely on submaximal exercise tests to assess CRF because maximal exercise testing is not always feasible in the health/fitness setting. [6]

The basic aim of submaximal exercise testing is to determine the HR response to one or more submaximal work rates and use the results to predict VO2max. Although the primary purpose of the test has traditionally been to predict VO2max from the HR workload relationship, it is important to obtain additional indices of the client's response to exercise. [6]

Modes of exercise testing [6]- 1) Field tests

2) Motor driven treadmill

3) Mechanically braked cycle ergometer

4) Step tests.

CRF from cardiopulmonary exercise testing on a treadmill with directly measured VO2max. [6]. Although submaximal exercise testing is not as precise as maximal exercise testing, it provides a general reflection of an individual's physical fitness at a lower cost, potentially reduced risk for adverse events, and requires less time and effort on the part of the subject. Some of the assumptions inherent in a submaximal test are more easily met (e.g., steady state HR can be verified), whereas others (e.g., estimated HRmax) introduce errors into the prediction of VO2max. [6]

Methodology and Materials

Methodology: -

1. Study design- Comparative study
2. Target Population- 6-12 years of age
3. Sample Size – 25 Children
4. Sampling Method- Random sampling

Materials Required: -

1. Record sheet and Pen
2. Stop Watch
3. Measuring Tape
4. Chalk/Marker
5. Cones
6. BP apparatus
7. Stethoscope

Inclusion Criteria

GROUP 1	GROUP 2
Both Gender	Both Gender
Age- 6-12	Age- 6-12
Children developed with normal development milestones	Children with CP (GMFCS E&R Level

Exclusion Criteria

1. Individual with any associated comorbidities
2. Individual not willing to participate
3. Individual having any complains

Procedure: -

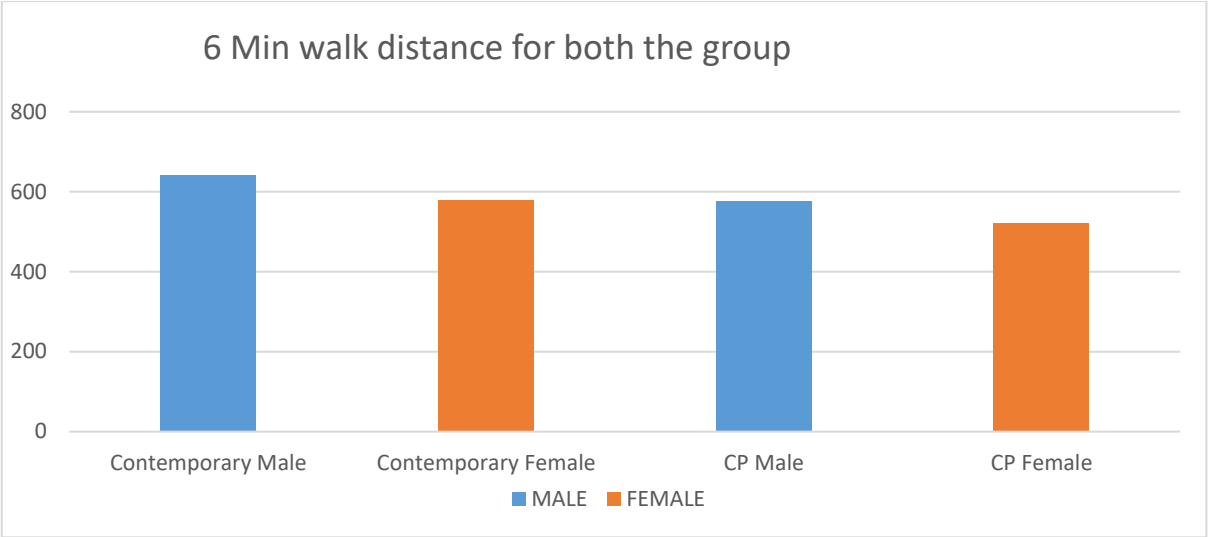
- For the study I have taken permission from institutional ethical committee of TMV's Indutai College of Physiotherapy.
- Institutions such as ZHEP Remedial Learning Center, Asha Foundation, Chetana Foundation were approached and permission was taken prior to the study for data.
- Explanation of the study is being given to the participants and their parents/guardians and they were selected on basis of inclusion and exclusion criteria.
- The participants willing to participate were included by taking consent from their parents/guardians.
- The study consists of two group of children between age group of 6-12 years of both gender.
- The study is a comparative study between two groups where one group children have developed with normal developmental milestones where as other group consist of children with diagnosed Cerebral Palsy (GMFCS E&R Level 1). [6]
- The study aimed to assess the aerobic capacity using the six minute walk test for both the groups. Before starting the test participant's demographic data of age, gender, BMI and diagnosis was recorded.
- The test was performed by all the participants and data collected was stored securely. Review and clean the collected data to rectify any errors or inconsistencies.
- Summarized the data and results were calculated by comparing both the groups.

Results

Table : 6 Min walk distance for both the group

Group		Mean ±S.D	p value
Contemporary Children	Male	642.69 ±100.84	<0.0001
	Female	579.06 ±60.60	<0.0001
Children with CP	Male	576.44 ±67.14	<0.0001
	Female	520.89 ±41.26	<0.0001

The above data is pictured in the next graph

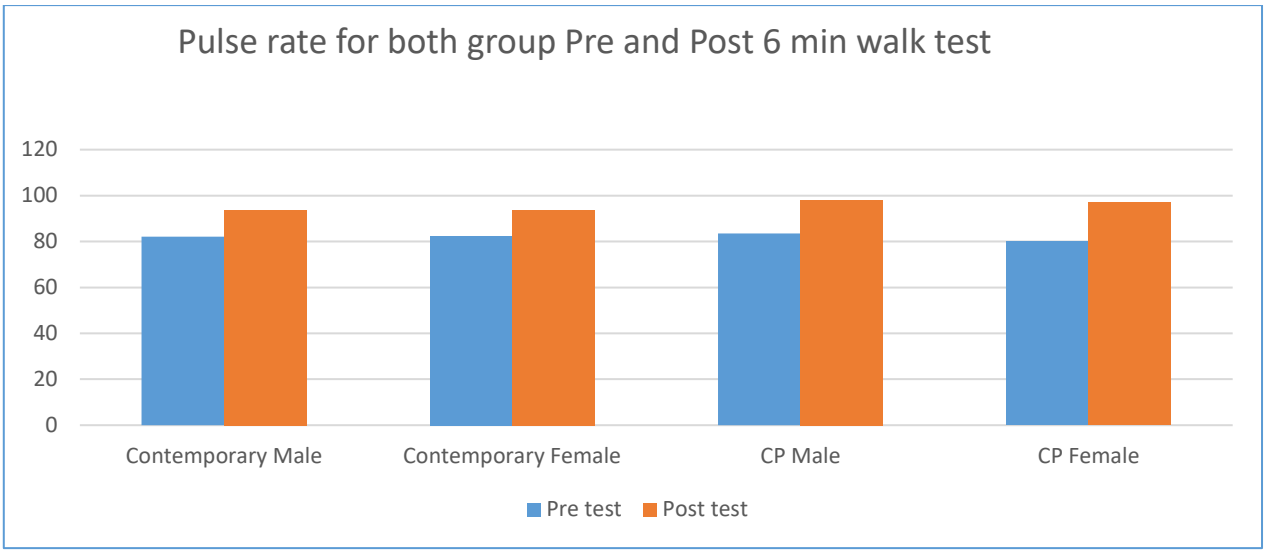


Interpretation: The above graph shows 6 minute walk distance covered by both groups where blue represents male population and orange represents female population

Table 2 : Pulse rate for both group Pre and Post 6 min walk test

Group			Mean± S.D	P value
Contemporary Children	Male	Pre test	82.17±9.26	<0.0001
		Post test	93.69±13.80	<0.0001
	Female	Pre test	82.31±9.26	<0.0001
		Post test	93.79±14.04	<0.0001
Children with CP	Male	Pre test	83.50±6.08	<0.0001
		Post test	98.06±5.97	<0.0001
	Female	Pre test	79.88±4.72	<0.0001
		Post test	97±4.41	<0.0001

The above data is pictured in the next graph

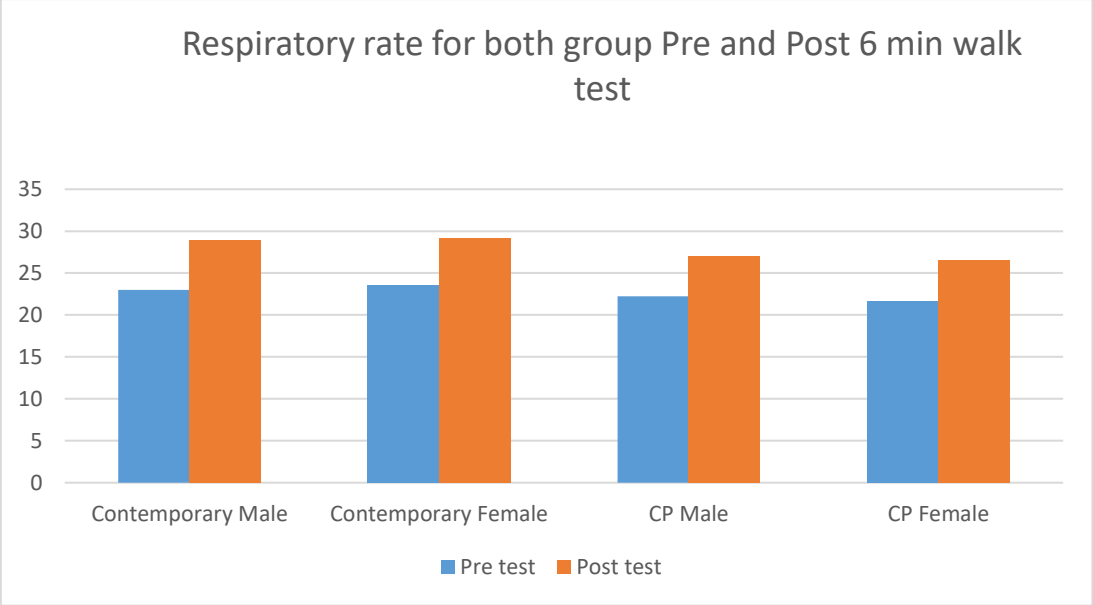


Interpretation: The above graph shows pre and post comparison in change in pulse rate after performing 6 minute walk test for both the group

Table 3 : Respiratory rate for both group Pre and Post 6 min walk test

Group			Mean± S.D	P value
Contemporary Children	Male	Pre test	22.99±4.14	<0.0001
		Post test	28.89±5.93	<0.0001
	Female	Pre test	23.50±4.32	<0.0001
		Post test	29.11±6.03	<0.0001
Children with CP	Male	Pre test	22.25±1.91	<0.0001
		Post test	27.06±2.01	<0.0001
	Female	Pre test	21.66±2.06	<0.0001
		Post test	26.55±2.12	<0.0001

The above data is pictured in the next graph

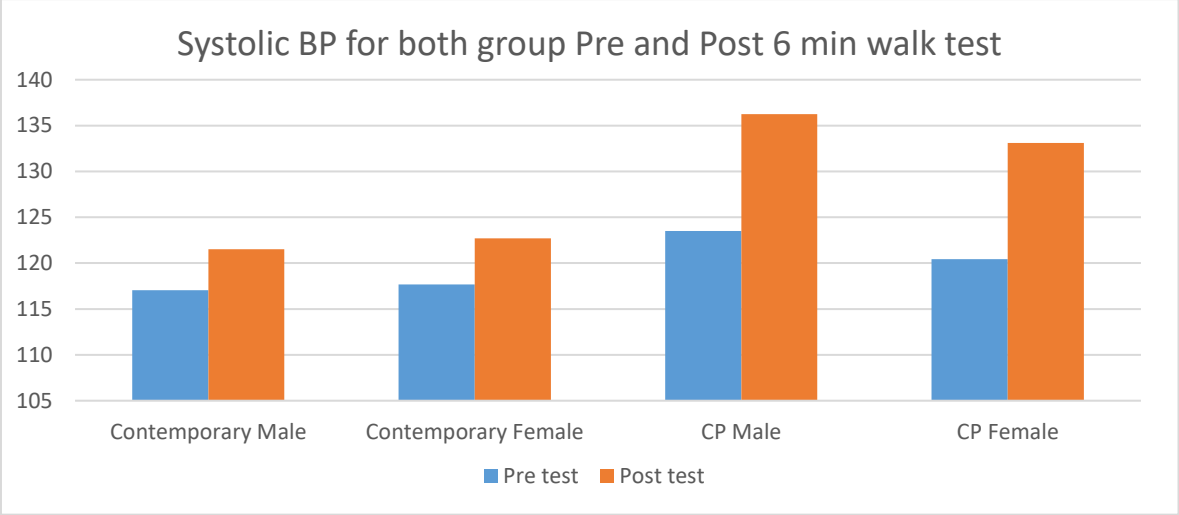


Interpretation: The above graph shows pre and post comparison in change in respiratory rate after performing 6 minute walk test for both the group

Table 4 : Systolic BP for both group Pre and Post 6 min walk test

Group			Mean± S.D.	P value
Contemporary Children	Male	Pre test	117.04±7.50	<0.0001
		Post test	121.53±6.86	<0.0001
	Female	Pre test	117.69±6.81	<0.0001
		Post test	122.70±7.67	<0.0001
Children with CP	Male	Pre test	123.50±10.50	<0.0001
		Post test	136.25±7.71	<0.0001
	Female	Pre test	120.44±16.33	<0.0001
		Post test	133.11±13.70	<0.0001

The above data is pictured in the next graph

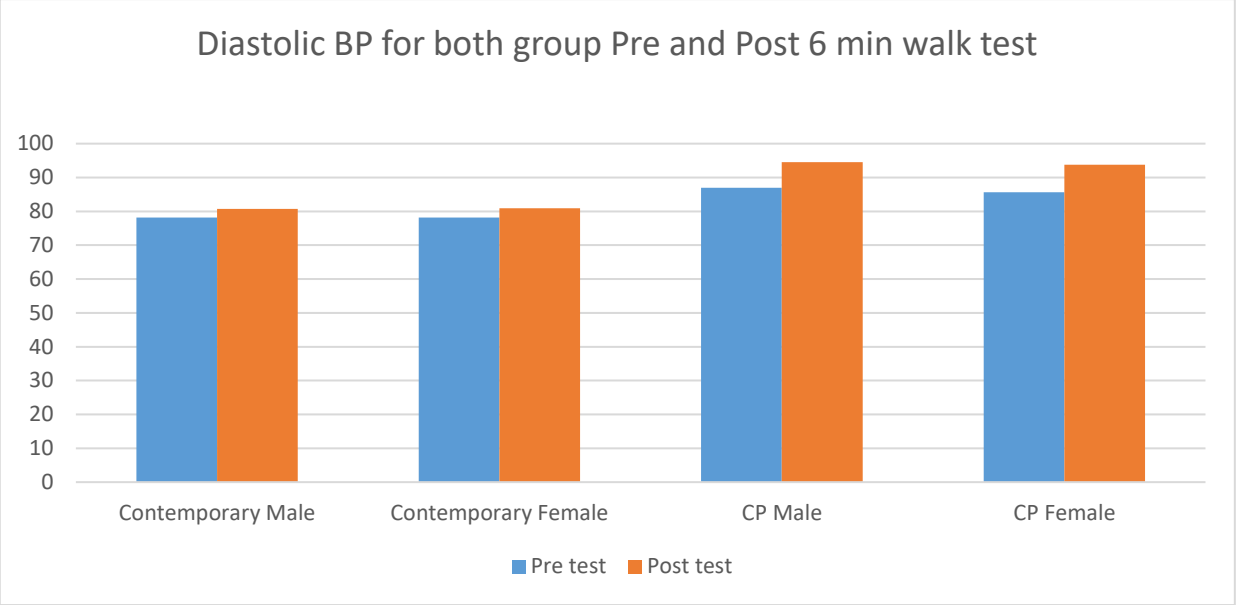


Interpretation: The above graph shows pre and post comparison in change in systolic blood pressure after performing 6 minute walk test for both the group

Table 5 : Diastolic BP for both group Pre and Post 6 min walk test

Group			Mean± S.D.	P value
Contemporary Children	Male	Pre test	78.19±6.85	<0.0001
		Post test	80.74±5.97	<0.0001
	Female	Pre test	78.15±5.04	<0.0001
		Post test	80.89±6.99	<0.0001
Children with CP	Male	Pre test	87.00±8.17	<0.0001
		Post test	94.50±5.53	<0.0001
	Female	Pre test	85.66±8.51	<0.0001
		Post test	93.77±6.22	<0.0001

The above data is pictured in the next graph

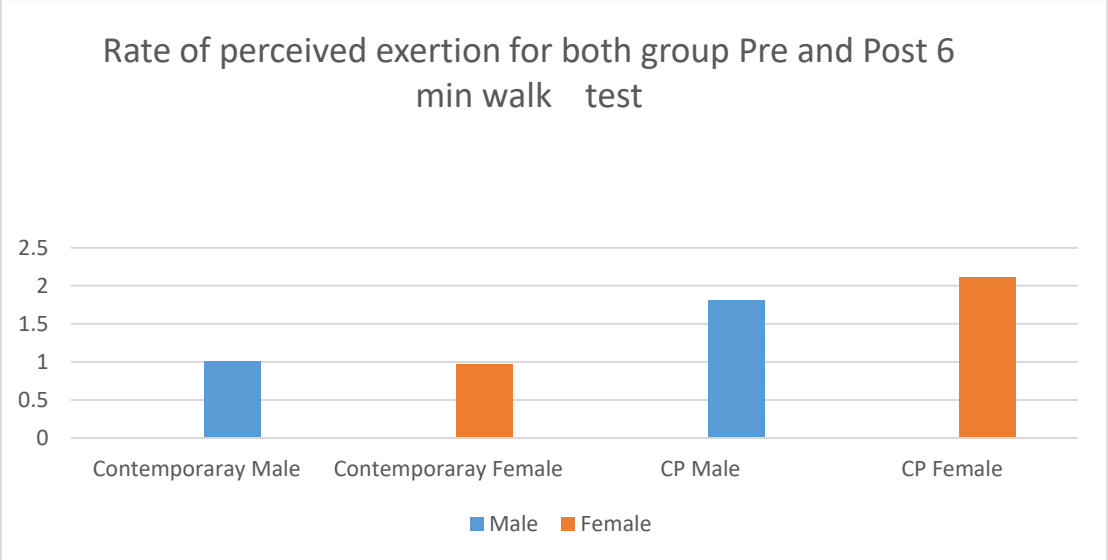


Interpretation: The above graph shows pre and post comparison in change in diastolic blood pressure after performing 6 minute walk test for both the group

Table5 :Rate of perceived exertion for both group Pre and Post 6 min walk test

Group			Mean± S.D	P value
Contemporary Children	Male	Pre test	0.00±0.00	<0.0001
		Post test	1.01±0.91	<0.0001
	Female	Pre test	0.00±0.00	<0.0001
		Post test	0.96±0.84	<0.0001
Children with CP	Male	Pre test	0.00±0.00	<0.0001
		Post test	1.81±1.42	<0.0001
	Female	Pre test	0.00±0.00	<0.0001
		Post test	2.11±1.83	<0.0001

The above data is pictured in next graph

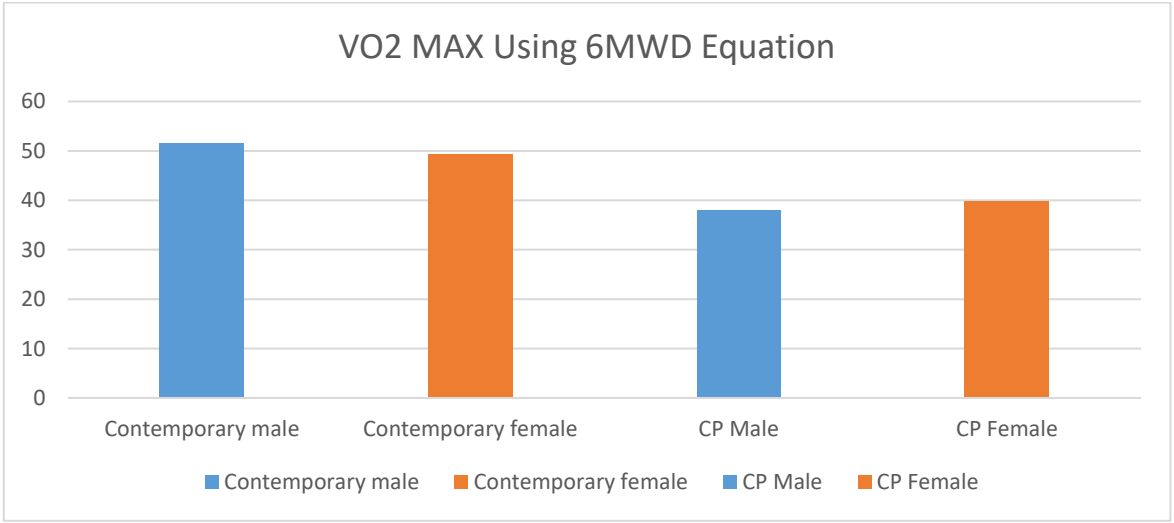


Interpretation: The above graph shows pre and post comparison in change in rate of perceived exertion experienced by the patient after performing 6 minute walk test for both the group

Table 6: VO2 max using 6MWD formula

Group		Mean
Contemporary Children	Male	51.6
	Female	42.9
Children with CP	Male	32.186
	Female	29.509

The above data is pictured in the next graph



Interpretation: The above graph shows VO2max calculated using 6MWD for both the groups

Discussion

The main goal in rehabilitation of CP patients is to make them independent and bring them back to socially accepted environment with minimal difficulties. For this the physical and cardiovascular fitness plays an

important role. The potential to enhance cardio-respiratory fitness it is necessary to assess the aerobic capacity in children with cerebral palsy. For the study I will take permission from institutional ethical committee of TMV's Indutai College of Physiotherapy. Institutions such as ZHEP Remedial Learning Center, Asha Foundation, Chetana Foundation were approached and permission was taken prior to the study for data collection. Explanation of the study was given to the participants and their parents and their consent was taken prior to the study. The participants were selected on basis of inclusion and exclusion criteria. The study consists of children between age group of 6-12 years diagnosed with Cerebral Palsy and classified as Level 1 on GMFCS E&R Scale of both the gender.

The reference research paper taken for this research was article by Olaf Verschuren and Tim Takken titled as 'Aerobic capacity in children and adolescents with Cerebral Palsy'. The study was conducted to assess the aerobic capacity in children with CP using maximal exercise protocol on treadmill was performed. The results show that the aerobic capacity in children diagnosed with cerebral palsy is relatively low. [4]

The aim of the study was to assess the submaximal aerobic capacity of the children diagnosed with cerebral palsy. For assessing the submaximal test the most reliable and easy mode of test is using Six minute walk test as it has a good reliability and also easy to perform.

For the study as it is a special population the sample size was 30 but we assessed 25 children as 5 denied their participation. In the study both the gender were included out of which there were 9 females and 16 males all in the age group of 6-12 years. The test was conducted at three different institutes in their outdoor setting where a ramp of 20 meters was drawn and at both the ends cones were placed to mark the end pivot points. All the participants were explained the test procedure and were asked to not have heavy food before the test. Before the beginning of the test all participant's demographic data, diagnosis, body mass index and consent was taken. Participants pre-test vitals like pulse rate, respiratory rate, blood pressure and rate of perceived exertion was monitored.

Six-minute walk test: The outcome of the test is based on how much distance a participant can walk in 6 minutes. As it is a self-paced test the individual is allowed to walk at his pace and is allowed to take rest in case of any discomfort.

All the participants performed six-minute walk test and vitals were checked immediately after the test, after 3 minutes and again after 6 minutes. The distance covered in six minutes and any associated complaint experienced by the participant was also noted. Using the six minute walk distance the VO2 max for the children between age group of 6-12 was calculated and the mean for all the individuals.

As it is a comparative study the reference values for contemporary group of all the necessary parameters were taken from study conducted in Navi Mumbai titled as "Predictive equation for six-minute walk test in Indian children, adolescents, and adults" by Bela Agarwal, Monal Shah, Bhoomika Sawant, Hiranmayee Bagwe, Payal Murkudkar, Rajani Mullerpatan. This study showed all the parameters and VO2 max calculated on age group of 6-12 years and the reference values were taken to compare the values obtained by performing six-minute walk test on children with cerebral palsy.

Results were obtained by plotting various bar graphs in which both the group were compared and also segregated on the basis of gender. The graphs were drawn to compare both the groups for the distance covered in six minute which showed that the children group diagnosed with cerebral palsy has covered lesser distance when compared to their peer group. Graphs were plotted to compare the pre and post pulse rate, respiratory rate, blood pressure, RPE and VO2 max. It was noted that the children with cerebral palsy has reduced level of VO2 max as compared to their peer groups. Results also showed significant changes

in pre and post systolic blood pressure and rate of perceived exertion experienced by children with cerebral palsy.

Conclusion

In conclusion, Children aged between 6-12 years diagnosed with Cerebral palsy showed reduced level of VO2 max as compared to the contemporary children of their same age group. The results also show that there is a significant rise in the Blood Pressure and Rate of perceived exertion faced by children with cerebral palsy following the six-minute walk test.

Limitations

- The study is limited by small sample size of 25 individuals when compared to the reference article where there were more than 200 sample were taken to conduct the study.
- The study can also be limited by the physical limitations of the children with cerebral palsy as the test required the children to walk for six minute which might be difficult for due to certain physical limitations.
- There is limited access to data. Researches to assess aerobic capacity using submaximal testing method on Indian Population are limited.
- The study was unable to separate the cerebral palsy population according to the types of cerebral palsy as depending on the type of diagnosis the walking pattern is affected.

Future Scope

- Future research can be made by classifying the Cerebral palsy children according to the type of their disability as it gives a better understanding on how the VO2 max level can change as per the disability.
- Additionally, studies can be conducted to assess the aerobic capacity by using maximal exercise testing methods.
- Analysis of the assessment of the aerobic capacity is necessary in order to make interventions to improve the cardiovascular endurance of children with cerebral palsy as it is important to have good cardiovascular endurance.

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