

Comparison of Energy Expenditure in Community Ambulating Spastic Diplegic Children with and without Walker: A Cross-sectional Study

Jaya Shanker Tedla, Kavitha Raja

ABSTRACT

Purpose: To compare energy expenditure of ambulation with and without walker on outdoor uneven surface and indoor even surface in children with spastic diplegia. **Methods:** Twenty five children (13 boys, 12 girls) with spastic diplegia, between 5-17 years walked for 50 meters on an indoor even surface and outdoor uneven surface with and without walker. Their energy expenditure was measured by Physiological Cost Index (PCI). **Results:** Independent t-test and paired t-test were used for analysis. There was a statistically significant difference between children who walked either with hand support or independently and with walker. Indoor performance was better than outdoor performance under both conditions. Children walking independently or using hand support consumed less energy than children who used walker on both surfaces ($p < 0.05$). **Conclusions:** Children with spastic diplegia require more energy when ambulating with walker than when ambulating with hand holding assistance or independently.

Key words: spastic diplegia, walker, energy expenditure, physiological cost index.

INTRODUCTION

Increased energy expenditure during walking is one of the hall marks of spastic diplegia [1]. Assessment of energy expenditure during walking is an important parameter, which can be used to determine clinical and functional improvement in children with spastic diplegia. Energy expenditure has traditionally been calculated by measuring oxygen consumption, but this method involves the use of expensive and cumbersome equipment. Such apparatus may adversely affect the measurement itself and it is particularly unsuitable to use for children and the disabled [2, 3].

Studies have shown that heart rate is linearly related to oxygen consumption at submaximal levels [4, 5, 6]. Speed of walking can also be a useful indicator. In normal subjects, speed increases from childhood to young adulthood, then declines with age. With each age group, the relationship has been found to be linear in normal children and adults up to a speed of 100 meters per minute [7]. This relationship is also seen in children with cerebral palsy [8, 9].

Both speed and heart rate have been used as indicators of efficiency and energy cost of locomotion [10]. Mac Gregor first reported their combined use in 1979. He suggested that the effect of an activity was better represented by the net heart rate (working heart rate - resting heart rate) divided by speed of walking, thus yielding a physiological cost index (PCI) in net beats per meter. He demonstrated that for a variety of normal and handicapped subjects, PCI was minimal at self-selected or preferred speeds of walking and that the relation was reproducible [11].

PCI can be used either to measure changes in

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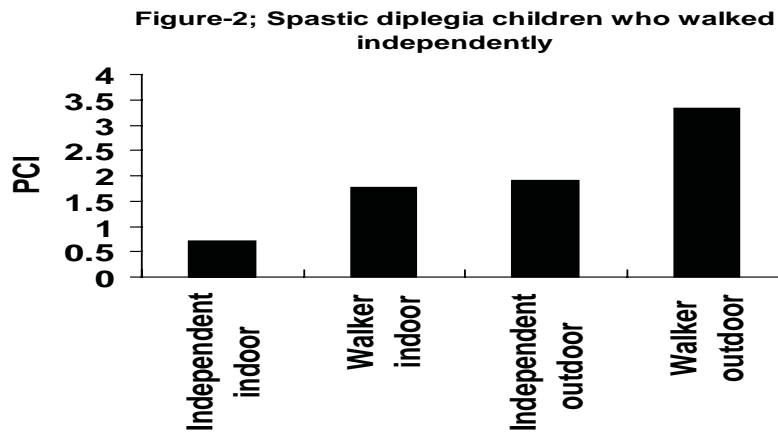
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locomotor efficiency over time, or changes as a result of the use of different Orthotic and prosthetic devices, or as an indicator of handicap when compared with the matched normative data.^{3, 9, 12} In general, whatever the cause of disability, a pathological gait yields a higher value for PCI.

Duffy CM et al looked for differences in the energy expenditure patterns of ambulant children

ed device like AFO to improve energy expenditure in ambulant children with cerebral palsy [13, 14]. Many children with cerebral palsy have difficulty in walking. Assistive devices like walkers are frequently prescribed to these children to provide the additional stability required for ambulation.

The thrust towards ambulation is greater in our country due to socio cultural reasons. Walkers are the most common assistive devices prescribed to

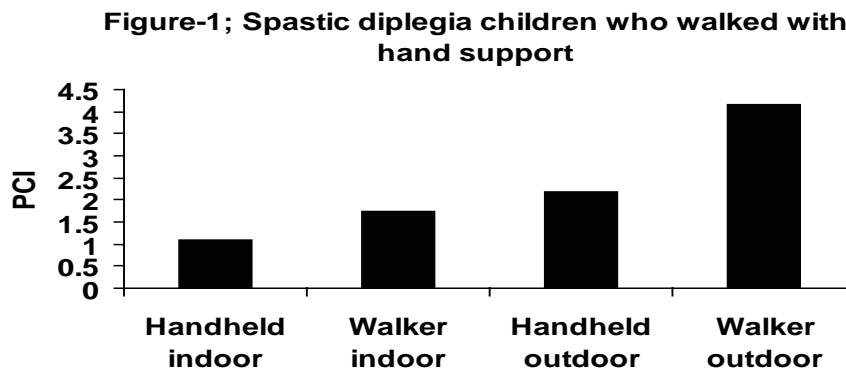


with cerebral palsy and spina bifida compared with normal healthy children. The rate of oxygen consumption (ml/kg/min) was significantly higher in the children with diplegia than in those with hemiplegia, spina bifida or healthy children. This suggests that energy expenditure in children with cerebral palsy is more than normal [12].

Earlier studies have shown the efficacy of assist-

children with spastic diplegia who are capable of ambulation with assistance at the time of discharge from hospital. Walkers also help in improving gait pattern of spastic diplegics [15]

One of the common observations noticed in children with spastic diplegia at the time of review in the hospital is that they do not use the walker



prescribed to them effectively in community ambulation reasons given for not using walker are unsubstantiated [16]. The clinical decision-making has increasingly become difficult, as there is lack of literature for children with spastic diplegia to measure the energy expenditure using walker on different surfaces.

PURPOSE OF THE STUDY

Objective of this study was to compare the variation of energy expenditure with and without walker on outdoor uneven surface and indoor even



(Figure-3)

surface in children with spastic diplegia.

METHOD

Children were selected by convenience sampling from four special schools in our locality, consent form was obtained from the parents/ guardian. Children with diagnosis of cerebral palsy of spastic

diplegic type, Age 5 to 17 (mean $12y \pm 1.5y$) years, who are able to walk fifty meters independently or with one hand held for the past six months with and with out walker in outdoor were included in the study.



(Figure-4)

Children who are unable to follow simple commands, with severe behavioral problem, with severe visual and perceptual problems, with uncontrolled seizure disorder and with diagnosed cardiovascular problem were excluded from the study.

Energy expenditure was tested with the use of physiological cost index in these 25 children with spastic diplegia of age between 5-17 years (mean $12y \pm 1.5y$) .out of 25 children 13 were boys and 12 were girls.

Outcome measures used was Physiological Cost Index (PCI) and Instruments used are a Seat, Stop

watch, Two twenty five meter walk ways – one in indoor and other on outdoor.

The Procedure was explained to the parents/guardian. The therapist then completed a screening checklist to ensure that all inclusion and exclusion criteria were met. The subject was made to sit quietly for five minutes on a seat. Resting heart rate was measured as the average heart rate taken over a two-minute period after five minutes rest. Then subject was made to walk at his/her own pace on fifty-meter indoor level surface and the time taken was measured [17]. The subject made to sit after the walk and the heart rate was measured for first fifteen seconds manually and calculated for minute. The same procedure was repeated and average of two trials was measured to determine PCI.

Test one: PCI was determined with above procedure on indoor even surface without using a walker(Figure-3)

Test two: PCI was determined on indoor even surface with a walker that he/she was being trained with.

Test three: PCI was determined on outdoor uneven surface with out a walker

Test four: PCI was determined on outdoor uneven surface with a walker that he/she was being trained with.

In all these procedures subject was made to walk with their preferred speed using their own assistive devices like AFO, splints, or any orthosis and the therapist accompanied the subject. Sufficient rest period to gain the resting heart rate was given between the trials. If the subject required hand support

this assistance was given when they were not using walker by parents/guardian (Figure-4). These children were analyzed as a separate cohort from the children who walked independently.

Data analysis

Subjects were grouped as those walked independently and those who required hand support for analysis. Data analyzed using the statistical package SPSS (version10). PCI of same group of subjects with and without walker was compared by using paired t test. PCI of both groups of patients was compared by using independent t test. Results were expressed in terms of mean, standard deviation. A 'p' value less than 0.05 were considered significant.

RESULTS

There was no significant difference in the PCI values of subjects who required hand holding assistance and those who walked independently. This was true for both surfaces indicating that the groups were homogenous at baseline. Hence the whole group was analyzed as a single cohort.

Paired t test mean values of children with spastic diplegia with and without walker, indoor versus outdoor are showed in Table 1. This indicates that there is a statistically significant difference between children who walked either with hand support or independently and with walker indoor or outdoor. In all the children indoor performance is better than outdoor.

PCI mean values of spastic diplegic children are graphically expressed in Figure 1 and 2. Both the figures show a linear improvement in PCI .

DISCUSSION

This study was designed to determine the energy

Table 1. PCI values of ambulation with and with out walker indoor versus outdoor

Mode of ambulation	Number of children	PCI Mean (SD)	p value
Hand held indoor	16	1.08±1.10	0.020
Walker indoor	16	1.75±1.36	
Hand held outdoor	16	2.19± 1.19	0.000
Walker outdoor	16	4.16± 1.76	
Hand held indoor	16	1.08± 1.10	0.000
Hand held outdoor	16	2.18±1.19	
Walker indoor	16	1.75±1.36	0.000
Walker outdoor	16	4.16±1.76	
Independent indoor	9	0.72±0.16	0,010
Walker indoor	9	1.76±1.03	
Independent outdoor	9	1.89±1.13	0.006
Walker outdoor	9	3.34±1.90	
Independent indoor	9	0.72±0.16	0.013
Independent outdoor	9	1.89±1.13	
Walker indoor	9	1.76±1.03	0.020
Walker outdoor	9	3.34±1.90	

expenditure of children with spastic diplegia with and without walker, indoor and outdoor. To minimize the study bias, the subjects involved in this study were restricted to those children with spastic diplegia as per clinical criteria. All the children were familiar with the walkers because they were using the walker.

Children with cerebral palsy show higher heart rates and low walking speeds when walking with walker. This means that a higher physiological workload was sustained during ambulation by these children.¹³ This study also show similar findings .PCI values of children when ambulating without walker was better than with walker either indoor or outdoor. To encourage walker use for longer duration, reduced energy expenditure is desirable; therefore energy conservation is a major issue when choosing an assistive device.

Using walker consumes more energy in children with spastic diplegia. These children have impaired postural control, abnormal muscle tone and pathological muscle coordination which make them diffi-

cult to control their own body along with the walker. When they walk independently they use their upper limbs for balance. But when assistive device is used for gaining balance extra energy may be expended in using the device.

When normal children are compared with indoor and outdoor they do not have any significant differences in PCI. In this study children with spastic diplegia who walked independently or with hand support showed significant differences in PCI on indoor and outdoor surfaces. Even with walker outdoor values of PCI are significantly differ from indoor values. This may be due to their physical condition or due to environmental barriers or because of lack of regular practice.

So before prescribing assistive device like walker energy expenditure values should be considered in indoor and outdoor environments according to patient requirements. Also practicing with walker outdoors regularly may decrease energy consumption.

Severity of involvement in the patients being dissimilar may have affected the results. Not using the walker outside regularly can also be a reason for significant differences. Walkers, which were not custom fitted, may have interfered with efficient ambulation. The following are suggestions for future study. PCI should be evaluated in children with various types of cerebral palsy with various types of available assistive devices and also with custom fitted supportive devices.

CONCLUSION

Children with spastic diplegia require more energy when ambulating with assistive device than self selected mode of ambulation, indoors and outdoors. Clinical significance of this study is that prescription of walker should take in to consideration not only gait pattern but also efficiency as this may dictate patient compliance.

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