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Comparative Assessment between Children with Diplegic and Hemiplegic Cerebral Palsy in Body Mass Index, Functional Level and Quality of Life

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Abstract
Aim: *This study aimed to compare between children with diplegic and hemiplegic cerebral palsy (CP) in body mass index (BMI), gross motor functional level and quality of life (QOL) and to determine the relation between the functional level, QOL and BMI.*
Subjects and Methods: *One hundred cerebral palsy (CP) children were participated in this study (58diplegia and 42 hemiplegia).Their age ranged from 8-12years.All children were assessed for functional level, BMI and QOL using gross motor functional classification system (GMFCS), BMI-for age and gender charts and pediatric quality of life inventory CP module (PedsQL) respectively.*
Results: *The results showed statistically significant differences in functional levels, and some PedsQL subtests scores between both groups in favor of hemiplegic children while non-significant difference was observed in BMI between both groups. Additionally, there were significant negative relationships between GMFCS levels and PedsQL scores in both groups with the exception of speech and communication subtest in hemiplegic group. Non-significant relationships were found between GMFCS levels and BMI and BMI and PedsQL subtests scores in both groups with the exception of pain and hurt and fatigue subtests in diplegic group.*
Conclusion: *Diplegic CP children have a lower functional level and QOL scores compared to hemiplegic children. Gross motor functional level is indirectly correlated with BMI and QOL in hemiplegic and diplegic children.*
Key words: *Cerebral palsy, Hemiplegia, Diplegia, Body mass index, Functional level, Quality of life*

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I. Introduction

Cerebral palsy (CP) is defined as a neuro-developmental impairment that limits activity, and is attributed to non-progressive disturbances during brain development in fetuses or infants leading to persistence of movements and posture abnormalities[1].Several classification systems are used to describe children with CP including motor type, functional severity and comorbidities[2].Spastic CP is the most common type, classified into diplegic, hemiplegic, quadriplegic, and monoplegic subtypes based on the topographic distribution of the affected areas of the body[3, 4].

Hemiplegic CP is a form of spastic CP in which one arm and leg on either the right or left side of the body is affected. The upper limb is typically more affected than lower limb and both tend to have more distal involvement than proximal involvement[5].Spastic diplegia is one of the most common clinical subtypes of CP with motor impairments both in upper and lower extremities but upper extremities milder than the lower one. Most children have significant weakness in the trunk and spasticity of the extremities. The functional problems include difficulty with mobility, posture and gait[6, 7].

There are many nutritional problems in most CP children occur at an early age represented in oral muscles problems, feeding difficulties and weight abnormalities, which can interfere with the physical growth and nutritional status[8]. Altered body weight, height and fat stores are the most important signs resulting from nutritional problems which lead to poorer health status and decreased societal participation in children with moderate-to-severe motor disability[9]. It was reported that CP children with moderate-to-severe gross motor disability have decreased body mass index (BMI) while those with mild motor dysfunction have increased BMI when compared with those children with typical development[10, 11].

It is not surprising that CP children do not meet the recommended amount of physical activity compared with their typically developing peers, because the restrictions in gross motor function make the CP children vulnerable to the risk of being overweight and obese[12].The risk of increased BMI interferes with the success of daily activities and may affect the general health negatively by leading to limitation in the participation of physical activities and insufficient self-care which affects quality of life (QOL)[13-17].

Slow and insufficient growth in CP children often leads to deterioration of the general health, thus increasing the number of health services needed[18].Both weight abnormalities in conjunction with increasing musculoskeletal impairments may result in progressive loss of function and mobility[19].Therefore this study aimed to compare between diplegic and hemiplegic children in terms of BMI, QOL and gross motor functional level and to determine the relationships between gross motor functional level, QOL and BMI.

II. Subjects And Methods

Subjects

One hundred children with spastic CP of both sexes were participated in this study (58 diplegic and 42 hemiplegic children). Their age ranged from 8 to 12 years. They were selected from the Outpatient Clinic of Pediatrics, Faculty of Physical Therapy, Cairo University. They were enrolled in this study if they had the following inclusion criteria: a) mild to moderate spasticity according to modified Ashworth scale[20].b) gross motor functional level from I to III according to Gross motor function classification system (GMFCS) [21]. C) BMI less than -2SD to more than +2SD according to BMI-for age Z score charts [22]. Children were excluded from the study if they have had fixed contractures or deformities of the spine, upper or lower extremities, visual or respiratory disorders.

This study was performed according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans. It was approved by the Ethics Review Committee of the Faculty of Physical Therapy, Cairo University, Egypt (No: P.T. REC/012/002004).

The purpose and procedures of the current study were explained to the parents of participating children and they gave signed written informed consent approving their children participation in the study. This study was conducted from August 2018 to March 2019.

Procedures

1. Assessment of gross motor function level

Gross motor function classification system was used to determine the gross motor functional level of children in both groups. It is a standardized method to classify gross motor function in children with CP into one of five clinically meaningful levels from level I (most able) to level V (most limited) [21].

2. Calculation of body mass index

The weight and height were assessed for all children using weight and height scale. Each child was asked to wear light clothes during weight assessment and to stand bare feet while looking forward with head vertical. The weight measured to the nearest one kilogram and height to the nearest one cm [23].BMI was calculated by dividing weight in kilogram by square height in meter. BMI value was plotted against age and gender–specific BMI reference (BMI-for age Z-score charts) and Z-score interpreted as follow overweight :>+1SD,obese:>+2SD, thin:<-2SD, and normal: from 1SD to -2SD [22].

3. Assessment of quality of life

Pediatric Quality of Life Inventory (PedsQL) CP Module3.0 was used to assess QOL of all children. It is an inventory scale parent proxy report for children ages from 8-12years. This module includes seven subtests which encompass 35 items as follow :(1) daily Activities (9 items); (2) school Activities (4 items); (3) movement and balance (5 items); (4) pain and hurt (4 items); (5) fatigue (4 items); (6) eating activities (5items); and (7) speech and communication (4 items) [24]. Arabic version was used in this study [25].

The parent was asked about the grade of the problem of each item the child had in the past month. A 5point response scale was used (0-4); 0 if it is never a problem, 1 if it is almost never a problem, 2 if it is sometimes a problem, 3 if it is often a problem and 4 if it is almost always a problem. Items are linearly transformed to a 0-100 scale as follows: 0=100, 1=75, 2=50, 3=25, and 4=0. Scale scores computed as sum of the items over the number of items answered with lower scores indicating poorer QOL and higher scores indicating better QOL[24].

Statistical analysis

All statistical tests were conducted through the statistical package for social studies (SPSS) version 19 for windows (IBM SPSS, Chicago, IL, USA). The level of significance for all statistical tests was set at $p < 0.05$. Independent t test was conducted for comparison of the mean values of age, weight, height, BMI and PedsQL subtests scores between both groups. Mann-Whitney test was used for comparison of the median values GMFCS levels between both groups. Spearman Correlation Coefficient was used to determine the relationship between GMFCS levels, PedsQL scores and BMI. Pearson Correlation Coefficient was used to determine the correlation between BMI and PedsQL.

III. Results

One hundred children with spastic CP participated in this study including 58diplegic and 42 hemiplegic children. Demographic and clinical characteristics of participants including age, weight, height and BMI, gender, GMFCS levels, BMI categories were illustrated in table 1.

There were statistically significant differences between diplegic and hemiplegic children in the mean values of PedsQL subtests scores including daily activities (P=0.0001), school activities (p=0.001), movement and balance (p=0.008), and fatigue (p=0.003) with greater values in hemiplegic group. Non-significant differences were observed in pain and hurt, eating activities and speech and communication subtests between both groups (p>0.05).Also, there was significant difference in the median values of GMFCS levels between both groups (p = 0.0001).Non-significant difference was observed in the mean values of BMI between diplegic and hemiplegic children (p = 0.52) as shown in table 2.

As illustrated in table 3, there were significant moderate negative correlations between GMFCS levels and PedsQL subtests scores in the children with diplegia in terms of daily activities (p = 0.0001), school activities (p = 0.01), movement and balance (p = 0.0001) and pain and hurt (p = 0.001), eating activities (p = 0.001) speech and communication (p = 0.01) and weak negative significant correlation with fatigue subtest (p = 0.02). In hemiplegic children, there was significant moderate negative correlation between GMFCS and PedsQL subtests scores in terms of daily activities (p = 0.0001),school activities (p = 0.002), movement and balance(p = 0.0001), pain and hurt(p = 0.001), fatigue (p = 0.005),eating activities(p = 0.01) and non-significant weak negative correlation with speech communication subtest score. Furthermore, non-significant weak negative correlations were found between GMFCS and BMI in children with hemplegia (p = 0.32) and diplegia(p = 0.36).

As shown in table 4, there were weak positive non-significant correlations between BMI and PedsQL subtests scores in diplegic children with in terms of daily activities (p=0.89) and movement & balance subtests (p=0.54).Weak negative non-significant correlations were found in school activities (p=0.5), eating activities (p=0.73) and speech &communication (p=0.8) subtests while weak negative significant correlations was observed with pain & hurt (p = 0.01) and fatigue subtests (p=0.03). In children with hemiplegia, there were weak positive non-significant correlations between BMI and PedsQL subtests scores in terms of daily activities (p = 0.45), school activities (p = 0.1), movement & balance (p = 0.06), pain & hurt (p= 0.19), eating activities (p = 0.09), speech & communication(p=0.09)subtests while weak negative non-significant was observed in fatigue subtest(p =0.72).

IV. Discussion

The purpose of the current study was to compare between diplegic and hemiplegic CP children in PedsQL, GMFCS and BMI and to determine the relationships between GMFCS, QOL and BMI.

The results showed statistically significant differences in functional abilities, and PedsQL subtests scores between both groups including; daily activities, school activities, movement and balance and fatigue in favor of hemiplegic children while non significant differences were observed in pain and hurt, eating activities, speech and communication subtests scores between both groups. Non-significant difference was observed in BMI between both groups. Additionally, there were significant negative relationships between GMFCS and PedsQL subtests in both groups with the exception of speech and communication subtest in hemiplegic group. Non-significant relationships were also found between GMFCS and BMI and BMI and PedsQL subtests scores in both groups with the exception of pain and hurt and fatigue subtests in diplegic group.

The results of present study revealed that the rate of obesity and overweight tend to be higher in less severe cases of children with spastic CP (hemiplegia and diplegia). This finding comes in agreement with Delalik etal.[26] who found that the rate of obesity and overweight increase in the children with CP who can walk. They added that less severely affected children don't have feeding problems but they tend to have disproportionate ratio between energy intake and energy output leading to weight gain.

According to the results of the current study, hemiplegic children tend to have greater heights and weights than diplegic type. This finding agrees with Staneket al.[27] who found that children with hemiplegia are consistently at the top of the growth curves, having the highest growth rate for height and weight. Children with diplegia fall into the intermediate range, and children with quadriplegia are at the bottom of the curves with the lowest growth rates. Stevenson et al.[28] found strong correlation between level of disability and growth in patients with CP. Non-significant difference in BMI was found between both types which come in consistent with Stallings et al. [29]who found that there was no difference in the growth or nutritional status patterns of children with diplegia compared with those with hemiplegia. They added that less severe type of spastic CP has weight abnormalities more in young age. Contradictory to this result, Delalik et al.[26] found increasing rate of obesity in diplegic than hemiplegic type.

The current study demonstrated that there were significant differences between both groups in PedsQL subtests scores as diplegic children showed lower scores in most of the subtests.

This could be attributed to the effect of laterality reported by Varni etal.[30]who said that QOL was significantly decreased for the four domains of PedsQL physical, emotional, social, and school function in diplegic than hemiplegic CP children. This finding disagrees with Dickinson etal.[31]who found no relation between QOL and laterality in CP children. Regarding fatigue subtest score, there was significant difference in fatigue score between both groups which comes in agreement with Jahnsen et al.[32]who found a higher prevalence of fatigue in diplegic than hemiplegic children. They attributed the high levels of fatigue in diplegic children to an imbalance between work capability and the workload required for daily life.

In the present study, there was significant difference between diplegic and hemiplegic children in gross motor functional level as there is an increase in the level of impairment in ambulant diplegic than hemiplegic children. The hemiplegic children is classified obviously at level I (71%) and level II (29%) with no children in level III which has also been found in other studies [33-35]. On the other hand, diplegic children were classified mainly at level II and III (83%).This finding is consistent with Himmelmann et al.[33]who found that diplegic children are classified at all levels as most of them were at level II and few children were classified at level V. Similarly, Pfeifer et al.[36] showed that most quadriplegic classified at level V (71.1%),diplegic at level III(33.3%) and hemiplegic children at level I (93.3%).

Negative correlation was found between GMFCS levels and PedsQL subtests scores in both groups. This comes in agreement with Varni et al. [30]who reported that children with quadriplegia demonstrated a significantly lower QOL scores than children with hemiplegia and diplegia meaning that when the GMFCS level increases the QOL scores decreases in CP children.

This study showed that there was non-significant negative correlation between GMFCS levels and BMI in both groups meaning that children at lower levels of impairment according to GMFCS tend to have increased BMI. This comes in agreement with Hurvitzet al.[11]and Oftedal et al.[37]who found an increase in the percent of overweight and obesity in ambulant children with level I, II and III.

According to the results of the present study, significant negative correlations were found between BMI and PedsQL subtests scores in terms of pain and hurt and fatigue in children with diplegia. These findings agree with Mcpheeet al.[38] who study the association between BMI and fatigue in CP children and reported that higher BMI causes greater fatigue in these children. Conversely, Russchenet al.[39] found non-significant association between BMI and fatigue in spastic CP.

The present study have some limitations, intelligence quotient (IQ), social level and caregiver education are not considered which may affect QOL scores. A relative small sample size restricts the ability to make generalization of the results. Future study is needed including larger sample size of CP children at all functional levels. Further studies are recommended in order to investigate the difference in growth rates, QOL and physical activity among all types of CP.

V. Conclusion

This study demonstrated significant differences in weight, height, QOL scores, and functional level between hemiplegic and diplegic CP children. Negative correlation was found between gross motor functional level, BMI and QOL in hemiplegic and diplegic CP children.

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Conflict of interest

The authors reported no conflict of interest.

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Table1. Demographicand clinical characteristics of participants in both groups

	Diplegic group (n=58)	Hemiplegic group (n=42)	t-value	p-value
Age (years)	10.5±1.24	10.31 ± 1.51	0.6849	0.4950
Weight (kg)	24.46 ± 7.12	28.39 ± 10.04	2.2914	0.0241*
Height (cm)	119.42 ± 12.76	125.33 ± 13.25	2.2495	0.0267*
BMI (kg/m²)	17.13 ± 2.88	17.55 ± 3.56	0.6514	0.5163
Gender				
Girls	20 (34%)	18 (43%)		
Boys	38 (66%)	24 (57%)		
GMFCS level				
Level I	10 (17%)	30 (71%)		
Level II	25(43%)	12 (29%)		
Level III	23(40%)	0 (0%)		
BMI categories				
Thin	7 (12%)	4 (9%)		
Normal	30 (52%)	23 (55%)		
Overweight	14 (24%)	8 (19%)		
Obese	7 (12%)	7 (17%)		

Values are presented as mean± standard deviation or number (%) of cases, BMI: body mass index, GMFCS: gross motor function classification system, p-value: probability value**,** t-value: independent t-test, *p <0.05

Table 2. Comparison of PedsQL subtests scores, BMI and GMFCS levels between both groups

Variable		Diplegic group	Hemiplegic group	t-value	p-value
PedsQL subtests (score)	**Daily activities**	51.27 ± 16.15	66.37 ± 18.01	-4.39	0.0001*
	School activities	53.47 ± 22.56	68.6 ± 22.7	-3.29	0.001*
	Movement and balance	67.24 ± 15.42	75.47 ± 14.51	-2.7	0.008*
	Pain and hurt	72.84 ± 20.8	76.63 ± 21.25	-0.89	0.37
	Fatigue	58.55 ± 19.6	71.13 ± 20.7	-3.09	0.003*
	Eating activities	75.17 ± 20.3	81.42 ± 20.54	-1.51	0.13
	Speech and communication	70.8 ± 23.86	75.14 ± 25.62	-0.87	0.38
BMI(kg/m²)		17.13 ± 2.88	17.55 ± 3.56	-0.65	0.52
GMFCS level		2(2-3)	1(1-2)	z-value =420	0.0001*

Values are presented as mean± standard deviation or median (inter quartile range), PedsQL: Pediatric quality of life inventory, BMI: body mass index, GMFCS: gross motor function classification system, p-value: probability value**,** t-value: independent t-test, z-value: Mann-Whitney test*p <0.05

Table 3. Correlation between GMFCS levels and BMI and PedsQL subtests scores in both groups

Variables			r.value	p-value
GMFCS level	BMI	Diplegia	-0.12	0.36
		Hemiplegia	-0.15	0.32
	PedsQL subtests			
	Daily activities	Diplegia	-0.63	0.0001*
		Hemiplegia	-0.6	0.0001*
	School activities	Diplegia	-0.33	0.01*
		Hemiplegia	-0.47	0.002*
	Movement and balance	Diplegia	-0.68	0.0001*
		Hemiplegia	-0.54	0.0001*
	Pain and hurt	Diplegia	-0.4	0.001*
		Hemiplegia	-0.5	0.001*
	Fatigue	Diplegia	-0.28	0.02*
		Hemiplegia	-0.42	0.005*
	Eating activities	Diplegia	-0.44	0.001*
		Hemiplegia	-0.38	0.01*
	Speech and communication	Diplegia	-0.33	0.01*
		Hemiplegia	-0.25	0.1

GMFCS: gross motor function classification system, BMI: body mass index, PedsQL: Pediatric quality of life inventory, p-value: probability value, r-value: Spearman correlation coefficient, *p <0.05

Table 4. Correlation between BMI and PedsQL subtests scores in both groups

Variables	PedsQL subtests	r.value		p-value
BMI	Daily activities	Diplegia	0.01	0.89
		Hemiplegia	0.12	0.45
	School activities	Diplegia	-0.08	0.5
		Hemiplegia	0.25	0.1
	Movement and balance	Diplegia	0.08	0.54
		Hemiplegia	0.29	0.06
	Pain and hurt	Diplegia	-0.31	0.01*
		Hemiplegia	0.2	0.19
	Fatigue	Diplegia	-0.27	0.03*
		Hemiplegia	-0.05	0.72
	Eating activities	Diplegia	-0.04	0.73
		Hemiplegia	0.26	0.09
	Speech and communication	Diplegia	-0.03	0.8
		Hemiplegia	0.26	0.09

PedsQL: Pediatric quality of life inventory, BMI: body mass index, p-value: probability value, r-value: Pearson correlation coefficient, *p <0.05

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