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Prevalence and correlations of weight abnormalities with diet and exercise frequency in Egyptian children with Cerebral Palsy

Tayseer S. Abdeldayem[1], Sabah Mohamed Elkady[2], Asmaa Foad Abdelmonem[3], Tamer M. Sabry[4], Khalid Turky[5], Ahmed Barakat Bekheet [6], and Mai A. Ahmed[1]

[1]Lecturer, Physical Therapy Department for Woman and Child Health, Faculty of Physical Therapy, Beni-Suef University.

[2]Lecturer, Department of Basic Science, Faculty of Physical Therapy, Cairo University, Giza, Egypt.

[3]Lecturer, Department of Biomechanics, Faculty of Physical Therapy. Galala University - Cairo University.

[4]Consultant PT. DPT Cairo university.

[5]Assistant Professor Galala University. Faculty of Physiotherapy. Department of cardiovascular and geriatrics.

[6]Colleague of physical therapy for musculoskeletal disorders at Elsahel Teaching Hospital,Cairo, Egypt.

Abstract

BACKGROUND: Obesity amongst children and teenagers is becoming more prevalent than ever. Cerebral palsy (CP) kids are less active than children without physical limitations and tend to develop risk factors more frequently. for becoming overweight or obese.

AIM: This study's goal was to determine the prevalence of different weight abnormalities and risk of ab-dominal obesity in a random sample of Egyptian children.

DESIGN: cross-sectional study.

SETTING: pediatric physical therapy rehabilitation clinics.

POPULATION: all cerebral palsy cases at six private pediatric rehabilitation clinics in four different governorates (Cairo, Alexandria, Sharkia and Beni-Suef).

METHODS: 249 children diagnosed as having cerebral palsy, age 2-18 years were recruited from different Egyptian governorates in a Cross-sectional study. Body mass index (BMI) and waist to hip ratio (WHR) were computed. Type of cerebral palsy was detected according to the child diagnosis.

RESULTS: The distribution of the study group revealed that 62.7% of the children were at low risk for abdominal obesity, compared to 18.9% who were at high risk. Children with cerebral palsy who had abnormal weight made up 57.42% of the population. Children with cerebral palsy were found to have an abdominal obesity risk of 37.34%.

CONCLUSIONS: The results of our sample population's BMI and WHR analysis show the frequency of overweight and obesity in children with CP is quite low.

CLINICAL REHABILITATION IMPACT: Weight abnormality and central obesity of Cerebral palsy children should be monitored regularly during rehabilitation program. Diet and regular exercises are crucial for maintaining proper weight of CP Children.

Key words: Cerebral Palsy; GMFCS; Obesity; Body mass index; WHO growth charts.

Introduction

Obesity is a complex disease caused by multiple factors, e.g., genetic, behavioral, socioeconomic, and environmental origins. The main factor causing obesity is a Long-term energy imbalance between calories consumed and calories burned. Obesity raises the possibility of developing significant conditions such type 2 diabetes, fatty liver disease, hypertension, myocardial infarction, stroke, dementia, osteoarthritis, obstructive sleep apnea, depression, and several diseases, which decreases both life expectancy and quality of life. The cost of treating these illnesses can contribute to the burden on healthcare systems. For instance, it is anticipated that treating obese patients will cost 30% more than treating patients with normal body mass index (1) .

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Obesity is a main factor creating an economic burden due to its links to unemployment, social disadvantages, and decreased socio-economic output. The obesity pandemic appears to be primarily caused by modifications to the world's food system and a rise in sedentary behaviors (2).

Throughout recent years, childhood obesity has reached endemic proportions and obesity rates are higher in children with cerebral palsy and develop obesity-related complications than normally developed children due to having difficulties with neuromuscular tasks, such as gait, posture, and balance, are prone to other medical, biomechanical, and behavioral barriers to their participation in physical activity (3).

Among the secondary health issues are severe pain, social withdrawal, depression, falls or other injuries, and excessive exhaustion associated with children with disabilities that are likely to get worse with weight gain. Obesity or the potential for obesity combined with a physical or cognitive handicap may make it more difficult for the person and their caregivers to do daily tasks and may raise the cost of care due to the combined negative health effects of both conditions (4).

Up to researchers knowledge no previous studies were conducted to determine prevalence of obesity among Egyptian kids who have cerebral palsy, hence the current study might be helpful in offering suggestions for decision-makers and policymakers and a component in decreasing its economic burden.
The goal of this research was to examine a sample of Egyptian children with cerebral palsy in order to identify the incidence of various weight abnormalities and the likelihood of abdominal obesity.

Materials and methods

Study Design, Study Population, and Time: In this cross-sectional investigation, all cerebral palsy cases at six private pediatric rehabilitation clinics in four different governorates (Cairo, Alexandria, Sharkia and Beni-Suef) during the period between the August 2020 and December 2021. Data were collected from patients, records of the referrals to pediatric physical therapy rehabilitation clinics and the therapists took measurements of the patient's height, weight, hip circumference, and waist circumference.

259 children diagnosed as having cerebral palsy (CP), age 2-18 years from both sexes were recruited from different Egyptian governorates.

These six settings were selected because:1) They represent different geographical and socioeconomic levels in Egypt, 2) All of them offer pediatric physical therapy rehabilitation sessions at approximately the same range of price, 3) At that time general hospitals were still strictly committed to coronavirus control measures, so no data could be available from general hospitals.

Study Procedure: The body mass index (BMI), expressed as kg/m^2, was calculated using height and weight. The waist to hip ratio was calculated using measurements of the waist and hips (WHR). Based on sex-specific growth norms for the age group established by the WHO growth charts, BMI percentiles were recorded. Cerebral palsy type was detected according to the child diagnosis, degree of spasticity was estimated on the basis of the Modified Ashworth Scale (MAS) , according to the Gross Motor Functional Classification System, a child's functional level was identified (GMFCS). A questionnaire was designed to get the caregivers' report about presence of associated impairments, number of meals each day and number of exercising hours each week. Type of associated impairments, quality of meals and type of exercises could not be specified accurately due to the different sociocultural level of caregivers.

Inclusion criteria:

The study included all children diagnosed as Cerebral Palsy between the age of two to 18 years old from both sexes in the participating clinics.

Exclusion criteria:

- Children suffering from developmental motor delays due to any other diagnosis
- Children who refused to engage in measurement procedures (weight, height, waist circumference and hip circumference)
- Children suffered from fixed deformity that didn't allow to get accurate measurements

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Ethics: The institutional ethical committee gave its approval to the procedures, and informed written consent was obtained. The investigator held the written, informed consent for everyone in the strictest confidentiality. Parents gave their consent to participate. N.P.T.REC/012/004234 has received ethical approval. Faculty of Physical-Therapy, Cairo University.

Statistical analysis

IBM SPSS statistics (Statistical Package for Social Sciences), version 28.0, IBM Corp. software was used to code, tabulate, and statistically analyze the collected data, Chicago, USA, 2021. The following information was extracted from the patient records: sex, age, diagnosis, subtype of Cerebral Palsy, level of function and degree of spasticity. No data were available in the records about associated impairments, dietary intake (number of meals or quality of meals) and number of exercise hours each week. A questionnaire was designed to get the caregivers' report about presence of associated impairments, number of meals each day and number of exercising hours per week. Type of associated impairments, quality of meals and type of exercises could not be specified accurately due to the different sociocultural level of care givers and difficulty to interview all care givers. By taking weight and height measurements, BMI: kg/m^2 was computed. By measuring the waist and hip circumferences, WHR was computed. Based on the WHO growth charts' determination of sex-specific age group growth standards, BMI percentiles were recorded.

Data was reported numerically as mean and standard deviation (SD). Categorical data were expressed numerically (percent)..

Descriptive statistics of frequencies, percentages, and confidence interval (CI) were utilized in presenting the subjects demographic and measured data. Chi-square statistics (Fisher Exact test) was utilized to examine associations between weight abnormality and risk of abdominal obesity with participants' characteristics, number of meals and exercise. All statistical tests had a $p < 0.05$ set as the criterion of significance.

Data availability

the data associated with the paper are not publicly available but are available from the corresponding author on reasonable request for confidential.

Results

Subjects characteristics: In the study, 249 children with cerebral palsy participated. The mean ± SD of the study group's age was 6.99 ± 3.96 years with minimum of two years and maximum of 18 years who are recruited from six private pediatric rehabilitation clinics in four different governorates.

Gender distribution was shown in (Table 1). There were 144 (57.8%) boys and 105 (42.2%) girls.

Sub-type of cerebral palsy: Distribution of the selected sample of children showed that 27 (10.8%) were ataxic, 13(5.2%) flaccid, 38 (15.3%) hemiplegic, 36 (14.5%) quadriplegic and 135 (54.2%) diplegic (Table 1).

Degree of Spasticity: As assessed by Modified Ashworth Scale (MAS), distribution of the selected sample of children showed that 20 (8.0%) were grade 1, 77 (30.9%) grade 2, 93 (37.3%) grade 3, 55 (22.1%) grade 4 and 4 (1.6%) grade 5 (table 1).

Level of function: According to GMFCS, distribution of the selected sample of children showed that 22 (8.8%) level I, 78 (31.3%) level II, 75 (30.1%) level III, 49 (19.7%) level IV and 25 (10.0%) were level V (table 1).

Presence of associated impairments: Distribution of the selected sample of children showed that 111 (44.6%) was suffering from associated impairment while 138 (55.4%) were without any associated impairments, as reported by the caregivers in the questionnaire (table 1).

Number of meals per day: The caregivers reported that 128(51.4 %) were consuming 3 and more meals, while 121 (48.6 %) were adapted to less than three meals per day (table 1).

Number of exercise hours per week: The care givers reported also that 86 (34.5 %) were exercising less than six hours per week, while 163 (65.5 %) were exercising six or more hours per week (table 1).

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Weight status: The distribution of study group showed that 106 (42.6%) with normal weight, 45 (18.1%) with obesity, 21 (8.4%) overweight and 77 (30.9%) were underweight (table 2)

Risk of abdominal obesity: The distribution of study group showed that 47 (18.9%) children were at high risk of abdominal obesity, 46 (18.5%) had moderate risk while the majority 156 (62.7%) were at low risk (Table 2).

Prevalence of weight abnormality and risk of abdominal obesity The prevalence of weight abnormality among the selected sample of children with cerebral palsy was 57.42% with 95% CI of 51.22- 63.41%.

The prevalence of risk of abdominal obesity among the selected sample of children with cerebral palsy was 37.34% with 95% CI of 31.57- 43.5%. (Table 3) (Figure1).

Association between weight abnormality and subject characteristics, number of meals and exercise: The prevalence of abnormal weight has significantly increased in children with 2-6 years compared with children with 6- 12 years (p = 0.001), while weight abnormality did not significantly correlate with gender, diagnosis, spasticity, GMFCS and associated impairment (Table 4) (Figure2).

Association between weight abnormality and number of meals and exercise: The number of meals and exercise did not significantly correlate with abnormal weight (p > 0.05). (Table 5).

Association between risk of abdominal obesity and subject characteristics
Compared to boys, girls had a significantly higher prevalence of the risk of abdominal obesity (p = 0.001), while there was no significant correlation between risk of abdominal obesity and age, diagnosis, spasticity, GMFCS and associated impairment (Table 6) (Figure 3).

Association between risk of abdominal obesity with number of meals and exercise of participants: Children who exercised 6 or more hours per week had a significantly higher prevalence of risk for abdominal obesity than kids who exercised less than 6 hours per week. (p = 0.005), the risk of abdominal obesity and quantity of meals did not significantly correlate with one another. (p > 0.05). (Table 7).

Discussion

In this study, a sample of Egyptian cerebral palsy children was analyzed to assess the prevalence of weight abnormalities and the risk of abdominal obesity. 249 cerebral palsy children took part in this study. The mean ± SD age of the study group was 6.99 ± 3.96 years with minimum of two years and maximum of 18 years who are recruited from six private pediatric rehabilitation clinics in four different governorates.

By analysis of obtained data, this age range was found to lie in two groups of age range: from two to six years 126 (50.6%) and from six to 12 years 123 (49.4%), while there were not any children between 12 and 18 years old (table 1).

This may be attributed to that adolescents with cerebral palsy probably get to a plateau level for improvement and this probably does not meet child and parents' goals and expectations so, they stop attending pediatric rehabilitation sessions in private clinics for the purpose of getting more social participation experiences and roles. On the other hand, they probably have developed many coping strategies to their disabilities as children having CP can manage daily challenges like enrollment challenges (5).

This confirms **Abas et al.** (6) whose study sample likewise contained no patients older than 12 receiving physiotherapy. They stated that this finding may be related to the extremes of the disability spectrum, which are either mild and nearly fully rehabilitated or severe and left at home without care due to logistical issues (difficulty transporting adult patients, disapproval of severe cases in the low socioeconomic population, or concerns about money).

According to sex distribution, the study sample was represented as 144 boys (57.8%) and 105 girls (42.2%) having a greater ratio of male to female (1.3) (table 1). This distribution is compatible with **Romeo et al.** (7) who made the claim that males more inclined to develop CP than females are, perhaps as a result males' greater biological sensitivity in terms of their cerebral structure, the protective role of hormones, and genetic polymorphisms. (8-10). The increased prevalence of preterm birth, mortality from preterm delivery, death, and

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intraventricular hemorrhage in this sex also lends support to the idea that male offspring are more biologically vulnerable (11).

Epidemiological data show that females are significantly less likely to die from respiratory illnesses, like as sudden infant death syndrome, regardless of age, indicating that they may be more resistant to hypoxia (11).

The incidence of boys more than girls in the study sample may also be attributed to the inherited preference of the Egyptian community to treat boys more than girls. This was also reported by **Romeo et al.**(7) who reported that in the rehabilitation and intervention sector, boys received physiotherapy more frequently and in greater amounts than girls, perhaps because they are anticipated to engage in greater physical activity, and families or therapists are more willing to treat boys (12, 13).

Locally in Egypt, this distribution comes in agreement with **Abas et al.** (6) who established a database of children having CP obtaining physical therapy in public hospitals, insurance-covered hospitals, and treatment centers in the Bani-Mazar region of the Elminia governorate and stated that his study sample having a male to female ratio that was slightly higher (1.22), almost identical to the 1.3 observed by **Johnson** (14) in Europe.

It also agrees with study of **El-Tallawy et al.** (15) who investigated the epidemiology of CP in El- Kuseir city and stated that their study sample had a higher male to female ratio (2:1).

Analysis of the study sample revealed that the most prevalent sub-type of cerebral palsy was diplegia with prevalence of 135 children (54.2%), followed by hemiplegia 38 children (15.3%), then quadriplegia 36 children (14.5%), dystonic sub-type 27 children (10.8%) and the least prevalence was for flaccid subtype 13 children (5.2%). These results are consistent with those made by **El-Tallawy et al.** (14) that the most severe motor impairment caused by CP was thought to be diplegia and quadriplegia, was found to be the most prevalent sub-type (72.5%), followed by mixed type (23.5%), and ataxic type (3.9%). This study's prevalence of children with different CP subtypes was comparable to the percentages reported by previous researchers (6,15–18).

Based on the Modified Ashworth Scale (MAS), the study sample showed different degrees of spasticity (19). The highest proportion was spasticity of level 3; significant increase in muscular tone passive and difficult movement, 93 children (37.3%), followed by level 2; Greater rise in muscle tone through most of the ROM, but affect part(s) easily moved, 77 children (30.9%), then level 4; difficult passive movement, 55 children (22.1%), level 1; Slight increase in muscular tone, 20 children (8 %) and the least percentage was for level 5 ; rigidity of the affected part(s) in flexion or extension by 4 children (1.6%). The functional level evaluated by Gross Motor Functional Classification System (GMFCS) seems to be matching with the proportions of spasticity. GMFC classification system: LEVEL I - Walks without Limitations, LEVEL II - Walks with Limitations, LEVEL III - Walks Using a Hand-Held Mobility Device, LEVEL IV - Self-Mobility with Limitations; May Use Powered Mobility, LEVEL V - Transported in a Manual Wheelchair.

The study sample showed the highest prevalence for level II GMFCS; 78 (31.3%), followed by level III; 75 (30.1%), then level IV;49 (19.7%), V; 25 (10.0%) and I ;22 (8.8%) respectively. This may be attributed to the expected functional outcomes of children classified as level II and III rather than IV and V in addition to the little requirement of a child level I to attend rehabilitation centers. This distribution matches Abas et al. [6] whose findings were level I cases made up 9.5% of all cases, level IV cases 18.5%, and level V cases 15.5%. and **Brunner et al.,** (20) who stated that 52.4% of their study sample were in GMFCS levels IV and V. This could be interpreted as a reflection on the general public's knowledge of the many etiologies, the norms for neonatal care, the need of early detection, and the success rates of rehabilitation initiatives.

Regarding associated impairments, the study sample revealed 111 children (44.6%) with associated impairment, while 138 children (55.4%) without associated impairments as reported by caregivers. This matches with the proportion of functional level GMFCS II and III for the same sample (61.4%). However, for the nutritional status, the study sample revealed that 128 children (51.4%) consumed three meals or more while 121 children (48.6%) were consuming less than three meals per day. These were reported by caregivers concerning number of meals regardless the nutritional content or eating behavior. This distribution matches **Demirci et al.** (21) who found that lower malnutrition ratings and food selectivity were observed in their study sample of kids with cerebral palsy and **Brunner et al.** (20), in their sample of CP children, the level of motor activity and nutritional status of patients at rehabilitation facilities in Argentina were significantly correlated.

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Regarding level of activity, the questionnaire asked about number of exercise hours per week. Analysis of results revealed that many children 163 (65.5%) was exercising six or more hours per week, while 86 (34.5%) were exercising less than six hours per week. This may be due to the sample was recruited from pediatric rehabilitation clinics, and most of them follow the intensive way of exercising for cerebral palsy or follow a full day program approach. This is consistent with **Hsu et al.** (22) who stated in their systematic review that, the therapeutic intervention considered had an average defined daily dose of 0.752 hours per day, which means a total of around 5.26 hours per week.

Analysis of the study sample results regarding weight status according to Body Mass Index and WHO growth charts showed that the highest prevalence was for normal weight children; 106 (42.6%), followed by prevalence of underweight; 77 (30.9%), then obese children; 45 (18.1%) and overweight children; 21(8.4%). Regarding risk of abdominal obesity, the highest prevalence was for low risk 156 (62.7%), followed by high risk and moderate risk with nearly the same prevalence 47 (18.9%) and 46 (18.5%) respectively.

These results could be explained by psychosocial and abnormal variables in special needs children and adolescents which may affect feeding behavior as mentioned by **Demirci et al.** (21). They stated that children with specific needs frequently exhibit the emergence of food preferences or sensitivities, and malnutrition affects children with cerebral palsy at a rate of between 22.2% and 78.2%. (23), and that physical and social disparities influence nutrition and body weight, thus it is important to consider emotional undereating and food selectivity in cerebral palsy children throughout the treatment phase (21).

Poor eating habits are more prevalent among individuals with lower social status, special needs, or need for special care than among those with greater status, this could be a factor in their discrepancy in health (24). Difficulties experienced by individuals with special needs including cerebral palsy with nutritional disorders such malnutrition, dental issues, and growth retardation in failing to achieve their nutritional demands (25). In **Demirci et al.** (21), The average body mass index of the study sample of children with special needs, which included cerebral palsy, was (22.17± 7.01), which was outside the suggested BMI ranges for kids. Boys with CP were also found to have significantly higher sub-scores for emotional low eating and food selectivity than others.

These findings match **Brunner et al.** (20) who discovered that when the motor impairment is seriously affected, there is a strong probability that Argentine CP children who attend rehabilitation and therapeutic institutions may present with severe and moderate undernutrition. They discovered a strong correlation between undernourishment and the severity of motor disabilities as measured by GMFCS level: as the motor disability rises, the risk of undernourishment also rises. They claimed that compared to developed nations, where a higher percentage of children achieve a normal nutritional status and where the latest research indicates an increase in obesity and overweight, the incidence of nutritional disorders is different (26-28).

These results, however, contradict those of **Bansal et al.** (29), who claimed that children with CP have high rates of obesity and are at risk of obesity in their population analysis of BMI and WHR: BMI 7.5%: obese and 7.5% overweight, putting 15% at risk of obesity. WHR: 20% have a high risk of becoming obese.

Regarding correlation between weight abnormality and subject characteristics, number of meals and exercise, the findings of this study are like those of **Duran et al.** (26) who claimed that a significant proportion of cerebral palsy children with excess fat are of a normal weight (and normal BMI).

Furthermore, **Sadowska et al.** (30) stated that disorders in nutrition and growth are frequent in people with cerebral palsy due to the possibility that all CP children may experience them; however, they are more noticeable in people with more severe motor disabilities. Additionally, it expands our understanding of **Demirci et al** (21)it also adds to our knowledge that **Demirci et al.** (21) in their pilot study, when examined eating behavior children with cerebral palsy were found to have lower malnutrition scores and food selectivity scores than other children, there was no significant difference in total feeding behavior scores by eating behavior scale subscales according to gender and special need groups ($p = 0.155$).

The study's findings about the relationship between subject characteristics, meal frequency, and exercise and the likelihood of abdominal obesity may be explained by the particular challenges faced by children with disabilities

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when it comes to issues with physical activity. Generally, people with disabilities who want to enhance their exercise levels encounter accessibility issues or inadequate training.

The process of being active is more difficult for someone who has a condition that began as a child, such as CP. Many forms of exercise and activity during childhood and adolescence are social. People with disabilities that develop in childhood frequently struggle to participate in activities like competitive sports or treks with their able-bodied classmates. It is challenging for people with impairments to fully integrate into sporting activities, despite the increased awareness (31).

Lower levels of aerobic capacity have been seen in people with CP, which is a significant Overweight risk factor in this population (29). Additionally, **Myers et al.** (32) children with CP had lower values for heart rate, oxygen uptake, ventilation, and blood lactate concentrations compared with the control group when their physical work capacity and aerobic power were compared to a control group of 12 age- and sex-matched children without impairments. For a period of six years, the children were examined on a bicycle ergometer two- or three-times year. Even though the gap did not widen during the course of the six-year trial, the control group's fitness levels (measured by oxygen consumption and physical work capacity) were higher than those of the CP patients.

Children and teenagers with CP are presumably at higher risk of weight anomalies, at least in part because of sedentary behavior. To evaluate daily activity in children with cerebral palsy (CP), ten children with spastic diplegia were compared to ten children without disabilities using the ratio of total energy expenditure to resting energy expenditure measured using the doubly labelled water technique(29), Children with CP were significantly less active than their counterparts, and the authors hypothesize that this could be because children's physical activity was not intense enough to help them become more physically fit. A substantial risk of being underweight according to BMI was discovered in their clinic-based investigation (29) because to the higher metabolic demands of spastic muscles and energy usage during everyday activities.

Malnutrition may also be related in the more severely involved, non-ambulatory children. **Maltais et al.** (33) assessed the habitual physical activity of 11 children with mild CP using an activity monitor, to ascertain the connection between physical activity and biomechanical treadmill walking efficiency.

In a procedure intended to ascertain the relationship between physical activity and the cost of walking, a study team also used HR monitoring to evaluate the degree of physical activity in CP children. According to the study, kids who don't exercise much can have a higher energy expenditure when walking (34).

Conclusions

Analysis of BMI and WHR in our study of CP children within limitations indicates that the prevalence of obesity and overweight in CP children is low. Additionally, central obesity prevalence varied little according to risk category, with low risk having the highest prevalence, followed by high risk and moderate risk. The prevalence in our study was much lower than the incidence of childhood obesity in CP children in studies conducted in other countries. Additional research is required to assess the prevalence of obesity and the likelihood of abdominal obesity among Egypt's people with CP compared to that of other nations.

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TABLES

Table 1. Participants' characteristics

	N	**%**
Age		
2-6 years	126	50.6%
6- 12 years	123	49.4%
Gender		
Boys	144	57.8%
Girls	105	42.2%
Diagnosis		
Ataxic	27	10.8
Flaccid	13	5.2
Hemiplegia	38	15.3

Quadriplegia	36	14.5
Diplegia	135	54.2
Spasticity		
1	20	8.0
2	77	30.9
3	93	37.3
4	55	22.1
5	4	1.6
GMFCS		
I	22	8.8
II	78	31.3
III	75	30.1
IV	49	19.7
V	25	10.0
Associated impairment		
Yes	111	44.6%
No	138	55.4%
Number of meals		
Three and more	**128**	**51.4**
Less than three	**121**	**48.6**
Exercise (hours /week)		
Less than 6 hours /week	86	**34.5**
6 or more hours /week	163	**65.5**

Table 2. Weight status, risk of abdominal obesity

	N	%
Weight status		
Normal	106	42.6
Obese	45	18.1
Overweight	21	8.4
Underweight	77	30.9
Risk of abdominal obesity		
High risk	47	18.9
Moderate risk	46	18.5
Low risk	156	62.7

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Table 3. Prevalence of weight abnormality and risk of abdominal obesity

	Prevalence	95% CI*
Weight abnormality (Underweight, Overweight, Obesity)	143 (57.42%)	51.22- 63.41%
Risk of abdominal obesity (low, moderate & high)	93 (37.34%)	31.57- 43.5%

*CI, Confidence interval

Table 4. Association of weight abnormality with participants' characteristics

	Weight abnormality		χ^2 value	p -value
	Yes	No		
Age				
2-6 years	87 (69%)	39 (31%)	14.08	0.001
6- 12 years	67 (54.5%)	56 (45.5%)		
Gender				
Boys	85 (59%)	59 (41%)	0.35	0.55
Girls	58 (55.2%)	47 (44.8%)		
Diagnosis				
Ataxic	14 (51.9%)	13 (48.1%)	4.07	0.39
Flaccid	10 (76.9%)	3 (23.1%)		
Hemiparesis	21 (55.3%)	17 (44.7%)		
Quadriplegia	24 (66.7%)	12 (33.3%)		
Spastic Diplegia	74 (54.8%)	61 (45.2%)		
Spasticity				
1	15 (75%)	5 (25%)	7.25	0.12
2	38 (49.4%)	39 (50.6%)		
3	58 (62.4%)	35 (37.6%)		
4	31 (56.4%)	24 (43.6%)		
5	1 (25%)	3 (75%)		
GMFCS				
I	13 (59.1%)	9 (40.9%)	6.3	0.17
II	37 (47.4%)	41 (52.6%)		
III	45 (60%)	30 (40%)		
IV	34 (69.4%)	15 (30.6%)		

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			χ^2 value	p -value
V	14 (56%)	11 (44%)		
Associated impairment				
Yes	69 (62.2%)	42 (37.8%)	1.83	0.17
No	74 (53.6%)	64 (46.4%)		

χ^2, Chi-squared value; p value, Probability value

Table 5. Association of weight abnormality with number of meals and exercise of participants

	Weight abnormality		χ^2 value	p -value
	Yes	No		
Number of meals				
Three and more	73 (57%)	55 (43%)	0.01	0.89
Less than three	70 (57.9%)	51 (42.1%)		
Exercise (hours /week)				
Less than 6 hours /week	53 (61.6%)	33 (38.4%)	0.94	0.33
6 or more hours /week	90 (55.2%)	73 (44.8%)		

χ^2, Fisher Exact test; p value, Probability value

Table 6. Association between risk of abdominal obesity with participants' characteristics

	Risk of abdominal obesity		χ^2 value	p -value
	Yes	No		
Age				
2-6 years	48 (38.1%)	78 (61.9%)	0.06	0.81
6- 12 years	45 (36.6%)	78 (63.4%)		
Gender				
Boys	10 (6.9%)	134 (93.1%)	134.91	0.0001
Girls	83 (79%)	22 (21%)		
Diagnosis				
Ataxic	14 (51.9%)	13 (48.1%)		
Flaccid	2 (15.4%)	11 (84.6%)		
Hemiparesis	9 (23.7%)	29 (76.3%)	8.7	0.06
Quadriplegia	13 (36.1%)	23 (63.9%)		
Spastic Diplegia	55 (40.7%)	80 (59.3%)		

Spasticity				
1	6 (30%)	14 (70%)		
2	24 (31.2%)	53 (68.8%)		
3	37 (39.8%)	56 (60.2%)	3.29	0.52
4	24 (43.6%)	31 (56.4%)		
5	2 (50%)	2 (50%)		
GMFCS				
I	7 (31.8%)	15 (68.2%)		
II	27 (34.6%)	51 (65.4%)		
III	32 (42.7%)	43 (57.3%)	3.98	0.41
IV	21 (42.9%)	28 (57.1%)		
V	6 (24%)	19 (76%)		
Associated impairment				
Yes	42 (37.8%)	69 (62.2%)	0.02	0.88
No	51 (37%)	87 (63%)		

χ2 , Chi-squared value; p value, Probability value

Table 7. Association between risk of abdominal obesity with number of meals and exercise of participants

	Risk of abdominal obesity		**χ^2 value**	**p -value**
	Yes	**No**		
Number of meals				
Three and more	46 (35.9%)	82 (64.1%)	0.22	0.63
Less than three	47 (38.8%)	74 (61.2%)		
Exercise (hours /week)				
Less than 6 hours /week	22 (25.6%)	64 (74.4%)	7.77	0.005
6 or more hours /week	71 (43.6%)	92 (56.4%)		

χ2, Fisher Exact test; p value, Probability value

TITLES OF FIGURES

Figure 1. Prevalence of weight abnormality and risk of abdominal obesity.
Figure 2. Percentage of weight abnormality with participants' characteristics.
Figure 3. Percentage of abdominal obesity with participants' characteristics

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