# BODY COMPOSITION IN CHILDREN WITH CEREBRAL PALSY AND ITS RELATIONSHIP WITH DYNAMIC MUSCLE STRENGTH, BALANCE AND ENERGY COST OF AMBULATION

**Badaru, U.M.[1], Dabo, L.S.[1], Nuhu J.M.[1], Ahmad, R.Y.[1], Abba M.A.[1] and Shittu, A.[1]**
[1]Department of Physiotherapy, Faculty of Allied Health Sciences, Bayero University, Kano, Nigeria
Correspondence author: umbadaru.pth@buk.edu.ng OR badaruum@yahoo.com
Mobile: +2348035913759

**ABSTRACT**
*Cerebral palsy (CP) causes walking disability in children which could lead to profound changes in body composition. This study assessed relationship between body composition and each of dynamic muscle strength, mobility and energy cost of ambulation (ECA) among children with CP. The cross sectional survey, recruited participants from a secondary and a tertiary hospitals in Kano. Body composition was assessed with BMI for age charts and skin fold calipher. Dynamic muscle strength, balance and ECA were assessed with step-up test, time-up-and-go test and physiological cost index respectively. Data was analysed with Pearson Product Moment Correlation and unpaired t test at alpha level of P<0.05 using SPSS version 20 and Microsof excel. Twenty four children took part in the study, 13 (54.2%) females and 11(45.8%) males. Their mean age was 10.0 ± 4.6 years. Majority of them 17 (70.8%) were underweight. The mean percent body fat score was 11.78±3.85, with females having significantly higher amount of body fat than males (t=-3.37; P=0.003). There were no significant correlations between body compositon and each of dynamic muscle strength, balance and ECA (p>0.05). It was concluded that about two-thirds of the children with CP in the study are underweight and having low percent body fat. Body composition may not have significant influence on the muscle strength, stability and the energy expended during walking function. Paediatricians and physiotherapists should encourage caregivers of children with CP to feed them with balanced diet in order to avoid diseases associated with malnutrition.*
*Keywords: cerebral palsy, body composition, muscle strength, balance and physiological cost index.*

## INTRODUCTION

The physical disability caused by Cerebral Palsy (CP) often leads to profound changes in body composition (Park *et al.,* 2011; Finbraten *et al.*, 2015). Although children with CP are often viewed as being undernourished with stunted growth, a number of studies propose however that children with CP are at a high risk of becoming overweight probably because of their low level of physically activity and sedentary life (Rogozinski *et al.,* 2007; Reinehr *et al.,* 2010; Park *et al.,* 2011). Studies by Rogozinski *et al.* (2007) and Reinehr *et al.* (2010) have reported on the rapid increase in the prevalence of overweight and obesity among children with CP. Other studies also reported that ambulant children with CP tend toward having increased prevalence of being overweight (Hurvitz *et al.,* 2008; Park *et al.,* 2011). There is however dearths of published studies documenting the prevalence of overweight or obesity among ambulatory children with CP in Nigeria.

It has been suggested that body composition could have influence on the level of physical functioning and activity of individuals (Nene *et al.,* 1993; Marques *et al.,* 2011). Although muscle strength has been found to have influence on the walking ability and gait in children with CP (Eek 2009), Flanagan et al. (2011) has opined that body composition is another factor that could exert similar influence on activity and physical functioning in children with CP which should not be overlooked. It is however not clear in the literature whether body composition or in particular excess body fat could have any influence on the dynamic strength, balance and Energy Cost of Ambulation (ECA) in children with CP. This study therefore, assessed the relationship between body composition and each of muscle strength, balance and ECA in children with CP.

## MATERIALS AND METHODS

The study was a cross-sectional survey in which children with CP who are attending treatment at the out-patient unit of Physiotherapy Departments in Aminu Kano Teaching Hospital (AKTH) Kano and Murtala Muhammad Specialist Hospital (MMSH) Kano were recruited using purposive sampling technique. Inclusion criteria include: children with CP who are able to ambulate with or without walking aid (GMFCS 1-111) and the ablity to adhere to simple instructions. Stadiometer (SECA/Germany) was used to measure height and weight, skinfold caliper (Country technologies) was used to measure the skin fold thickness, body mass index-for-age percentiles charts (from American Center for Disease Control) was used to categorize the Body Mass Index (BMI) based on percentiles.

### Data Collection Procedure

Ethical approval was sought from the ethics committees of Aminu Kano Teaching Hospital (NHREC/MAC/21/08/2008/AKTH/EC/1339) and Kano State Hospitals Management Board for Murtala Muhammad Specialist Hospital before the commencement of data collection. Informed consent was obtained from the participants and their caregivers.

### Assessment of obesity

BMI for age percentile was used to determine obesity. The BMI was first determined by dividing weight of the children by the quare of their height ($W/H^2$). On the BMI-for-age chart, age was on the horizontal axis and BMI was on the vertical axis. The appropriate percentile score for each child was obtained at the intersection of age and BMI.

### Categorization of BMI for age percentiles

BMI for age <5th percentile was considered as underweight, ≥ 5th to <85th percentile was considered normal weight, ≥85th percentile to <95th percentile was considered risk of overweight, and ≥ 95th percentile was considered overweigh/obese (Liusuwan *et al.,* 2007).

### Assessment of percent body fat

This was assessed with skinfold caliper as a measure of subcutaneous fat to the nearest 0.1mm. The following Slaughter equations were used to measure the percent body fat

a.  1.21 x (triceps + subscapular) − 0.008 x (triceps + subscapular)$^2$ - 3.2 for black males

b.  1.33 x (triceps + subscapular) - 0.013 x (triceps + subscapular)$^2$ - 2.5 for all females (Dezenberg *et al.,* 1999).

### Measurement of dynamic muscle strength

This was measured with the step-up test. It involved counting the total number of times a child performed step-up and down task on the first step of a staircase in 30 seconds (Blundell *et al.,* 2003). Children that perform greater number of step-up and down task per unit time were regarded as having better dynamic strength.

### Assessment of balance

This was assessed using the Time-Up-and-Go (TUG) test. Each child was asked to sit back comfortably on a standard arm chair. They were asked to stand up from the chair and walk round a cone and come back to sit on the chair again. The chair was placed three metres away from the cone. Children that completed the TUG test in less total time were rated as having better balance.

### Assessment of energy cost of ambulation (ECA)

The physiological cost index (PCI) was used in the assessment of ECA. Each child was asked to walk 20 meters distance. The heart-rate was measured before and immediately after the 20 meters-walk using standard procedure. The PCI (beats per meter) was calculated as the diference between walking and resting heart rates (beats/min) divide by walking speed (meters/min) (Bailey and Ratcliffe, 1995; Delussu *et al.,* 2014).

### Data Analysis Procedure

Data was summarized using descriptive statistics of frequency, mean and standard deviation. Relationship between body composition and each of balance, dynamic muscle strength and ECA was assessed with Pearson's correlation. Unpaired t test was used to assess mean differences in percent body fat, balance, and dynamic muscle strength and ECA between males and females. Statistical analysis was performed using SPSS version 20.0. at $P < 0.05$ alpha level and Microsoft excel.

## RESULTS

### Characteristics of participants

Twenty four children with CP participated in this study, 11(45.8%) are males and 13 (54.2%) are females. The mean age of the children was 10 ± 4.61years, age range 4–18years and majority of them 20 (83.3%) could walk without any walking aid. These results are presented in Table 1.

The mean height of the children was 1.27 ± 0.25m, range 0.90m–1.80m. The meanweight was 23.67 ± 10.8kg, range 11.00kg − 55.00kg. The mean balance score was 18.80sec ± 10.41sec, range 10.00sec − 55.00sec as presented in Table 2.

Majority of the children 17(70.83) were underweight and 5(20.83%) had normal weight, 2 (8.33%) were at risk of overweight while none of them was obese. Further analysis revealed that most of the males 10 (58.82%) were underweight when compared with their female conterparts 7(41.18%). None of the males was also found to be at risk of overweight 0% as presented in figure 1

This study found significant gender difference in percent body fat (male=9.48 ± 2.14; female 13.89 ± 3.86, t=-3.371, P=0.003), but there was no significant gender difference in balance (male=16.64 ± 5.24; female=20.62 ± 13.31, t=-0.930, P=0.362), ECA (male =0.14 ± 0.25; female =0.98 ± 2.32, t=-1.194, P=0.245) and dynamic muscle strength (male=10.18 ± 4.21; female=9.23 ± 5.45, t= 0.471, P=0.642).

Furthermore, there were insignificant correlations between body compositon and each of dynamic muscle strength (r = -0.015, p = 0.945), balance (r = 0.107, p = 0.620) and ECA (r = 0.256, p = 0.228).

**Table 1:** Characteristics of participants

| Variables | N | % |
|---|---|---|
| **Sex** | | |
| Male | 11 | 45.8 |
| Female | 13 | 54.2 |
| **Child age category** | | |
| 4 – 10years | 13 | 54.2 |
| >10years | 11 | 45.8 |
| **Mother income** | | |
| Below minimum wage | 19 | 79.2 |
| Low income | 3 | 12.5 |
| Average income | 1 | 4.2 |
| High income | 1 | 4.2 |
| **Walking aid** | | |
| Cane | 1 | 4.2 |
| Walking frame | 3 | 12.5 |
| None | 20 | 83.3 |
| **Age category of mother** | | |
| 20 – 30 years | 8 | 33.3 |
| 30 – 40years | 10 | 41.7 |
| >40years | 6 | 25.0 |
| **Level of education of mother** | | |
| None | 4 | 16.7 |
| Primary | 6 | 25.0 |
| Secondary | 7 | 29.2 |
| Tertiary | 7 | 29.2 |
| **Child schooling** | | |
| Yes | 18 | 75.0 |
| No | 6 | 25.0 |
| **Type of CP** | | |
| Spastic | 15 | 62.5 |
| Athetoid | 4 | 16.7 |
| Ataxic | 5 | 20.8 |
| Mixed | 0 | 0 |

Keys: **N** = frequency, **%** = percent, **p** = percentile

**Table 2:** Dynamic strength, balance and body composition variables

| Variables | Mean ± SD | Ranges |
|---|---|---|
| Height (m) | 1.27 ± 0.25 | 0.90 – 1.80 |
| Weigth (kg) | 23.67 ± 10.80 | 11.00 – 55.00 |
| Balance score (sec) | 18.79 ± 10.41 | 10.00 – 55.00 |
| Dynamic strength | 9.67 ± 4.84 | 2.00 – 21.00 |
| Energy cost of ambulation | 0.59 ± 1.74 | -2.10 – 7.50 |
| RHR (beat/min) | 87.88 ± 13.87 | 52.00 – 108.00 |
| EHR (beat/min) | 94.08 ± 15.60 | 60.00 – 120.00 |
| Percentage body fat | 11.87 ± 3.85 | 7.04 – 18.90 |

Keys : **SD** = Standard deviation, **kg**=kilogram **RHR** = Resting Heart Rate, **EHR** = Exercise Heart Rate, **m** = meters, **sec=seconds**
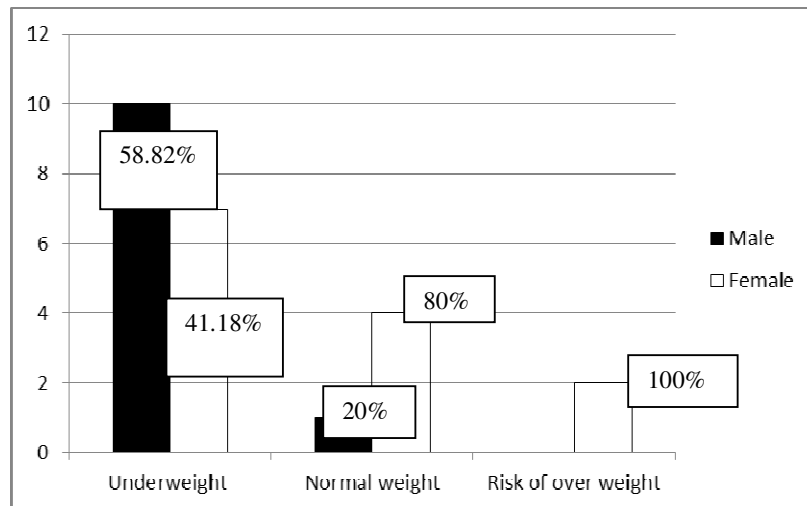


Figure1: Body weight distribution among children with CP based on gender

## DISCUSSION

The result of this study showed that about two-thirds of the study participants were underweight. The possible reason for the result obtained in this study could be that the children were malnourished probabbly due to the fact that majority of their caregivers earn monthly income below the minimum wage of ₦18,000. As such some of them may not afford to take good care of the children considering their meagre earnings. On the contrary, a retrospective 13 years study showed that ambulatory individuals with CP are more prone to being overweight than underweight (Park *et al.,* 2011). Hurvitz *et al.* (2008) also suggested that ambulatory children with CP tend toward having higher prevalence of overweight while underweight was more prevalent in non-ambulatory children. In the same vein, a study by Rogozinski *et al.* (2007) found that children with mild CP (GMFCS level II) had twice the odds of becoming obese than did children with greater involvement (GMFCS level III).

The mean balance (TUG) score in this study was lower compared with 19.8 and 25.4 that were reported by Salem and Godwin (2009) and higher when compared with 10.1 and 8.1 that were reported by Katz-Leurer *et al.* (2009). This implies that the children in this study had higher balance than the children in the study by Salem and Godwin (2009) but they however have lower balance when compared with particpants in Katz-Leurer *et al.* (2009). This is because high TUG score means low balance and vice versa. The possible reason for the difference in the outcome of this study and that of Katz-Leurer *et al.* (2009), on balance could be due to the fact that this study recruited only children with CP but Katz-Leurer *et al.* (2009) recruited children with CP and head injury and it is possible that children with head injury may have higher balance (Low TUG score) that children with CP.

The outcome of this study revealed that children with CP have high dynamic muscle strength. This is because, children in this study were able to perform average of 9.67 repetitions in 30 seconds that is, about 19 repetitions per minute. This was higher than the average of about 13 repetitions per minute that was reported by Katz-Leurer *et al.* (2009) and Blundell *et al.* (2003).

The children with CP in Blundell *et al* (2003) performed an average of 3.3 repetitions in 15 seconds and this gave average of 13.2 repetitions per minute.

The average ECA in this study was within normal limits for childen with CP based on the research report that, the ECA of apparenthy healthy children was 0.1 (beats per meters) and that of the children with CP was 6 times higher (Raja *et al*., 2007). Very high levels of ECA of 5.8 and 5.1 have also been reported by Katz-Leurer *et al* (2009). The implication of this finding is that the children in this study did not expend so much energy when walking, with appreciable gait efficiency and negligible locomotor disability (Bailey and Ratcliffe, 1995).

The average percent body fat in this study (i.e.11.87) was lower than the 21.5, 20.7, and 22.9 percent body fat that were reported by Finbraten *et al*. (2015). This implies that the chidren with CP in this study have very low body fat. Futthermore, the female participants in this study have significantly greater amount of body fat than the male participants. This implies that males are more malnourished than their female counterpart. Finally, it was found in this study that there was no significant relationship between body composition in children with CP and each of their Dynamic Muscle Strength,

Balance and ECA. This result implies that the amount of fatness in the body of children with CP may not have significant influence on their functional muscle strength, stability and amount of energy they expend during walking function. The possible reason for the result obtained above may be because the percent body fat is very low and most of the children were underweight, and in this situation, body composition is not likely to have any impact on any of the variables of walking function

## CONCLUSION

About two-thirds of the ambulant children in this study were underweight and majority of the underweight are males. The children generally have low percent of body fat. Amount of fatness in children with CP may not have significant influence on their functional muscle strength, stability and amount of energy they expend during walking function. Paediatricians and physiotherapist should encourage caregivers of children with CP to feed them with balanced diet to avoid diseases associated with malnutrition.

## Authors' contributions

All the authors have equal contributions in the design of this research, data collection, data management and research report

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