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BODY MASS INDEX IN AMBULATORY CHILDREN WITH CEREBRAL PALSY: A COHORT STUDY

Original Article

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What is already known on this topic:

1. Children who are overweight and obese are at risk of significant health consequences
2. In Australia, 25% of children in the general population are classified as being overweight or obese
3. Children with physical and intellectual disabilities have a unique set of environmental and personal risk factors that may increase the likelihood of the child being overweight and obese

What this paper adds:

1. For ambulatory children with CP 19.4% were overweight or obese. This was lower compared to statistics reported from the general population of children in Australia.
2. There was an association with gross motor function and weight. Children with a higher level of gross motor function (GMFCS level I) were more likely to have a healthy weight. Children with a lower level of gross motor function (GMFCS level III), were more likely to be obese.
3. In ambulant children with CP there was no significant difference in the distribution of BMI Z score according to sex.

Introduction

The prevalence of obesity and overweight children has been regularly described as being of epidemic proportions in the Australian paediatric population as well as many other countries around the world [1-6]. The links between being overweight or obese and chronic illnesses in children in both the short and longer term have been well documented including hypertension, cardiovascular illness and type 2 diabetes [5, 7, 8]. Secondary complications such as musculoskeletal impairments and depression may also be associated with being overweight or obese [2, 9, 10]. One study reported increased orthopaedic complications such as fractures, musculoskeletal discomfort, impaired mobility and lower extremity malalignment in obese children and adolescents [11, 12]. The longitudinal tracking of being overweight or obese from large population-based studies is well established and links between being overweight or obese in childhood and in adulthood are resulting in increased pressure on health care systems around the world [2, 8].

Many population-based studies of BMI in children from general populations have been reported from different countries [6, 13]. In 2012, the Australian Health Survey conducted by the Australian Bureau of Statistics reported that 25% of children aged 5-17 years were overweight or obese [14].

There are many risk factors for becoming overweight or obese including diet, family, cultural and environmental factors. A common risk factor is a sedentary lifestyle and reduced amounts of physical activity [15]. For Australian children, the recommendations for physical activity for children who are aged 5-17 years are 60 minutes of moderate to vigorous activity every day [15, 17].

Children with cerebral palsy (CP) may be at risk of becoming overweight or obese. CP, the most common physical disability of childhood, is a condition in which children have a complex mix of primary neurological and secondary musculoskeletal impairments that place restrictions on their mobility and participation in exercise [18, 22]. The severity of the motor disorder in CP can be measured using the Gross Motor Function Classification System (GMFCS) that contains five levels describing the functional level of a child and the need for walking aids or wheeled mobility. GMFCS level I describes a child that has minimal impairments to walking and running and GMFCS level V describes a child that is totally dependent on others for all mobility and care [24]. In a large population based study of Victorian children with CP 35% of children were functioning at GMFCS I, 16% at GMFCS II, 15% at GMFCS III, 16% at GMFCS IV and 18% at GMFCS V [25]. The brain lesion responsible for CP may result in spasticity, dystonia, weakness and impairments of selective motor control and balance. Secondary musculoskeletal impairments may include contractures and bony deformities [23]. For ambulatory children (GMFCS I-III) it is these impairments that often lead to children requiring gait corrective surgery to maintain their walking ability [23].

There are many factors that may influence an ambulant child with CP to become overweight or obese. Children with CP may have received an insult to the hypothalamic area of the brain controlling appetite and energy expenditure. It is not surprising that these children do not meet the recommended amount of physical activity compared to their typically developing peers, because of these restrictions in gross motor function [21, 26-29]. Children with CP may find simple activities such as walking demanding and disproportionately strenuous. They may choose to avoid physical activity, adopt a sedentary lifestyle [9, 30, 31]. Despite children

with CP having increased cost of walking, they have lower energy expenditure than typically developing children of the same weight and height [32]. There are also medical reasons that may influence weight in children with CP including the use of particular medications and feeding methods. Intellectual disability is found in 50% and 25% have been reported as having behavioural difficulties [33] and these factors may also influence the number of children becoming overweight or obese in this population.

For children with CP who already have difficulties with body image and may experience prejudice and discrimination, the combination of being overweight or obese with physical disability can also further impact on quality of life, to a greater degree than children who are obese but do not have a physical disability [9]. Increased body mass in conjunction with increasing musculoskeletal impairments may result in progressive loss of function and mobility when compared to peers without a disability [34]. This may be particularly rapid during the pubertal growth spurt. **For children requiring gait corrective surgery, prolonged hospital admissions and rehabilitation periods are required [23, 35].** For the adult population being overweight or obese can significantly hinder rehabilitation and surgical recovery [36-38] but these issues have not been examined in the population of children with CP.

Studies have been conducted in some countries to investigate the frequency of being overweight or obese in children with CP. In Korea it was found that of 1397 ambulatory children with CP, 5.8% were obese and 11.2% were overweight [34]. In a cohort from the United States of America 18.2% were found to be obese and 10.9% overweight [39]. In an Australia study of a developmental paediatric service that included 65 patients with CP, 10.7% were overweight and 9.3% obese [40].

Objective

To study the distribution of BMI in ambulatory children with CP, who attended a gait analysis laboratory for three dimensional gait analysis (3DGA), as part of the assessment protocol for gait correction surgery. In particular we wished to identify the percentages of children who were overweight or obese according to known reference ranges for children. Secondary aims were to compare BMI distribution to the general paediatric population of Australia and explore the relationship to gross motor function using the GMFCS.

Method

This was a retrospective cohort study. Children were identified from a clinical gait analysis laboratory database at a tertiary hospital in Australia. Inclusion criteria were a diagnosis of CP according to the definition of Rosenbaum and colleagues [41] and registration on a state-wide CP register. Children were included if they had a 3DGA, between July 1995 and January 2012, and were functioning at GMFCS levels I–III. For children who attended on multiple occasions, the first assessment was included. Age appropriate descriptors [24] were used by an experienced physiotherapist to assign GMFCS levels. Height and weight data were collected by trained physiotherapists as part of the 3DGA protocol. Weight data was obtained with an electronic physician scale and height with a stadiometer. The same equipment was used for all patients. The child's BMI was calculated using height and weight data and converted to Z scores. Growth charts have been reported for children and adolescents aged 2 – 20 years, which take into account the child's age and sex [42]. In Australia the accepted growth chart is from the Centre for Disease Control (CDC) [43, 44]. Using these charts, BMI was assigned to one of four categories; underweight, healthy, overweight and obese. An additional category combining overweight and obese together was created as both of these categories are considered at risk for health complications. In total,

587 children were included. Data were analysed using Minitab 17.0 and one sample tests of proportions were used to compare the percentage of children in each BMI category to data from the Australian Health Survey 2011-2012. A p-value of 0.05 was used to denote statistical significance.

Results

There were 347 boys and 240 girls, of mean age 10.4 years (SD 3.3); 140(23.9%) children were classified as GMFCS I, 309(52.6%) GMFCS II, 138(23.5%) GMFCS III. The vast majority of children had CP of the spastic type, 583(99%). Topographically, 358(61%) of the cohort were classified with diplegia, 185(31.5%) hemiplegia, 17(2.9%) triplegia, 18(3%) quadriplegia, 5(0.9%) monoplegia. Four (0.7%) had a mixed movement disorder. Mean BMI Z score was 0.11(SD 1.33). Seven percent of children were underweight, 73.6% healthy, 7.3% overweight and 12.1% obese, Figure 1 displays these percentages in comparison to the general population of children aged 5-17 years as described in the Australian Health Survey 2011-2012 [17]. There was a higher incidence of children who were underweight and healthy in the CP population ($p=0.007$) and a lower incidence of children who were overweight ($p=0.000$) and obese ($p=0.001$). This was also the case when the categories of overweight and obese were combined ($p=0.007$). There were no significant differences according to sex (Figure 2) except when the overweight and obese category were combined ($p=0.001$).

GMFCS level I had the largest number of children in the healthy category (GMFCS I 72%, GMFCS II 70%, GMFCS III 63 %).GMFCS level III had the highest number categorised as obese (GMFCS I 9%, GMFCS II 8%, GMFCS III 18%) (Figure 3).

Discussion

In this cohort there were a small significant reduction in the proportion of children who were overweight and obese when compared to Australian children; 19.4% vs. 25% [17]. This was similar to studies from Korea and the United States of America where there were no increases in the percentages of overweight and obesity when comparing children with CP to known data from their countries' populations [34, 39].

For children who functioned at a lower functional level (GMFCS III) there was a slightly higher percentage of obesity. This was consistent with an Australian clinical based study that also found the highest proportion of children who were overweight and obese were functioning at GMFCS level III [40]. It may be hypothesised that children who have a lower functional level and greater neuromuscular involvement have greater difficulties with physical activity, which may contribute to a higher level of obesity. As these children require mobility aids to ambulate, there may be additional environmental barriers such as access to physical activity programs as well as parental barriers associated with misconceptions regarding participation in these types of activities [22, 27, 46]. However children who have even greater involvement functioning at GMFCS levels IV and V are known to be more likely to be underweight [32]. These differences may be related to eating methods and opportunities. Children functioning at GMFCS levels IV and V often have problems with eating and require significant physical assistance with eating or alternative methods such as a percutaneous endoscopic gastrostomy tube [47]. Children who are functioning at GMFCS level III are less likely to have feeding difficulties and may be more likely to eat and obtain food independently [48].

Whilst it is pleasing that there is not a larger percentage of obesity in this cohort of ambulatory children with CP compared to the Australian population of children, it is still of

concern as there may be more detrimental implications for this cohort of children. With the secondary musculoskeletal impairments associated with CP [23], the co-morbidities associated with being overweight or obese may therefore be compounded and it is reasonable to expect greater risks and impairments for this cohort with the two conditions.

A further consideration is that for children with ambulatory CP attending a gait analysis laboratory, it is likely that gait corrective surgery will be required at some point in their childhood. Whilst it is known that being underweight carries significant risks when considering surgery, what is not known is if being overweight or obese also carries risks for these children. These risks may be related not just to the surgical procedure itself but for the long and intensive period of rehabilitation that follows. The rehabilitation period post operatively is extremely important for children after gait corrective surgery [35], however increased weight and obesity further restricts movement and therefore it may be assumed that it can also affect the ability to rehabilitate [36].

There are several limitations to this retrospective cohort study. It is not possible to generalise to the population of ambulatory children with CP as this study only included those that were referred for 3DGA for gait corrective surgery planning. Research is needed in the form of larger population-based studies. The cohort included children with varying topographical presentation. There were fewer children at GMFCS I who have mild CP and high levels of physical function as they are less likely to require major gait correction surgery [25, 35].

It is important to consider the effect of being overweight or obesity on the gait patterns of children with CP. With the known links between obesity and lower limb malalignment in the general population [11] we do not know the impact of obesity on pre-existing musculoskeletal deformities.

The impact of being overweight or obese on the development of particular detrimental gait patterns such as crouch gait also warrants further study. This gait pattern involves increased knee flexion and consequently patellar femoral forces [49], obesity is already linked to knee pain and joint degradation for the adult population [38] and it could be hypothesised that obesity could further impact on the integrity of the knee joint in these children. Further research is required to investigate the effect of BMI and the outcome of gait corrective surgery to understand the impact on the rehabilitation period and to be able to predict the outcomes and support families in planning the procedure and undertaking rehabilitation after surgery.

In conclusion the levels of obesity in this cohort of ambulatory children with CP who attended a gait analysis laboratory are less than what is reported for the Australian population of children. Further research must be undertaken to gain a greater understanding of the magnitude, impact and consequences of obesity on the general population of children with CP.

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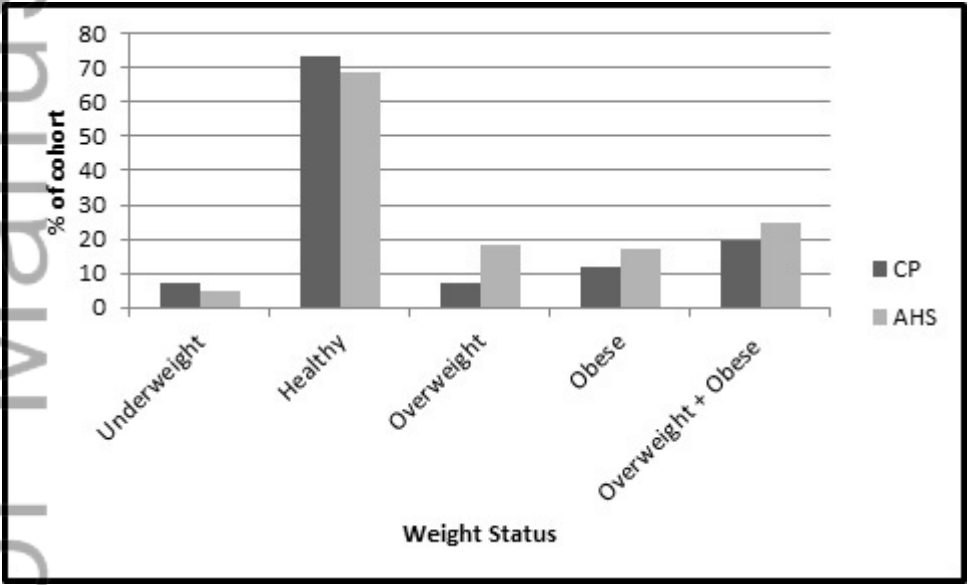
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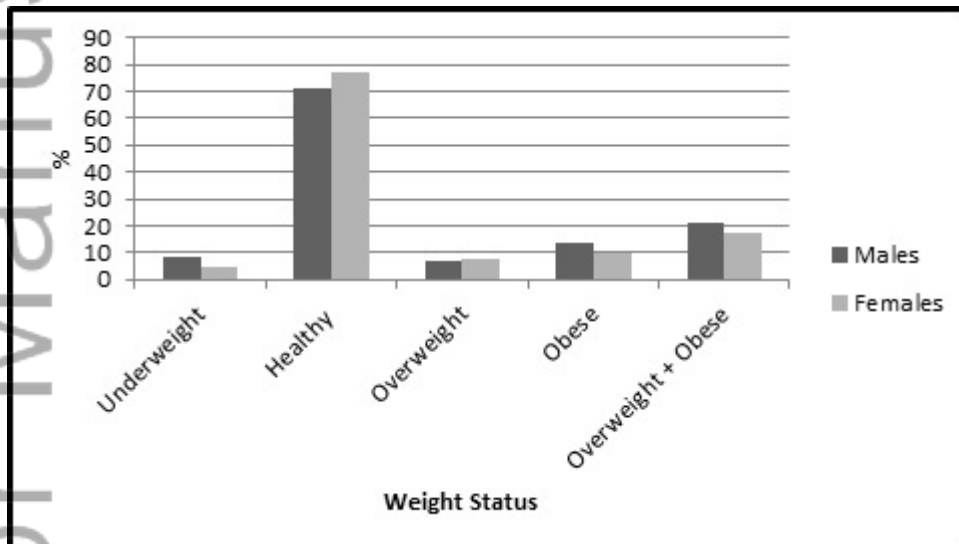
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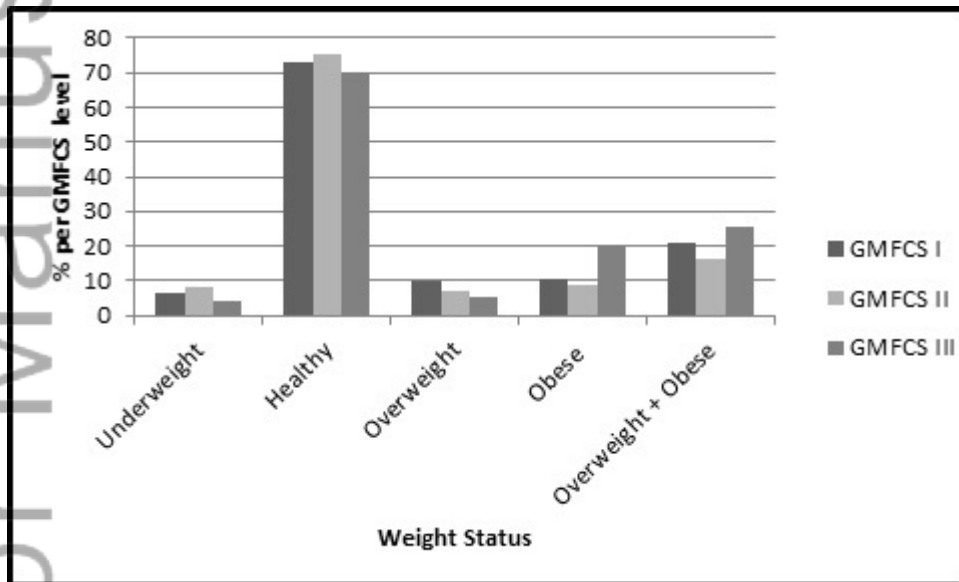
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