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Original Article

Physical activity and obesity in children with congenital cardiac disease

Trenda D. Ray, Angela Green, Karen Henry

Ambulatory Care Services, Arkansas Children's Hospital, 1 Children's Way, Little Rock, Arkansas, United States of America

Abstract *Background:* Children with congenital cardiac disease experience challenges in developing healthy patterns of physical activity due to decreased exercise capacity and parental fear and confusion about what is permissible. The purpose of this study was to describe physical activity habits in children 10–14 years of age with congenital cardiac disease and the relationship of those habits to obesity as defined by body mass index. *Methods:* This cross-sectional study used self-report measures and clinical data to describe the association between physical activity participation and body mass index in 10- to 14-year-old children with congenital cardiac disease. Further, physical activity levels were compared between children who were overweight or obese and those who were not. *Results:* Children ($n = 84$; 51 males; 33 females) reported low rates of physical activity compared to reports on healthy children. Only 9.5% were overweight (body mass index between the 85th and 94th percentile), and alarmingly 26% were obese (body mass index at or above the 95th percentile). Physical activity and body mass index were not significantly correlated ($r = -0.11$, $p = 0.45$) and there was no significant difference in mean physical activity ($t = 0.67$) between children who were overweight or obese and those who were not. *Conclusions:* Children in this study reported low rates of physical activity and a higher obesity rate than was reported in previous studies. However, the two were not significantly correlated. Further research is indicated to determine the specific factors contributing to obesity and to test interventions to combat obesity in children with congenital cardiac disease.

Keywords: Body Mass Index; pediatric; exercise

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CHILDREN WITH CONGENITAL CARDIAC DISEASE represent one of the largest populations of children with chronic illness[1] with over one million children in the United States suffering from some form of congenital cardiac disease.[2] During the last 30 years of medical advances, the number of survivors with congenital cardiac disease has continued to grow, and now as many as 85% of children born with a cardiac defect survive into adolescence.[3] Some children have defects that may result in significant challenges in developing healthy lifestyles because of activity restrictions and altered exercise capacity. However, little is known about their rates of activity participation and how that links to obesity.

Children with congenital cardiac disease may be at particular risk for low rates of participation in physical activity because of activity restrictions.[4] These restrictions may be parentally imposed, medically imposed, or self-imposed due to fear, fatigue, or misinterpretation of the instructions given by the healthcare professionals. Furthermore, parents may underestimate their child's physical abilities and may impose unnecessary restrictions.[5] This is worrisome because cardiovascular exercise performance in children with medically imposed restrictions declines progressively, whereas it remains stable in those groups not requiring restrictions.[6]

Furthermore, exercise capacity may be a barrier to participation in physical activity in children with congenital cardiac disease. Research suggests decreased

Correspondence to: Trenda Ray, PhD, APN, University of Arkansas for Medical Sciences, 4301 W. Markham, Slot 721, Little Rock 72205-7199, Arkansas, USA. Tel: (office) 526-6990, ext. 8767; Fax: 501-686-5694; E-mail: raytd@archildrens.org; trendamail@gmail.com

aerobic exercise capacity[7] and lower oxygen uptake than healthy controls.[8] Furthermore, oxygen uptake declined for boys with congenital cardiac disease after the age of 12–13 years (Fredriksen et al 1999).

The risks for decreased participation in physical activity in this population suggest a risk for obesity as well. There are two studies that described the incidence of obesity in children with congenital cardiac disease as nearly identical to that of the general population, with rates of 16[9] and 15.2%.[10] This limited research indicates that children with congenital cardiac disease are not immune to obesity, but rather are equally susceptible. This is surprising because many of these same children begin life with difficulties with weight gain requiring complex feeding regimens and high caloric demand. Further, exercise-intolerant and activity-restricted children with congenital cardiac disease experienced larger increases in absolute body mass index and body mass index percentile than did those without activity restrictions.[1]

Research to date suggests risk factors for both decreased activity participation and obesity. However, the association between the two is not described in this group of chronically ill children. Therefore, the purpose of this cross-sectional study was to describe the association between physical activity participation and body mass index in 10–14-year-old children with congenital cardiac disease. This crucial period in children marks the beginning of adolescence, a time of transition in both physiological and psychological change.[11] Children in this age group are beginning to make their own choices about how they spend their time and developing lifestyle choices that they will carry into adulthood. Developmentally, adolescence marks one of the single most vulnerable periods in an individual's life for the development of overweight or obesity, while also occurring during a period of time when stereotyping and discrimination are beginning to be experienced.[12] Therefore, this is a critical age group in terms of understanding the connection between physical activity and obesity.

Little is known about these concepts and the relationships among them in children with congenital cardiac disease. However, this information is vital to the development of future interventions to optimise long-term health and decrease the risk of obesity in this vulnerable population. Therefore, the aims of this study are as follows: to describe the physical activity of 10–14-year-old children with congenital cardiac disease; to describe the prevalence of overweight and obesity; and to describe the association between physical activity and body mass index.

Materials and methods

Sample and setting

Children with congenital cardiac disease were recruited using purposive sampling from the Cardiology Clinic at a large free-standing paediatric centre serving over 84,000 cardiac outpatient visits annually. Inclusion criteria included diagnosis of congenital cardiac disease; age between 10 and 14 years; and being capable of completing self-report instruments. We approached 88 children, of whom one declined and three were later found to not fully meet the inclusion criteria. Children with a broad range of diagnoses were included. The diagnoses were categorised according to severity as described by Uzark et al[5] (Table 1). The only exclusion criterion was a cardiac diagnosis that required physical activity restriction such as critical aortic stenosis or those children not neurologically able to complete the instruments.

Measures

Data were collected using self-report measures and clinical data. Participation in physical activity was collected using the Previous Day Physical Activity Recall.[13] Clinical data, including cardiac diagnosis, height, weight, and body mass index, were also collected. Body mass index was categorised by Centers for Disease Control and Prevention criteria as follows: overweight was defined as a body mass index at or above the 85th percentile and lower than the 95th percentile and obesity was defined as a body mass index at or above the 95th percentile for children of the same age and sex.[18]

The previous day physical activity recall instrument

The Previous Day Physical Activity Recall is a self-report measurement of intensity, frequency, and duration of physical activity captured in one afternoon of activities.[13] Children record their physical activity for one afternoon. The investigator then converts the self-reported physical activities to metabolic equivalents[11] using a table defining the metabolic equivalents for a large number of activities.[14] For example,

Table 1. Cardiac diagnoses of sample.

Classification of congenital cardiac disease	Sample (%)
Mild congenital cardiac disease requiring no therapy	21.5
Moderate congenital cardiac disease requiring no therapy or surgically corrected	16.7
Surgically treated congenital cardiac disease with need for future surgical interventions	40.5
Complex or severe congenital cardiac disease, uncorrectable or palliated	21.4

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one metabolic equivalent is the estimated energy required to sit quietly.[14] The instrument is found to be a reliable measure of physical activity compared to other recall measures in 6th grade children ($r = 0.72$).[15] Self-report measures, such as the Previous Day Physical Activity Recall, are useful for assessing activity patterns, quantifying and classifying activity, and for recording the context in which activity takes place[16] in a more cost-effective and less intrusive manner than pedometers which must be worn by the participant over the course of several days.

Body mass index

Cardiology Clinic staff measured height and weight upon arrival at the clinic using a calibrated standardised scale for weight and a stadiometer for height. The body mass index is automatically calculated as part of the electronic medical record for the clinic visit. To determine if children were of normal weight, overweight, or obese, body mass index percentiles were calculated for each child using the Children's Body Mass Index Percentile for age calculator.[17]

Procedure

After obtaining Institutional Review Board approval, children were recruited from the Cardiology Clinic at a paediatric institution. After obtaining parental consent and child assent, children completed the Previous Day Physical Activity Recall in a private location at the clinic. Clinical data, such as diagnosis and body mass index, were collected by the research team from the clinic record. Data were entered into a Microsoft Excel spreadsheet, checked for accuracy, and then imported into SPSS 14.0[22] for analysis. Demographic data – for example, age, gender – were analysed using descriptive statistics. Missing data were minimal with only five responses missing across all variables for the 84 participants. Therefore, all participants were included in the analysis. The physical activity of the children was described using descriptive statistics. The association between physical activity and the body mass index of the participants was computed using Pearson's correlation coefficient. In addition, an independent samples *t*-test was used to compare the physical activity participation of children who were overweight or obese with those who were not.

Results

Sample

The sample consisted of 84 children, 61% males and 39% females. Diagnostic categories are described in Table 1. The category of children with mild congenital cardiac disease included diagnoses such as aortic insufficiency, pulmonary stenosis requiring no intervention, or those children who underwent balloon procedures only. Children categorised as moderate cardiac disease with no therapy or surgically corrected included diagnoses such as atrial septal defects, ventricular septal defects, coarctations, or aortic stenosis without the need for surgical intervention. The category of surgically treated diseases with the need for future interventions included participants with tetralolgy of Fallot, transposition of the great vessels, and those requiring valve replacements. Finally, those participants categorised as the most complex included diagnoses of hypoplastic left heart, total anomalous pulmonary venous return as well as participants who had undergone a cardiac transplant.

The mean age of the participants was 12 years of age (standard deviation = 1.39), and the majority of participants were Caucasian (83.3%), followed by African American (10.7%) and Hispanic (6%). Just over 88% of children attend a public or private school, whereas 10.7% are homeschooled.

Physical activity

The mean score for the Previous Day Physical Activity Recall was 31.7 metabolic equivalents (standard deviation = 11.2). The activity was further explored by distinguishing the amount of time spent in vigorous activity compared to that in moderate activity. Vigorous activity was defined as the number of 30-minute blocks spent in activities where the metabolic equivalents were six or greater – such as running or swimming at a medium intensity – whereas moderate activity was defined as the number of blocks of time spent in activities ranging from 3 to 5.9 metabolic equivalents – such as light walking or an easy bike ride.[14] In all, 57% of the children reported no participation in moderately vigorous activities, and nearly 74% reported no participation in vigorous activities, indicating that their participation in physical activity was primarily in those activities considered sedentary.

Physical activity participation declined as the level of severity increased across the diagnostic categories as described in Table 2. Children in category 1, simple defects, had the highest level of physical activity, whereas those in category 4, complex defects, had the lowest levels of physical activity. The number of patients within each diagnostic category was relatively small, which limited options for analysis. Therefore, effect size was calculated and was small at 0.2 despite the noted trend

Body mass index

The mean body mass index for the group was 23.3, with an average weight of 50.5 kilogram (standard deviation = 19.8). Given the 4-year span in age

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Table 2. Physical activity participation in metabolic equivalents and percent overweight or obese.

Diagnostic category	Physical activity: metabolic equivalents mean ± SD	Overweight or obese (%)
Mild congenital cardiac disease requiring no therapy	34.2 ± 9.5	44
Moderate congenital cardiac disease requiring no therapy or surgically corrected	32.7 ± 2.6	22
Surgically treated congenital cardiac disease with need for future surgical interventions	32.2 ± 13.3	41
Complex or severe congenital cardiac disease, uncorrectable or palliated	26.5 ± 8.01	37

range, body mass index percentile is a more useful measure than raw body mass index. Using the Centers for Disease Control and Prevention definitions described previously, over 9.5% of the sample was classified as overweight. Of greater concern, an additional 26.2% were considered obese. When body mass index was reviewed according to diagnostic category, the percentage of children who were overweight or obese ranged from 22% to 44% as described in Table 2, with the lowest incidence in those with moderate disease requiring no therapy or that were surgically corrected and the highest incidence in those with mild disease that required no therapy.

Physical activity and body mass index

Pearson's correlation was used to assess the association between participation in physical activity and body mass index. Physical activity and body mass index were not significantly correlated ($r = -0.11$, $p = 0.45$). The low activity levels do not appear to be in relationship to the body mass index of participants in this sample.

In addition, children were divided into categories according to their body mass index. Children with a body mass index greater than or equal to the 85th percentile were categorised as obese or overweight. Those with a body mass index of less than the 85th percentile were categorised as not obese or overweight. The weight categories were broken down into only two groups due to the small number of children in the overweight group. Previous Day Physical Activity Recall scores were compared for the two groups using independent samples *t*-tests. There was no significant difference in mean physical activity ($p = 0.67$) between children who were overweight or obese and those who were not. See Table 3 for metabolic equivalents for normal weight children compared to those who were classified as overweight or obese.

Table 3. Mean metabolic equivalents for participants by body mass index.

Participants	Physical activity (metabolic equivalents)
Normal weight (n = 54)	31.39
Overweight or obese (n = 29)	32.37

Discussion

Children in this study reported critically low rates of physical activity participation. The average reported activity in metabolic equivalents is far below what would be required to meet the Centers for Disease Control and Preventions guidelines for activity in children, which specifies that children should have at least 60 minutes of physical activity daily.[18,19] Furthermore, the children in this study had much lower physical activity scores than those published for healthy children – 31.7 total metabolic equivalents in the sample versus 53.5 total metabolic equivalents in healthy children.[20]

Despite the number of children in each diagnostic category precluding analysis beyond descriptive analysis, the trend of decreasing physical activity with increasing severity of congenital cardiac disease suggests a need for further examination of this with larger sample sizes. Children with the mildest defects demonstrated greater physical activity than those with the most severe, despite the moderate and surgically corrected groups being closest in rates of participation. In addition, the results presented here demonstrate an obesity rate that is alarming and much higher than the 15–16% incidence reported in previous studies[9,10] as well as the Arkansas average of 17.6% reported by the Centers for Disease Control and Prevention. Despite these worrisome findings, the body mass index percentile was not significantly correlated with physical activity participation using the Previous Day Physical Activity Recall, and nor was there a mean difference in physical activity between children who were either overweight or obese and those who were not. Despite both the decreased physical activity and increased body mass index data contributing to considerable risk for children with congenital cardiac disease, other factors may be at play including self-efficacy, which is shown to be significantly correlated with physical activity children with congenital cardiac disease.[21]

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In addition, this group of children is subjected to the same environmental factors that contribute to obesity as other healthy children. These factors may include lifestyle and dietary habits that result in increased intake of foods that are high in fat and less nutrient dense. Additional research is needed to increase understanding of the factors contributing to the low rates of physical activity participation and high rates of obesity. Furthermore, educational interventions are needed with children and families to provide accurate health information regarding the importance of physical activity and about the degree of physical activity that is permissible. Finally, further measures are needed to prevent and treat overweight and obesity in this vulnerable population before the comorbidities of the disease cause irreversible harm. These additional measures should include objective data obtained from the use of activity monitors to confirm the data provided here by the Previous Day Physical Activity Recall instrument.

Limitations

The sample size was a limitation in this study as were the use of recall instruments. Participants were recruited from a single site and each diagnostic category contained a small number of participants. In addition, measuring physical activity using recall measures is a limitation of this study. The use of recall instruments in children create opportunities for children to over-report based on what they believe is socially acceptable. Furthermore, children may have difficulties remembering tasks from day to day, making a recall instrument potentially less reliable. Despite the Previous Day Physical Activity Recall in previous studies with 8th grade students being moderately reliable when compared to accelerometers ($r = 0.41–0.44$),[13] the use of this subjective measure for assessing physical activity may have impacted the results. Therefore, studies with larger samples and using objective measures for activity, such as Actigraphy, are needed to explore these patterns as objective measures will capture data at the moment instead of relying on recall. Despite the limitations, this study identified that children with congenital cardiac disease have both critically low levels of physical activity and critically high levels of overweight and obesity.

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