

The Pit and The Pendulum. Extremes in Body Habitus in Children with Congenital Heart Disease: Differences and Outcomes in Cardiac Catheterization

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Abstract

Background: Obesity has reached epidemic proportions worldwide and is one of the major comorbidities in children and adolescents with congenital heart disease [1].

Objectives: We aim to see whether children with congenital heart disease severe enough to warrant catheterization and who happen to be on the extremities of body habitus have any different characteristics or outcomes than their peers with congenital heart disease and with normal weight.

Methods: This is a retrospective study in a cardiac catheterization laboratory of a large pediatric hospital. The material consisted of 378 children from 2 to 19 years old who underwent cardiac catheterization in the years 2011 - 2019. Their anthropometric data were collected, and the Body Mass Index (BMI) was calculated. The Centers for Diseases control definition was used to determine whether the child was underweight, normal weight, overweight or obese.

Results: The children in the extremes of underweight and obesity were both younger, with a mean age of 5.61 years and 5, respectively. In comparison, the underweight children had a mean of 8 years, normal weight 8.61 years, overweight 9.64 years, and obesity 9.61 years. This difference is statistically significant ($p < 0.005$).

Conclusions: No difference was observed in the length of stay or rate of complications during the catheterizations. Further research is necessary to determine whether extremes of body habitus pose a modifiable risk factor for perioperative outcomes.

Keywords: Adipose, Adolescence, Cardiometabolic health, Cardiovascular disease, Obesity

Introduction

Being overweight and obese are becoming major health issues worldwide. Moreover, as the majority of children with congenital heart disease reach adulthood, the prevalence of obesity and overweight is increasing to reach the proportion of children without congenital heart disease. At the same time, undernutrition is also present depending on the severity of congenital heart disease.

We aim to see whether children on the extremities of body habitus have different characteristics than the children with normal weight gain and whether they have any different outcomes in cardiac catheterization.

Methods

From 2011 to 2019, 752 cardiac catheterizations were performed in children aged 1 day to 19 years. We excluded children under 2 years old from the sample, leaving 394 catheterizations for analysis. The seven children without any recorded height were removed from the study as were the 12 (i.e., nine catheterizations) and children with chromosomal syndrome, leaving 374 eligible catheterizations for analysis.

The children's BMI was calculated by dividing weight by squared height. The BMI percentile was calculated according to the Centers for Diseases Control's criteria for age and sex. Children were defined as being "underweight" if the BMI was less than the 5th percentile for sex and age, "of healthy weight" if their BMI was in the 5th to 85th percentiles, "overweight" if their BMI was in the 85th to 95th percentiles and "with obesity" if their BMI was

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greater than the 95th percentile. Children whose BMI centile was less than the 1st percentile were classified as “extremely underweight” and children whose BMI was more than the 99th centile were classified as “extreme obesity”.

We next recorded whether the cardiac catheterization was diagnostic or interventional, the type of heart disease, and whether it was cyanotic or acyanotic as shown in Table 1. Based on the results, the children were divided into three categories: preschool-age children, (i.e., 2 - 5 years old), school-age children (i.e., 6 - 12 years old), and adolescents (i.e., 13 - 19 years old). As for data collection, from January to March 2020, we retrospectively searched the records of the hemodynamic laboratory of a large pediatric hospital and gathered data regarding all heart diseases of all types of severity subject to pediatric cardiology. The data were thus highly representative of the population of children suffering from congenital heart disease. The study was approved by the Hospital Ethics Committee.

The statistical processing of the study data was done with the statistical package SPSS for Windows (version 22) and statistical significance was set at the $p = 0.05$ level. The chi-square test was used to determine any correlation between congenital heart disease type, sex, age type, catheterization type, and complications encountered. The Kruskal-Wallis test was used to compare the age, height, weight, hemoglobin, hematocrit, and mean Pulmonary Artery Pressure.

Results

Of the 374 catheterizations in our sample, 225 had been invasive (60.16%), 147 (39.3%) diagnostics, and in 2 cases the procedure was abandoned. As shown in Table 1, while 82 children (21.93%) suffered from cyanotic heart disease and 265 (70.86%) suffered from acyanotic heart disease, in 27 cases (7.22%) heart catheterization was performed for other reasons. By age, the children were 2 - 19 years old (Mean = 8.1 years; specifically, 122 children (32.65%) were of preschool age, 187 (50%) were of school age and 65 (17.38%) were adolescents. By sex, there were 205 boys (54.81%) and 169 girls (45.19%).

Overall, the children with a healthy weight were 202 (54%). The prevalence of extremely underweight children was 16.5% ($n = 62$) and of underweight children was 3.74% ($n = 14$). On the other side of the spectrum of body habitus, the overweight children were 11.49% ($n = 43$), the ones with obesity 8.82% ($n = 33$), and the ones with extreme obesity 5.34% ($n = 20$). In total, the children who were underweight were 20.3% of the total and the ones with excess weight were 25.66%.

The children in the extremes of underweight and obesity were both younger, with a mean age of 5.61 years and 5, respectively. In comparison, the underweight children had a mean of 8 years, healthy weight 8.61 years, overweight 9.64 years, and obesity 9.61 years. This difference is statistically significant ($p < 0.005$). Similarly, the mean PAP measured invasively was higher in children with extremely underweight (mean PAP 29.4 mmHg) as well as extreme obesity 28.82 mmHg) than the children with underweight (17.32 mmHg), healthy weight 21.19 mmHg, overweight (22.03 mmHg), and Obesity (21.56 mmHg). The difference is statistically significant ($p < 0.005$) (Figure 1). There was no statistical difference between the days of admission ($p = 0.587$). No deaths were observed. Regarding immediate complications, there was one bleeding incidence and one arrhythmia. Complications were managed without any long-term sequelae.

Discussion

Children with congenital heart disease have a reported pooled prevalence of malnutrition of 27.4% showing some catch-up growth postoperatively [1,2]. At the same time, the prevalence of increased weight i.e., overweight and obesity has been increasing with a pooled prevalence of 9.5 - 31.5% and 9.5 - 26%, respectively [3,4]. Interestingly, children with congenital heart disease may present with varying degrees of malnutrition with the

Table 1: Body habitus and congenital heart disease.

	Extreme Underweight	Underweight	Healthy Weight	Overweight	Obesity	Extreme Obesity
Number	62	14	202	43	33	20
Percentage	16.5	3.74	54	11.49	8.82	5.34
Age (years)	5.61	8	8.61	9.64	9.61	5
SD	3.34	3.8	4.19	4.42	3.17	2.34
Range	2 - 15 years	2 - 16 years	2 - 19 years	2 - 16 years	4 - 16 years	2 - 10 years
Acyanotic (n)	31	12	144	33	29	16
%	50	85.7	71.3	76.7	87.9	80
Cyanotic (n)	28	1	42	7	2	2
%	45.2	7.1	20.8	16.6	6.1	10
Other (n)	3	1	16	3	2	2
%	4.8	7.1	2.9	7	6.1	10
Male (n)	40	6	106	27	20	6
%	64.5	42.9	52.5	62.8	60.6	30
Female (n)	22	8	96	16	13	14
%	35.5	57.2	47.5	37.2	39	70
mPAP (mmHg)	29.44	17.32	21.19	22.03	21.56	28.82
SD	17.21	13.1	8.12	12.92	3.51	16.99
Days	7.97	4.59	7.68	5.1	7.3	8.39
SD	3.34	4.35	15.17	6.98	13.3	16.43

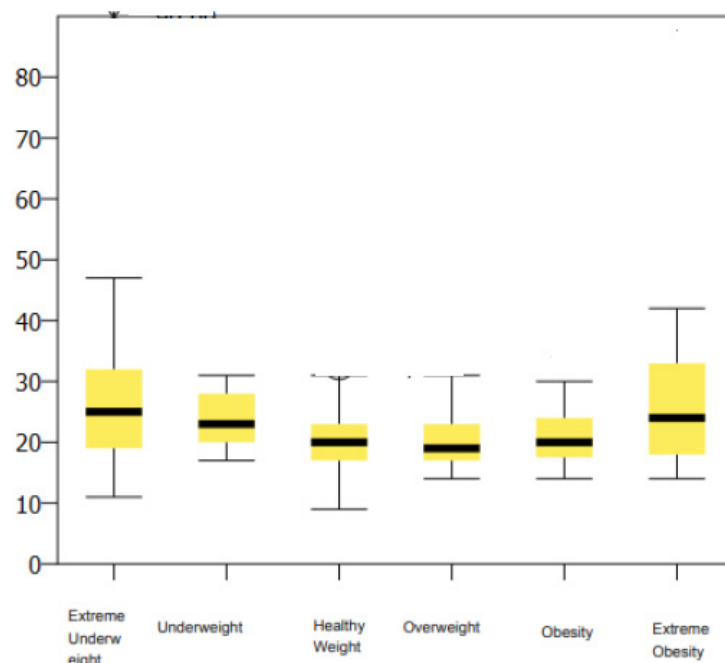


Figure 1: mPAP(mmHg) in extremities of body habitus.

impact of malnutrition being worse among children under the age of five [5,6]. Wasting is more prevalent in children with cyanotic heart disease compared with those with acyanotic congenital heart disease with data indicating a potential for weight among those initially underweight later in life. At the same time, overweight and obesity are also notable features of malnutrition in children with congenital heart disease [5,6].

Both obesity and underweight are associated with an increased risk of composite adverse outcomes independently of other risk factors [7,8]. After congenital heart surgery, obese patients had longer bypass time, longer mechanical ventilation duration, longer hospital length of stay, and risk of postoperative wound infection compared to their non-obese counterparts [9]. Similarly, increased body mass index was independently associated with postoperative arrhythmias in congenital heart surgery [10] but not in heart transplants [11].

Further research is necessary to determine whether extremes of body habitus pose a modifiable risk factor for perioperative outcomes.

Conflict of Interest

There are no conflicts of interest.

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No grants were given regarding this manuscript.

Ethics Statement

The study was approved by the Hospitals' Ethics Committee (Protocol No.13293/18.06.2020).

Credit Author Statement

Andriana Anagnostopoulou: Conceptualization, Methodology, Investigation, Software, Writing; Nikolaos G Eleftherakis: Resources, Data curation, Supervision; Evangelos Karanasios: Supervision.

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