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The impact of obesity in children with congenital and acquired heart disease

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Abstract

Over the past three decades childhood obesity has increased dramatically, and has been deemed a national epidemic by the Centers for Disease Control. Approximately 31% of children in the United States are overweight or obese. While obesity is a known risk factor for future cardiovascular disease in the general pediatric population, significantly less is known about the impact of obesity in children with congenital and acquired heart disease (HD). Recent data suggests that the prevalence of obesity in children with HD is similar to that of the general pediatric population. Further study is necessary to evaluate unique risk factors for obesity in the HD population such as restriction from physical activity. Investigation of the cardiovascular sequelae of obesity in children with HD is also warranted. Anatomic and/or functional abnormalities related to past cardiac surgery are often fixed; thus obesity may be one of the few modifiable risk factors for future cardiovascular disease in this patient population.

Keywords: Congenital heart disease; Obesity; Children; Exercise; Atherosclerotic disease

1. Introduction

Advances in the fields of pediatric cardiology and cardiac surgery over the past several decades have dramatically improved the survival of children with congenital heart disease (HD), so that the majority are likely to survive into adulthood [1]. It is estimated that there are now greater than one million adults living with congenital heart disease (HD; [2]). In the same time period, childhood obesity has increased dramatically, and has been deemed an epidemic by the Centers for Disease Control and Prevention (CDC; [3]). The 2002 National Health and Nutrition Examination Survey (NHANES) reported that the prevalence of overweight [body mass index (BMI) ≥ 85th–94th percentile] and obese (BMI ≥ 95th percentile) children age 6 to 19 years was 31%, a 45% increase from the previous survey [4]. Children with HD and other chronic illnesses may be at increased risk for obesity as a result of the sedentary lifestyle associated with these conditions. The impact of obesity on preexisting congenital or acquired HD diagnosed in childhood may cause significant morbidity and even early mortality.

2. Complications of childhood obesity

Childhood obesity has many sequelae both in early and adult life including type 2 diabetes, systemic hypertension, and hyperlipidemia, as well as social isolation and behavioral problems [5,6]. Obese children are likely to become obese as adults. In the Bogulusa Heart Study, 77% of obese children remained obese in adulthood [7]. Moreover, childhood obesity is associated with an increased risk of atherosclerotic disease in adulthood [8]. In an autopsy series, Berenson et al. showed that the presence and severity of coronary atherosclerotic plaque in asymptomatic young adults was significantly related to the number of risk factors present, including higher BMI, hypertension, and hyperlipidemia [8]. A recent longitudinal study also demonstrated a link between childhood obesity and adult cardiovascular events. Baker and colleagues identified 275,835 Danish adults in whom there was information on childhood BMI [9]. They found that childhood BMI was

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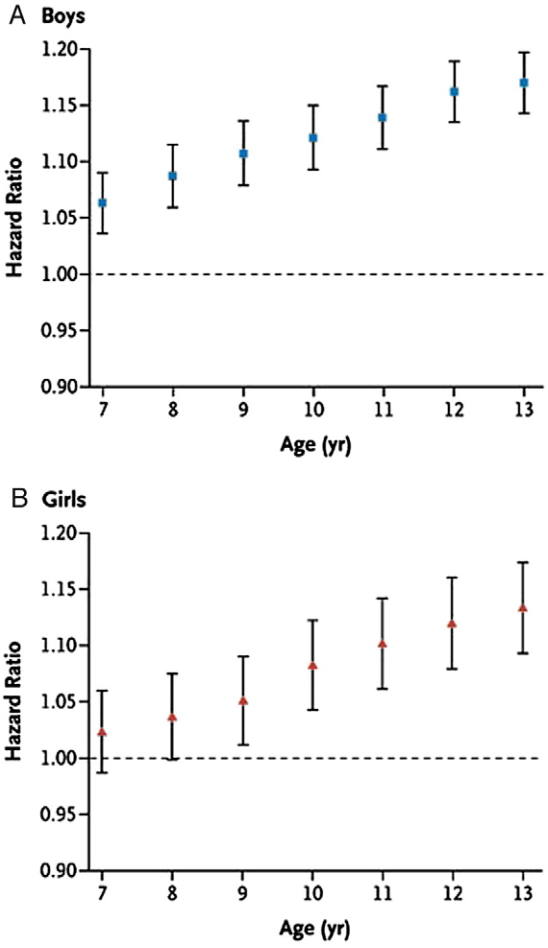

Fig. 1. BMI in childhood and the risk of coronary heart disease in adulthood. The graphs depict the association between childhood BMI and the risk of having a coronary heart disease event (nonfatal or fatal) in adulthood. Hazard ratios and 95% confidence intervals are given for a 1-unit increase in BMI z score at each age from 7 to 13 years. The data are from 139,857 boys (Panel A) and 136,978 girls (Panel B) in the Copenhagen School Health Records Cohort. The associations were linear within each age, since trend tests resulted in the rejection of the alternative of nonlinearity modeled as a restricted cubic spline with five knots (all P values >0.15).

significantly associated with coronary artery events (myocardial infarction, death) in adulthood (Fig. 1). The impact of BMI was more profound in boys in comparison to girls.

Due to the difficulty in conducting longitudinal studies, several investigators have identified surrogate markers of cardiovascular disease, which can be more readily evaluated as outcomes in pediatric obesity studies. Data collected from the Framingham study revealed that increased left ventricular mass was significantly associated with cardiovascular events and death in adults [10]. Recent studies in children have shown a link between childhood obesity and left ventricular mass. In the Strong Heart Study, anthropometric and echocardiographic data was collected on 460 adolescents (age 14–20 years, 6). Left ventricular hypertrophy was more prevalent in obese (33.5%), and overweight (12.4%) patients, compared to normal weight participants (3.5%, $p<0.001$). In adults, carotid intima-media thickness, and peripheral endothelial dysfunction (as assessed by brachial artery flow-mediated vasodilation and pulse wave velocity) have also been associated with coronary artery disease and coronary events [11,12]. In the pediatric population, Woo et al. established that abnormal brachial flow-mediated vasodilation and increased carotid intima-media thickness were present in obese children [13]. The same group also reported that some of these findings can reverse with a long-term exercise and diet regimen [14].

3. Obesity in children with heart disease

Little is known concerning the impact of obesity in children with HD. A recent joint statement of the American Heart Association (AHA) and American Academy of Pediatrics (AAP) emphasized the need for additional study of the prevalence and etiology of obesity, as well as presence of other cardiovascular disease risk factors in children with congenital and acquired HD, including those who have undergone cardiac transplantation [15]. The AHA/AAP statement identified several groups of children at risk for premature atherosclerotic cardiovascular disease, including patients with congenital and acquired HD (Table 1).

The first group of HD patients includes those with congenital abnormalities of the coronary arteries. An anomalous coronary artery that courses between the aorta and pulmonary artery has been associated with myocardial infarction and sudden death in children and adolescents [16]. Surgical correction may not completely alleviate the potential for ischemia and the long-term risks are unknown [17]. Patients with acquired abnormalities of

Table 1
Disease stratification by risk

	Risk category	Rationale	Disease process/Condition
Tier I	High risk	Manifest CAD <30 years of age: Clinical evidence	Homozygous familial hypercholesterolemia (FH) Diabetes mellitus, type 1 Chronic kidney disease (CKD)/end-stage renal disease (ESRD) Post-orthostatic heart transplantation (OHT) Kawasaki disease with current coronary aneurysms
Tier II	Moderate risk	Accelerated atherosclerosis: Pathophysiological evidence	Heterozygous FH Kawasaki disease with regressed coronary aneurysms Diabetes mellitus, type 2 Chronic inflammatory disease
Tier III	At risk	High-risk setting for accelerated atherosclerosis: Epidemiological evidence	Post-cancer treatment survivors Congenital heart disease Kawasaki disease without detected coronary involvement