Echocardiographic Changes in Obese Children and Adolescents

Thesis

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ABSTRACT

Obesity has become a major health problem worldwide. Cardiovascular abnormalities have been described not only in obese adults but also in obese children and adolescents. The aim of the present study was to detect early left ventricular structural and functional changes in obese Egyptian children and adolescents without comorbidities. Anthropometric, laboratory and echocardiographic parameters were obtained from 50 obese children and adolescents with an average body mass index (BMI) of 32.7 ± 5.2 and compared to 25 non-obese sex- and age-matched controls, with a BMI of 17.4 ± 3.2. Cardiac dimensions, left ventricular systolic and diastolic functions were evaluated. The obese group had a significantly higher end-diastolic septal ((0.90 ± 0.17 vs 0.62 ± 0.06, $p < 0.01$) and posterior wall thickness (0.72 ± 0.14 vs 0.57 ± 0.06, $p < 0.01$) and left ventricular mass index (47.40 ± 25.62 vs 28.16 ± 3.12, $p < 0.01$) than the non-obese group. BMI and waist circumference values showed significant correlations with these echocardiographic variables. Obese children showed abnormal diastolic parameters whereas systolic function remained normal. Multiple regression analysis showed that the body mass index is a significant predictor of left ventricular mass index. Obese children and adolescents have significant left ventricular hypertrophy and changes in early diastolic filling, even in the absence of other comorbidities, early in the course of the disease.

KEY WORDS

Obesity, Body mass index, waist circumference, Left ventricular mass index, Echocardiography, diastolic dysfunction, Systolic dysfunction and Obesity cardiomyopathy.

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LIST OF ABBREVIATIONS

A- Wave	**flow velocity during atrial contraction**
AAP	**American Academy of Pediatrics**
ADA	**American Diabetes Association**
AGB	**Adjustable gastric banding**
ANP	**Atrial natriuretic peptide**
AO	**Aorta**
BIA	**Bioelectrical Impedance Analysis**
BMI	**Body mass index**
BSA	**Body surface area**
CDC	**Centers for Disease Control and Prevention**
CHD	**Coronary heart disease**
CNTF	**Ciliary Neurotropic Factor**
CV	**Cardiovascular**
DBP	**Diastolic blood pressure**
DEMPU	**Diabetes, Endocrine and Metabolism Pediatric Unit**
DT	**E- wave deceleration time**
DXA	**Dual energy x-ray absorptiometry**
E- wave	**flow velocity during early filling**
E/A	**E/A ratio**
FDA	**US Food and Drug Administration**
FG	**Fasting glucose**
FI	**Fasting insulin**
FS	**fractional shortening**
HDL	**High density lipoprotein**
HF	**Heart failure**
HOMA	**Homeostatic model assessment of insulin resistance**
HR	**Heart rate**

IDF	**International Diabetes Federation**
IGF-1	**Insulin like growth factor-1**
IOTF	**International Obesity Task Force**
IR	**Insulin resistance**
IRS	**Insulin resistance syndrome**
IVSd	**Interventricular septum diameter**
LA	**Left atrium**
LDL	**Low density lipoprotein**
LV	**Left ventricle**
LVEDD	**Left ventricular end-diastolic dimension**
LVESD	**left ventricular end-systolic dimension**
LVH	**Left ventricular hypertrophy**
LVM	**Left ventricle mass**
LVMI	**Left ventricle mass index**
MetS	**Metabolic syndrome**
NCEP	**National Cholesterol Education Program**
NCEP-ATP III	**National Cholesterol Education Program—Adult Treatment Panel III**
NCHS	**National Center for Health Statistics**
NHANES	**National Health and Nutrition Examination Survey**
NHBPEP	**National High Blood Pressure Education Program**
POMC	**Propiomelanocortin**
PW	**left ventricle posterior wall**
RV	**Right ventricle**
RWT	**Relative Wall Thickness**
RYGB	**Roux-en-Y gastric bypass**
SBP	**Systolic blood pressure**
TC	**Total cholesterol**

TDI	**Tissue Doppler Imaging**
TG	**Triglycerides**
TNF	**Tumor necrosis factor**
TNF- α	**Tumor necrosis factor- α**
TV	**Television**
VLDL	**Very low density lipoprotein**
WC	**Waist circumference**
WHO	**World Health Organization**
WHR	**Waist-hip ratio**
WhtR	**Waist-height ratio**

CONTENTS

INTRODUCTION

The rising prevalence of childhood obesity poses a major public health challenge ***(Lakshman et al., 2012)***. Childhood obesity is associated with a number of metabolic, cardiovascular and other disturbances, which include lipid abnormalities, altered glucose metabolism and type 2 diabetes, pulmonary disorders including obstructive sleep apnoea and reactive airway disease, a pro-inflammatory state and coagulation abnormalities ***(Han et al., 2010)***.

Obesity has been associated with risk factors for cardiovascular disease ***(Ice et al., 2009)***. A variety of adaptations /alterations in cardiac structure and function occur in the individual as adipose tissue accumulates in excess amount ***(Poirier et al., 2006)***. Obesity can affect the cardiac autonomic modulation, blood lipid levels and the physical capacity ***(Paschoal et al., 2009)***. Because of its maladaptive effects on various CV risk factors and its adverse effects on CV structure and function, obesity has a major impact on CV diseases, such as heart failure (HF), coronary heart disease (CHD), sudden cardiac death, and atrial fibrillation, and is associated with reduced overall survival ***(Lavie et al., 2009)***. Cardiac dysfunction during childhood may affect the quality of life in adulthood ***(Khositseth et al., 2006)***.

Waist circumference (WC) may predict cardiovascular risk better than body mass index (BMI) in adults. The relationships between WC and echocardiographic measurements known to predict adult cardiovascular risk have not yet been explored in children ***(Mehta et al., 2009)***.

Pediatric echocardiography has clearly become the primary tool for describing and characterizing diastolic function in infants and children both with and without heart disease. It is established as an important noninvasive diastolic monitoring tool that allows serial assessment of pathologic diastolic disease in both primary myocardial and systemic disease states ***(Frommelt, 2006)***.

Obese children need a regular cardiovascular and metabolic screening to prevent the development of early cardiovascular damage ***(Giordano et al., 2003)***.

AIM OF THE WORK

The present study aims at:

- Identifying the prevalence and types of cardiac abnormalities in a sample of Egyptian obese children.
- Identifying some risk factors that predispose to the development of cardiac abnormalities in these children.
- Determine anthropometric measurements which correlate to cardiac abnormalities.

Identifying obese children, at particular risk for cardiac abnormalities will allow to risk stratify these patients, in order to intensify therapy leading to better control and minimization of associated problems.

OBESITY IN CHILDREN AND ADOLESCENTS

Obesity is a public health problem that has raised concern worldwide. An exhaustive body of literature has emerged to show that overweight and obesity are major causes of co-morbidities, including type II diabetes, cardiovascular diseases, various cancers and other health problems, which can lead to further morbidity and mortality ***(Brown et al., 2009; Guh et al., 2009)***. As the prevalence of obesity increases so does the prevalence of the co morbidities associated with obesity. For this reason it is imperative that health care providers identify obese children so that counselling and treatment can be provided ***(Dietz and Robinson, 2005)***.

Definition

Obesity is generally defined as the abnormal or excessive accumulation of fat in adipose tissue to the extent that health may be impaired. Measuring the level of adipose tissue and determining when it is likely to affect health is not an easy task ***(Kiess et al., 2004; Chan and Woo, 2010)***. For this reason, obesity is often assessed by means of indirect estimates of body fat (i.e., anthropometrics) ***(Flodmark et al., 2004)***.

Unfortunately, there is no uniform consensus on the definition of childhood obesity, and the lack of a standard definition and