Cardiovascular complications of obesity in adolescents

F. Orio Jr¹, S. Palomba², T. Cascella¹, S. Savastano¹, G. Lombardi¹, and A. Colao¹
¹Department of Molecular and Clinical Endocrinology and Oncology, University “Federico II”, Naples; ²Department of Obstetrics and Gynecology, University “Magna Graecia”, Catanzaro, Italy

ABSTRACT. Obesity is an increasingly important worldwide health problem, representing the major risk factor for coronary heart disease. The increase in the prevalence of obesity, particularly among younger age groups, is likely to have long-term implications for cardiovascular disease (CVD) in the years to come, especially at a young age. Obesity plays a central role in the insulin resistance (IR) syndrome and increases the risk of atherosclerotic CVD. The present review will examine the relationships among cardiovascular risk (CVR) factors during the childhood-adolescence-adulthood transition. In fact, the relation between obesity, in particular visceral obesity and CVD, appears to develop at a relatively young age. The foremost physical consequence of obesity is atherosclerotic CVD, and an intriguing example of obesity-related cardiovascular complications affecting young women is the polycystic ovary syndrome (PCOS).

INTRODUCTION
Obesity and the cardiovascular risk
Obesity is an increasingly important worldwide health problem, affecting about 15-30% of the population in Europe and North America (1). According to the guidelines from the National Institutes of Health, overweight and obesity are defined on the basis of body mass index (BMI) - body weight in kilograms divided by the height in square meters - and especially in adulthood, overweight is defined as a BMI from 25 to 29.9 kg/m² and obesity as a BMI >30 kg/m² (2). The definition of pediatric obesity, according to the Center for Disease Control and Prevention (CDC), the American Academy of Pediatrics, the North American Association for the Study of Obesity, and the American Obesity Association, is age- and gender-specific (3). In particular, children with a gender-specific BMI-for-age <95th percentile are considered normal weight, and those with a BMI-for-age ≥95th percentile are defined as obese. In all children, the relative body weight (RBW) should also be evaluated, calculated as the percentage of the ratio between height and body weight at the 50th percentile for age and gender, according to Tanner’s growth tables (4). BMI is widely used as a surrogate measure of adiposity, and among children it has been demonstrated to reflect the positive association between height and adiposity better than other weight-height indices (5). BMI does not consider body fat distribution, and because of the relation between abdominal obesity with cardiovascular disease (CVD) and other metabolic risk factors, in clinical practice it is useful to measure waist circumference (WC) and waist-to-hip ratio (WHR) in addition to BMI. Abdominal obesity in adulthood is defined as a WC of 102 cm or more in men and of 88 cm or more in women or by a WHR >0.90 in men and >0.85 in women (2, 6). Since there are no reference values for WC for children and adolescents, a large sample population has been used to establish classifying criteria for enlarged WC. In particular, subjects with a value ≥90th percentile for age and sex from this sample population are classified as having enlarged WC (7). The choice of the 90th percentile is based on the association between truncal fat and WC according to Taylor et al. (8).
WC may be useful in clinical practice as a means of determining a child or adolescent’s response to weight control measures. In epidemiological studies, it may be used to characterize a population in terms of abdominal fat distribution and to determine the prevalence of central-obesity related risk factors. Therefore, at present, WC should be considered as an additional measure in the assessment of childhood obesity to identify the increased metabolic risk due to excessive abdominal fat (9). Despite intervention programs, the incidence of obesity continues to increase rapidly, assuming epidemic proportions (10, 11). This trend seems to be related to the diffusion of the typical Western diet with ingestion of oversized and/or fast and cheaper food portions, high in fats and calories (6), sedentary jobs and a decline in physical activity (2). Data from the National Health and Nutrition Examination Survey (NHANES) demonstrate that the prevalence of overweight and obesity has increased for both sexes in all ages and racial groups; between the 1988-1994 survey and 1999-2000 survey the prevalence of overweight among children rose from 4 to 15.3%, among adolescents and adults it increased respectively from 5 to 15.5% and from 55.9 to 64.5% (10, 11). Considering that the American Heart Association classifies obesity as a major risk factor for coronary heart disease (12), the increase in the prevalence of obesity, particularly among younger age groups, is likely to have long-term implications for CVD in the years to come. In fact, it has been demonstrated that obesity in children is a strong predictor of obesity in adulthood (13), even if the Harvard Growth Study showed that overweight in adolescence predicted a broad range of adverse health effects that were independent of adult weight (14). Obesity is a predisposing factor for the development of Type 2 diabetes, hypertension, dyslipidemia, osteoarthritis, certain types of cancer and CVD (2). In particular, visceral obesity is related to a cluster of factors that are constituents of the metabolic syndrome, representing independent risk factors for CVD, such as insulin resistance (IR), atherogenic dyslipidemia and hypertension (15, 16). Obesity is also associated with less conventional cardiovascular risk (CVR) factors, such as increased coagulability, endothelial dysfunction and inflammation (15, 17, 18). It is well known that fat represents not only a simple passive depot for storing excess calories, but it is a biologically active tissue that produces chemical messengers [eg adiponectin, resistin, angiotensin-2, tumor necrosis factor-α (TNF-α), and interleukins] that may affect CVR risk factors (19). Adipocytes are able to secrete a large number of peptides and cytokines, including prostaglandins and androgen and estrogen steroid hormones. In this respect, adipose tissue is not only an important repository for energy but also an active endocrine organ, with an influence on cardiovascular and metabolic function, fertility and sexual maturation (20).

In this view, we have explored CVR, complications and consequences of obesity from childhood to adulthood. In the face of the major impact that adult CVD has in the westernized societies, it seems crucial to examine the relationships among CVR factors during the childhood-adolescence-adulthood transition, ie, the putative earliest point in the development of CVR. This may result as important information on the etiologic relations between early indicators of the IR syndrome, Type 2 diabetes, and establishment of risk in young adulthood. Many studies have shown that obesity tends to track across the life course, so that once a child becomes fat, he or she is more likely to be fat later in life, although the magnitude of this risk depends on the measures used and study duration (20). Atherosclerotic cardiovascular disease is the number one killer in the adult population of Western societies (21), but the pathological processes and risk factors associated with its development have been shown to begin during childhood (22). A study called the Bogalusa study (22) in Louisiana has provided detailed information on CVR factors in childhood and their persistence into adulthood (23). In this study, overweight during adolescence was associated with an 8.5-fold increase in hypertension, a 2.4-fold increase in the prevalence of high total serum cholesterol values, a 3-fold increase in high LDL serum cholesterol values and an 8-fold increase in low HDL serum cholesterol levels as adults aged 27-31 yr (24). Similarly, the Muscatine study in Iowa has shown that adolescent obesity, especially in males, is associated with higher levels of total and LDL cholesterol in adulthood (25).

Several studies have shown links between weight gain in childhood and a subsequent increase in CVR factors in urban African-Americans (26) and in populations in Finland (27). The Finnish data suggest that the cluster of CVR factors in adulthood, including hypertension, hypertriglyceridemia, low HDL cholesterol and hyperinsulinemia, sometimes referred to as the metabolic syndrome, is especially common among obese adults who were also obese as children. Obesity is frequently associated with hypertension in adults and the same appears true in children. In fact, measures of resting blood pressure are correlated with WC and skin-fold measurements in children (28). Measures of blood pressure during exercise may provide further evidence of the links between obesity and hypertension in children (29).