

INTRODUCTION

There has been a worldwide increase in obesity among people of all ages. As many as 250 million people, or about 7% of the current world population, are obese (*Speiser et al., 2005*).

The prevalence and severity of obesity have increased in recent years as a result of complex interactions between genes, dietary intake, physical activity, and the environment (*Biro and Wien, 2010*).

Obesity is a chronic disease with important health and psychosocial consequences. The medical complications affect almost every body system. Obesity has a particular impact on the cardiovascular system including an increased prevalence of heart failure, hypertension and coronary heart disease, obstructive sleep apnea, symptoms of breathlessness and asthma are all more common in the obese (*Finer, 2010*).

Lang et al. (2010) cited that obese children and adolescents are more likely to become obese as adults. Childhood obesity also confers long-term effects on mortality and morbidity (*Wang and Lobstein, 2006*).

Each of these children is at increased risk of developing metabolic syndrome and subsequently progressing to diabetes type II and cardiovascular disease in later life. Early identification of children at risk and preventive action are

therefore very important. Unless action is taken, diabetes experts agree that this is the first generation where children may die before their parents (*Zimmet, 2007*).

Total and in particular central adiposity are associated with risk factors for cardiovascular disease, such as hypertriglyceredemia, hypercholesterolemia, insulin resistance, elevated blood pressure, and endothelial dysfunction both in children and adults. Among these factors, tissue resistance to insulin action is considered a key factor that might explain the association between obesity and cardiovascular diseases (*Krekouktaa et al., 2007*).

Vitamin D deficiency is another increasingly prevalent public health concern in developed countries (*Hyppönen, 2007, Ginde et al., 2009*), and there is evidence that vitamin D metabolism, storage, and action both influence and are influenced by adiposity. Observational studies have reported an increased risk of vitamin D deficiency in those who are obese; however, the underlying explanations and direction of causality are unclear (*Earthman et al., 2012*).

Active vitamin D (1,25-dihydroxyvitamin D) may influence the mobilisation of free fatty acids from the adipose tissue. In vitro experiments in rats have also shown that large doses of vitamin D₂ lead to increases in energy expenditure due to uncoupling of oxidative phosphorylation in adipose tissues (*Shi et al., 2001*).

However, randomized controlled trials (RCTs) testing the effect of vitamin D supplementation on weight loss in obese or overweight individuals have provided inconsistent findings (*Sneve, 2008; Zittermann et al., 2009; Salehpour et al., 2012*). It has also been suggested that obesity could result from an excessive adaptive winter response, and that the decline in vitamin D skin synthesis due to reduced sunlight exposure contributes to the tendency to increase fat mass during the colder periods of the year (*Soares et al., 2012*).

However, vitamin D is stored in the adipose tissue and, hence, perhaps the most likely explanation for the association is that the larger storage capacity for vitamin D in obese individuals leads to lower circulating 25-hydroxyvitamin D [25(OH)D] concentrations, a marker for nutritional status (*Wortsman et al., 2000*).

Although there is a genetic contribution to obesity, people generally become obese by consuming food and drink that contains more energy than they need for their daily activities. Thus, obesity can be prevented by having a healthy diet and exercising regularly.

Compared to people with a healthy weight, obese individuals have an increased risk of developing diabetes, heart disease and stroke, and tend to die younger.

They also have a higher risk of vitamin D deficiency, another increasingly common public health concern. Vitamin D, which is essential for healthy bones as well as other functions, is made in the skin after exposure to sunlight but can also be obtained through the diet and through supplements (*Davey, 2003*).

A recent study carried out by researchers from the University of Copenhagen found that low levels of Vitamin D can substantially increase one's risk of heart attack and early death (*Ebrahim, 2003*).

Researchers found that when somebody is both obese and has low Vitamin D levels, their risk of insulin resistance is much greater than if they have either factor alone. In other words, Vitamin D deficiency plus obesity, combined, increases your risk of developing insulin resistance much more than just obesity or just low Vitamin D.

Shaum Kabadi, from Dextrel University, said "Vitamin D insufficiency and obesity are individual risk factors for insulin resistance and diabetes. Kabadi and team found that people with healthy levels of Vitamin D who were obese were nearly 20 times more likely to suffer from insulin resistance, compared to the rest of the population. However, obese people with low serum Vitamin D were 32 times more likely to have insulin resistance (*Karani et al., 2009*).

AIM OF THE WORK

Assess the anthropometric measurements and Vitamin D level in obese children and adolescents and its relation to insulin resistance.

Chapter one

OBESITY

Definition of Obesity:

Obesity may be considered a pathological condition characterized by an excessive accumulation of body fat in adipose tissue which is a normal and essential constituent of the body providing a reserve of energy which can be mobilized as metabolic demands are required (*Bellman et al., 2006, Wertheim et al., 2007*).

It means having too much body fat. It reflects an overall imbalance between the energy ingested in food and the energy expended (*Charney, 2004*).

It is defined as a body mass index (BMI) at or above the 95th percentile for children of the same age and sex (*Centers for Disease Control and Prevention [CDC], 2009*).

BMI is calculated by dividing an individual's weight in kilograms by the square of their height in meters (kg/m²). BMI correlates strongly with the amount of body fat, though it does not measure it directly (*Johns, 2009*).

Obesity in children is defined as a weight for height above 90th percentile or weight excess of 120% of the medium weight for a given height. Super obesity defined as weight for height above 97th percentile and weight in excess of 140% of

the median weight for a given height. Those with BMI above 85th percentile are termed over weight or a better term "at risk for obesity (*Al-Sayed, 2005; CDC, Rosenthal et al., 2007*).

WHO parameters for BMI-for age parameters are defined by standard deviations and describe overweight to be greater than +1standard deviation from the mean (equivalent to BMI=25 kg/m² at 19 years) and obese as +2 standard deviations from the mean for 5-19 year olds (equivalent to BMI=30 kg/m² at 19 years) (*WHO, 2011*).

The World Health Organization (WHO), United States (U.S.) CDC, and International Obesity Task Force (IOTF) each have definitions of overweight and obesity in children and adolescents (See table 1) (*Harvard School of Public Health [HSPH], 2013*).

Table (1): Global Child Obesity Trends Body Mass Index.

<i>Organization</i>	<i>Definition of Childhood Obesity</i>
World Health Organization [WHO]	WHO Child Growth Standards (birth to age 5) (De Onis et al., 2007) Obese: Body mass index (BMI) > 3 standard deviations above the WHO growth standard median Overweight: BMI > 2 standard deviations above the WHO growth standard median Underweight: BMI < 2 standard deviations below the WHO growth standard median. WHO Reference 2007 (ages 5 to 19) (WHO, 2012) Obese: Body mass index (BMI) > 2 standard deviations above the WHO growth standard median Overweight: BMI > 1 standard deviation above the WHO growth standard median Underweight: BMI < 2 standard deviations below the WHO growth standard median.
Centers for Disease Control and Prevention [CDC]	CDC Growth Charts (Kuczmarski et al., 2000) In children ages 2 to 19, BMI is assessed by age and sex specific percentiles: ☐ Obese: BMI> 95th percentile ☐ Overweight: BMI> 85th and < 95th percentile ☐ Normal weight: BMI>5th and < 85th percentile ☐ Underweight: BMI < 5th percentile In children from birth to age 2, the CDC uses a modified version of the WHO criteria (Grummer-Strawn et al., 2010).
International Obesity Task Force [IOTF]	Provides international BMI cut points by age and sex for overweight and obesity for children age 2 to 18 (Cole et al., 2000). ☐ The cut points correspond to an adult BMI of 25 (overweight) or 30 (obesity).

(De Onis et al., 2007; Grummer-Strawn et al., 2010; WHO, 2012)

Classification of Obesity:

Obesity classified either to etiology or to pathogenic causes. According to pathogenic changes involved the mechanisms in the development of obesity (*Pauline and Kilay, 2006*).

According to mechanism, "Regulatory obesity" implies that there, is no metabolic abnormality, but that food are eaten in excess than requirements for psychological reasons, because of damage of hypothalamic control centers, or because energy output is decreased through a sedentary way of living. "Metabolic obesity" might arise from enzymatic, hormonal or conceivably neurological changes, as in some forms of lipodystrophy. The thirdclass is "constitution obesity" due to fat cell hyperplasia (*Davidson et al., 2005; Peter et al., 2007*).

A further dimension differentiates between the actual obesity of a subject and the disposition to obesity, if the natural weight of a child is genetically determined, as the liability to develop diabetes mellitus then may be genetically lean, but becomes fat for regulatory reasons (*Gordon, 2006*).

However, BMI does not account for the wide variation in body fat distribution, and may not correspond to the same degree of fatness or associated health risk in different individuals and populations (*Sweeting, 2007*).

Other measurements of fat distribution include the waist–hip ratio and body fat percentage. Normal weight obesity is a condition of having normal body weight, but high body fat percentages with the same health risks of obesity (*Katherine and Zeratsky, 2010*).

Body Mass Index (BMI):

Healthcare professionals around the world often use Body Mass Index (BMI) when determining whether pediatric patients are underweight, healthy weight, overweight or clinically obese. Pediatric people who are clinically obese have a greater risk of developing diabetes, stroke, some cancer, and cardiovascular diseases (*MediLexicon International Ltd, 2004*).

The initial step in evaluation of obesity is calculation of BMI. To measure BMI, one begins by weighing the child in underclothes and no shoes. Height is measured without shoes. BMI is calculated by dividing weight (in kilograms) by square height (in meters) (See figure 1A, 1B) (*Jtangia, 2006; Johns, 2009*).

$$\text{BMI} = \frac{\text{kilograms}}{\text{meters}^2}$$

Body mass index or BMI is a simple and widely used method for estimating body fat mass (*Mei et al., 2002*).

The healthy BMI range varies with the age and sex of the child, Obesity in children and adolescents is defined as a BMI greater than the 95th percentile (*CDC, 2009*).

BMI for age weight status categories and the corresponding percentiles are shown in table 2 and figure 2 (*WHO, 2012*).

5% of never-married males age 10-19 and 6% of never married females age 10-19 in Egypt was classified as overweight, i.e., their BMI values at or above the 95th percentile on age and sex-specific BMI growth charts (*El-Zanaty and Way, 2008; Ogden et al., 2012*).

Although several classifications and definitions for degrees of obesity are accepted, the most widely accepted classifications are those from the WHO, based on BMI. The WHO designations include the following:

- Grade 1 overweight (commonly and simply called overweight) - BMI of 25-29.9 kg/m²
- Grade 2 overweight (commonly called obesity) - BMI of 30-39.9 kg/m²
- Grade 3 overweight (commonly called severe or morbid obesity) - BMI greater than or equal to 40 kg/m².

(*WHO, 2012*)

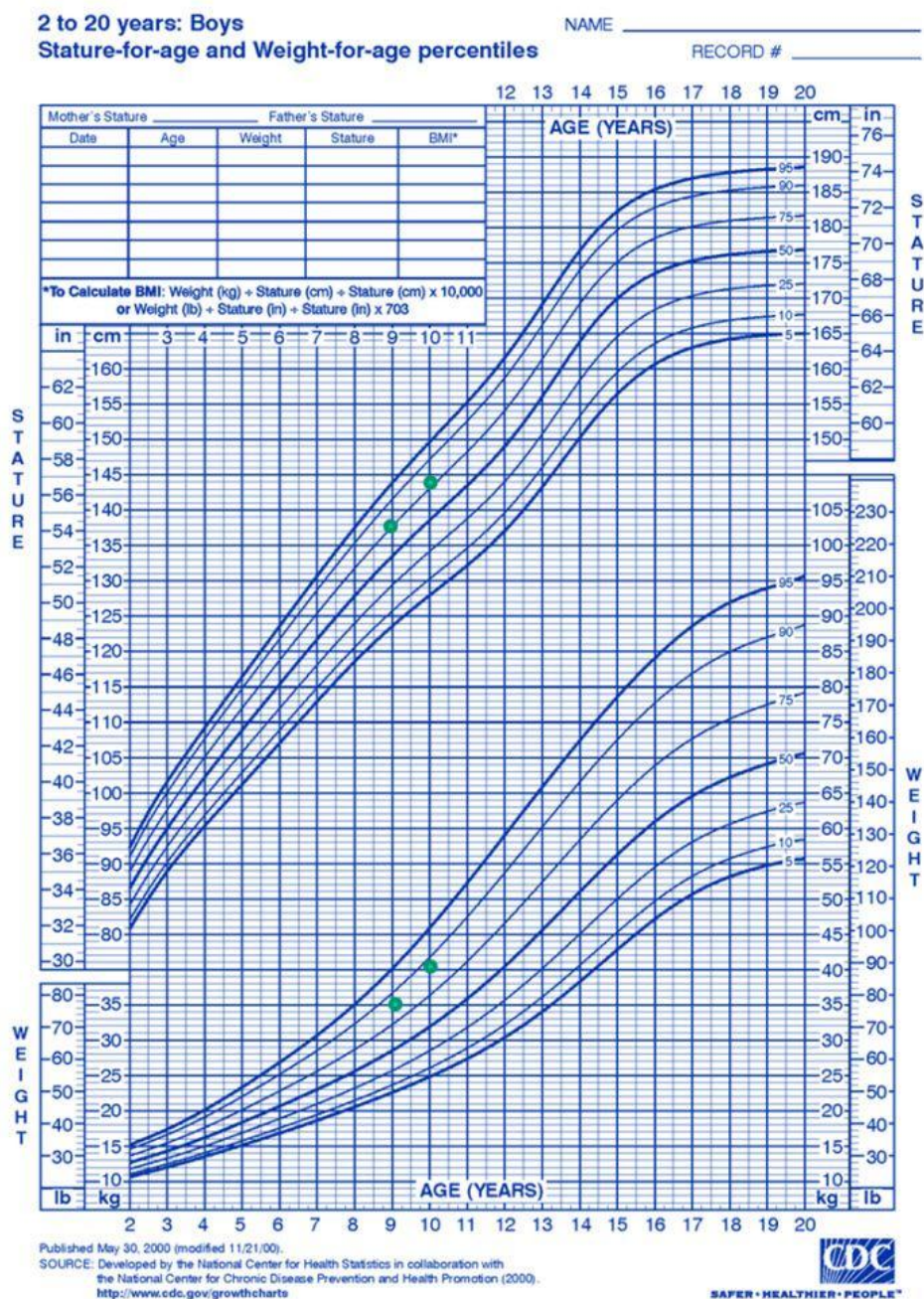
The cut-off for each grade varies according to an individual's ethnic background. For example, a BMI of 23 kg/m² or higher may define grade 1 overweight and 27.5 kg/m² or higher may define grade 2 overweight (obesity) in many Asian populations, in which the risk was shown to be high and extremely high for grade 1 and 2 overweight at these levels, respectively. Other BMI cutoffs identified as potential public health action points in these populations are 32.5 and 37.5 kg/m² (*Shiwaku et al., 2004*).

In children, a BMI above the 85th percentile (for age-matched and sex-matched control subjects) is commonly used to define overweight, and a BMI above the 95th percentile is commonly used to define obesity (*Hamdy, 2013*).

Table (2): Body Mass Index-for-Age Weight Status Categories

<i>Weight Status Category</i>	<i>Percentile range</i>
Underweight	Less than the 5 th percentile
Healthyweight	5 th percentile to less than 5th percentile
Overweight	85 th to less 95 th percentile
Obesity	Equal to or greater than the 95 th percentile

(*CDC, 2011*)



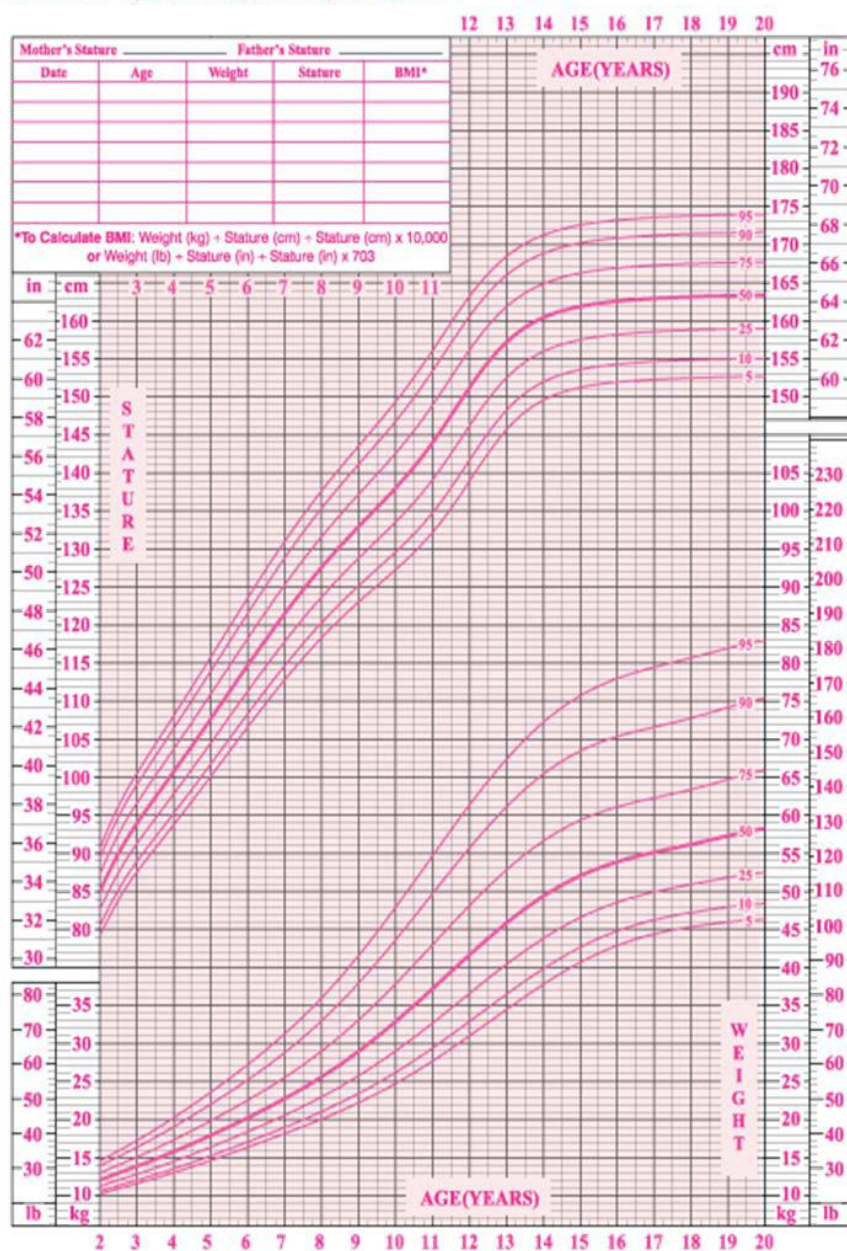
**Figure (1): A) Body Mass Index-for-Age Percentile: Boys; 2 to 20 Years
CDC Growth Charts: United States (CDC, 2012a).**

2 to 20 years: Girls

Stature-for-age and Weight-for-age percentiles

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SOURCE : Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
<http://www.cdc.gov/growthcharts>

Figure (1): B) Body Mass Index-for-Age Percentile Girls; 2 to 20 Years
CDC Growth Charts: United States (CDC, 2012b).

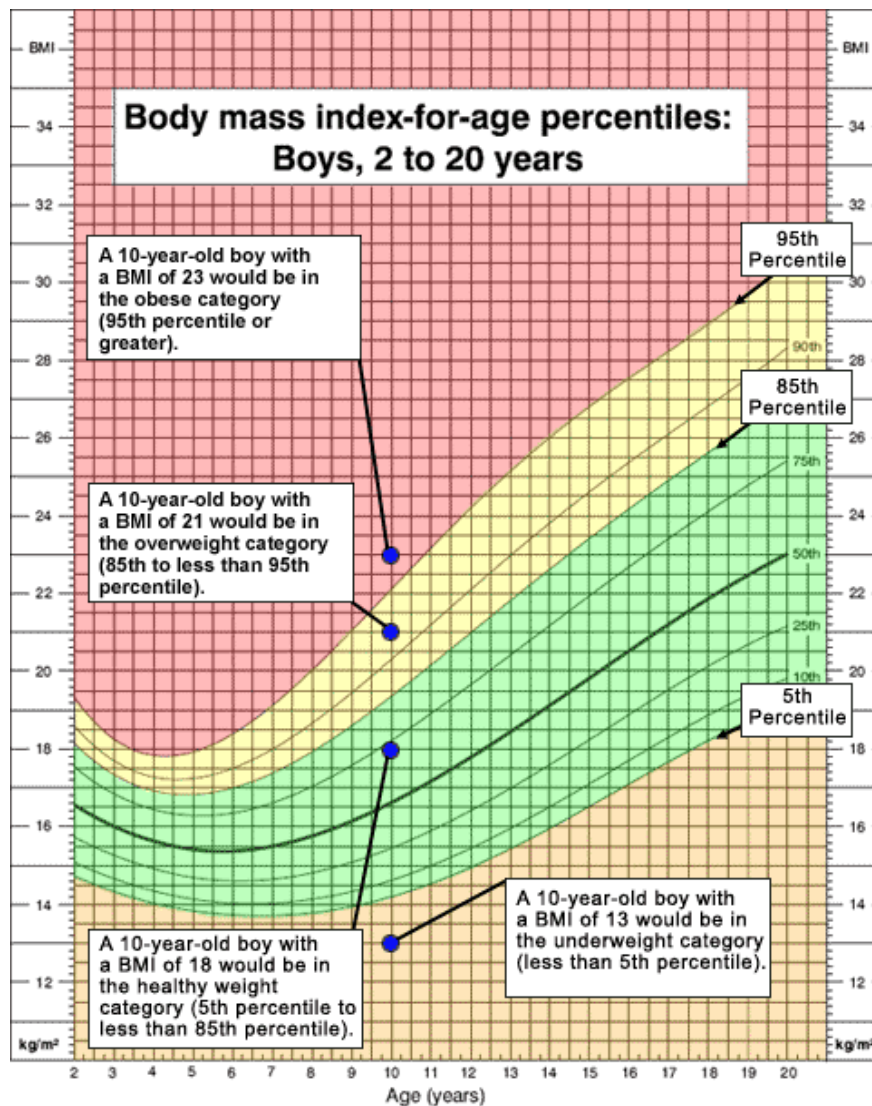


Figure (2): Body Mass Index-for-Age Weight Status Categories Calculate Body Mass Index (BMI) (*World Health Organization [WHO], 2012*).

Body Fat Percentage:

Accumulating data suggest that regional fat distribution substantially affects them incidence of co-morbidities associated with obesity (*Wijga et al., 2010*).