Obesity Degree and Cardiometabolic Risk among School Students

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Abstract: Rationale: Childhood obesity is a risk factor for developing cardio metabolic diseases in adulthood. **Objective:** Studying the association of cardio metabolic risk factors in students (7 - 16 years) with different degrees of obesity. **Methods:** Cross-sectional study including 169 student: 72 obese [body mass index (BMI) > 95th percentile] and 97 extremely obese (BMI > 97th percentile) for age and gender based on Egyptian Growth Reference Charts. Interrelationship between risk factors prevalence: hypertension, high waist circumference (WC), impaired fasting glucose, hyperinsulinieamia, insulin resistance, and dyslipideamia (abnormal TC, LDL-C, HDL-C, and triglyceride), according to age groups and degree of obesity were assessed. A set of cardio metabolic risk factors were defined for each individual, ranging from 0 (no risk factors) to 9 (all risk factors). **Results:** In younger age group (7 - 11 years), extremely obese students were proven to have higher frequencies of cardio metabolic risk factors in comparison to obese group, with highly significant differences regarding fasting glucose level and WC. Older students aged 12- 16 years recorded insignificant differences in the frequency of cardio metabolic risk factors between obese and extremely obese ones. For both age groups, elevated total and LDL-Cholesterol were significantly linked to disturbances of carbohydrate metabolism; indicated by fasting glucose level. Highly significant positive interrelationships between WC and triglycerides for children, and diastolic blood pressure for adolescents were detected. Among extremely obese students, 81% of younger and 60% of older had a cluster of at least three risk factors or more in comparison to only 56.7% and 48.7% of obese. **Conclusion:** Cardio metabolic risk factors are associated with degree of obesity in young age (7-11 years), but not in those aged 12-16 years. Elevated triglycerides are the most common risk factors in both age groups.

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1. Introduction:

Overweight and obesity are an important risk factor for cardiovascular diseases. Although the clinical manifestations of these diseases occur in adulthood, studies have demonstrated that comorbidities such as dyslipidemias, hypertension and insulin resistance may be present in childhood and adolescence **(Botton et al, 2007)** , and are responsible for the increased risk of morbidity and mortality in adulthood **(Baker et al, 2007; Berkowitz, 2010).**

In Egypt, as in other parts of the world, the obesity epidemic affects a growing number of children and adolescents **(El-Masry, 2007, Shaaban et al, 2008).** The study of **Jackson et al (2003)** among female adolescents showed that 35 % of the girls were overweight and 13 % were obese. In the final report of Diet, Nutrition and Prevention of Chronic non communicable diseases in Egyptian Adolescents **(DNPCNCD, 2008)**, it was found that about 20.5% of the adolescents were either overweight or obese with higher prevalence among urban than rural and females compared to males.

Few studies correlating obesity with cardiovascular risk factors have been conducted among adolescents in developing countries, particularly in Egypt **(Hassan et al, 2011a, b)**. However, according to the World Health Organization's report **(WHO 2006)**, children and adolescents from low socioeconomic levels are as exposed to obesity and cardiovascular risk factors as their peers from high socioeconomic levels. For the development of more efficient clinical prevention and intervention programs, studies targeted at this population are necessary.

In fact, obesity-related diseases may depend on the ethnic or genetic background. Therefore, studies including Egyptian children and adolescents with obesity of all degrees are necessary to examine the effects of adiposity on health in this age group and its association with cardio metabolic risk factors.

The aims of this study are: 1). to determine whether the prevalence of obesity-related risk factors in Egypt is as high as reported for other parts of the world; 2) to examine whether a clustering of several risk factors occurs; and 3) to explore the prediction of single and multiple comorbidities by the degree of obesity as defined by BMI adjusting for potential confounders as age.

2. Subjects and methods:

Between October 2007 and April 2009, 5798 students (2655 boys and 3143 girls), with age range 7-16 years, were studied in a cross-sectional survey for evaluation of overweight and obesity. These students were recruited from 6 public schools (two Primary Schools, two preparatory and two secondary schools) situated in Giza governorate. Permission to perform the study was granted by the Ministry of Education, and the directors of the school included in the research. Parents were informed about the purpose of the study and their permission in the form of written consent was obtained. Another assent was taken from the students to be involved in this research. The protocol was approved by the "Ethical Committee" of the "National Research Centre". The agreement reference number is 07/091.

Of the total sample, four hundred and sixty-two students only (8.0%) complaint of obesity; 174 boys and 288 girls; their mean age was 13.43± 2.65 years**,** 26.4 % aged 7 – 11 years and 73.6% aged 12 – 16 years. Obese students were excluded if they had a prior major illness, including type 1 or 2 diabetes, took medications or had a condition known to influence body composition, insulin action or insulin secretion (e.g. glucocorticoid therapy, hypothyroidism and Cushing's disease). All overweight students refused to participate. Of the obese students eligible to the study, informed consent and assent were only obtained from the parents of 169 students for the laboratory data; 72(45 boys and 27 girls), were defined obese (with body mass index (BMI) equal to or greater than the 95^{th} - 97^{th} percentile for age and gender based on the Egyptian Growth Reference Charts **(Ghali et al, 2008)** and 97 (28 boys and 69 girls) as extremely obese (with BMI higher than the 97^{th} percentile). Data of BMI percentiles, waist circumference (WC), blood pressure (BP), fasting lipids and glucose were collected.

Each student subjected to a simple questioner as past history of chronic diseases, assessment of socioeconomic status; and a complete physical examination, including anthropometric measures. The height was measured to the nearest 0.5 cm using a Holtain portable anthropometer, and the weight was determined to the nearest 0.1 kg using a Seca scale Balance with the subject dressed minimum clothes and no shoes. Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. Waist circumference was measured at the level of the umbilicus with subject standing and breathing normally, using non-stretchable plastic tape to the nearest 0.1 cm. Each measurement was taken as the mean of three consecutive measurements, using standardized equipments and following the recommendations of International Biological programmes (**Hiernaux and Tanner, 1969**). Blood pressure was measured with a standard mercury sphygmomanometer after the subjects had rested at least 10 min. Systolic blood pressure was recorded at the appearance of sounds, and the diastolic blood pressure was recorded at the disappearance of sounds. The blood pressure measurement was repeated for 3 consecutive days, if it was high to be sure from the diagnosis of hypertension.

Venous blood samples were obtained to measure plasma glucose, plasma insulin levels and lipid profile in the morning by venipuncture after overnight fasting. Plasma glucose was determined by the glucose oxidase method. Plasma insulin was measured using ELIZA immunoassay (DRG Diagnostic Products Corporation, Los Angeles, CA). Plasma concentrations of total cholesterol and triglycerides were estimated in serum by using calorimetric assay kit produced by P.Z. cormay, Lublin, Poland. High-density lipoprotein-cholesterol (HDL-C) was determined in serum by using calorimetric assay kits produced by Stanbio laboratory, Boerne, Texas. Low-density lipoprotein-cholesterol (LDL-cholesterol) was calculated as follows:

$$\text{LDL} = \text{Total cholesterol} - \text{HDL} = \frac{\text{TG}}{5}.$$

WC was considered high if > 90^{th} percentile for age and sex. BP related to age and sex was considered elevated if systolic or diastolic blood pressure above the 90^{th} percentile of Egyptian reference ranges **(Zaki et al, 2006).** *Dyslipideamia* (abnormal lipid levels) were defined according to the American Heart Association **(Grundy et al, 2004)** as follows: total cholesterol (TC) >210 mg/dL, high-density lipoprotein (HDL-C)-cholesterol <40 mg/dL, low-density lipoprotein (LDL-C)-cholesterol > 130 mg/dL, or triglycerides (TG) >110 mg/dL. Any one elevated level out of the following was classified for "Impaired carbohydrate metabolism" according to modified WHO criteria adapted for children **(1999);** impaired fasting glucose tolerance>6.1 mmol/L, hyperinsulinieamia was defined from norms for age: 7- 11 years> 15 mU/L; and 12 – 18 years>30 mU/L; insulin resistance is defined as the levels of the HOMA-IR greater than 3.16, according to **Keskin et al** (**2005**). HOMA-IR (The homeostatic model assessment for insulin resistance) was calculated as follow:

HOMA-IR= fasting insulin (µU/mL) x fasting glucose (mmol/L)/22.5.

Statistical analysis

Statistical analyses were carried out with calculations of the proportions of students exposed to different risk factors: hypertension, high WC, impaired fasting glucose, hyperinsulinieamia, insulin resistance, and dyslipideamia (abnormal TC, LDL-C, HDL-C, triglyceride), in the obese and in the extremely obese groups, with the respective odds ratios (OR) and 95% confidence intervals (CI).Interrelationship between risk factors prevalence according to the age groups were assessed by chi-square test. Data was examined by one sample Kolmogorov-Smirnov Z test for normal distribution, which revealed that the data was not normally distributed. So, bivariate Spearman's correlation tests were used to examine the association between contributing risk factors. Variables with significant associations only ($p < 0.05$) in the bivariate analysis were included in the correlation tests. Finally, a set of cardiovascular risk factors was defined as the number of conditions present in each individual, ranging from 0 (absence of all conditions) to 9 (presence of all the conditions mentioned).The prevalence of combination of multiple risk factors was examined also. Statistical significance was taken as $p < 0.05$. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS/Windows Version 16.0, SPSS Inc., Chicago, IL, USA).

3. Results:

According to BMI, 42.6% were obese, their BMI >95th up to 97th percentile, and 57.4 % were extremely obese, their BMI > 97th percentile. Girls presented somewhat more frequently (56.8%) than boys (43.2%). In spite of insignificant differences in the age of boys and girls (mean age of boys 12.32 ±2.51, while that for girls 12.78 ±2.77), girls had higher degree of obesity (71.9% of girls were extremely obese) than boys (38.4%), while obesity; BMI between 95th -97th percentile; was more prominent in boys (61.6%) than girls (28.1%), namely that girls tended to be extremely obese than boys (table 1).

Insignificant sex differences were observed in both age groups; 7-11 and from 12 to 16 years; regarding WC, BP and all the laboratory data. So, the analysis was completed without sex differentiation.

The frequencies and odds ratios(OR) with respective 95% confidence intervals for the variables of cardiovascular risk factors in relation to BMI degree in the two age groups are presented in tables 2 and 3. In the younger age group (7 to 11 years), extremely obese students were proven to have higher frequencies of abnormal triglycerides and fasting glucose levels, hypertension and high WC in comparison to the obese group, with highly significant differences regarding fasting glucose level and WC. Waist circumference > 90th percentile was recorded in 91.9% (crude OR = 7.16).The frequency of abnormal glucose levels was 35.1% (crude OR = 7.85). Hypertension was present in 27.0% of extremely obese (crude OR=7.0). Approximately 78% of the extremely obese students had high triglyceride levels (crude OR = 1.99). However, in the older students aged 12- 16 years (table 3), insignificant differences in the frequency of different variables of cardiovascular risk factors between the obese and extremely obese students were recorded.

Table 1: Frequency distribution of the sample

	BMI>95		BMI >97		Total
	Boys	Girls	Boys	Girls	
	N (%)	N (%)	N (%)	N (%)	N (%)
7 – 11 years	20 (29.4)	11(16.2)	12(17.6)	25(36.8)	68(40.2)
12 –18 years	25(24.8)	16 (15.8)	16(15.8)	44(43.6)	101(59.8)
Total	45(26.6)	27 (16.0)	28 (16.6)	69 (40.8)	169 (100.0)

Table 2: Frequencies (%) and odds ratio (OR) with their respective 95% confidence intervals (CI) for the variables related to cardiovascular risk factors in children aged 7 -11 years using Chi- square test

Variables	BMI>95			BMI >97			Crude OR (95% CI)	P
	N	yes		N	yes			
		N	%		N	%		
WC > 90th percentile	31	19	61.3	37	34	91.9	7.16 (1.79-28.57)	0.003
Glucose >6.1 mmol/L	31	2	6.5	37	13	35.1	7.85 (1.61-38.28)	0.007
Insulin > 15 mU/L	31	6	19.4	37	3	8.1	0.37 (0.08-1.61)	0.282
HOMA > 3.16	31	6	19.4	37	3	8.1	0.37 (0.08-1.61)	0.282
Triglycride>110 mg/dL	31	20	64.5	37	29	78.4	1.99 (0.68 – 5.84)	0.319
TC > 210 mg/dL	31	13	41.9	37	9	24.3	0.45 (0.16-1.25)	0.198
HDL-C<40 mg/dL	30	17	56.7	37	20	54.1	0.90 (0.34-2.37)	1.000
LDL-C > 130 mg/dL	30	15	50.0	37	15	40.5	0.68 (0.26-1.8)	0.600
Hypertension	31	1	3.2	37	6	27.0		
SBP> 90th percentile	31	1	3.2	37	7	18.9	7.00(0.81-60.43)	0.063
DBP> 90th percentile	31	1	3.2	37	4	10.8	3.64 (0.39-34.38)	0.366
Cardiovascular risk factors								
1 CV risk	31	3	9.7	37	1	2.7		0.202
2 CV risk	31	7	22.6	37	6	16.2		
3 CV risk	31	17	56.7	37	30	81.0		

Table 3: Frequencies (%) and odds ratio (OR) with their respective 95% confidence intervals (CI) for the variables related to cardiovascular risk factors in children aged 12 -18 years using Chi- square test

Variables	N	BMI>95 yes N	BMI>95 yes %	N	BMI >97 yes N	BMI >97 yes %	Crude OR (95% CI)	P
WC > 90th percentile	37	14	37.8	60	15	25.0	0.55 (0.23-1.33)	0.266
Glucose >6.1 mmol/L	41	11	26.8	60	14	23.3	0.83 (0.33-2.07)	0.869
Insulin > 15 mU/L	41	2	4.9	58	1	1.7	0.61 (0.26-1.41)	0.568
HOMA > 3.16	33	9	27.3	48	15	31.3	1.21 (0.46-3.23)	0.891
Triglycride>110	40	29	72.5	60	41	68.3	0.82 (0.34-1.98)	0.824
TC > 210 mg/dL	38	11	28.9	60	18	30.0	1.05 (0.43-2.57)	1.000
HDL-C<40 mg/dL	39	19	48.7	56	39	69.6	2.42 (1.03-5.64)	0.065
LDL-C > 130 mg/dL	40	13	32.5	58	18	31.0	0.94 (0.39-2.22)	1.000
Hypertension	37	6	16.2	60	17	28.3		
SBP> 90th percentile	37	3	8.1	60	8	13.3	1.74 (0.43-7.04)	0.524
DBP> 90th percentile	37	4	10.8	60	15	25.0	2.75 (0.84-9.05)	0.116
Cardiovascular risk factors								
1 CV risk	41	7	17.1	60	8	13.3		0.696
2 CV risk	41	12	29.3	60	15	25.0		
3 CV risk	41	19	48.7	60	36	60.0		

Table 4: Interrelationships between adverse cardiovascular risk factors by Spearman correlation test.

Risk factors		Waist Circumference 7- 11 years	Waist Circumference 12 – 16 years	Fasting glucose level 7- 11 years	Fasting glucose level 12 – 16 years
SBP	*r*	.178	.198	-.168	-.147
	p	.147	.051	.171	.150
DBP	*r*	-.110	.306**	-.028	-.142
	p	.371	.002	.823	.167
Triglycerides	*r*	.483**	-.120	-.228	.223*
	p	.000	.244	.061	.026
Total cholesterol	*r*	.106	-.121	.268*	.214*
	p	.388	.238	.027	.033
HDL	*r*	.041	-.119	.083	-.246*
	p	.743	.254	.502	.015
LDL	*r*	.038	-.033	.272*	.353**
	p	.761	.753	.026	.000
Insulin level	*r*	.235	.119	-.204	-.368**
	p	.053	.252	.095	.000
HOMA	*r*	.226	.114	-.063	-.117
	p	.064	.273	.610	.249

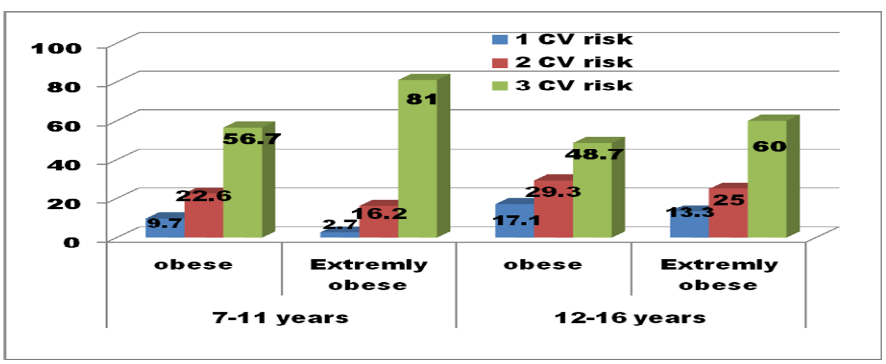

Figure 1: Prevalence of cardiovascular risk factors

Frequency distribution of cardiovascular risk factors is shown in **Tables 2, 3** and Figure 1. Six students only had no risk factors: 4 obese students aged 7 -11 years, and 2 students aged 12- 16 years (1 obese and 1 extremely obese). Of the extremely obese students, 81% of younger students aged 7- 11years and 60% of older ones aged 12- 16 years had a cluster of at least three risk factors or more in comparison to only 56.7% and 48.7% of the obese students. The most common association of 2 risk factors in both age groups was elevated triglycerides and decreased HDL-C. In case of existence of 3 risk factors or more, high WC, elevated triglycerides and LDL-C were the common associations in the young age (7-11 years), while elevated triglycerides, total cholesterol and decreased HDL- were the common association in the older students (12 – 16 years).

Interrelations between CV risk factors using Spearman's correlation test revealed highly significant positive interrelationships between waist circumference and triglycerides in young age group (7 -11 yrs), and diastolic BP for older age group (12 – 16 yrs). Elevated total cholesterol and LDL-cholesterol were each significantly linked to disturbances of carbohydrate metabolism; indicated by fasting glucose level; in both age groups. Moreover, increased triglycerides decreased HDL-C and elevated insulin level were also significantly associated with increased fasting glucose level in older students aged 12- 16 years (Table 4).

4. Discussion:

Although the clinical symptoms of cardiovascular diseases occur in adulthood, the atherosclerotic process starts in childhood, and obesity is one of its main determinants **(McMahan et al, 2006).** The presence of cardiovascular risk factors including dyslipidemia, hypertension and abnormal baseline insulin levels characterizes the metabolic syndrome **(Agirbasil et al, 2006; Lottenberg et al, 2007; Sun et al, 2008).**

This study included 169 school students suffering from various degree of obesity. The association between the degree of obesity and cardio-metabolic risk factors was investigated. Despite the higher prevalence of obesity among girls (56.8%) than boys (43.2%), yet the WC, BP and all the laboratory data were similar for both sexes as there were insignificant sex differences. This coincided with previous studies **(Jackson et al, 2003, El-Masry, 2007; Shaaban et al, 2008 Hassan et al, 2011)** which recorded higher prevalence of obesity among girls compared to boys.

Results revealed that obese children and adolescents had adverse CV risk factors, which related to degree of obesity in children only and not in adolescents. Extremely obese children were proven to have higher frequencies of high waist circumference (91.9%), abnormal triglycerides (78.4%), high fasting glucose levels (35.1%) and hypertension (27.0%) compared with obese ones (61.3%, 64.5%, 6.5% and 3.2% respectively). Extremely obese children were found to have nearly 7 fold (times) risk for having high WC and fasting glucose levels than obese ones, and the differences were highly significant. However, in adolescents, differences in the frequency of cardiovascular risk factors between the obese and extremely obese students were minimal and insignificant. These results coincide with the previous studies **(Steinberger and Daniels, 2003; Wannamethee et al,. 2005; Kohli and Greenland 2006; Saland, 2007)** which concluded that high levels of body mass index among children and adolescents has been reported to be associated with abnormal levels of lipids, insulin, blood pressure and all components of the metabolic syndrome**.** Other large epidemiologic studies **(Suk et al, 2003; Wang et al, 2005; Yusuf et al, 2005)** stressed on **t**he importance of WC in predicting cardio metabolic risk factors and their adverse outcomes (e.g., diabetes, CHD, and death rate). They attributed that to the finding that the body fat distribution; mainly excess abdominal fat (also known as central or upper-body fat) is an important risk factor for obesity-related diseases. However, precise measurement of abdominal fat content requires the use of expensive radiological imaging techniques. Therefore, waist circumference (WC) is often used as a surrogate marker of abdominal fat mass, because WC correlates with abdominal subcutaneous and intra-abdominal fat mass, and is associated with cardio metabolic disease risk **(Pouliot et al, 1994)).**

Freedman et al (1999) in the Taipei Children Heart Study, reported a significant relation between obesity and high fasting glucose level**.** While **Geiss et al (2001)** in Korean children and adolescents recorded that fasting glucose concentrations did not increase according to the increase in weight status.

Literature reviews proved that adiposity leads to increased triglycerides in obese children **(Baranowski et al, 2006; Weiss et al, 2004). Chu et al (1998)** have shown a strong relationship between triglycerides and obesity (OR 7.1 (5.8–8.6)) among US children. The same was recorded by **Weiss et al (2004) and Kim et al (2006)** among the obese children of Central European studies.

Reinehr et al (2005a, b) demonstrated in a longitudinal study that hyperinsulineamia may be the central abnormality in obese children and adolescents, and this contributes to dyslipideamia. The physiological mechanism suggested for this process is that the intra-abdominal fat has a high and intense metabolic activity, permitting the triglyceride depots concentrated in this region to be more easily mobilized to the blood stream, thus leading to an increased production of free-fatty acids and LDL-c in the liver **(Björntorp 1997).**

The present study showed that ***extremely obese*** adolescents *aged 12- 16* years (69.6%) had marked lowering of the HDL-cholesterol concentration compared to *obese* ones (48.7%). They were found to have a 2 times risk for having low concentrations of HDL-C than obese ones. On the other hand, the frequency of having low HDL-C was nearly similar concerning the younger age group aged 7 to 11 years (56.7% of obese children and 54% of extremely obese ones). However, the differences were insignificant for both age groups. Previous studies of **Weiss et al (2004)** and **Baranowski et al (2006)** proved that adiposity leads to markedly lowered HDL-cholesterol concentrations. As observed in the general population, HDL-cholesterol concentrations are lowered by puberty or age >12 years, most probably caused by increasing androgens **(Bao et al, 1996; Williams et al, 2002)** or reduced physical inactivity **(Akerblom et al, 1999)**

Results of this study recorded that obese (50%) and extremely obese children (40.5%) had high frequency of elevated LDL- C than obese (32.5%) and extremely obese (31%) adolescents. This coincided with **Morrison et al (2003)** who concluded that pubertal obese adolescents had a lower probability of elevated LDL-cholesterol concentrations, which was explained by the increase of estradiol concentrations both with puberty and adiposity, even in male subjects**.** Inspite of that, the present study detected that LDL-cholesterol level was very weakly related with the degree of obesity for both studied children (OR 0.68(0.26- 1.8)) and adolescents (OR 0.94(0.39- 2.22)). This finding supports previous observations that LDL-cholesterol is not related to BMI or to the metabolic syndrome **(Baranowski et al, 2006; Kim et al, 2006; Weiss et al, 2004).** However, **Freedman et al (1999)** in population based studies; and particularly in younger children; recorded the effect of BMI on LDL-cholesterol.

Over the past decade, BP in children increased substantially **(Ford et al, 2004; Muntner et al, 2004)** and was associated with the concurrent increase of body weight **(Couch and Daniels 2005)**, even as early as in 2- to 5-year-old children in a study of **Falkner et al (2006)** in a primary care setting**.** Irrespective of the effects of obesity, elevated BP in childhood is predictive of sustained hypertension and target-organ damage in young adulthood **(Sorof et al, 2003; Vos et al, 2003; Lande et al, 2006).** The National Health and Nutrition Examination Survey (NHANES) on children and adolescents, increased obesity; especially abdominal obesity indicated by WC; was observed to explain part of the tendency to elevated blood pressure levels, because there is an association between hypertension and hyperinsulinism **(WHO 2006).** The prevalence of elevated BP in the present study was roughly similar in both extremely obese children (27%) and adolescents (28%), but higher compared with obese children (3%) and adolescents (16%). **Sharpe et al (2006)** found that diastolic hypertension was more often elevated than systolic.

Another important observation in this study was the clustering of 2 or more CV risk factors, being closely associated with the degree of excess weight. The most common association of 2 risk factors in both age groups was elevated triglycerides and decreased HDL-C. In case of clustering of 3 risk factors or more, the most prevalent was elevated triglycerides level for both obese and extremely obese students which were associated with high WC and LDL-C in young children, and impaired total cholesterol and HDL-C, in adolescents (12- 16 years). Similar results were reported in previous studies **(Weiss et al, 2004; Baranowski et al, 2006).**

A clustering of three or more adverse CV risk factors has been shown to be the most severe obesity-related health hazard. This is supported by the observation that there is a close interaction between increased triglycerides, BP, and impaired carbohydrate metabolism. Triglyceride-induced insulin resistance and hyperinsulinemia may be the common pathophysiological link between these parameters, but the exact nature of the relation between increased fat mass, insulin resistance, and arterial hypertension in children remains unclear **(Sinaiko et al . 2002).**

The present study demonstrated that disturbances of carbohydrate metabolism; indicated by fasting glucose level; was significantly associated with the decreased HDL-cholesterol and insulin level in adolescents aged 12- 16 years, and with elevated total cholesterol and LDL-cholesterol in both children and adolescents. These results are consistent with many other studies as dyslipidemia is well documented in older children and adults who are obese **(Boyd et al, 2005; Reinehr et al, 2005)**, and associations have been found between serum fasting insulin concentrations and serum lipids in 2–3-y-old Hispanic children **(Shea et al, 2003).**

A significant positive correlation between waist circumference and diastolic BP for adolescents only was detected also in the present study. This comes in agreement with the German study of **Reinehr et al (2005)**, who found that the degree of body mass index correlates positively with diastolic hypertension**.**

Obesity tracks from childhood to adulthood, and childhood adiposity is a strong predictor of obesity, insulin resistance **(Steinberger et al, 2001),** and abnormal lipids in adulthood **(Srinivasan et al, 1996).** Moreover, the rate of increase in adiposity during childhood was significantly related to the development of cardiovascular risk in young adults **(Sinaiko et al, 1999).** However, BMI only accounts for 60% of the variance of insulin resistance in adults **(Abbasi et al, 2002),** which suggests that other factors are important. It has been reported that a transient insulin-resistant state occurs in children during normal pubertal development **(Caprio et al, 1989; Moran et al, 1999).** Studies with euglycemic insulin clamps have shown that insulin resistance increases at the beginning of puberty, peaks at mid puberty, and returns to near-prepubertal levels by the end of puberty **(Moran et al , 1999).** The increase in growth hormone, sex hormone, and insulin-like growth factor-1 levels that occurs during puberty is thought to be the cause of this form of insulin resistance **(Moran et al, 2002).** Thus the insulin level in children and adolescents is influenced not only by the obesity degree but also by the normal increase in growth hormone, sex hormone, and insulin-like growth factor-1 levels that occurs during normal pubertal development.

In summary: This study revealed that obese children and adolescents did show adverse cardio metabolic risk factors. The most prevalent risk factor was elevated triglycerides level which were associated with impaired carbohydrate metabolism, as well as with insulin resistance, hypertension and high waist circumference.

Conclusion:

Cardio metabolic risk factors tend to cluster, being closely associated with the degree of excess weight,; particularly in young children. Thus a comprehensive screening is crucial for all obese children and adolescents to identify cardio metabolic risk factors as early as possible aimed at reducing morbidity and mortality in adulthood.

For the development of more efficient clinical prevention and intervention programs, studies targeted at this population are necessary. Evaluation of the nutritional status is, therefore, essential in the clinical practice, aiming at detecting and preventing obesity and the associated cardio metabolic risk factors. Changes in lifestyle by encouraging physical activities and an adequate balanced diet are key strategies for maintaining healthy weight.

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