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IMPACT OF OBESITY AND PHYSICAL INACTIVITY ON FASTING BLOOD GLUCOSE, LIPID PROFILE AND HOMEOSTATIC MODEL ASSESSMENT (HOMA) AMONG CHILDREN

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Abstract: Purpose: to study the impact of overweight and obesity on fasting blood glucose level and lipid profile among children.
Methodology: A cross sectional study included 200 child aged 2 -12 years was done to screen for plasma glucose, lipid profile and insulin abnormalities. They were assessed by interview questionnaires, anthropometric measures and by measuring their fasting blood glucose and plasma lipid levels.
Findings: The risk for having high triglycerides and low HDL levels is more than double among obese children compared to non-obese. Physically inactive children have 7.8 times the risk for obesity compared to active children. Significant high percentages among obese as regards prediabetes state and insulin resistance. The consumption of unhealthy snacks was higher than vegetables and fruits regardless of BMI.
Value: High BMI predisposes children to many of the medical complications of obesity found in adults, in particular components of insulin resistance syndrome.

Keywords: *Screening – Risk Factors – Fasting Blood Glucose– Lipid Profile – Insulin Resistance – Homa - Children*

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INTRODUCTION

The World Health Organization has declared obesity to be a pandemic problem WHO, (2005). The World Health Organizations 2008 report, presented in Geneva reflects a global increase in non-communicable diseases. These diseases, now considered the leading killers worldwide, consist of heart disease, diabetes, and stroke. This report predicted an increase in this growing health trend well beyond 2030 Sanity Rose, (2008). Obesity in children seem to be on the rise to become a significant public health problem. Excess adiposity is more than just a cosmetic problem, having substantial metabolic consequences. Insulin resistance, hyperinsulinemia, impaired fasting glucose, and frank diabetes are often seen in obese children Alan Greene, (2002). In a recent article in Diabetes Care, the STOPP-T2D (Studies to Treat or Prevent Pediatric Type 2 Diabetes) study group reported on 1,740 eighth-grade students and found that 49% had a body mass index (BMI) greater than or equal to the 85th percentile for sex and age, 40.5% had a fasting glucose value ≥100 mg/dl (impaired fasting glucose), and 36.2% had fasting insulin levels ≥30μU/ml. Not surprisingly, fasting and 2-hour glucose and insulin values increased across BMI percentiles Baranowski et al, (2006). The National Study of Diet, Nutrition and Prevention of Chronic Non-Communicable Diseases (DNPCNCD) conducted by NNI 2005 - 2008 revealed a prevalence of 13.4% for overweight and 7.1% for obesity among adolescents Mervat et al, (2008). A study carried by Salem et al. (2004) for screening for DM among obese adolescents (404 students) revealed the presence of 2 having type II and 3 having impaired fasting glycemia. DNPCNCD showed that pre-diabetic state was present among 15.0% of adolescents in the pre-pubertal stage and up to 21.0% of adolescents in the post-pubertal stage based on fasting blood glucose Mervat et al, (2008). The challenge of diabetes among children is that the longer a person has diabetes the greater the chance he or she will develop one or more serious complications

of this disease, including blindness, renal, heart disease and stroke Food insight (2003). This leaves clinicians and researchers caring for children with a host of adult-type problems. There is now a need to research how to decrease the soaring numbers of children developing obesity, pre-diabetes, and diabetes DOC News, (2006). Aim of the study is to illustrate the impact of overweight and obesity on fasting blood glucose level and lipid profile among children, to test for the presence of insulin resistance among those with glucose and lipid disorders and to clarify the association between overweight, obesity in one hand and physical inactivity and bad dietary habits on the other hand.

METHODOLOGY

Data Source

Sample design, selection and size: Ethical approval was obtained from the research Ethics committee of the General Organization for Teaching Hospitals and Institutes. Cross-sectional observational study included 200 child whom screened for plasma glucose, lipid profile and insulin abnormalities They attended the outpatient pediatric clinics of National Nutrition Institute (NNI) for duration of 6 months throughout the year 2009.

Inclusion Criteria

- General good health
- Ages eligible for Study: 2 Years - 12 Years
- Genders eligible for Study: Both
- Acceptance of parents

Data Forms

- **Medical assessment;**

a. Interview questionnaire for careful history taking including family history of obesity, diabetes and hypertension and pattern of physical activity.

b. General examination.

- **Anthropometric assessment**; weight in kg and height in cm were measured to the nearest 0.1 kg and 0.1 cm respectively and waist circumference measurements were recorded also. Body mass index (BMI) was calculated according to the following formula:

BMI = weight (kg) / Height (meter)^2

*BMI defined for age and sex specific, 5th to 85th percentile as normal weight, 85th - < 95th percentile as overweight and ≥ 95th percentile as obese using categories reported by **World** Health Organization (2007).

*Waist circumference measurements were recorded and defined for for age and sex specific, 10to to 90th percentile as normal values and ≥ 90th percentile as obese using categories reported by Fernandez et al, (2004).

- **Laboratory assessments;** Table (1)

a. Fasting blood glucose level (FBG) was performed using Ascensia Entrust glucometer (Bayer) and glucometerenin Trind (1969).

b. Determination of lipid profile:

- Total cholesterol (TC) using an enzymatic method with cholesterol esterase and cholesterol oxidize Allain et al, (1974).

- Triglycerides (TG) were measured using an enzymatic method with glycerol phosphate oxidize Dryer (1970).

- HDL-cholesterol were measured after precipitation of apo-B containing lipoproteins with magnesium chloride / dextran reagent using the same enzymatic method Finley (1978).

- LDL-cholesterol were calculated in plasma samples using Friedwald formula:

LDL-Cholesterol = total cholesterol – (HDL-Ch + Triglyceride/5) Friedwald et al, (1972).

c. Fasting plasma Insulin levels by ELISA procedure Templ et al, (1995).

- **Dietary assessment;**

Food intake assessed by "24 hours recall" method to obtain accurate and detailed information about food and beverage consumed by studied participants on the day before the data collection. The conversion of household measures to grams based on a prepared list of weights of different household measures. A specific food code for each item was then recorded which based on four digits; first two digits were denoting the food group and next two digits were for serial number of food item in the group. The pattern of consumption of different food items assessed using the frequency food sheet. Selected food items in the main six food groups were those known risky in terms of obesity occurrence**.**

- **Data Management:**

Dietary data; Nutrients' content of the 24-hours food intake were computed by a computer program connecting participants' dietary information to the food composition table (FCT) of National Nutrition Institute (NNI) data base developed form indexed by food coding key (2006) for cooked food NNI (2006). The nutrients' intake was compared to the recommended daily allowances "RDA" (FAO, 2000).

STATISTICAL ANALYSIS

Data management and statistical analysis of the collected data were processed using the software SPSS (statistical package for social science), version 13. Mean ± SD summarized quantitative variables and frequency and percentages were used for qualitative variables. Chi-square test pointed for significant differences among qualitative variables and used for risk estimation statistics. An OR was considered significant if it's 95% confidence interval (CI) did not include one which is signed for the reference category. A relative risk greater than one occurs when the risk of having a particular health disorder is higher among the obese than the non-obese. A relative risk < one occurs when the risk of having a particular health disorder is lower among the obese than the non-obese suggesting that obesity may be protective. Independent samples" t" test detected the significance between numerical data groups. Mann-Whitney test used to test for unpaired data not following the normal distribution. Insulin resistance among children were measured by HOMA-R; that is derived from the following equation according to Keskin et al, (2004), table (1):

HOMA-r = Insulin (μIU/ml /) X fasting glucose (mmol / l) /22.5

RESULTS

Table (1): Illustrated cut-off of FBG, Lipid parameters, Insulin and HOMA-R categories.

Table (2): Showed physical and biochemical characteristics of the studied children. BMI differed between boys and girls with significant results in the age range of 2 – to - 6 years and females had higher values. Boys to girls comparisons regarding other physical and biochemical characteristics did not vary significantly.

Table (3): Revealed Clinical, dietary, and laboratory results of studied children in relation to FPG categories showed that the prevalence of positive family history of Diabetes and prevalence of overweight and obesity were more among children with impaired FPG if compared to those with normal FPG. Lipid and lipoprotein patterns did not differ according to FPG categories. Comparing different cutoffs of HOMA-R and fasting insulin level in relation to FPG categories, it was found that both parameters were higher in prediabetics than those with normal plasma glucose.

Table (4): Showed odds Ratio (OR), confidence interval (95% CI) of having obesity in presence of positive family history of CNCD, physical inactivity and risky lipid pattern. It showed that prevalence of chronic non communicable diseases (CNCD) was higher among families of obese children than those of non-obese. Obesity, diabetes mellitus and hypertension were prevalent among families of obese children by 7 times, 3 times and 2 times their occurrences in families of non-obese children respectively. The risk for having high triglycerides and low HDL levels is more than double among obese children compared to non-obese. Physically inactive children have 7.8 times the risk for obesity compared to active

children. The risk for overweight and obese children to have high HOMA-R > 2.5 was 7.5 times compared to non-obese with significant result.

Figure (1&2): illustrated percent frequency distribution of the studied children according to Body Mass Index (BMI) categories and age and sex groups where the overall percentage of overweight and obesity children was 43.3% with higher values in older age group and girls.

Figure (3): Revealed Percent frequency distribution of studied children having risky categories of fasting blood glucose, HOMA – R and lipid components according to (underweight & normal) and (overweight & obese) categories of BMI. Results showed significant high percentages among obese as regards prediabetes state and insulin resistance reflected by HOMA- R. Lipid and lipoprotein patterns did not differ significantly between obese and normal weight children.

Figure (4): Showed Percent frequency distribution of studied children with unhealthy Lifestyle and risky dietary factors according to (underweight & normal) and (overweight & obese) categories of BMI. It shows that physical inactivity was linked to BMI significantly. Only about 14.5% of children with normal BMI compared to 27.7 % of obese children were consuming artificial milk. Nearly 63 % of the children consuming 2 snacks per day. The consumption of unhealthy snacks was higher than vegetables and fruits regardless of BMI. Sweets & ships where consumed on daily basis by about 2/3 of the studied students.

Discussion: Obesity in children has been related with comorbid conditions being an important risk factor in adult morbidity and mortality. Obesity refers to excess adiposity rather than excess weight, and body mass index (BMI) is a

measure for adiposity Myrta and Lourdes et al. (2008). The higher the BMI during childhood, the more likely adult obesity will manifest. Children and adolescents with BMI ≥ the 95th percentile have a 62–98% chance of being obese at 35 years of age Guo et al (2002). This present study revealed that an average girls had higher BMI than boys with significant difference in the younger age group table (2). HK Blomquist and E Bergström (2006) reported similar results as he stated that Overweight and obesity in pre-school children in Sweden is more prevalent in girls than in boys. In contrast, Lluis et al (2006) reported that obesity was significantly higher in Spanish boys than in girls between 6 and 13 years of age. This may me related to different socio-cultural factors that influence the lifestyle behaviors of both sexes.

There is solid information showing that type 2 diabetes and risky factors for CVD have increased in children, particularly the obese Pedro et al., (2005). The early onset of type 2 diabetes suggests that these patients will be at risk for the development of cardiovascular disease at a young age. If the secular trend seen with increasing prevalence and severity of obesity in childhood and adolescence continues, it is likely that the problem of type 2 diabetes also will increase in the pediatric age group Fagot et al, (1998). Current study revealed significant high percentages of prediabetes state and insulin resistance reflected by HOMA- R among obese children compared to those with normal weight and lipid and lipoprotein patterns showed a trend toward higher values among obese Figure (3). This goes with Julia et al (2003) who reported that in a study of 122 children, obese individuals were significantly more insulin resistant and had an abnormal lipid profile when compared with lean subjects. They stated also that insulin resistance was significantly related to an abnormal lipid profile in heavy children but not in thin children, and insulin resistance varied directly with the degree of adiposity. Eckel

et al (2002) stated that adipose tissue is a metabolically active endocrine organ producing a large number of hormones, peptides, and small molecules that affect metabolism and cardiovascular regulation, these include inflammatory cytokines, thrombotic and inflammatory markers, and vasoactive substances that contribute directly or indirectly to changes in vasculature and CVD. However, not all overweight children have the same risk of developing these complications. Appropriate risk stratification could guide clinicians to recognize overweight children who are at higher risk of developing type 2 diabetes or CVD and lead to prompt intervention. Stratification of children based on severity of overweight, estimates of insulin resistance and cardiovascular risk profile may be useful for the longitudinal follow-up of overweight children . Sedentary lifestyle, duration of overweight, and underlying conditions are major determinants of risk for type 2 diabetes and cardiovascular disease (CVD) Pedro et al., (2005). Patients with type 2 diabetes often have other risk factors for cardiovascular disease. The prevalence of hypertriglyceridemia has ranged from 4% to 32% Fagot et al (2000). Because type 2 diabetes is a relatively recent problem in children, few data on long-term follow-up exist. One study of Pima Indians monitored 36 individuals with type 2 diabetes for a mean of 10 years until they reached a median age of 26 years. In this cohort, at baseline (age 5 to 19 years), 85% were obese, 14% had hypertension, 30% had total cholesterol >200 mg/dL, and 55% had triglyceride concentrations >200 mg/dL. Thus, these patients have a constellation of risk factors that place them at increased risk of cardiovascular disease at an early age Julia et al (2003). Simple methods of assessing insulin sensitivity and secretion are important in the evaluation and follow-up of children with obesity and risk factors for type 2 diabetes Gungor (2004). Although studies link childhood obesity to cardiovascular risk factors that predict CVD, screening is not routinely performed in obese youth. Recommended

screening for cardiovascular risk factors in obese youth includes measurement of fasting insulin and glucose, and traditional lipoprotein analysis Freedman (2002) & Freedman (2001). Table 3 showed that Prediabetics were more likely to have BMI > 85th, high fasting insulin and insulin resistance state. The high the cut- off points for HOMA, the higher is the risk. Results also demonstrated that the presence of positive family history of Diabetes was more among children with impaired FPG if compared to those with normal FPG while Lipid and lipoprotein patterns did not differ significantly according to FPG categories. Rodríguez et al, (2010) conducted a population-based cross-sectional study on children and reported that that the presence of FHD in a first degree relative is associated with IFG, even in the absence of obesity.

Atherosclerotic cardiovascular disease is the number one killer in the adult population of Western societies, but the pathological processes and risk factors associated with its development have been shown to begin during childhood. Obesity plays a central role in the insulin resistance syndrome, which includes hyperinsulinemia, hypertension, hyperlipidemia, type 2 diabetes mellitus, and an increased risk of atherosclerotic cardiovascular disease Julia et al (2003). Table 4 showed that The risk for overweight and obese children to have high TG and low HDL-c was 2.4 times and their risk for having high HOMA-R > 2.5 was 7.5 times compared to non-obese with statistically significant results. Investigators from the Bogalusa Heart Study reported that overweight schoolchildren, in comparison with their lean counterparts, were 2.4 to 7.1 times more likely to have elevated total cholesterol, LDL cholesterol, and triglycerides, and 12.6 times more likely to have hyperinsulinemia Freedman et al,(1999). Julia et al (2003) reported that the association between obesity and dyslipidemia observed in adults also has been documented in children and adolescents. In the Lipid Research Clinics Population Studies

Data Book, obese adolescents had an abnormal "atherogenic" lipid profile consisting of elevated LDL cholesterol and triglycerides and low HDL cholesterol. In more recent studies in children, insulin resistance was also implicated in the association between obesity and dyslipidemia. In a study of insulin resistance and lipids that compared 82 normoglycemic, obese adolescents with 40 lean adolescents, abnormalities consistent with an atherogenic lipid profile were present in the obese subjects. The dyslipidemia correlated with the degree of insulin resistance in the obese children, and it was shown that the degree of insulin resistance explained a significant portion of the variance in the levels of triglycerides, LDL cholesterol, and HDL cholesterol Steinberger et al, (1995).

Homoeostasis model assessment (HOMA) index could be a useful tool to detect children and adolescents with the metabolic syndrome Tresaco et al, (2005). HOMA that has attracted the most attention since it only requires fasting glycemia and insulinemia samples Sinaiko et al, (2007). HOMA index is an attempt to demonstrate the relationship between pancreatic insulin production capacity and the ability to maintain adequate glycemic levels. Within the pediatric age group, however, HOMA provides less information because, during this phase, hyperglycemia rarely occurs. This being so, it appears that nowadays there is consensus that fasting insulinemia is a reliable parameter and adequate for assessing Insulin resistance (IR) in children; however, the ideal cutoff points are not yet known Carlos et al, (2008). There is no consensus on cutoff points for HOMA indices in childhood and adolescence. The figure that is most widely stated as a cutoff point for HOMA index is 3.45 Garcia et al, (2007). However, other authors have also suggested values such as 2.5, da Silva et al , (2005), and 3.8 Barja et al (2003) among others. Insulin resistance was defined by Reinehr et al (2004) as a HOMA value of >4 for adolescents. One thing that can be observed is that, a fixed cutoff point

appears to be highly inadequate, considering a significant variation between different age groups in at least two of the five age bands studied. Isabel et al, (2008) stated that HOMA- IR may be useful to detect MS and the cut-off 2.5 seems to be the best in obese and overweight pre-pubertal children. The present study also demonstrated similar result as it found that the best HOMA cutoff point for diagnosis of insulin resistance and cardiovascular risk was 2.5 table (4). However Tresaco et al, (2005) found that HOMA cut-off values need to be defined in the paediatric population; near to 3 seem to be adequate.

Obesity is a multifactorial disorder, The most important environmental factors that is associated with obesity include the energy intake in relation to the need, and physical activity. The identification of risk factors in early childhood may allow early targeted interventions Elisabeth et al (2010). Figure (4) Showed percent frequency distribution of Lifestyle and dietary risky factors among studied children with normal and obese BMI categories. Proportion of obesity was higher among physically inactive children and those who were consuming frequent (3 per day) unhealthy snacks (chips) and inadequate intake of vegetables and fruits with statistical significant results. Aewha (2007) who were conducted a cross-sectional study of 799 school children reported nearly similar results as he found that frequent snacking, inadequate vegetable consumption, and sedentary lifestyle increased significantly the likelihood of obesity in children, which suggest that obesity intervention in this age group should focus more on those variables. These results also were consistent with other studies showing positive correlation between physical inactivity and obesity in children (Andersen, 1998; Crespo, 2001; Epstein, 2001; Lowry, 2002). Data from the National Health and Nutrition Examination Survey (NHANES) III revealed that children who had physical inactivity 4 or more hours each day were most likely to be obese (Andersen, 1998).

Lee et al. (2000) suggested that television viewing contributes to the development of overweight among children by reducing opportunities to engage in physical activity and increasing opportunities for snacking. In conclusions: High BMI predisposes children to many of the medical complications of obesity found in adults, in particular components of insulin resistance syndrome: High HOMA –IR, dyslipidemia, and impaired glucose metabolism. As these children age, the obesity epidemic will lead to epidemics of diabetes and CVD. Health care providers of overweight children need to pursue efficient screening procedures earlier in the progression of overweight in order to prevent children from developing type 2 DM and cardiovascular diseases. Future investigations are needed to assess these urgent areas of Egyptian children health status and formulate effective interventions.

BIOGRAPHY

Dr. Nebal Abdel Rahman Aboul Ella obtained a Master in Pediatrics, Faculty of Medicine, Cairo University and PhD in Medical Childhood Studies, Department of Medical Studies, Ain Shams University.Currently, she is an Associate Professor in the Department of Clinical Nutrition in National Nutrition Institute (NNI), General Organization of Teaching Hospitals and Institutes, Ministry of Health, Cairo, Egypt and Administrator of NNI website www.nni.org.eg and Middle East and North Africa Nutrition Association (MENANA) website www.menana.net. She was the Co-principal Investigator in National Egyptian Survey about diet, nutrition and prevention of chronic non-communicable diseases among Egyptian adolescents.

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Parameters	Categories	Cut - offs
Fasting blood glucose:*		
	Normal	<100mg/dl
	Pre-diabetic	≥100-125mg/dl
	Diabetic	≥126mg/dl
Lipid:**		
Total cholesterol:		
	Acceptable	< 170 mg/dl
	Borderline	170-199 mg/dl
	High	≥200 mg/dl
LDL-cholesterol:		
	Acceptable	< 110 mg/dl
	Borderline	110-129 mg/dl
	High	≥130 mg/dl
HDL-cholesterol:		
	Acceptable	≥35 mg/dl
	Low	<35 mg/dl
Triglycerides:		
	Acceptable	≤150 mg/dl
	High	>150 mg/dl
Insulin:***		
	Low	< 7.7 µIU/ml
	Normal	7.7-20 µIU/ml
	High	> 20 µIU/ml
HOMA-R: ****** (high insulin resistance)		>2,5[1] >3,16[2] >4,0[3]

* ADA, 2003
** NCEP, 1993
***Temple et al., (1995)
**** Isabel et al, (2008) [1], Tresaco et al , (2005) [2] and Reinehr et al (2004) [3]

Table (1): Categories of fasting plasma glucose, lipid parameters, insulin and HOMA-R for children.

Parameter	2- < 6 years		≥ 6 -12 years	
	Boys	Girls	Boys	Girls
BMI (kg/m2)				
Median	16.0	16.9	17.5	18.8
25 to 75 quartiles	14.9-19.0	15.7-22.8	14.8-26.8	15.5-26
M- W test*	0.054		N.S.	
Waist circumference (cm)				
Median	52.0	53.3	59.0	62.0
25 to 75 quartiles	47.3-56.5	48.1-59.6	54.0-79.0	53.4-78.8
M- W test*	N.S.		N.S.	
FBS (mg/dl)				
Median	90.0	93.0	90.0	90.0
25 to 75 quartiles	85.8 - 96.5	87-99	86.3-96.5	86-97.5
M- W test*	N.S.		N.S.	
Insulin (mg/dl)				
Median	7.8	7.6	8.1	8.2
25 to 75 quartiles	3.8-14.7	3.7- 11.5	4.7-14.0	5.3 -13.1
M- W test*	N.S.		N.S.	
Total Cholesterol (mg/dl)				
Median	142.0	136.0	145.0	148.5
25 to 75 quartiles	122.0-162.0	124.3-162.3	126.0-178.0	127.8-168.5
M- W test*	N.S.		N.S.	
HDL-C (mg/dl)				
Median	41.0	37.1	42	44
25 to 75 quartiles	34.0-51.0	31.3-48.0	34.8-52.0	36.0-51.3
M- W test*	N.S.		N.S.	
LDL-C (mg/dl)				
Median	85.6	86.9	88.9	88.6
25 to 75 quartiles	63.6-100.0	75.4-107.5	69.4-118.0	69.1-112.6
M- W test*	N.S.		N.S.	
TG (mg/dl)				
Median	67.0	55.0	65.5	76.0
25 to 75 quartiles	55.0-86.0	46.0-81.5	50.0-85.0	50.5-87.3
M- W test*	N.S.		N.S.	

M- W test*= Mann-Whitney test

N.S. = Not-significant

Table (2): Anthropometric and biochemical characteristics of the studied children according to age and sex.

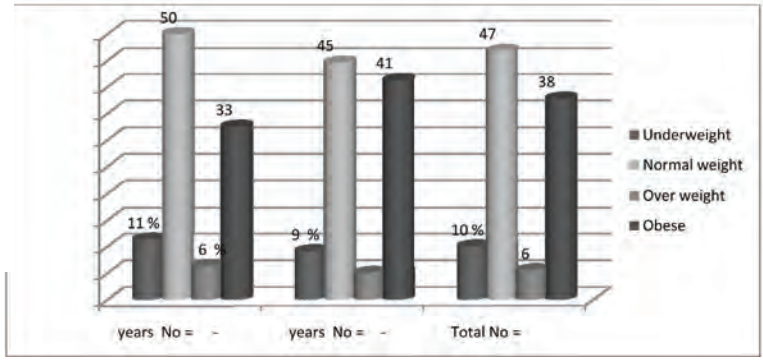

Figure (1):
Percent frequency distribution of the studied children based on categories of Body Mass Index (BMI) and Age.

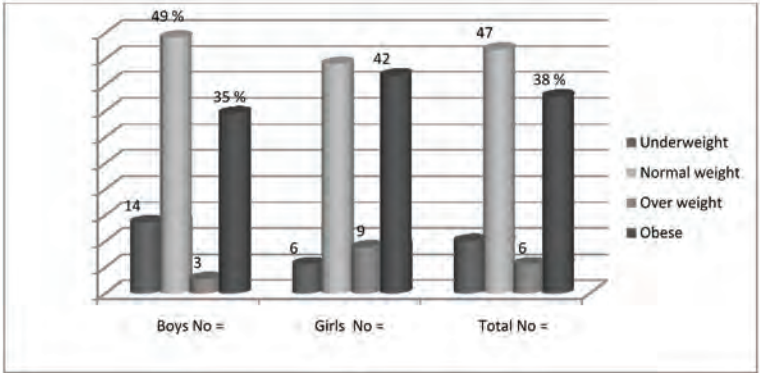

Figure (2):
Percent frequency distribution of the studied children based on categories of Body Mass Index (BMI) and Sex.

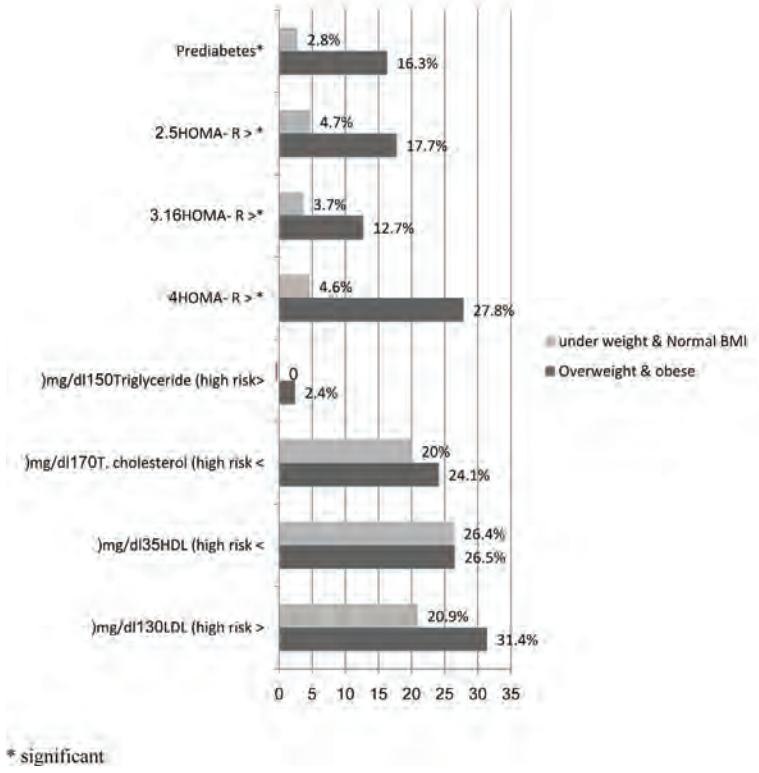

Figure (3): Percent frequency distribution of studied children having risky categories of fasting blood glucose, HOMA –R and lipid components according to (underweight & normal) and (overweight & obese) categories of BMI.

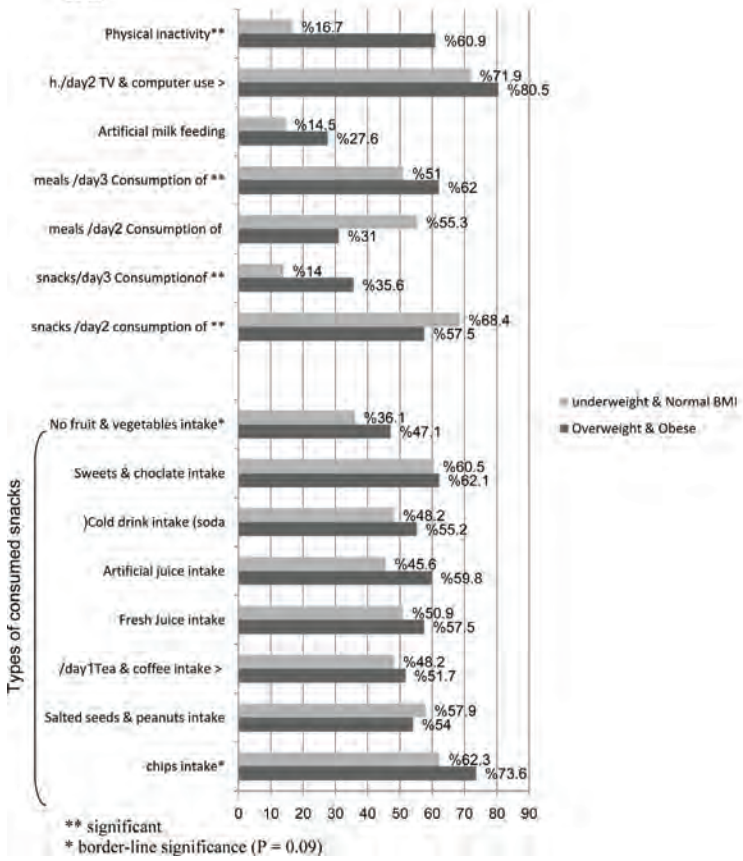

Figure (4):
Percent frequency distribution of studied children with unhealthy Lifestyle and risky dietary factors according to (underweight & normal) and (overweight & obese) categories of BMI.

	Normal FBG		Pre-diabetics	
	%	Total No	%	Total No
Family history:				
Obesity	45.7	(184)	56.3	(16)
DM	37.6	(184)	68.8*	(16)
Hypertension	32.4	(184)	37.5	(16)
History of chronic use of corticosteroids	9.2	(184)	25.0	(16)
Anthropometric data:				
BMI ($\geq 85^{th}$ Percentile)	36.6	(184)	81.3*	(16)
Waist ($\geq 90^{th}$ Percentile)	23.8	(184)	50.0	(16)
Environmental factors:				
Kcal/ day >= 100 % RDA	21.4	(184)	18.8	(16)
Energy from fat > 30%	42.2	(184)	37.5	(16)
No physical activity	34.7	(184)	56.3	(16)
Laboratory data:				
Lipid profile:				
TC (> 170 mg /dl)	23.1	(184)	12.5	(16)
TG (> 150 mg /dl)	1.2	(184)	0.0	(16)
LDL-C (> 130 mg /dl)	25.4	(184)	18.8	(16)
HDL-C (<= 35 mg /dl)	26.0	(184)	31.3	(16)
Fasting insulin level :				
High (≥20 µIU/ml)	9.9	(184)	37.5*	(16)
HOMA-R:				
HOMA-R (>2.5)	11.6	(184)	6.3*	(16)
HOMA-R (>3.16)	7.0	(184)	12.5*	(16)
HOMA-R (>4.0)	11.6	(184)	50.0*	(16)

* significant

Table (3): Clinical, dietary, and laboratory results of studied children in relation to FPG categories.

	Overall adiposity (BMI> 85 percentile)	
	OR	95% CI
Family history :		
Obesity	6.9 *	(3.7-12.8)
DM	2.7 *	(1.6-5.9)
Hypertension	2.1 *	(1.1-3.9)
Environmental factors:		
No physical activity	7.8*	(0.4-14.9)
Energy from fat > 30%	1.3	(0.7-2.3)
Laboratory data:		
Lipid profile:		
TC (> 150 mg /dl)	1.3	(0.7-2.3)
TG (> 150 mg /dl)	2.4*	(2.0 -2.8)
LDL-C (> 130 mg /dl)	1.7	(0.7-3.9)
HDL-C (> 35 mg /dl)	2.4*	(2.0-2.8)
HOMA-R (>2.5)	7.5*	(3.8-14.8)
HOMA-R (>3.16)	7.5*	(3.3-16.9)
HOMA-R (>4)	7.95*	(2.9-22.1)

* significant

CNCD: chronic non- communicable diseases

Table (4):
Odds Ratio (OR), confidence interval (95% CI) of having obesity in presence of positive family history of CNCD, physical inactivity and risky lipid pattern.