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Association between Anthropometric Parameters and Cardio-Metabolic Disease Risk Factors Among Obese Children and Adolescents

Nayera E Hassan[1], Sahar A El-Masry[1], Nadia L Soliman[2], Mona M El-Batran[2], Muhammad Al-Tohamy[1], Salwa R El-Batrawy[1], Mehrevan M Abd El-moniem[3]

[1]Biological Anthropology Department, Medical Research Division, National Research Centre, El-Bohooth St., Dokki, Giza, Cairo 12622, Egypt; [2]Oral and Dental Medicine Dept., Dental Division, National Research Centre, El-Bohooth St., Dokki, Giza, Cairo 12622, Egypt; [3]Medical Biochemistry Dept., Medical Research Division, National Research Centre, Dokki, Giza, Egypt

Abstract

Background: Childhood obesity increases risk for developing cardio-metabolic diseases.

Objectives: to investigate the relation of some anthropometric parameters with cardio-metabolic disease risk factors in obese children and adolescents.

Subjects and Methods: Cross sectional study, comprised of 139 obese pupils; aged 8 to 16 years (classified to 3 age groups). Each pupil underwent complete physical examination, anthropometric and laboratory assessment (fasting blood sugar and lipid profile).

Results: Boys had significantly higher values of abdominal skin fold thickness in the age groups II and III and in central adiposity, waist circumference, waist/hip ratio and sub scapular skin fold thickness in adolescents. For boys, fasting blood sugar correlated with most of the anthropometric measurements in young age, and with skinfold thickness in the three age groups. While lipid profile correlated with skinfold thickness particularly at subscapular area in the age groups I and II. For girls, none of the parameters under study showed any significant correlation except subscapular skinfold thickness which had significant correlations with lipid profile in age groups I and II.

Conclusion: Skin fold thickness particularly subscapular; is important indicator for cardio-metabolic complications in obese children of both sexes. Obese boys are more liable to cardio-metabolic complications.

Introduction

Obesity is a serious global public health problem [1-3]. Concern for children and adolescents, data from NHANEs survey (1976-1980 and 2003-2006) showed that the prevalence of obesity has increased for children aged 6-11 years from 6.5% to 17%, and for those aged 12-19 years, the prevalence has increased from 5% to 17.6% [1, 4].

It has been widely accepted that obese children and adolescents are at risk for health problems during their youth and adults, i.e. they are more likely to have risk factors associated with cardio-metabolic diseases such as high blood pressure, high cholesterol, and type II diabetes than other healthy, wellbeing children and adolescents [3, 5-8].

Nowadays, obesity is not only of the major causes of life threatening diseases in Western Societies,

but also, it has become one of the most important health problems in developing countries [9].

In 1998, The World Health Organization (WHO) defined obesity as a condition with excessive fat accumulation in the body, to the extent that health and wellbeing are adversely affected [8].

However, some studies in adults and fewer in children showed the associations between obesity with cardio-metabolic risk factors, such as dyslipidaemia, high blood sugar and high blood pressure [10]. Body mass index (BMI) is usually used to detect obesity although it can't distinguish fat from muscle mass. Waist Circumferences (WC) and waist-to-hip ratio (WHR) are other indices to measure obesity, especially upper abdominal fat distribution (visceral obesity). Despite several publications on the relation between anthropometric markers and lipid profile, the best anthropometric index of fat location remains controversial [5, 11].

There is a large body of evidence that obesity related diseases including its cardiovascular consequences begins in childhood [4]. Thus identifying high risk children for targeted interventions is needed. Moreover, there is a large number of questions remain to be answered.

This study focuses to investigate the relation of some anthropometric parameters with cardio-metabolic disease risk factors in obese children and adolescents.

Subjects and Methods

Data of this cross-sectional study was obtained from 5798 children and adolescents (2655 boys and 3143 girls), aged from 7-18 years, affiliated to 6 public schools in Giza Governorate (2 primary, 2 preparatory and 2 secondary schools) during the period of October, 2007 to April 2009. Permission to perform the study was granted by the "Ethical Committee" of the "National Research Centre", the Ministry of Education, and the directors of the school included in the research. A local consultation with the directors of schools was done for any concerns and ethical issues of the research. Parents were informed about the purpose of the study and their permission in the form of written consent was obtained. Verbal assent was obtained from children and adolescents to be involved in this research.

Of the total sample, those with the complaint of obesity were four hundred and sixty-two students only

(8.0%); 174 boys and 288 girls; their mean age was 13.43+2.65 years. Parental informed consent to do lab investigations were obtained only from one hundred and thirty nine pupils (70 boys and 69 girls), with the complaint of obesity. These pupils were required to meet the following inclusion criteria: age, 8-16 years and BMI, greater than the 95th percentile for age and gender based on the Egyptian Growth Reference Charts [12]. These charts group the children every 6 months interval (e.g. 7.25, 7.75, 8.25 years) from 2 years up to 21 years of age. Subjects were excluded from this study for any obvious mentally retarded diseases or those cases suffering from chronic diseases and drug use, or abnormal signs compatible with syndrome obesity. The sample was divided into 3 groups according to their age:

1. group (I): included 27 pupils (16 boys and 11 girls) aged 8-10 years + 6 months;

2. group (II): included 62 pupils (29 boys and 33 girls) aged 11 -13 years + 6 months; and

3. group (III): included 50 pupils (25 boys and 25 girls) aged 14 -16 years + 6 months.

Each pupil underwent a complete physical examination; including anthropometric measurements (body weight "Wt.", body height "Ht.", waist and hip circumferences and skin fold thickness at triceps, biceps, subscapular, abdominal and suprailiac areas.

Anthropometric measurements: Body height was measured to the nearest 0.1 cm using a Holtain portable anthropometer. Body weight was determined to the nearest 0.01 kg using a Seca scale Balance with the subject dressed minimum clothes and no shoes. Waist circumference was measured at the level of the umbilicus with pupil standing and breathing normally, hip circumference at the level of the iliac crest, using nonstretchable plastic tape to the nearest 0.1 cm. Skin fold thickness at the five sites was measured at left side of the body using Harpender Tanner-White house Holtain skin fold caliper to the nearest 0.2mm. Each measurement was taken; by well-trained researcher and another one assisted to him; as the mean of three consecutive measurements, using standardized equipments and following the recommendations of International Biological Program [13].

The following indices were calculated:

1. Body mass index (BMI): as weight (in kilograms) divided by height (in meters) squared;

2. Waist/ Hip ratio (cm/ cm);

3. Peripheral obesity: as the sum of triceps and biceps skinfold thickness;

4. Central obesity: as the sum of sub scapular, suprailiac and abdominal skinfold thickness.

Laboratory data: Venous blood samples were obtained to measure plasma glucose level and lipid profile in the morning by venipuncture after after 12-hours overnight fasting. Professional staff performed venipuncture. The blood samples were left to clot; sera were separated by centrifugation for 10 minutes at 5000 rpm then stored at –80ºC until assays. Plasma glucose was determined by the glucose oxidase method. Plasma concentrations of total cholesterol [14], triglycerides [15], and high-density lipoprotein-cholesterol (HDL-C) [16] were measured using commercially available kits provided by STANBIO Laboratory Inc.(1261 North Main Street Boerne Texas 78006 USA). LDL-C was calculated according to an equation developed by Friedewald et al., [17] as follows:

LDL-C= Total cholesterol –Triglycerides/5+ HDL-C.

Statistical Analysis: Data was examined for normal distribution using "One-Sample Kolmogorov-Smirnov Test". All the anthropometric and laboratory parameters were normally distributed (p< 0.05, and SD < 25% of the mean value) except waist circumference and waist/hip ratio in age groups II and III (p>0.05). Statistical evaluation of the results was performed with the SPSS version 9.05 computer programs. All values are reported as the mean ± SD. Sex differences were examined using "Student's *t- test* "in case of normal distributed data and "Mann-Whitney Test" in case of data not normally distributed. Pearson´s correlation coefficients were used to measure the degree of association between anthropometric parameters and lipid profile in both gender and in all age groups in case of normally distributed data, while Spearman's correlation coefficients were used in case of data not normally distributed. The level of significance was set at a probability of less than 5% (p<0.05).

Results

The total sample included 139 pupils, 50.4% were boys (n: 70) and 49.6% were girls (n: 69). Descriptive data for the anthropometric parameters, fasting blood glucose and lipid profile for boys and girls are shown in Tables 1-3. Analyses of the pupils of group (I) aged 8 -10 years ± 6 months (Table 1) revealed significant gender differences in some anthropometric

Table 1: Anthropometric characteristics and laboratory data of the group (I) by sex (Age 8-10 ± 6 months).

Parameters	Boys (N = 16)		Girls (N = 11)		p
	Mean	+SD	Mean	+SD	
Weight (Kg)	45.0000	4.7889	52.5455	7.2679	0.003**
Height (cm)	134.0250	4.2246	139.4636	8.9769	0.084
BMI (Kg/cm²)	24.9648	1.0822	26.9341	1.8743	0.007**
Waist C (cm)	76.3250	4.6426	76.9273	4.0655	0.731
Hip C (cm)	86.8500	4.9280	91.5091	6.0855	0.038*
Waist/Hip ratio	.8787	0.01	.8423	0.04	0.023*
Skinfold (mm)					
Triceps	26.2500	4.973	26.0091	5.489	0.907
Biceps	20.0000	2.633	18.0000	5.300	0.267
Subscaular	23.2500	1.5275	27.0727	5.4172	0.043*
Suprailiac	25.7500	3.8902	26.5818	5.7803	0.658
Abdominal	27.8500	4.3534	25.0727	6.9950	0.214
Peripheral fat	46.2500	6.6282	44.0091	7.0456	0.408
Central fat	76.8500	7.4596	78.7273	16.5460	0.730
Laboratory data					
Fasting Bl. sugar	104.7500	5.904	90.3818	28.718	0.131
TG	110.6872	17.4436	138.6564	37.8269	0.039*
TC	201.3075	40.5578	161.1460	40.9913	0.019*
HDL-C	30.1595	12.8451	44.8783	19.2251	0.027*
LDL-C	148.8295	41.1653	86.0085	48.9964	0.002**

N.B.: *p< 0.05= Significant differences. **p<0.01= highly significant differences. Comparisons done using t-test as all the parameter are normally distributed.

measurements and all lipid profile parameters. Girls had significantly higher mean values of body weight, BMI, hip circumference, sub scapular skinfold thickness, high triglycrides and HDL-C within normal range (p<0.05) than boys, while waist/ hip ratio, high LDL-C and total cholesterol were significantly higher in boys. While in group (II) aged 11-13 years ± 6 months (Table 2), girls

Table 2: Anthropometric characteristics and laboratory data of the group (II) by sex (Age 11 -13 ± 6 months).

Parameters	Boys (N = 29)		Girls (N = 33)		p
	Mean	+SD	Mean	+SD	
Weight (Kg)†	67.2241	11.4963	74.2455	9.3644	0.010**
Height (cm)†	150.1552	8.6072	154.3485	6.7412	0.036*
BMI (Kg/cm²)†	29.5513	2.3308	31.0713	2.6301	0.020*
Waist C (cm)‡	87.5172	11.7035	95.0909	23.9576	0.927
Hip C (cm)‡	101.1724	8.3967	102.4545	10.3478	0.597
Waist/Hip ratio‡	.8617	0.05	.9556	.3637	0.076
Skinfold (mm)					
Triceps†	27.1071	4.969	26.7839	6.267	0.828
Biceps†	19.9071	6.349	17.4710	5.772	0.128
Subscaular†	26.0214	5.6046	27.6065	5.3969	0.273
Suprailiac†	25.3500	5.5347	26.8097	6.8729	0.376
Abdominal†	29.5500	5.9700	25.4677	6.1576	0.012*
Peripheral fat†	47.0143	10.6482	44.2548	10.8239	0.329
Central fat†	80.9214	14.2400	79.8839	14.7713	0.785
Laboratory data					
Fasting Bl. sugar†	98.6621	15.888	100.5455	11.437	0.599
TG†	136.4539	34.2146	144.6530	44.8485	0.432
TC†	179.9251	63.5769	189.5879	58.5681	0.539
HDL-C†	41.7939	11.8665	34.8089	21.9199	0.125
LDL-C†	112.5897	61.9323	129.5482	56.0266	0.266

N.B.:*p< 0.05= Significant differences. † Comparisons done using t-testt as the parameter is normally distributed. ‡Comparisons done using Mann-Whitney Test as the parameter is not normally distributed.

had significant gender differences for body weight, height and BMI. While boys had significantly higher values of abdominal skin fold thickness than girls. Group III aged 14-16 years ± 6 months (Table 3) showed significant

Table 3: Anthropometric characteristics and laboratory data of the group (III) by sex (Age 14-16 ± 6 months).

Parameters	Boys (N = 25)		Girls (N = 25)		p
	Mean	+SD	Mean	+SD	
Weight (Kg)†	89.9680	12.1175	88.1560	10.5521	0.575
Height (cm)†	166.5640	9.4539	160.4400	8.3530	0.019*
BMI (Kg/cm²)†	32.3639	2.8282	34.2464	3.3732	0.038*
Waist C (cm)‡	104.9200	14.9033	91.6476	7.0508	0.000**
Hip C (cm)†	114.6120	9.4225	111.6667	9.2256	0.292
Waist/Hip ratio‡	.9192	.1421	.8231	0.05	0.000**
Skinfold (mm)					
Triceps†	26.9476	6.376	27.3480	8.155	0.856
Biceps†	21.2429	8.300	22.0880	7.470	0.718
Subscaular†	33.2524	6.4419	30.5800	8.3438	0.238
Suprailiac†	29.9000	10.1188	23.1200	7.6666	0.016*
Abdominal†	36.8333	7.5565	24.4800	7.6369	0.000**
Peripheral fat†	48.1905	12.8845	49.4360	14.4761	0.761
Central fat†	99.9857	19.1086	78.1800	21.2930	0.001**
Laboratory data					
FBS†	94.7160	15.285	83.4160	12.925	0.007**
TG†	132.1809	71.4628	143.4132	69.5784	0.576
TC†	173.8990	56.0588	174.7620	61.3258	0.959
HDL-C†	43.7640	17.3949	59.1586	32.7036	0.044*
LDL-C†	102.0242	58.1636	85.8683	65.6661	0.366

N.B.:*p< 0.05= Significant differences. **p<0.01= highly significant differences. † Comparisons done using t-testt as the parameter is normally distributed. ‡Comparisons done using Mann-Whitney Test as the parameter is not normally distributed.

gender differences for body height, waist circumference, waist/ hip ratio, suprailiac and abdominal skin fold thicknesses, central adiposity and fasting blood sugar where boys had the higher values. While girls had significant higher value of BMI and HDL-C. It was obvious that boys had significant tendency for increase in the anthropometric parameters indicating central obesity with increase in age, inspite of having high LDL-C and low HDL-C in young age only. While girls had significant higher values of BMI in the three age groups.

Correlation of fasting blood sugar and lipid profiles and the anthropometric measurements for all groups by gender are presented in tables 4 and 5. For boys (Table 4), fasting blood sugar showed significant strong positive correlations with weight, BMI, waist circumference, hip circumference, triceps and subscapular skinfold thicknesses in group (I) aged 8-10 years . While in both groups II and III, fasting blood sugar had significant negative correlations with biceps and suprailiac skinfold thickness. Moreover, fasting blood sugar had significant negative correlations with abdominal skinfold thickness in second group, and with hip circumference, peripheral and central fat in the third group. Triglycerides had significant negative correlations with subscapular skinfold thickness in the first group, and with biceps skinfold thickness in the third group. Inspite of that, it had significant positive correlations with triceps, subscapular, suprailiac skinfold thickness and central fat in second group. Total cholesterol had significant negative correlations with waist/hip ratio and subscapular skinfold thickness in the first group, and with triceps and suprailiac skinfold thickness in the second group. HDL-C had significant negative correlations with biceps and abdominal skinfold thickness and peripheral and central fat in both first and second groups only. While LDL-C had significant negative correlations with subscapular skinfold thickness in first group, and positive one in second group.

For girls (Table 5), in group I (8–10 years), triglyceride had significant positive correlation with waist circumference and subscapular skinfold thickness. For group (II) aged 11-13 years ± 6 months, none of the parameters under study showed any significant correlation except HDL-C which had significant negative correlations with subscapular skinfold thickness. Group III aged 14-16 years ± 6 months, fasting blood sugar only had significant positive correlation with BMI.

It was obvious that for boys, fasting blood sugar correlated with most of the anthropometric measurements

Table 4: Correlations of anthropometric indices with laboratory data of obese boys.

	Group I 8 - 10 y (n = 16)					Group II 11 – 13 y (n =29)					Group III 14 – 16 y(n= 25)				
	FBS	TG	TC	HDL-C	LDL-C	FBS	TG	TC	HDL-C	LDL-C	FBS	TG	TC	HDL-C	LDL-C
Anthropometry															
Weight (Kg)†	0.783**	-.061	-.055	.169	-.093	.269	.164	-.012	-.086	.001	-.239	.036	-.089	-.117	.020
BMI (Kg/cm²)†	0.760**	-.034	-.020	.151	-.059	.023	.122	-.237	-.241	-.207	-.342	-.130	-.333	.057	-.269
Waist C (cm)‡	0.893**	-.211	-.399	.546*	-.538*	.124	.040	-.002	-.116	.060	-.136	-.336	-.342	-.007	-.220
Hip C (cm)†	0.904**	-.215	-.305	.349	-.385	.094	.349	.120	-.414*	.188	-.507**	-.327	-.248	.020	-.289
Waist/Hip ratio‡	0.251	-.085	-.500*	.881**	-.755**	.320	.114	.204	-.078	.239	.313	.198	-.033	-.061	.101
Skinfold (mm)															
Triceps†	0.556*	.050	.208	-.166	.254	-.128	.522**	.417*	-.203	.410*	-.399	.032	.067	.055	.169
Biceps†	0.017	-.288	.144	-.949**	.459	-.455*	.231	.189	-.495**	.275	-.601**	-.457*	.232	.244	.142
Subscaular†	0.983**	-.728**	-.790**	.175	-.764**	.172	.384*	.338	-.335	.382*	-.411	-.286	-.023	.004	.071
Suprailiac†	0.357	.294	.440	-.127	.449	-.428*	.563**	.418*	-.346	.431*	-.463*	-.060	.056	.114	-.003
Abdominal†	0.040	-.234	.194	-.919**	.494	-.550**	.379	-.061	-.680**	.010	-.253	-.292	.068	.007	.151
Peripheral fat†	0.424	-.077	.213	-.501*	.373	-.331	.380	.306	-.389*	.356	-.584**	-.278	.182	.184	.175
Central fat†	0.411	-.132	.181	-.567*	.366	-.329	.515**	.264	-.534**	.322	-.484*	-.244	.049	.064	.082

N.B.:*p< 0.05= Significant differences. **p<0.01= highly significant differences. † Pearson s correlation was used as the parameter is normally distributed. ‡Spearman correlation was used as the parameter is not normally distributed.

Table 5: Correlations of anthropometric indices with laboratory data of obese girls.

	Group I 8 -10 y (n = 11)					Group II 11 - 13 y (n =33)					Group III 14 – 16 y(n= 25)				
	FBS	TG	TC	HDL-C	LDL-C	FBS	TG	TC	HDL-C	LDL-C	FBS	TG	TC	HDL-C	LDL-C
Anthropometry															
Weight (Kg)†	.173	.253	-.157	-.072	-.197	.125	.291	-.252	-.158	-.207	.091	.162	.188	.147	.041
BMI (Kg/cm²)†	.250	.186	-.051	-.428	.118	.333	.073	.027	.136	-.020	.502*	-.027	.122	-.026	.108
Waist C (cm)‡	.014	.625*	-.369	-.287	-.492	-.123	.008	-.110	-.275	-.012	-.094	-.109	.299	-.027	.283
Hip C (cm)†	-.140	.528	-.460	.111	-.601	.152	.115	-.152	.072	-.177	.300	-.204	.145	.039	.114
Waist/Hip ratio‡	.181	-.012	.182	-.403	.290	-.303	-.175	.038	-.132	.140	-.459	-.088	.163	-.188	.219
Skinfold (mm)															
Triceps†	.090	-.132	.145	-.177	.345	.168	-.008	.162	.025	.184	-.052	.238	-.207	-.256	-.124
Biceps†	.309	.404	.233	-.230	.076	.089	-.325	-.012	.025	.007	-.050	.194	-.009	-.149	.020
Subscaular†	.210	.624*	.092	.116	-.082	-.316	.072	-.338	-.392*	-.166	.070	.185	.022	-.043	.002
Suprailiac†	-.045	.514	-.103	.178	-.199	-.221	-.149	-.238	.039	-.193	-.072	.280	-.039	.016	-.124
Abdominal†	-.250	.217	-.392	-.100	-.284	-.032	.010	-.075	-.167	.043	-.005	.376	-.062	-.020	-.153
Peripheral fat†	.303	.201	.288	-.240	.281	.145	-.178	.087	.028	.110	-.055	.234	-.121	-.221	-.059
Central fat†	-.053	.476	-.171	.065	-.205	-.232	-.039	-.265	-.196	-.135	0.000	.308	-.027	-.018	-.099

N.B.:*p< 0.05= Significant differences. **p<0.01= highly significant differences. † Pearson s correlation was used as the parameter is normally distributed. ‡Spearman correlation was used as the parameter is not normally distributed.

in young age, and with skinfold thickness in the three age groups. While lipid profile correlated with skinfold thickness particularly at subscapular area in the age groups I and II (8 -13 years). For girls, none of the parameters under study showed any significant correlation except subscapular skinfold thickness which had significant correlations with lipid profile in age groups I and II (8 -13 years).

Discussion

Childhood is an important period in individual's life and appears to be a critical period for the development of obesity. Although the fundamental causes of epidemic obesity are sedentary life style and high calorie energy dense diet, yet, obesity participates in the pathway that increases the risk for developing cardio-metabolic diseases. However, obesity is associated with a broad range of health issues ranging from specific diseases (type II diabetes and hypertension) to impaired quality of life [18].

As far as we knew, most adipose tissue (~85% of total adipose tissue mass) is located under the skin (subcutaneous fat), and smaller (~15%) is located within the abdomen (intra-abdominal fat) in lean and obese persons [19]. The relative contribution of intra-abdominal fat mass to total body fat is influenced by sex, age, race, ethnicity, physical activity, and total adiposity [20].

The current results revealed prominent interactions of age and sex on the development of obesity, as reflected by the significant higher values of abdominal skin fold thicknesses for boys in the age groups I, II (11 -16 years old) and subsequently, in

central obesity in adolescence (14-16 years old). Inspite of existing of significant high LDL-C and low HDL-C in young age only. Boys had higher values of abdominal skinfold thickness in the 3 age groups, which was significant only in older two age groups (age from 11 to 16 years), and in central adiposity, waist circumference, waist/hip ratio and subscapular skinfold thickness in adolescents aged 14 -16 years, and also high LDL-C and low HDL-C in young age. While girls had significant higher values of BMI, high triglycrides levl and high HDLC (significant in group I only) in the three age groups. This is in agreement with results of many authors, and it may be attributed to the separate threshold of sex specific difference in pattern of fat distribution throughout the body, as well as, to the stage of sexual maturation [6, 19-23]. Hashemipour et al., found that the prevalence of high LDL-C and low HDL-C was higher in boys than in girls aged 6-11 years [4].

The term "visceral fat" is commonly used to describe intra-abdominal fat and it includes both intraperitoneal fat (mesenteric and omental fat), which drains directly into portal circulation, and retroperitoneal fat, which drains into the systemic circulation. The relation between visceral fat and plasma lipid-lipoprotein concentration may be explained by the peculiar feature of intra-abdominal adipocytes. This fat depot has a high lipolytic rate resulting in an increased fatty acid flux draining into the portal circulation. The consequent enhanced expose of the liver to increased fatty acids and insulin may be important in the pathogenesis of increased TG in central obesity. Furthermore, the exposure of peripheral tissue to high concentration of fatty acids may lead to decreased tissue sensitivity to insulin [19]. The current study addresses the link between anthropometric

parameters especially central (visceral) fat and cardio metabolic disease risk in obese pediatric population.

Presence of childhood obesity determined a greater chance of finding high level of LDL-C and triglyceride (TG). Our findings are consistent with many previous studies [6, 7, 18, 19, 24], where the anthropometric variables exhibited diagnostic capacity for cardio metabolic risk factors for younger boys aged from 8-16 years provided by the presence of significant association where fasting blood sugar correlated with most of the anthropometric measurements in young age, and with skinfold thickness in the three age groups. While lipid profile correlated with skinfold thickness particularly at subscapular area in the age groups I and II (8 -13 years).For girls, none of the parameters under study showed any significant correlation except subscapular skinfold thickness which had significant correlations with lipid profile in age groups I and II (8 -13 years).

For adolescents, there is insignificant correlation between any one of the lipid profile and most of the anthropometric parameters in either gender. This finding came in agree with that of Hashemipour et al.,[4] where they concluded that no single anthropometric index was found to be associated with risk factors in different sex and age groups. However, study of Kelishadi et al., 2007, [25] in Iran, documented that BMI, WC and WHR were the most appropriate indices in predicting lipid profile among youths.

In the current study, WHR was a good predictor of lipid profile (cardio-metabolic risk factors) for young boys (8-10 years old) and not in adolescents (11- 16 years old); this might be because of the physiologic changes in fat deposition during growth and subsequent puberty. Our finding is consistent with a previous study which determined the diagnostic accuracy for detecting excess body fatness, measured by different anthropometric indices among Swedish adolescents, using ROC analyses. In this study significant correlation was observed between HDL-C and anthropometric indexes. Similar studies among children have reported significant correlation for such variables [26, 27].

Some researchers have suggested that defining obesity by BMI has many disadvantages such as a lack of consensus on the cutoff for distinguishing overweight and obesity, and not presenting body fat distribution [1, 28]. However, we found that BMI had good correlation with fasting blood sugar and lipid profile in younger boys aged from 8-10 years.

These findings contradict those of Margolis et al., [29] who found high correlation between females' lipid level and body mass index, which may be attributed to the differences of age and nutritional status in the respective population.

This study has concluded that fat distribution among obese children; using anthropometric assessment

in form of skinfold thickness particularly subscapular; is important indicator for cardio-metabolic complications in both sexes. Young obese boys are more liable to cardiometabolic complications. This young age is critical and need to give more attention to avoid obesity complications in adult age.

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