

Association between Metabolic Syndrome Criteria and Body-composition Components in Children with Type 1 Diabetes Mellitus

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Abstract

Background

Metabolic syndrome (MES) consists of central obesity, hypertension, reduced high density lipoprotein (HDL), elevated serum triglycerides and high Fasting blood sugar (FBS). They are susceptible to cardio-vascular disease, and insulin resistance. The goal of present research was to assess any relation between the composition of the body in Type 1 Diabetes Mellitus (T1DM) children and having components of metabolic syndrome.

Materials and Methods

This cross sectional study included all T1DM children who were referred to the pediatric clinic of diabetes, affiliated to the Shiraz University of Medical Sciences, Iran during Jul 2013 to Aug 2014. Anthropometric data, blood pressure, fasting blood glucose, lipids and body mass indices like android and gynoid fat mass was done by one physician with standard scale and techniques. The obtained data were analyzed using SPSS-18.

Results

Overall 87 cases with definite diagnosis of T1DM were admitted in this duration (2013-2014). There was a positive correlation appeared between hypertriglyceridemia and Android fat mass ($r=0.1$ and $P=0.046$). Otherwise, there wasn't any relation between body composition criteria and the reduced HDL level, high blood pressure, Abdominal obesity and elevated FBS ($P>0.05$).

Conclusion

It was revealed that hypertriglyceridemia was associated with Android fat mass. However, more pathophysiological research is needed to reveal the association of MES components and body-composition in T1DM children.

Key Words: Adolescents, Aggression, Children, Life Satisfaction, Self-rated Health.

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1- INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a prevalent autoimmune disease caused by destruction of insulin -producing beta cells in pancreas, that presents in childhood and young adulthood (1). Its Peak incidence occurs around puberty(2). T1DM is a risk factor leading individuals to long term complications involving kidneys, eyes, peripheral and autonomic nervous system and cardiovascular diseases (3-7). As reported in literature T1DM might be associated with metabolic syndrome (MES) (8), a complex disorder consist of five criteria's including central obesity, high blood pressure, high density lipoprotein cholesterol (HDL) level reduction, elevated serum triglycerides and high fasting glucose. Individuals having three or more of these components are diagnosed as metabolic syndrome (9). Diabetic individuals have high fasting glucose, so having two or more of the above components puts them in MES patients group. Insulin therapy in T1DM may increase the risk of obesity (10-12).

Metabolic syndrome can elevates the risk of cardiovascular diseases as much as 1.7 folds (13). Sujoy Ghosh et al., estimated the prevalence of metabolic syndrome about 30% in type 1 diabetic individuals, attending in a Diabetes Day Centre of Scotland (14). Thorn et al., demonstrated that metabolic syndrome, according to National Cholesterol Education Program (NCEP) criteria, occurs in 38% of men and 40% of women in adult patients with type 1 diabetes from 57 centers from all over Finland (8). Possibility of metabolic syndrome was higher in older age. It might be the result of increasing abdominal obesity, blood pressure and lower androgen level in the process of aging (13, 15). Another study showed that adolescent female complicated with T1DM had a higher Body mass index (BMI) and total fat mass (16). Also, Sarnblad study showed that BMI was 2.7 kg/m² higher in

T1DM patient than in controls (20). The existence of higher BMI in diabetic mellitus type 1 patients has reflected a higher body fat concentration. The focus of fat in the upper part of the body in diabetic mellitus type 1 patients may be attributed to increase in serum lipid in these individuals, which is one of the metabolic syndrome criteria (16). There are some evidences that reveal the higher existence of total fat mass, fat mass index and lean mass index in T1DM in comparison with normal individuals, however they showed some controversies (21). According to the fact that T1DM patients are more susceptible to developing to cardiovascular morbidity and mortality; and lack of sufficient data about the relationship between T1DM children's body composition and each of MES components in the literature, we sought to explore the association between body composition in diabetic children (type-1) and components of MES to assess the impact of regional body composition in probability of developing to MES in such patients.

2- MATERIALS AND METHODS

2-1. Study Design and Population

This study was a cross section study on all type 1 diabetic mellitus children referred to the pediatric clinic of diabetes affiliated to the Shiraz University of Medical Sciences, South West of Iran, between July 2013 and August 2014.

2-2. Sampling Method

62 sufficient sample size was calculated with $\alpha = 0.05$, $\beta = 0.1$ (power = $1 - \beta = 0.90$), $P_1 = 70$, and $P_0 = 50$. To find more accurate results, 87 children with type 1 diabetes were studied.

2-3. Measuring tools

The measuring of waist circumference, height and weight of diabetic children's for calculation of body mass index (BMI) was

done by one physician with standard scale (Seca, Germany), respectively; while the child standing erect with a light dress and no shoes. The parents were asked about glycemic control, insulin regimen and family history of type 2 diabetes during this visit. Henceforth within minimum 5 minute intervals, 3 sequential blood pressure of T1DM patients were measured in a resting position, by using a proper cuff and sphygmomanometer (Zhejiang, china).

After overnight fasting, fasting blood glucose and lipids were measured. The enzymatic colorimetric method was selected for measuring FBS, in which the glucose oxidase test was utilized. Enzymatic reagents (Pars Azmoon, Tehran, Iran) was used to determine the serum cholesterol and triglyceride concentrations (level) with a Selectra Autoanalyses. Hologic system Dual X-ray energy absorptiometry (DEXA) (Discovery QDR, USA), was used for measuring body composition.

2-4. Inclusion and exclusion criteria

The children or their parents signed the informed consent forms. The inclusion criteria were: FBS >125 mg/dl or random blood sugar \geq 200 mg/dl along with the presence of diabetes symptoms (e.g. polydipsia, polyuria), insulin dependency for controlling blood sugar in normal range, age < 20 years old and duration of T1DM more than 2 years (19).

Frequent presence of auto antibodies, glutamic acid decarboxylase, and Islet cell antibody and insulin autoantibody in blood samples of children confirmed diagnosis of T1DM. Exclusive criteria that were considered include: chronic liver disease, congenital heart disease and chronic kidney disease.

We define Type 1 diabetes mellitus as FBS more than 125 mg/dl along with diabetes symptoms (such as polyuria and polydipsia), and insulin dependency for maintaining blood sugar in normal range

(19). Diagnosis of T1DM in children was confirmed by the presence of autoantibodies (Glutamic acid decarboxylase, Islet – cell antibody and Insulin autoantibody) in blood samples. Also, metabolic syndrome was diagnosed in children based on age- modified standards of ATPIII as (5, 11) :

- 1) Reduced HDL-C level (\leq 40 mg/dl);
- 2) High blood pressure (systolic and/or diastolic blood pressure \geq age and sex and height specific 90th percentile, except for those 18-20 years old which has the cut-off values of \geq 130 and \geq 85 mmHg for systolic and diastolic blood pressure, respectively);
- 3) Elevated serum Triglyceride (TG) (\geq 110 mg/dl).
- 4) Abdominal obesity (waist circumference \geq the age- and sex specific 90th percentile for this population);
- 5) Elevated FBS (\geq 110 mg/dl).

All our diabetic patients had the fifth criterion (elevated FBS). Since all of our patients had the last criterion (elevated FBS), thus individuals owning two or more of above mentioned criteria were considered as the subgroup of Metabolic syndrome patients' group.

2-5. Ethical considerations

The Ethics Committee of the Shiraz University of Medical Sciences approved our study (ID number: 2899).

2-6. Data analyses

The obtained data were analyzed using SPSS-18. Data were presented as mean \pm standard deviation (SD). Prevalence of metabolic syndrome in both gender, type of insulin regime and family history of Type 2 diabetes mellitus (T2DM) [yes or no] was also calculated. The prevalence values in each group were contrasted and compared using the Chi-square test. $P < 0.05$ was considered as statistically significant.

3- RESULTS

Overall, eighty-seven type 1 diabetic children were included in this study. 48(55%) were female and 39(45%) were male. The mean age of samples was 12.38 ± 4.2 (ranging from 4 to 21 years old). The mean diabetes duration in our population is 8.02 ± 3.9 months. **Table.1**, summarized the clinical characteristics of individuals and comparison between both genders. In addition, the amount of HbA1C, FBS, high density lipoproteins (HDL) and waist circumference (WC) were not significantly different between both genders. According to **Table-1**, it shows that girls have higher fat mass index ($P=0.027$), but boys have higher lean mass index ($P=0.047$).

Based on National Cholesterol Education Program (Adult Treatment Panel III) [NCEP ATP III] definitions of metabolic syndrome (8), the overall prevalence of metabolic syndrome in our samples was about 30 percent (29% in female and 30% in male). In addition, the prevalence of the MES doesn't differ significantly in both genders ($P=0.798$).

Table.2, compares the positive criteria of metabolic syndrome which had been seen in these diabetic children. The prevalence of patients with one, two and three risk factors in girls group was almost more than boys; but the difference was not significant. 14.9% (13 cases) of our diabetic patients had hypertension, 55.2 % (48 cases) had high triglyceride, 41% (33 cases) had low HDL cholesterol (HDL-C) and 1% (1 case) of the patients had central obesity, there was no difference regarding to these criteria between these parameters in both sexes ($P>0.05$). Results showed that 89% (77 cases) of our cases had one criteria of MES (elevated FBS); 46% (40 cases) had two risk factors; 29 % (25 cases) had three and 1% (1 cases) had four risk factors leading to MES. 32(41%) children consisting of 14 boys and 18 girls, had low levels of HDL. More than a half of patients (55%)(48 cases) had high

triglyceride level. Hypertention (HTN) was seen in 13 patients (15%). Overall 29% (25 cases) child with diabetic mellitus possess two or more of metabolic syndrome criteria; so they were considered as metabolic syndrome patients.

Table.3, summarized the result of our study in investigating the relationship between the criteria of metabolic syndrome and the body composition components. The only positive association was seen between Triglycerid (TG) code and Android fat mass ($r=0.1$ and $P=0.046$). Other criteria (such as hypertension and low HDL) didn't show any significant correlation with mentioned body composition components. The ratio of abnormal to normal cases (1/86) investigating for abdominal obesity was not suitable for statistical analysis, so we only represented the quantities of the mean values of normal and abnormal cases in table4.

4- DISCUSSION

The aim of this survey was to evaluate the relationships between the body composition indices and metabolic syndrome characteristics in diabetic children. We present a novel finding of a positive correlation between android fat mass in diabetic children and hypertriglyceridemia as a metabolic syndrome criterion. In this regard, findings reported by Daniels et al. provide that a greater android fat distribution in normal children population was significantly related to plasma triglycerides, HDL cholesterol and systolic blood pressure, three parameters of the metabolic syndrome disorder (17) . They studied these factors in a large normal population. However, there is no relevant study in diabetic children. Future studies with a larger sample size of diabetic children could help us to discuss this gap.

One previous study by Nadeau et al. showed a significant positive correlation between fat mass and blood pressure values along diabetic children was

observed (1). This study reported their own observation showing coexistence of higher blood pressure values and excessive body mass, especially increased fat mass. However, our data demonstrated no correlation between body fat and blood pressure level in diabetic children. The definitive conclusion about the association between body composition and blood pressure in diabetic children is yet to be made based on further studies.

In our study, no relationship could be shown between waist circumferences and body composition components in these patients. Contrary to our result, in a large scale study among healthy population, findings strongly indicated that the WC, Body mass index (BMI), and DEXA-derived percentage body fat were all correlated with each other (18). Abdominal obesity is considered to be an indicator of insulin resistance, which is a risk factor of cardiovascular disease (19, 20). Also, abdominal obesity is the most common component which is obvious in most metabolic syndrome definitions (22, 23).

Despite the novelty of this study in evaluating for the first time the relationship between T1DM children's body composition and each of MES components in Middle East, there are several limitations to this study. The most important one is that the number of our population was somehow low for statistical analysis so absence of positive correlation between most of our parameters is probably due to lack of enough cases.

5- CONCLUSIONS

The present study revealed that hypertriglyceridemia was associated with Android fat mass in type 1 diabetic children. However, more pathophysiological research is needed to reveal the association of MES components and body-composition in T1DM children. Concerning the prevention of obesity in

type 1 diabetic children might improve their lipid profile and prevent metabolic syndrome among them.

6- CONFLICT OF INTEREST: None.

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Table-1: Clinical characteristic and body composition of T1DM children in both genders (Mean± SD)

Variable	Total Mean ± SD	male Mean ± SD	Female Mean ± SD	P-value
Age (years)	12.37±4.21	12.97±4.40	11.87±4.03	0.23
Age of Onset of D1M (years)	8.02±3.99	8.64±4.41	7.52±3.58	0.20
HbA1C (mmol/L)	10.15±2.23	10.06±2.19	10.23±2.28	0.73
Daily insulin (unit per kg)	0.69±0.26	0.66±0.29	0.72±0.24	0.34
FBS (mg/dL)	228.31±108.57	207.0±105.07	246.78±109.32	0.09
HDL (mg/dL)	45.68±11.93	45.31±11.74	45.99±12.20	0.79
WC (cm)	70.16±9.87	72.21±10.27	68.54±9.33	0.09
WC percentile (%)	47.19±22.01	49.26±21.10	45.56±22.80	0.43
Systolic BP percentile	58.87±27.05	58.12±28.30	59.47±26.27	0.82
Diastolic blood pressure percentile	62.28±19.34	63.84±18.25	61.02±20.28	0.49
Fat Mass Index (kg/m ²)	5±1.6	4.5±1.6	5.3±1.6	0.027
Lean Mass Index (kg/m ²)	12.4±1.9	13.1±2.1	11.5±1.8	0.047

Table-3: Prevalence of metabolic syndrome criteria in patients, classified by gender

Criteria Of metabolic syndrome	Boys (%) n=39	Girls (%) n= 48	Total (%) n= 87	P-value
Low HDL	14(35.89)	18(37.5)	33(41.7)	0.098
High TG	24(61.53)	24(50)	48(55.17)	0.871
HTN	6(15.38)	7(14.33)	13(14.94)	0.794
WC	0(0)	1(2.08)	1(1.11)	0.524
High FBS+ one positive criteria	19(48.71)	21(44.75)	40(45.97)	0.611
High FBS+ 2 positive criteria	11(28.2)	14(29.16)	25(28.73)	0.162
High FBS+ 3 positive criteria	1(2.56)	0(0)	1(1.11)	0.513
MES patients	12(30.7)	14(29.16)	26(29.88)	0.33

Table-4: Association of metabolic syndrome criteria and body composition components

MET.S	HDL (mg/dl)			TG (mg/dl)			Waist circumference (cm)			Blood Pressure (cmHg)			Metabolic syndrome code		
	NL n=54	abNL n=33	P- value	NL n=39	abNL n=48	P- value	NL n=86	abNL n=1	P- value	NL n=74	abNL n=13	P- value	NO n=61	YES n=26	P- value
Total fat (g)	28.6±5.8	28±5	0.6	27.6±5.9	28.9±5.74	0.7	28.3±5.8	31.2± 5.3	0.11	28.3±5.9	29±4.7	0.4	28±6.1	29.1±5.1	0.47
Android fat mass (g)	594.6±371	606±350	0.9	552±26	636±42	0.046	605±363	488±283	0.05	606±356	543±410	0.34	587±346	627±406	0.66
Gynoid fat mass (g)	2015±946	1938±897	0.9	1940±890	2028±960	0.89	2015±920	1332± 911	0.12	2030±902	1703±106 7	0.14	2017±913	1916±970	0.66
And/Gyn fat ratio	0.69±0.1	0.72±0.14	0.24	0.69±0.09	0.71±0.14	0.11	0.7±0.12	0.74±0.11	0.08	0.7±0.11	0.7±0.15	0.25	0.69±0.1	0.72±0.16	0.36
Trunk/ leg fat ratio	0.66±0.8	0.68±0.09	0.49	0.67±0.08	0.68±0.08	0.73	0.68±-.06	0.73±-.07	0.41	0.68±0.08	0.66±0.08	0.86	0.67±0.08	0.69±0.09	0.53
Trunk/ limb fat ratio	0.64±0.09	0.68±0.1	0.66	0.66±0.1	0.65±0.09	0.83	0.65±0.09	0.71±0.1	0.11	0.65±0.09	0.68±0.09	0.94	0.65±0.09	0.66±0.09	0.68