Original Article

Effect of lifestyle on metabolic syndrome in Turkish children and adolescents

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ABSTRACT

Objective: The study aimed to determine the effect of lifestyle factors such as diets and physical activity on metabolic syndrome in children.

Methodology: Four hundred individuals aged 6 to 18 participated in the study. Waist circumference, systolic and diastolic blood pressure, blood HDL cholesterol, triglyceride, fasting insulin and glucose levels of children were measured. International Diabetes Federation (IDF) criteria was used in defining metabolic syndrome in children. Three-day nutrition consumption record and a food consumption frequency questionnaire was applied in order to determine the food habits.

Results: Incidence of metabolic syndrome in the sample population was found to be 1.8%. It was observed to be significantly lower in the group where triglyceride level, one of the components of metabolic syndrome, is 35% of the rate of energy originating from fat in comparison with the group with a level of 25-35% ($p < 0.05$). A positive correlation was found between dietary fructose with high blood triglycerides and calcium intake and abdominal obesity. It was found out that fasting insulin averages and waist circumferences of individuals who use computers and watch TV for 4 hours or more everyday were significantly higher than those who spend less time with computers or TV ($p < 0.05$).

Conclusion: These results indicated that diets and physical activities affect metabolic syndrome components in children. Conducting long-term and multi-directional studies will definitely be very helpful to have a better understanding of the effect of diets and their components on metabolic syndrome.

KEY WORDS: Metabolic syndrome, Children, Diet, Physical Activity.

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INTRODUCTION

Metabolic syndrome is defined as the presence of at least three risk factors from central or abdominal obesity, hypertriglyceridemia, hypertension, low HDL cholesterol and high fasting glucose levels. The most common cause of insulin resistance in children is obesity.[1] Recent studies indicate that the prevalence of metabolic syndrome is higher in obese children and adolescents showing the role which obesity and insulin resistance play in the etiology of metabolic syndrome. Environmental and lifestyle-related factors are among the causes of metabolic syndrome, apart from genetic affinity. Diets and physical activities can be protective against insulin

resistance and related risk factors.[2] Although it is known that metabolic syndrome occurs as a result of environmental factors such as diets and physical activities, but studies conducted on children are in limited numbers.

The aim of this study was to examine the effect of lifestyle factors such as diets and physical activity on metabolic syndrome in children.

METHODOLOGY

Four hundred children aged 6-18 were included in the study who presented at the Maternity and Children's Hospital pediatric policlinic. Blood HDL cholesterol, triglyceride, fasting insulin and glucose levels of children were measure after a 10-hour fasting in the morning.

The part between the lowest rib and the iliac crest was fixed and waist circumference was found by measuring the circumference on this part and it was evaluated using waist circumference percentiles by age and gender due to CDC (Centers for disease control and prevention).[3]

Systolic and diastolic blood pressure levels were measured three times using a wrist blood pressure monitor on the left arm in the sitting position and their average was taken.

IDF criteria was used in defining metabolic syndrome in children. Based on IDF, the existence of at least three or more of the criteria[4] triglycerides ≥ 150 mg/dl, HDL < 40 mg/dl, waist circumference ≥ 90 percentile, fasting blood glucose ≥ 100 mg/dl, blood pressure SKB ≥ 130 mm/Hg-DKB ≥ 85 mm/Hg was defined as metabolic syndrome.

The amount of macro and micro nutrients received by the individuals through diets were determined as a three-day food consumption record two days during the week and one day in the weekend. The amounts of macro and micro nutritional elements received through the diet have been assessed by calculating the data obtained from the three-day food consumption record using BeBis (Food Information System) Food Consumption Analysis Program.[5]

Table-I: Mean and standard deviation values of metabolic syndrome components based on the fat levels of individuals received through diet.

Metabolic syndrome components	*25 – 35% n=181 X ± SD*	*35% ↑ n=207 X ± SD*	*†p*
SBP(mm/Hg)	111.49±10.80	112.50±10.96	0.363
DBP(mm/Hg)	60.78±8.41	60.25±8.46	0.539
Triglyceride (mg/dl)	82.18±43.61	73.91±32.61	0.037*
HDL(mg/dl)	45.05±8.86	46.40±8.25	0.123
Fasting glucose (mg/dl)	95.53±9.84	97.31±8.26	0.056
Fasting insulin (µU/ L)	8.91±5.20	8.25±4.87	0.203
Waist circumference (cm)	71.34±10.81	69.89±9.45	0.164

† t- Test * p< 0.05

Ethics Committee Approval: The study protocol was approved by the Ministry of Health Zeynep Kamil Maternity and Children's Hospital of Turkey.

Statistical Analysis: Data obtained were assessed with SPSS 15.0 statistics software package.[6] T-test was used to test the significance of the difference between two groups and Anova was used to test the difference among more than two groups. Significance level in these tests was determined to be < 0.05.

RESULTS

Of the children included in the study, 310 were female and 90 were male. The number of individuals aged 6-8 was 20, the number of those aged 9-11 was 54, and the number of those aged 12-14 and 15-18 were 93 and 233, respectively.

This study showed that only the triglyceride averages of individuals with the rate of energy from the diet originating from fat over 35 percent was significantly lower than the individuals with a fat level of 25-35% (p<0.05), and it did not affect other components of metabolic syndrome (Table-I). It was

Table-II: Evaluation of metabolic syndrome components in individuals based on the time they spend with TV-computers.

Variables	*Time of their spend with TV-computers*			*† p*
	≤ 1 h/day n=56	*2-3 h/day n=282*	*≥ 4 h/day n=62*	
Trglyceride (mg/dl)	73.20±32.39	77.58±37.17	88.37±50.88	0.077
HDL(mg/dl)	45.33±8.77	45.92±8.20	44.77±9.71	0.601
Fasting glucose (mg/dl)	97.05±9.02	95.98±8.96	98.04±9.49	0.235
Fasting insulin (µU/ L)	7.67±3.70	8.41±5.28	10.19±5.03	0.016*
Systolic KB(mm/Hg)	111.21±11.22	111.80±10.81	114.66±11.57	0.142
Diastolic KB(mm/Hg)	59.69±7.90	60.20±8.26	62.48±9.82	0.121
Waist circumference (cm)	68.41±10.72	70.01±9.57	76.51±11.74	0.000*

† One-Way ANOVA * p< 0.05

Table-III: Relation between the intake of soluble dietary fiber, insoluble dietary fiber, fructose, calcium and magnesium intake and metabolic syndrome components.

Components	*Soluble Dietary fiber*			*Insoluble Dietary fiber*			*Fructose*			*Calcium*			*Magnesium*		
Abdominal obesity	*n*	*r*	*p*	*n*	*r*	*p*	*n*	*r*	*p*	*n*	*r*	*p*	*n*	*r*	*p*
High Trglyceride	10	0.376	0.284	10	0.490	0.151	10	-0.377	0.283	10	0.700	0.024*	10	0.344	0.331
Low HDL	20	-0.269	0.251	20	-0.246	0.297	20	0.533	0.015*	20	0.202	0.394	20	-0.040	0.867
High glucose	97	-0.164	0.108	97	-0.130	0.205	97	-0.050	0.629	97	-0.093	0.362	97	-0.098	0.341
High SBP	150	-0.095	0.250	150	-0.085	0.300	150	-0.149	0.068	150	-0.154	0.059	150	-0.107	0.191
High DBP	19	0.454	0.051	19	0.425	0.069	19	0.044	0.857	19	0.066	0.788	19	0.121	0.621
Abdominal obesity	5	0.052	0.934	5	0.020	0.975	5	-0.769	0.128	5	-0.431	0.469	5	-0.450	0.447

r : Pearson correlation coefficient P<0.05

found out that fasting insulin averages and waist circumferences of individuals who use computers and watch TV for 4 hours or more everyday were significantly higher than those who spend less time with computers or TV ($p<0.05$) (Table-II).

As shown in Table-III, a positive correlation was found between dietary fructose with high blood triglycerides and calcium intake and abdominal obesity. Triglyceride, fasting insulin and systolic blood pressure averages of those doing sports activities (basketball, volleyball, football, cycling, dancing) for more than 1 hour everyday are lower than those with the activity level of ≤ 30 min/day and >30min-1 h/day, triglyceride average of the group doing sports activities for >30min-1 h everyday was found significantly higher than the groups doing sports activities for ≤ 30 min/day and > 1 h/day (Table-IV).

DISCUSSION

Many studies that have been conducted indicate that the dietary habits play an important role in the development of metabolic syndrome. In a study by Demosthenes et al[7], it was indicated that the consumption of cereals, vegetables, fruits and fish reduced the clinical indicator levels of metabolic syndrome and, that of meat and alcohol caused a negative effect.

The effect of the macronutrient composition of the diet on insulin sensitivity, blood lipids and obesity has been studied comprehensively in adults.[8] It is associated with the decline in the ability of the low carbohydrate and high-fat dietary insulin to reduce the plasma glucose, yet, low-fat, high-carbohydrate diets can be explained by the recovery in the ability of the insulin to reduce the plasma glucose.[9]

Although it is considered that dietary fat consumption might have a decisive role in insulin sensitivity, the relations between dietary fat intake and insulin resistance are contradicting. In adults, the increase in the dietary fat intake is associated with the decline in insulin sensitivity, but what we know about children is limited.[10] When daily dietary fat consumption is very high, it may negatively affect insulin sensitivity. The reason why some of the studies conducted on this subject gave different results is thought to be resulting from the fact that the fat intake is not high enough.[9]

In a study conducted on 162 healthy individuals, it was found that the diet with a higher level of saturated fat (17% saturated fat, 14% monounsaturated fat, 6% polyunsaturated fat) caused a 10% decrease in insulin sensitivity compared to the diet with high monounsaturated fat content (8% saturated fat, 23% monounsaturated fat, 6% polyunsaturated fat).[9] This study pointed out

Table-IV: Mean and standard deviation values of metabolic syndrome components based on the time of their daily sports activities.

Variables	*Time of daily sports activities*			*† p*
	≤ 30 min/day n=211	*>30min-1 h /day n=99*	*> 1 h/day n=90*	
Trglyceride (mg/dl)	76.24±35.91	89.40±46.69	72.41±35.34	0.005*
HDL(mg/dl)	45.61±8.23	45.86±8.98	45.55±8.73	0.962
Fasting glucose (mg/dl)	97.02±8.70	95.74±9.65	95.91±9.24	0.417
Fasting insulin (µU/ L)	8.96±5.27	8.83±5.52	7.43±3.90	0.051
SBP(mm/Hg)	112.44±10.66	112.13±10.93	111.54±11.98	0.810
DBP(mm/Hg)	60.52±8.47	60.71±8.95	60.13±8.10	0.891
Waist circumference (cm)	71.17±9.97	71.73±10.97	68.89±10.52	0.128

† One-Way ANOVA * p< 0.05

that only the triglyceride averages of individuals with the rate of energy from the diet originating from fat over 35 percent was significantly lower than the individuals with a fat level of 25-35% ($p<0.05$), and it did not affect other components of metabolic syndrome. When it is examined why the triglyceride level of the group with the fat level of 35% was lower than that of the group with lower fat consumption; it was found out that the saturated fatty acid level consumed by the group with the fat level above 35% was 15%, their polyunsaturated fatty acid level was 8%, and monounsaturated fatty acid level was 13%; that the saturated fatty acid level of the group with the fat level of 25-35% was 12%, their polyunsaturated fatty acid level was 6%, and monounsaturated fatty acid level was 10%,. On the other hand the group with the dietary fat intake level above 35% had significantly low levels of simple sugar consumption, and higher magnesium intakes and that this group with a high level of total fat consumption had low triglyceride average. It was explained by the fact that the level of unsaturated fat and the amount of magnesium which they consumed was high and their simple sugar consumption levels were low.

In a study conducted on adults, it was observed that high carbohydrate intake was associated with lower HDL cholesterol levels and higher triglyceride levels.[11] A positive correlation was observed between dietary fructose intake and high blood triglyceride in this study.

Although the role of magnesium deficiency on the development of insulin resistance in the childhood period was not clearly defined, it was demonstrated that reduced magnesium intake serum levels in adults were associated with type-2 diabetes, insulin resistance, hypertension, dyslipidemia, cardiovascular disease and metabolic syndrome.[12] It was also revealed that serum magnesium and dietary magnesium had a negative correlation with fasting insulin and positive correlation with insulin sensitivity. It was concluded that there was a correlation between magnesium deficiency in childhood and insulin resistance.[13] No correlation was observed between dietary magnesium and metabolic syndrome components in our study.

Some studies have indicated that there is a negative correlation between the consumption of dairy products and obesity. The number of studies conducted on children and adolescents in this subject is limited in comparison with the adults. In studies, the majority of which have been conducted on adults, it was demonstrated that the increase in the intake of dairy products and/or calcium reduced the risk of diseases associated with obesity and metabolic syndrome such as hypertension, coronary artery disease and apoplexy.[14] This study revealed that there was a positive correlation between calcium intake and abdominal obesity. It is thought that the whole-fat dairy products consumed by children have an effect on this.

Obesity and physical activity are two important determinants of metabolic syndrome. Prevalence of childhood obesity has dramatically increased over the last 15-20 years.[15] Some studies have demonstrated that the prevention of obesity is the direct means to prevent metabolic syndrome. It is known that watching television causes lower metabolic speed when compared to sedentary activities such as reading, writing and sewing. In many studies, it has been reported that there is a positive correlation between watching television and obesity. In another study, it was demonstrated that physical activity is protective against low HDL cholesterol levels and the emergence of metabolic syndrome, and watching television is correlated with high triglyceride levels and fasting glucose levels.[16]

In this study, waist circumferences and fasting insulin levels of those who watch TV and use computers for 4 hours or more during the day was similarly found high in comparison with those who watch TV for ≤ 1 h/day vs 2-3 h/day($p<0.05$). Also, triglyceride levels of individuals doing sports activities for more than 1 hour everyday have been found significantly lower than those who do sports for ≤ 30 min/day and >30min-1h/day.

During this study lasting for a year majority of those who agreed to participate were mostly girls. Hence the number of male in the sample is less than female. Body fat and blood pressure are affected by puberty. The percentage of body fat increases strikingly in females through adolescence, but changes in body fat in males are not consistent. Systolic blood pressure also rises with pubertal stage particularly in female. For this reason, in our study, the sheer number of female may have influenced the incidence of metabolic syndrome in the sample, but there was no difference between the genders in terms of nutrient intakes and physical activity.

CONCLUSION

Diet and physical activity have an effect on metabolic syndrome components in Turkish children. The best approach to reduce the incidence of metabolic syndrome in children is to prevent

its development. Children and their families must be instructed to make certain lifestyle changes such as nutritional habits, increasing the level of physical activity and reduce the level of sedentary activity. Schools, school canteens and society-based programs must be developed and encouraged for a better arrangement of dietary and physical activity behavior for all children and their families. Conducting long-term and multi-directional studies will definitely be very helpful to have a better understanding of the effect of diets and their component on metabolic syndrome.

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Authors' Contributions:

NHN: Completed the study design, manuscript writing, data collection and statistical analysis.
GK: Completed the study design, editing manuscript.