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The relationship between diet quality and insulin resistance in obese children: adaptation of the Healthy Lifestyle-Diet Index in Turkey

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Abstract

Background: Childhood obesity and its complications are serious health problems and diet/lifestyle changes can be beneficial for the prevention of diseases. Adaptation of the Healthy Lifestyle-Diet (HLD) Index in accordance with the dietary guidelines for Turkey (TR) and determination of the relationship between metabolic syndrome risk factors in obese children were the aims of this study.
Methods: This study was conducted on 164 overweight or obese children (87 male, 77 female) aged 9–13 years. For all participants, the HLD-TR Index and a 24-h dietary recall were performed and the mean adequacy ratio (MAR) was calculated. Anthropometric measurements and the body composition of the children were taken. Metabolic syndrome risk factors and insulin resistance were assessed.
Results: The mean age of the male and female children was 11.2±1.49 and 11.0±1.40 years, respectively. The majority of the children were obese in both genders. There were no statistically significant differences in the HLD-TR scores between the genders. As the index scores increased, a decrease in the energy intake and an increase in the MAR were observed. Negative correlations between the index scores and body mass, waist circumference and body fat mass were observed. Furthermore, a one-unit increase in the index score decreases the insulin resistance risk by 0.91 times after adjustments for age and gender (odds ratio: 0.91 [0.85–0.97]).
Conclusions: The HLD-TR Index is a valid tool that can give an idea about the quality of the diet in obese children. Furthermore, with the increase in the compliance with recommendations for diet/lifestyle changes, indicators of obesity and metabolic syndrome were decreased.

Keywords: children; diet quality; insulin resistance; nutrition; obesity.

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Introduction

Obesity is a clinical problem that requires prevention and treatment in all age groups [1, 2]. The prevalence of childhood obesity has reached epidemic levels in both developed and developing countries and childhood obesity has become one of the most important health problems of the 21st century in terms of its harmful effects on children, their families and society [3]. Overweight and obesity in childhood have a significant impact on both physical and psychological health [4]. Children with obesity have greater cardiometabolic risk factors (hyperlipidemia, hypertension, insulin resistance). Furthermore, the majority of these children isolate themselves from society and remain obese in adulthood [5].

Various studies have underlined some of the lifestyle patterns and eating habits that increase the risk of childhood obesity [5, 6]. Lifestyle changes in recent years have led to increased sedentary behavior, the consumption of more energy-dense foods and a decrease in the time spent on physical activity [7]. A lifestyle intervention that comprises a combination of diet, exercise and/or behavioral changes is seen as a basic element in the management of obesity [8].

Children develop their eating behaviors and food preferences while growing and they also maintain these habits in their youth and adulthood [9]. Detecting children who have adopted an unhealthy lifestyle and poor eating habits and beating the risk of being overweight/obese is critically important for public health [10, 11].

In studies regarding a healthy diet and lifestyle in children, the impact of specific foods, food groups and/or nutrients and some parameters of physical activity/a sedentary behavior on health status was analyzed [12–15]. However, the results of these studies do not reflect the cumulative effect of the overall diet and lifestyle quality. Because the dietary habits of individuals are associated with the lifestyle model it makes it difficult to assess the quality of the diet-lifestyle [16].

Several factors are responsible for the etiology of obesity. In this context, the Healthy Lifestyle-Diet Index (HLD Index), which includes both dietary patterns and lifestyle, has emerged as an alternative approach. With this index, the diet-lifestyle quality of children was assessed based on the United States Department of Agriculture (USDA) dietary guidelines and a negative correlation was found between insulin resistance and the index scores [11].

The aim of this study is to adapt the HLD Index in accordance with the dietary guidelines for Turkey and determine the relationship between metabolic syndrome parameters in obese children.

Materials and methods

This study was conducted on 164 overweight or obese volunteer children (87 male, 77 female) aged 9–13 years who were admitted to Gazi University, Faculty of Medicine, Department of Pediatric Endocrinology, in Ankara, between June and October 2015. Children who applied to the policlinic to get healthy nutrition recommendations from a dietitian were invited to join the study. Exclusion criteria were not having any chronic diseases (diabetes mellitus, cardiovascular diseases, polycystic ovary syndrome, thyroid dysfunction, asthma, etc.), were of normal weight and not receiving hormone therapy and not taking medications. Ethical approval for the study was obtained from the Ethics Committee of Gazi University.

Data were collected using a questionnaire prepared by researchers. Children and their parents were asked about the demographic characteristics (age, education level, occupational status), the HLD Index and a 24-h dietary recall. Anthropometric measurements (body weight, height and waist circumference) and the body composition of the children were assessed.

Anthropometric measurements and body composition

The body weight (kg), height (cm) and waist circumference of the children were measured using standard measurement protocols [17]. Height was measured with a stadiometer while the children were in a Frankfort plane. Waist circumference was measured at the midpoint, above the iliac crest and below the lowest rib margin at minimum respiration, using a flexible tape to the nearest 0.1 cm. The body weight and body fat percentage (%) of the children were obtained using a bioelectrical impedance analyzer (TBF-300, Tanita Corporation, Tokyo, Japan). All the participants underwent body composition analysis following at least a 4-h fasting by not consuming any fluid (water, tea, coffee), not doing heavy physical activity and not having any metal objects in contact with their skin. Z-scores for body mass index (BMI) for age were calculated from the World Health Organization (WHO) growth reference data for children aged 5–19 years with the AnthroPlus program (WHO, Geneva, Switzerland). The children were grouped as overweight and obese, in accordance with the cut-off points of ≥+1 standard deviation (SD)–2 SD and ≥+2 SD Z-scores, respectively [18].

Biochemical parameters and blood pressure

The fasting blood glucose, insulin, total cholesterol, low-density lipoprotein-cholesterol (LDL-C), high-density lipoprotein-cholesterol (HDL-C) and triglyceride levels of the children, which are routinely analyzed at the Gazi University, Faculty of Medicine, Department of Pediatric Endocrinology, were recorded. Blood pressure measurement in children were taken by the researchers in accordance with the standard measurement protocol, in a position which children seated comfortably. The arm was supported at the heart level and the first and last audible sounds were taken as systolic and diastolic pressures to the nearest 2 mmHg [19].

Assessment of insulin resistance

In order to evaluate insulin resistance, the homeostasis model assessment for insulin resistance (HOMA-IR) value was calculated by using the fasting blood glucose (mmol/L) × fasting insulin (μU/mL)/22.5 formula [20]. A value greater than 3.16 was accepted as the cut-off value determined for children and adolescents as per Keskin et al. [21].

Food consumption records

The food consumption of the children was examined through face-to-face interviews by a dietitian via the 24-h dietary recall method, accessed through the children and their parents. The dietary energy and nutrient intakes of the children (see Supplementary Material Table 1) were calculated using a food database program which was described as the nutrition information system (in Turkish: Beslenme Bilgi Sistemi – BeBiS 7). This database contains Turkish food composition tables for all foods [22]. The nutrient adequacy ratios (NARs) of the children were calculated using dietary reference intake (DRI) recommendations (%) for selected nutrients (vitamin A, vitamin C, riboflavin, vitamin B_6, folate, vitamin B_{12}, calcium, iron, magnesium, zinc, potassium and sodium) [23]. The mean adequacy ratio (MAR) was obtained by dividing the NARs into the number of nutrients.

Diet quality index

The HLD Index (originally contained 10 components) developed by Manios et al. [11] was adapted to Turkish culture and used for determining the quality of the children's diet. As the dietary recommendations in the orginal HLD Index were similar to the Turkish Nutrition Guideline 2015 for children [24], the servings did not change. However, certain food categories were examined in more detail; for example, cereals were separated into bread, cornflakes and rice/pasta; dairy products into milk, yogurt and cheese; and meats into red meat, poultry and processed meats. Furthermore, as meat product consumption preferences can vary according to the fat content in

Turkey [25–27], the degree of fat content was examined as whole fat, medium fat and lean separately. Consumers may prefer not to buy visible fats or buy different types of meat whose fat contents can vary (veal, beef, mutton, goat meat, etc.). Likewise, because the consumption of different types of bread is very common [28, 29], breads and grains were examined as wheat, whole wheat or whole grain separately.

The frequency of children watching television almost every day is 92.5% and nearly half (46%) of the children aged 6–15 years use a computer according to the Statistics on Children 2014 report in Turkey [30]. For this reason, we also examined the frequency of using a computer.

Based on all the changes made, the adapted HLD-TR Index comprises 11 components (Table 1). The consumption of food groups is examined via eight components and the status of physical activity (moderate [walking, dancing, etc.] to vigorous physical activity [running, jumping, etc.]) [31], watching TV and using a computer through another three components. Assessment of the HLD-TR Index is on a five-point (0–4) scoring system. The total score that can be achieved from the index ranges from 0 to 56 points. An increase in the total score indicates the degree of adherence to a "healthy" lifestyle. All frequencies of the components were evaluated using the scores as shown in Table 1. However, in the 9th, 10th and 11th questions, which contain types of food, their first part score is obtained in two steps. First, the type of food (in parenthesis) is examined and scores are assigned for each food separately. Second, all points are added up and rescored as follows: 0 points (score: 0), 2 points (score: 1), 4 points (score: 2), 6–8 points (score: 3), 10–12 points (score 4). For the index component scores of the children see Supplementary Material Table 2.

Statistical assessment

The obtained data were divided into three tertiles – <17 points, 17–23 points and >23 points – according to the HLD-TR Index score. Intergroup differences were assessed using one-way analysis of variance (ANOVA) for parametric data and the Kruskal-Wallis test for non-parametric data. Bonferroni adjustment was performed to assess between-group differences. Correlations were calculated using the Pearson (for parametric data) or Spearman's test (for non-parametric data). Logistic regression analysis was performed to examine the relationship between insulin resistance and the index scores and odds ratios. The statistical significance level was selected as $p < 0.05$. The SPSS version 15.0 statistical software package was used for all analyses.

Results

The characteristics of the children according to gender are shown in Table 2. The mean age of the male and female children was 11.2 ± 1.49 and 11.0 ± 1.40 years, respectively. Most of the children were obese in both genders (97.7% in males and 96.1% in females). There were no statistically significant differences in the HLD-TR scores between genders ($p > 0.05$). Although, the MAR values of the male children were higher than those of the females, they were below 100% in both genders ($p > 0.05$).

As the index scores increased, a decrease in the dietary energy intake and increase in the protein percentage were determined ($p < 0.05$). No correlation was found between other macronutrients and the index scores ($p > 0.05$) (Table 3). However, as the MARs increased, the HLD-TR Index scores also increased and the MARs were higher in the third tertile than in the first ($p < 0.05$) (Table 3).

In Table 4, negative correlations between the index scores and body mass, waist circumference and body fat mass were observed ($p < 0.05$). Body mass was lower in the third tertile than in the first; body fat mass and body fat percentage were lower in the third tertile than in other tertiles ($p < 0.05$). Furthermore, no statistically significant differences were found between the index scores and serum triglyceride, LDL-C and HDL-C levels among tertiles ($p > 0.05$). However, there were statistically significant differences between the index scores and other biochemical parameters and blood pressure among tertiles ($p < 0.05$). In addition, as the index scores increased, serum fasting glucose, insulin levels, HOMA-IR and blood pressure decreased ($p < 0.05$).

The frequency of insulin resistance was 62.2% according to the HOMA-IR assessment in children. The binary logistic regression model (Table 5) showed that a one-unit increase in the HLD-TR Index score decreases the insulin resistance risk 0.91 times after adjustments for age and gender ($p < 0.05$).

Discussion

Childhood obesity is increasing in Turkey [32], as in other parts of the world [33]. According to the results of the Turkish Nutrition and Health Study 2010, the rate of overweight children aged 6–18 years was found to be 14.3%, while the rate of obese children was 22.5% [34]. Together with this, as the eating habits and lifestyle of children and adolescents are the determinants of potential chronic diseases that might arise in later ages, the interest in these subjects has increased in recent years [35]. In this study, the HLD Index developed by Manios et al. has been adapted to Turkish culture and assessment of the compliance of overweight and obese children aged 9–13 years with the general recommendations for nutrition, and the relations between some anthropometric measurements, body composition and particularly the parameters of the metabolic syndrome have been ensured. At the end of the study, we found that the adapted index was an effective tool for the assessment of the diet/lifestyle quality in obese children. Adherence to the index was associated with decreased

Table 1: HLD-TR Index scoring system, Ankara/Turkey – 2015.

Index items	Amount	Frequency or type of foods	Score
1. Fruits, fruit juice	1 medium fruit or 1/2 water glass (or cup) of fruit juice (120 mL)	Never	0
		1–6 servings per week	1
		1–2 servings per day	2
		2–3 servings per day	3
		>3 servings per day	4
2. Vegetables, salads	8 tablespoon (110 g)	<1 serving per day	0
		1–2 servings per day	1
		2–3 servings per day	2
		3–4 servings per day	3
		>4 servings per day	4
3. Fish, seafood	2 palm-sized (60 g)	Never or rarely	0
		1–2 servings per week	2
		2–3 servings per week	4
		3–4 servings per week	3
		>4 servings per week	1
4. Sweets	30 g	Never or rarely	4
		1–2 servings per week	3
		2–4 servings per week	2
		4–6 servings per week	1
		≥1 serving per day	0
5. Soft drinks	1.25 water glass (or ~1 cup) (250 mL)	Never or rarely	4
		1–2 servings per week	3
		2–4 servings per week	2
		4–6 servings per week	1
		≥1 serving per day	0
6. Watching TV	–	<1 h/day	4
		1–2 h/day	3
		2–3 h/day	2
		3–4 h/day	1
		>4/day	0
7. Using computer	–	<1 h/day	4
		1–2 h/day	3
		2–3 h/day	2
		3–4 h/day	1
		>4 h/day	0
8. Physical activity	–	0–15 min/day	0
		15–30 min/day	1
		30–45 min/day	2
		45–60 min/day	3
		>60 min/day	4
9. Breads and grains	1 slice of bread (25 g) or 4 tablespoon of grains	Wheat (for bread, cornflakes and rice/pasta separately)	0
		Whole wheat (for bread, cornflakes and rice/pasta separately)	2
		Whole grain (for bread, cornflakes and rice/pasta separately)	4
		<2 servings or >14 servings per day	0
		2–6 servings per day	2
		7–14 servings per day	4
10. Milk and dairy products	1.25 water glass (or ~1 cup) (250 mL)/1 small egg-sized cheese (40 g)	Whole fat (for milk, yogurt and cheese separately)	0
		Low fat (for milk, yogurt and cheese separately)	2
		Light/no fat (for milk, yogurt and cheese separately)	4
		<1 serving per day	0
		1–2 servings per day	2
		>2 servings per day	4
11. Meat and meat products	2 palm-sized (60 g)	Whole fat (for meat, chicken/turkey and processed meats separately)	0
		Medium fat (for meat, chicken/turkey and processed meats separately)	2
		Lean (for meat, chicken/turkey and processed meats separately)	4
		<1 serving per week	0
		1–2 servings per week	1

Table 1 (continued)

Index items	Amount	Frequency or type of foods	Score
		3–6 servings per week	2
		1–2 servings per day	3
		>2 servings per day	4

Table 2: Characteristics of children according to gender ($\bar{x} \pm$ SD), Ankara/Turkey – 2015.

	Total (n = 164)	Male (n = 87)	Female (n = 77)	p-Value
Age, years[b]	11.1 ± 1.45	11.2 ± 1.49	11.0 ± 1.40	0.333
Index score[a]	19.9 ± 6.31	19.4 ± 6.98	20.4 ± 5.46	0.341
HOMA-IR[b]	4.7 ± 2.73	4.8 ± 2.98	4.5 ± 2.41	0.778
MAR[b]	89.2 ± 7.93	90.5 ± 5.32	87.8 ± 9.87	0.169
Obese, %[c]	97.0	97.7	96.1	0.666

[a]Student's t-test, [b]Mann-Whitney U-test, [c]χ^2-test. HOMA-IR, homeostasis model assessment of insulin resistance; MAR, mean adequacy ratio.

insulin resistance, better blood parameters and decreased obesity measurements.

Several tools have been used to determine the dietary quality and lifestyle in developed and developing countries [36–40]. Difficulties are encountered in the scoring for some of these indices, and some others do not include any constituents related to physical activity. With this purpose in mind, some investigators have used some methods to determine the physical activities of children together with the dietary quality [6, 41, 42] because it is known that inquiring about physical activity is important as physical activity is one of the important factors affecting obesity [41]. In this regard, the index used here has been preferred as it includes the physical activity together with the diet quality and also assesses the sedentary behavior.

It was found that the dietary quality of children is poor in Turkey based on the previous studies using the Healthy Eating Index (HEI) [43, 44]. Likewise, the HLD-TR Index scores of children in this study are also poor, and these data are supported by the food consumption records. The MAR values of children are under 100% in the present study. Therefore, it can be concluded that as the diet quality lowers, sufficient amounts of foods for ensuring nutritional diversity are not being consumed. Together with this, it has also been found that there is a tendency for energy intake to reduce, and the percentage of energy from proteins and the MAR values tend to increase with the increasing compliance with dietary and lifestyle recommendations included in the index. Thus, the increase in compliance with the dietary and lifestyle recommendations has resulted in an increase in the adequacy of the diet.

In the current study, increased index scores were negatively related with obesity measurements. While Hurley et al. [45] showed the presence of a negative correlation between the high body and abdominal fat percentages and HEI score, likewise, Jennings et al. [46] reported that increases in Dietary Quality Index (DQI) scores were related to decreases in the BMI, waist circumference and body fat. In addition to the studies with observations that dietary quality indices are negatively correlated with markers of obesity [6, 39], Royo-Bordonada et al. showed that the BMI values of children are not different based on the dietary diversity tertiles. However, it has been shown that the index scores are related to an increase in processed products, particularly processed meat products, and consequently an increase in energy intake. It has been highlighted that there can be a risk of obesity in the long term [47]. In another study, there were no differences

Table 3: Mean dietary energy, macronutrient intakes and MAR values of children according to the HLD-TR Index scores ($\bar{x} \pm$ SD) and correlations, Ankara/Turkey – 2015.

Nutrients	Total (n = 164)	Tertile 1 (n = 49)	Tertile 2 (n = 57)	Tertile 3 (n = 58)	p-Value	r
Energy, kcal[a,c]	2257.0 ± 470.16	2385.3 ± 489.85	2214.5 ± 462.19	2181.0 ± 439.58	0.058	−0.167[e]
Protein, %[b,d]	13.7 ± 2.34	13.2 ± 2.27	13.6 ± 2.30	14.2 ± 2.34	0.107	0.192[e]
Fat, %[a,c]	39.5 ± 6.56	38.6 ± 6.43	39.8 ± 6.89	39.8 ± 6.39	0.571	0.063
Carbohydrate, %[a,c]	46.7 ± 6.76	48.1 ± 6.43	46.4 ± 6.94	45.9 ± 6.74	0.209	−0.136
Fiber, g[a,c]	21.3 ± 7.47	19.9 ± 5.89	22.3 ± 8.65	21.3 ± 7.28	0.255	0.117
MAR, %[b,d]	89.2 ± 7.93	87.7 ± 6.33[g]	89.8 ± 7.26[g,h]	90.1 ± 9.43[h]	0.004	0.276[f]

[a]One-way ANOVA test, [b]Kruskal-Wallis test, [c]Pearson correlation, [d]Spearman's correlation, [e]$p < 0.05$, [f]$p < 0.01$, [g,h]statistically significant. MAR, mean adequacy ratio.

Table 4: Anthropometric measurements, biochemical parameters and blood pressures of children according to the HLD-TR Index scores ($\bar{x}\pm$SD) and correlations, Ankara/Turkey – 2015.

Parameters	Total (n=164)	Tertil 1 (n=49)	Tertil 2 (n=57)	Tertil 3 (n=58)	p-Value	r
Body weight, kg[a,d]	66.2±17.88	75.4±19.62[h]	65.6±16.95[i]	59.1±13.33[i]	0.000	−0.0378[f]
Body fat mass, kg[a,d]	23.3±9.87	27.4±10.87[h]	23.7±10.57[h]	19.3±6.19[i]	0.000	−0.378[g]
Body fat percentage, %[a,e]	34.1±6.96	35.1±7.46[h]	35.1±7.35[h]	32.2±5.80[i]	0.041	−0.0191[f]
Waist circumference, cm[b,d]	92.7±14.83	99.3±10.98[h]	91.8±15.14[i]	88.2±15.41[j]	0.000	−0.361[g]
Fasting glucose, mg/dL[a,d]	89.6±11.38	93.7±11.34[h]	90.2±11.48[h,i]	85.5±9.95[i]	0.001	−0.304[g]
Fasting insulin, μIU/mL[b,d]	20.6±10.45	23.5±11.51[h]	22.3±10.39[h]	16.3±8.00[i]	0.001	−0.298[g]
HOMA-IR[a,d]	4.7±2.73	3.0±0.44[h]	2.7±0.35[h]	1.9±0.25[i]	0.000	−0.333[g]
Triglyceride, mg/dL[a,d]	118.3±54.75	128.4±64.52	121.7±60.28	105.1±34.14	0.069	−0.132
Total cholesterol, mg/dL[a,d]	171.2±36.43	175.4±38.46	173.3±37.4	166.0±33.32	0.367	−0.123
LDL-C, mg/dL[c,d]	100.0±25.68	106.0±31.57	95.9±24.41	100.1±21.15	0.134	−0.101
HDL-C, mg/dL[a,d]	43.7±9.05	42.0±9.42	44.0±10.36	44.5±7.16	0.332	0.192
SBP, mmHg[b,d]	115.7±10.16	119.2±9.18[h]	116.4±11.68[h]	111.8±7.82[i]	0.000	−0.319[g]
DBP, mmHg[b,d]	72.4±7.56	75.1±6.80[h]	72.7±8.34[h,i]	69.7±6.38[i]	0.002	−0.266[g]

[a]Tukey test, [b]Kruskal-Wallis test, [c]one-way ANOVA test, [d]Spearman's correlation, [e]Pearson correlation, [f]$p<0.05$, [g]$p<0.01$, [h,i,j]statistically significant. HOMA-IR, homeostasis model assessment of insulin resistance; LDL-C, low-density lipoprotein-cholesterol; HDL-C, high-density lipoprotein-cholesterol; SBP, systolic blood pressure; DBP, diastolic blood pressure.

Table 5: Associations between the presence of insulin resistance and HLD-TR Index scores of the children, Ankara/Turkey – 2015.

Independent variable	Binary logistic regression	
	Presence of insulin resistance (dependent variable)	
	OR (95% CI)[a]	OR (95% CI)[b]
Index score	0.88 (0.83–0.94)	0.91 (0.85–0.97)

[a]Unadjusted. [b]Adjusted for age and gender. CI, confidence interval; OR, odds ratio.

between the BMI values based on Mediterranean Diet Quality Index (KIDMED) groups; however, physical activity levels increased with increasing compliance with a Mediterranean diet [48].

The relationship between nutrition and health is clear. Therefore, associations between diet quality and diversity are factors affecting the health outcomes. In this study, better glycemic parameters and lower blood pressure were related to increased index scores. Studies relating diet quality to biochemical parameters are limited in the literature. Royo-Bordonada et al. have shown that plasma vitamin A and E levels increase with increasing diet diversity. Furthermore, plasma HDL-C levels are higher and triglyceride levels are lower in individuals with the highest tertile of dietary diversity index than in those in the lowest tertile; however, the difference is not statistically significant [47]. In a study carried out on adolescents in Germany, compliance with dietary recommendations developed based on different indices on dietary quality had positive effects on some biochemical findings related to diabetes and cardiovascular risks (HbA_{1c}, homocysteine, C-reactive protein and diastolic blood pressure) [49]. Lazarou and colleagues showed in their study that they carried out using KIDMED and electronic kids dietary index (E-KINDEX) that compliance with the Mediterranean diet is related to the lowering of systolic and diastolic blood pressures [38, 41]. In yet another study, compliance with dietary recommendations in childhood was related to a decrease in diastolic blood pressure [50]. As we have seen, it has been shown once again in this study that low diet quality can be related to obesity, increased blood pressure, glucose and insulin values that are included in the risk factors particularly for metabolic syndrome and cardiovascular diseases.

Manios et al. [11] showed that the increase in the compliance with dietary recommendations included in this index used is effective in reducing insulin resistance. Likewise, insulin resistance decreased even after the adjustments for age and gender in the regression model, and it has been shown that a one-unit increase in the HLD-TR Index score decreases the insulin resistance risk 0.91 times after adjustments for age and gender. It is thought that insulin resistance is involved in the etiology of several diseases [51] and it is a known fact that it is related to nutrition [52] together with its genetic bases [53]. Paying attention to dietary habits during childhood will reduce the risk of having chronic diseases later in life. In this regard, the importance of nutrition education is increasing. Dixon et al. have reported that nutrition education is effective in terms of overall diet quality [40].

The strength of the study is determining the quality of the diet as a whole, including lifestyle habits, and assessing with an applicable index that includes nutritional guidance recommendations and dietary habits in Turkey. However, it is necessary to evaluate the validity of the study by applying it on children who are not obese with a larger sample. Furthermore, we used the 24-h dietary recall for assessing the dietary energy and nutrient intakes. Although, it is an accepted method, a 3-day recall or record would be used. To reduce the errors we obtained data from children and their parents face-to-face.

In conclusion, the HLD-TR Index is a valid tool that can give an idea about the quality of the diet in overweight/obese children and can be used to determine the diet quality and lifestyle of this age group in Turkey. Furthermore, with the increase in the compliance with recommendations for diet and lifestyle, some indicators of obesity, metabolic syndrome and cardiovascular diseases were decreased. Therefore, it will be beneficial to plan nutrition education in accordance with the assessments made using this index and taking the recommendations made in the Turkish Nutritional Guidelines into consideration.

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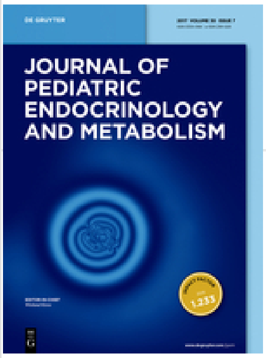

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