Original Article

Protective effects of a Mediterranean-like dietary pattern on obesity, abdominal obesity and large neck circumference in a cohort of Turkish children aged 6-9 years

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Background and Objectives: This study evaluated the association of the Mediterranean Diet Quality Index (KIDMED index) with neck circumference, obesity, and abdominal obesity in a national sample of Turkish children aged 6–9 years. It was hypothesized that the Mediterranean diet has beneficial effects on BMI and waist and neck circumferences in children. **Methods and Study Design:** The study sample consisted of 900 children aged 6–9 years recruited from seven primary schools in Ünye District in Ordu, Turkey. Anthropometric data were collected. The KIDMED score was used to assess the children's adherence to the Mediterranean diet. **Results:** Compared with girls, a higher percentage of boys were obese (27.9% vs 22.2%), and the KIDMED score differed between boys (4.89±2.0) and girls (5.27±2.48; $p<0.05$). Only 18.7% of children had optimal KIDMED scores, and 35.7% had poor KIDMED scores. Compared with boys and girls with medium and optimal KIDMED scores, boys and girls with poor KIDMED scores had higher body weight, height, BMI, and waist and neck circumferences ($p<0.05$). KIDMED scores of overweight boys and girls were higher than those of obese boys and girls ($p<0.05$). An inverse correlation was found between KIDMED scores and body weight, BMI, and waist and neck circumferences. **Conclusions:** The Mediterranean dietary pattern is significantly associated with improved anthropometric measurements in children. These results demonstrate that providing a diet similar to the Mediterranean diet can prevent obesity and related disorders in children.

Key Words: children, Mediterranean diet, obesity, abdominal obesity, neck circumference

INTRODUCTION

Childhood overweight and obesity have become worldwide public health concerns. The rising prevalence of childhood obesity has been found in both developed and developing countries.[1] According to the 2016 World Health Organization (WHO) report, more than 340 million children and adolescents aged 5–19 years are either overweight or obese.[2] In a pooled analysis of population-based studies including 31.5 million children and adolescents aged 5–19 years, it was concluded that the mean Body mass index (BMI) and the prevalence of obesity increased worldwide. This indicates an alarming trend of global increases in the prevalence of obesity from 0.7% to 5.6% in girls and from 0.9% to 7.8% in boys between 1975 and 2016.[3] A previous study found that the prevalence of childhood and adolescent obesity increased 11.6-fold, indicating an increase from 0.6% to 7.3% between 1990–1995 and 2011–2015 in Turkey.[4]

Obese babies and young children likely continue to be obese during childhood, adolescence, and adulthood.[1] Furthermore, childhood obesity increases the risk of obesity-related disorders such as dyslipidemia, hypertension, and diabetes mellitus. Multiple risk factors exist for childhood obesity. The most common cause of obesity in children is the positive energy balance due to hypercaloric food intake. Thus, the quality and quantity of nutritional intake in children are important to protect their health status.[5]

The Mediterranean diet is widely known as one of the healthiest dietary patterns. Current evidence suggests that greater adherence to the Mediterranean-like dietary pattern is associated with a significant improvement in health status.[6] The quality of the Mediterranean diet can be measured using the Mediterranean Diet Quality Index for children and adolescents (KIDMED index).[7] The KIDMED index is the most widely used scoring system[8] to assess the eating habits and nutritional status of children.[7] Additionally, anthropometric measurements are simple, noninvasive, time-saving, preferred, low-cost, and

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easy-to-apply screening tools that are applied in large population-based studies to screen the nutritional status of children and adolescents.[9,10]

BMI is the common anthropometric index used to assess the nutritional status of children in epidemiological studies.[9,11-16] Waist circumference (WC) is widely used as a simple measure to measure the extent of abdominal obesity. WC can be used as a reference for nutritional assessment at early ages.[17] Neck circumference (NC) is a reliable and easy-to-use alternative anthropometric index for assessing fat accumulation in the upper body.[18,19] NC is significantly correlated with adiposity,[20,21] and it can be used to identify overweight and obese children.[20]

The Mediterranean diet could have beneficial effects on BMI and WC in children.[6] In a school-age population, it was found that children that following the Mediterranean diet had a normal weight range than their overweight peers.[22] An inverse correlation was found between KIDMED scores and BMI, WC, and fat mass in a cross-sectional study in 1643 adolescents aged 11–16 years. It was found that good adherence to the Mediterranean diet reduced the risk of being overweight or obese by 30%.[23] A large cohort study in 16,220 children aged 2–9 years showed that high Mediterranean diet scores were inversely associated with overweight and obesity; the Mediterranean diet also protected against increases in BMI, WC, and waist-to-height ratio.[24] In addition, a negative correlation was found between the mean KIDMED index and BMI in Turkish children and adolescents.[25]

This study evaluated the association of the KIDMED index with NC, obesity, and abdominal obesity in a national sample of Turkish children aged 6–9 years. It was hypothesized that the Mediterranean diet has beneficial effects on BMI, WC, and NC in children.

METHODS

Study population and design

This cross-sectional study was conducted at seven primary schools in Ünye District in Ordu, Turkey. The sample size was calculated considering that the total number of students aged 6–9 years in the academic year 2016–2017 was 5500, with a tolerable error of 4% and a confidence level of 99%, resulting in a minimum sample of 873. Children were selected through the simple random sampling process. The number of students to be sampled in each school was determined according to gender, age, and school capacity. A total of 900 children comprising 455 (50.6%) boys and 445 (49.4%) girls aged 6–9 years were included and evaluated in the study to assess the association of KIDMED index with NC, obesity, and abdominal obesity. Children who experienced any health problem that may alter their nutritional status or body composition were excluded from the study.

Written informed consent was obtained from all children's parents or guardians after inviting them to participate in the study. The present study was conducted according to guidelines in the Declaration of Helsinki. This study was approved by the Ethics Committee of Eastern Mediterranean University (approval date: 30.05.2016, approval no: 2016/28-13). Official permission was also obtained from Ordu Province Directorate of National Education.

A semi-structured questionnaire containing questions for collecting data on socioeconomic and demographic characteristics, such as age, gender, and name of the school, was used. Anthropometric measurements, including weight, height, NC, and WC, were conducted, and BMI was calculated. Adherence to the Mediterranean diet was assessed using the KIDMED Index.[7] All questions were filled in by the researcher dietician in a face-to-face interview. All anthropometric measurements were also conducted by the same dietician.

Anthropometric evaluation

Data collection was performed in a suitable environment and in a different room within school hours. All measurements were conducted by a trained researcher dietician in accordance with standard procedures.

Weight, height, and BMI

Body weight measurement was conducted without shoes and heavy clothing to the nearest 0.1 kg by using a standard electronic digital scale with a maximum capacity of 150 kg. Height measurement was conducted without shoes to the nearest 0.5 cm with a nonelastic tape and in the Frankfort plane position.[26] BMI was calculated by dividing the weight in kilograms by the square of the height in meters. The cut-off point of WHO BMI for age and gender percentiles was used to categorize BMI.[27]

Waist circumference

WC was measured at the end of normal expiration to the nearest 0.5 cm by using a nonelastic tape at the point midway between the lowest rib and the top of the iliac crest, with the participant in the standing position. WC was classified according to the percentiles (3rd, 10th, 25th, 50th, 75th, 90th, and 97th percentiles for children aged 0–6 years and 3rd, 5th, 10th, 25th, 50th, 75th, 85th, 90th, 95th, and 97th percentiles for children aged 7–17 years) for Turkish children by age and gender.[28,29]

Neck circumference

NC was measured using a nonelastic tape at the level of the most prominent portion at the thyroid cartilage, with children standing upright and their head held erect, eyes facing forward, and shoulders relaxed and with an accuracy of 0.1 cm. NC was classified according to the percentiles (3rd, 5th, 15th, 25th, 50th, 75th, 85th, 90th, and 95th percentiles) for Turkish children aged 6–18 years by age and gender.[30]

Assessment of Mediterranean diet patterns

KIDMED index

Mediterranean diet quality was measured using the KIDMED index. This index is a simple tool that was developed to assess the eating habits and nutritional status of children and adolescents. It is also a validated tool for evaluating the degree of adherence to the Mediterranean diet. It consists of 16 yes-or-no questions and can be used by a dietician as a part of an interview. Items with yes answers having a positive relationship with the Mediterranean diet (items 1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 13, and 15) are scored as +1. Items with yes answers negatively related to the Mediterranean diet (items 2, 12, 14, and 16) are scored as -1. As a result, the total score ranges from -4 to 12. In the present study, adherence to the Mediterranean diet was classified into three levels based on KIDMED scores: score 8-12, optimal adherence to the Mediterranean diet (good); score 4-7, average adherence to the Mediterranean diet (medium); and score ≤3, very poor adherence to the Mediterranean diet (poor).[7]

Statistical analyses

Statistical analyses were performed using the software package of SPSS Statistics for Windows (version 20.0, Statistical Package for the Social Sciences). Data are expressed as the mean and standard deviation for continuous variables and as numbers (percentage) for categorical variables. Variables were tested for normality using the Kolmogorov–Smirnov test. It was determined that the data set followed normal distribution. Thus, parametric hypothesis tests were used in the study. The independent sample t test was used to determine differences between two independent groups (gender). Anthropometric characteristics were evaluated using Student's t-test. One-way ANOVA was used for multiple comparisons, and differences between two groups were tested using Dunnett's T3 test or Bonferroni test, as appropriate. Differences between categorical variables were tested using the chi-square test. Correlations between the KIDMED index and anthropometric measures were determined using Pearson correlation coefficients, adjusted for age and gender. Hypotheses were tested at 5% significance level.

RESULTS

Age and anthropometric characteristics of children by gender are presented in Table 1. The mean age of children was 7.4 years. The mean body weight was 28.6 kg (28.9 kg in boys and 28.3 kg in girls), mean height was 126 cm (127 cm in boys and 126 cm in girls), mean BMI was 17.5 kg/m^2 (17.5 kg/m^2 in boys and 17.5 kg/m^2 in girls), mean WC was 58.2 cm (59.0 cm in boys and 57.4 cm in girls), and mean NC was 27.0 cm (27.4 cm in boys ad 26.7 cm in girls). A significant difference was observed in WC and NC measurements between boys and girls (p<0.05).

According to the WHO, the overall prevalence rates of childhood overweight and obesity are 11.2% and 25.1%, respectively. In this study, the percentage of obesity was higher in boys (27.9% vs 22.2%) than in girls (Table 1).

KIDMED scores differed between boys (4.8±2.0) and girls (5.2±2.48; p<0.05). KIDMED scores were 5.0±2.45 in the overall sample, and only 18.7% of children had an optimal score (≥8); 35.7% were classified as having poor KIDMED scores (Table 2).

Compared with boys and girls with medium and optimal KIDMED scores, those with poor KIDMED scores had higher body weight, height, BMI, WC, and NC (p<0.05; Table 3).

Boys with normal weight had higher KIDMED scores (6.0±1.77) than overweight (3.5±1.41) and obese boys (2.3±1.30; p=0.001). Girls with normal weight had higher KIDMED scores (6.3±1.79) than overweight (3.3±1.32) and obese girls (2.4±1.51; p=0.001). Moreover, KIDMED scores of overweight boys and girls were higher than those of obese boys and girls (p=0.001; Table 4).

Boys with WC in 25–75th percentiles had higher KIDMED scores (4.9±2.39) than did those with WC in 75–90th percentiles (3.1±1.57) and >90th percentiles (2.0±1.38; p=0.001). Girls with WC in 25–75th percentiles had higher KIDMED scores (5.3±2.44) than did those with WC in 75–90th percentiles (4.0±2.24) and >90th percentiles (1.9±1.30; p=0.001). Moreover, both boys and girls with WC in 75–90th percentiles had higher KIDMED scores than did those with WC in >90th percentiles (p=0.001; Table 4).

Table 1. Anthropometric characteristics of children by gender

Anthropometric characteristics, mean±SD	Boys (n=455)	Girls (n=445)	Total sample (n=900)	p
Age†	7.5±1.14	7.4±1.18	7.5±1.16	0.148
Body weight (kg)†	28.9±9.12	28.3±9.59	28.6±9.36	0.396
Height (cm)†	127±10.1	126±11.0	126±10.5	0.052
Waist circumference (cm)†	59.0±9.2	57.4±9.66	58.2±9.47	0.012
Neck circumference (cm)†	27.4±2.22	26.7±2.31	27.0±2.29	<0.0001
BMI (kg/m^2) †	17.5±2.5	17.5±3.63	17.5±3.56	0.811
BMI classification, n (%) *				<0.0001
<5	30 (6.6)	25 (5.6)	55 (6.1)	
5-15	30 (6.6)	30 (6.7)	60 (6.7)	
15-85	219 (48.1)	239 (53.8)	458 (50.9)	
85-95	49 (10.8)	52 (11.7)	101 (11.2)	
>95	127 (27.9)	99 (22.2)	226 (25.1)	

†Student's t-test was used to calculate the p value; *Chi-square test was used to calculate p value.

Table 2. KIDMED scores of children according to gender

	Boys	Girls	Total	p
KIDMED score, mean±SD	4.8±2.40	5.2±2.48	5.0±2.45	0.019
KIDMED score adherence groups, n (%)				<0.0001
Poor	172 (37.8)	150 (33.7)	322 (35.7)	
Medium	214 (47.0)	196 (44.0)	410 (45.6)	
High	69 (15.2)	99 (22.3)	168 (18.7)	

Student's t-test was used to calculate the p value.

Table 3. Anthropometric characteristics of children according to KIDMED score categories

		KIDMED score (-4 to 12), mean±SD					
		Poor	Medium	Good	p_1	p_2	p_3
Boys	Body weight (kg)	35.7±9.85	24.9±5.87	24.2±3.67	<0.0001	<0.0001	0.371
	Height (cm)	130±10.3	124±9.36	127±9.30	<0.0001	0.018	0.056
	Waist circumference (cm)	66.2±10.0	54.9±5.46	55.0±5.08	<0.0001	<0.0001	0.843
	Neck circumference (cm)	29.0±2.30	26.3±1.44	26.3±1.31	<0.0001	<0.0001	0.780
	BMI (kg/m^2)	20.5±3.36	15.9±2.05	14.9±1.42	<0.0001	<0.0001	0.001
Girls	Body weight (kg)	36.5±11.3	24.7±5.12	23.3±4.05	<0.0001	<0.0001	0.019
	Height (cm)	130±12.4	123±9.64	124±9.44	<0.0001	<0.0001	0.472
	Waist circumference (cm)	65.2±11.39	53.7±5.58	53.8±5.53	<0.0001	<0.0001	0.852
	Neck circumference (cm)	28.5±2.64	25.8±1.44	25.6±1.20	<0.0001	<0.0001	0.179
	BMI (kg/ m^2)	21.0±3.62	16.0±1.91	14.9±1.34	<0.0001	<0.0001	<0.0001

p_1: poor-medium KIDMED score; p_2: poor-good KIDMED score; p_3: medium-good KIDMED score.
Bonferroni test was used to calculate p value.

Table 4. Mean KIDMED scores of children according to age and gender percentiles of BMI and waist and neck circumferences

	Gender		n	KIDMED score (mean±SD)	p	Post-Hoc
BMI percentiles	Boys	<5	30	7.2±1.59^1	0.001	
		5-15	30	6.9±1.21^2		1>3,4,5
		15-85	219	6.0±1.77^3		2>3,4,5
		85-95	49	3.5±1.41^4		3>4,5
		>95	127	2.3±1.30^5		4>5
	Girls	<5	25	7.6±1.38^1	0.001	
		5-15	30	7.3±1.29^2		1>3,4,5
		15-85	239	6.3±1.79^3		2>3,4,5
		85-95	52	3.3±1.32^4		3>4,5
		>95	99	2.4±1.51^5		4>5
NC percentiles	Boys	<5	55	6.3±1.54^1	0.001	
		5-15	56	6.3±1.55^2		1>3,4,5
		15-85	197	5.4±2.26^3		2>3,4,5
		85-95	63	4.0±2.16^4		3>4.5
		>95	84	2.3±1.55^5		4>5
	Girls	<5	50	6.9±1.50^1	0.001	
		5-15	56	6.4±1.77^2		1>3,4,5
		15-85	206	5.9±2.17^3		2>4,5
		85-95	64	3.8±2.16^4		3>4,5
		>95	69	2.3±1.68^5		4>5
WC percentiles	Boys	<10	95	6.3±1.56^1		
		10-25	147	5.8±2.03^2		1>3,4,5
		25-75	93	4.9±2.39^3	0.001	2>3,4,5
		75-90	60	3.1±1.57^4		3>4.5
		>90	60	2.0±1.38^5		4>5
	Girls	<10	113	6.6±1.55^1	0.001	
		10-25	76	6.1±2.04^2		1>3,4,5
		25-75	152	5.3±2.44^3		2>4,5
		75-90	52	4.0±2.24^4		3>4,5
		>90	52	1.9±1.30^5		4>5

One-Way ANOVA test was used to calculate p value. Dunnett's T3 test was used to calculate differences between two groups.

Boys with NC in 15–85th percentiles had higher KIDMED scores (5.4±2.26) than did those with NC in 85–95th percentiles (4.0±2.16) and >95th percentiles (2.3±1.55; p=0.001). Girls with NC in 15–85th percentiles had higher KIDMED scores (5.9±2.17) than did those with NC in 85–95th percentiles (3.8±2.16) and >95th percentiles (2.3±1.68; p=0.001). Moreover, both boys and girls with NC in 85–95th percentiles had higher KIDMED scores than did those with NC in >95th percentiles (p=0.001; Table 4).

Table 5 shows the distribution of KIDMED scores according to the anthropometric measurement percentile values of children. A statistically significant difference was found between the distribution of KIDMED scores and BMI percentiles (χ^2=27,799, p<0.0001 in boys; χ^2=278,476, p<0.0001 in girls), NC percentiles (χ^2=164,271, p<0.0001 in boys; χ^2=163,226, p<0.0001 in girls) and WC percentiles (χ^2=180,415, p<0.0001 in boys; χ^2=157,677, p<0.0001 in girls) in both boys and girls, respectively. A downward trend between the distribution of KIDMED scores according to BMI and NC and WC percentiles was also found. Only 0.8% and 2.0% of obese boys and girls had high KIDMED scores, 7.9% and 9.1% of them had medium KDIMED scores, and 91.3% and

Table 5. Distribution of KIDMED scores according to age and gender percentiles of BMI and waist and neck circumferences

		KIDMED score						X^2	df	*p*
		Poor		Medium		High				
		n	%	n	%	n	%			
BMI percentiles										
Boys	<5	0	0.0	18	60.0	12	40.0			
	5-15	0	0.0	18	60.0	12	40.0			
	15-85	28	12.8	147	67.4	43	19.7	27.799	8	<0.0001
	85-95	28	56.0	21	42.0	1	2.0			
	>95	116	91.3	10	7.9	1	0.8			
Girls	<5	0	0.0	12	48.0	13	52.0			
	5-15	0	0.0	13	43.3	17	56.7			
	15-85	24	10.0	149	62.3	66	27.6	278.47	8	<0.0001
	85-95	38	73.1	13	25.0	1	1.9			
	>95	88	88.9	9	9.1	2	2.0			
NC percentiles										
Boys	<5	2	3.6	39	70.9	14	25.5			
	5-15	4	7.1	41	73.2	11	19.6			
	15-85	55	27.9	104	52.8	38	19.3	164.271	8	<0.0001
	85-95	36	57.1	21	33.3	6	9.5			
	>95	75	89.3	9	10.7	0	0.0			
Girls	<5	3	6.0	28	56.0	19	38.0			
	5-15	3	5.4	35	62.5	18	32.1			
	15-85	45	21.8	104	50.5	57	27.7	163.226	8	<0.0001
	85-95	39	60.9	21	32.8	4	6.3			
	>95	60	87.0	8	11.6	1	1.4			
WC percentiles										
Boys	<10	6	6.3	67	70.5	22	23.2			
	10-25	29	19.7	88	59.9	30	20.4			
	25-75	35	37.6	41	44.1	17	18.3	180.415	8	<0.0001
	75-90	46	76.7	14	23.3	0	0.0			
	>90	56	93.3	4	6.7	0	0.0			
Girls	<10	5	4.4	75	66.4	33	29.2			
	10-25	12	15.8	44	57.9	20	26.3			
	25-75	53	34.9	60	39.5	39	25.7	157.677	8	<0.0001
	75-90	31	59.6	14	26.9	7	13.5			
	>90	49	94.2	3	5.8	0	0.0			

88.9% of them had poor KIDMED scores. Similarly, none of the abdominally obese children had high KIDMED scores, 6.7% and 5.8% of them had medium KIDMED scores, and 93.3% and 94.2% of them had poor KIDMED scores.

A negative correlation was found between KIDMED scores and body weight ($r=-0.615$, $p<0.0001$), BMI ($r=-0.729$, $p<0.0001$), WC ($r=-0.589$, $p<0.0001$), and NC ($r=-0.593$, $p<0.0001$; Table 6).

DISCUSSION

Increasing evidence indicates that high BMI in children may be associated with obesity and other cardiometabolic abnormalities.[9,11-16] The results of recent studies suggest that adherence to the Mediterranean-like dietary pattern in childhood has positive effects on body composition and anthropometric measurements.[22-25]

In this study, the overall prevalence rates of childhood overweight and obesity were 11.2% and 25.1%, respectively (Table 1). In a previous study, the prevalence of childhood obesity in the United States was found to be 18.5%.[31] The prevalence of overweight and obesity among children aged 9–10 years in Southern Italy was found to be 30.5% and 13.8%, respectively.[32] The prevalence of childhood overweight and obesity varies in regions due to environmental factors. Therefore, increasing access to and availability of healthy foods, enhancing national food culture, implementing healthy food subsidies, and increasing the quality of diet are needed to protect children from becoming overweight or obese.[31-33] Moreover, in this study, boys were more obese (27.9% vs 22.2%) than girls, similar to the findings of other epidemiological studies.[23,33]

According to the 2018 WHO report, the number of school-age children and adolescents with obesity has increased more than 10-fold in the past 40 years. Therefore, childhood obesity is one of the most serious global public health challenges affecting every country in the world.[34]

Table 6. Spearman correlation coefficients between KIDMED score and anthropometric measurements

		KIDMED score	Body weight	WC	NC	BMI
KIDMED score	r	1	-0.615	-0.589	-0.593	-0.729
	p		<0.0001	<0.0001	<0.0001	<0.0001

Childhood obesity may profoundly affect children's physical health, especially their social and emotional well-being. Compared with children within the range of healthy weight, those who are overweight or obese are more likely to experience negative consequences, including lower quality of life, lower self-esteem, poorer academic performance, and higher risk of obesity in adulthood.[35] Because early adiposity may lead to adverse health consequences in later years,[36] such as metabolic, cardiovascular, orthopedic, neurological, hepatic, and pulmonary disorders in adult life,[37] it should be closely monitored at younger ages to prevent complications that may occur later.[36] Thus, preventing obesity is contribute to children's health and well-being.[34]

Increases in total calorie and fat intake and excessive sugar intake, especially from soft drinks, have played a major role in the increasing prevalence of childhood obesity worldwide.[35] Accordingly, improving the quality of nutrition is essential to protect children's health status and to prevent obesity.[5] In childhood, energy-dense and low-nutrition food items are consumed more often than high-nutrition food items; thus, diet quality decreases.[38] Mediterranean diet quality can be measured using simple tools including the KIDMED index, which is the most widely used scoring system[8] to assess the eating habits and nutritional status of children.[7]

A study conducted in children aged 10–14 years in Turkey indicated that 59.2% of children had average adherence to the Mediterranean diet, 22.9% had optimum quality diet, and 17.9% had a very low quality diet.[39] In a sample of Spanish school children aged 8–10 years, the KIDMED index classification was determined to be average adherence in 49.5% of the population, optimal in 48.6%, and poor in 1.6%.[40] In a study conducted in Cyprus in children aged 9–18 years, the results revealed that 22.7% of the population was classified as having high adherence to the Mediterranean diet, 59.0% had average adherence, and 18.3% had poor KIDMED scores.[25] Mediterranean diet adherence widely varied within Mediterranean countries for both children and adolescents; scant data are available for non-Mediterranean countries.[8] In this study, 45.6% of children had medium KIDMED scores, only 18.7% had optimal KIDMED scores, and 35.7% had poor KIDMED scores (Table 2).

KIDMED scores were 4.8±2.0 in boys and 5.2±2.48 in girls ($p<0.05$). KIDMED scores of boys aged 10–14 years were 5.5±2.24 in the present study compared with 5.7±2.47 for girls in a different study ($p>0.05$).[39] A previous study found that KIDMED scores of boys and girls aged 9–13 years were 5.9±2.41 and 5.8±2.17, respectively.[25] Studies have obtained different results for overall diet quality in children according to gender.[41,42]

The Mediterranean diet-like dietary pattern is associated with weight status; therefore, improvement of dietary habits is an important lifestyle modification that can prevent overweight and obesity in the early stages of life.[23] In this study, compared with boys and girls with medium and optimal KIDMED scores, those with poor KIDMED scores had higher body weight, height, BMI, WC, and NC ($p<0.05$; Table 3). Similarly, in a previous study, school-age (8–17 years) children with normal weight had greater adherence to the Mediterranean diet than their overweight peers.[22] A cross-sectional study in adolescents aged 11–16 years showed that good adherence to the Mediterranean-like diet resulted in a 30% decrease in odds of being overweight or obese in both boys and girls.[23] Adherence to the Mediterranean diet was inversely associated with obesity in a sample of children aged 9–13 years. Consistently, compared with children with poor KIDMED scores, those with high KIDMED scores were 80% less likely to be overweight or obese.[43]

Compared with children with poor KIDMED scores, those with moderate and optimal KIDMED scores may have greater diet quality. Children with higher KIDMED scores are more likely to make healthy food choices.[38,44] It was emphasized that Mediterranean diet adherence is directly associated with physical activity and possibly diet adequacy.[8] A cross-sectional study investigated the dietary energy density factor score (DED-FS) and dietary energy density (DED) in Spanish children and adolescents aged 10–24 years and concluded that the KIDMED score was negatively associated ($p<0.001$) with DED and DED-FS. Higher DED is a risk for increased central fat distribution and is associated with poor adherence to the Mediterranean diet.[44]

The prevalence of overweight and obesity is higher among children consuming low-quality diet compared with those consuming a healthy diet in a study sample of 2818 children aged 6–17 years.[45] In this study, KIDMED scores of boys and girls with normal weight were higher than those of overweight/obese boys and girls. Moreover, abdominal obese boys and girls had lower KIDMED scores than their peers with weight in the normal range. These results revealed that children with normal NC (15–85th percentiles) had higher KIDMED scores than did those with NC in 85–95th percentiles and >95th percentiles (Table 4).

Similarly, in a cohort of Greek children, it was determined that overweight and obese children had significantly lower KIDMED scores than children with normal BMI.[46] A study that recruited 16,220 children aged between 2–9 years from study centers in eight European countries showed that high scores were inversely associated with overweight, obesity and percent fat mass.[24] Lifestyle intervention related to nutrient adequacy and diet quality in children with abdominal obesity can reduce BMI, ensure better nutritional adequacy, and improve diet quality.[47]

BMI was positively correlated with body fat percentage (%BF) and WC among 3750 Japanese school-age children.[48] A study in Italian children aged 7–13 years demonstrated a positive correlation between BMI and WC.[49] In the present study, a downward trend was found for the distribution of KIDMED scores according to the BMI, NC, and WC percentiles. Only 0.8% and 2.0% of obese boys and girls had high KIDMED scores, 7.9% and 9.1% of them had medium KIDMED scores, and 91.3% and 88.9% of them had poor KIDMED scores. Similarly, none of the abdominal obese children had high KIDMED scores, 6.7% and 5.8% of them had medium KIDMED scores, and 93.3% and 94.2% of them had poor KIDMED scores (Table 5).

NC was associated with BMI and abdominal obesity in children and adolescents aged 7–18 years.[18] In a cross-sectional study conducted in 2794 students aged 6–19 years in Brazil, NC was significantly correlated with BMI, WC, and %BF.[50] In a cross-sectional study in 1474 adolescents aged 12–17 years in Brazil, a positive correlation between NC and WC was found, and NC and BMI were found to be good indicators of adiposity. As a result, NC can be used to identify adolescents with high BMI.[51] In another study in children aged 6–18 years (n = 1102), NC was significantly correlated with BMI and WC in both boys and girls. That study emphasized that NC can reliably be used to identify children with high BMI.[20] Based on the aforementioned, NC, WC, and BMI are all highly correlated.

In this study, negative correlations were found between KIDMED scores and BMI ($r=-0.729$, $p<0.0001$), body weight ($r=-0.615$, $p<0.0001$), WC ($r=-0.589$, $p<0.0001$), and NC ($r=-0,593$, $p<0.0001$; Table 6). Limited studies have addressed the specific association between Mediterranean diet and general obesity/abdominal obesity in children and have suggested the potential protective effects of the diet and general obesity/abdominal obesity.[22-25] Until now, no study has investigated the association of the Mediterranean diet with NC. An inverse correlation was found between KIDMED scores and BMI, WC, and fat mass in a previous stuyd.[23] Moreover, a negative weak correlation was found between mean KIDMED scores and BMI in a sample of Turkish children and adolescents ($p<0.05$).[25] Adherence to the Mediterranean diet was consistently and negatively associated with body fat percentage ($r=-0.302$) and subscapular skinfold thickness ($r=-0.329$) in a cross-sectional study in 10-year-old children in Chile.[52] Higher KIDMED scores were negatively associated with BMI in a sample consisting of 1305 children and adolescents aged 3–18 years.[53]

Conclusion

The Mediterranean-like dietary pattern is directly associated with anthropometric measurements in children. Greater adherence to the Mediterranean-like dietary pattern is associated with a significant improvement in anthropometric measurements. The Mediterranean-like dietary pattern may reduce BMI, body weight, WC, and NC. Thus, a dietary pattern improving weight status, WC, and NC to prevent obesity and associated disorders must be adopted by children. Finally, additional studies on BMI, body weight, WC, and NC, including metabolic risk parameters, would strengthen the evidence of their relationship with the Mediterranean-like dietary pattern in children.

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AUTHOR DISCLOSURES

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