Original Article

The Association between Diet Quality Indices and Obesity: Tehran Lipid and Glucose Study

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Abstract

Background: The aim of this study was to investigate the ability of diet quality indices in predicting obesity and abdominal obesity in a population in nutrition transition.

Methods: This study explored the association of the Mediterranean Diet Scale (MDS), Healthy Eating Index-2005 (HEI-2005), and Diet Quality Index-International (DQI-I) with body mass index (BMI) and waist circumference (WC) in a cross-sectional study after 6.7 years of follow-up in the Tehran Lipid and Glucose Study (TLGS) population.

Results: Out of 192 subjects who had BMI < 25kg/m^2 and of 283 subjects who were free of abdominal obesity at baseline, 39.6% developed overweight and obesity and 43.1% developed abdominal obesity, respectively during 6.7 years of follow-up in the study population. In cross-sectional analysis, after adjusting for age, sex, energy intake, physical activity and smoking status, multivariate analysis of covariance did not show any significant results regarding the relation of the diet quality indices, BMI and WC. According to follow-up analysis, none of the indices had significant associations with BMI and WC after adjustments for confounders and baseline values of BMI and WC.

Conclusion: Adherence to MDS, HEI-2005, and DQI-I could not predict BMI and WC in Iranian participants after 6.7 years of follow-up.

Keywords: Abdominal obesity, diet quality, obesity

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Introduction

Obesity is one of the known modifiable causes of several cardio-metabolic risk factors that has a possible causal association with cancer[1] and a definite relationship with cardiovascular diseases.[2] One of the underlying mechanisms for these chronic diseases is insulin resistance[1,3] which may be induced by general and abdominal obesity.[1,4]

In recent years, Iran and other developing countries are experiencing a nutrition transition, a situation that shows a shift in disease pattern according to nutrition-related non-communicable diseases.[5] Obesity is one consequence of nutrition transition[6] and improvement in lifestyle has been considered a key strategy in reducing this trend[7]; diet, as one of the main constituents of the lifestyle, plays a crucial role. Substantial evidence suggests an association between different components of diet including energy, food groups and nutrients with obesity[8–12]; however, the interaction between foods and nutrients prompts investigators to assess overall dietary patterns in relation to obesity.[13] Healthy dietary patterns are inversely associated with obesity and abdominal obesity. The empirically-derived approach has been studied in Iran, and it has shown that healthy dietary patterns are predictors of obesity.[14] Reduced rank regression approach showed an inverse relation with obesity.[15] As different approaches of dietary pattern should run parallel, evaluations in different parts of the world have evaluated the index-based dietary pattern approach in relation to obesity.[16–22]

Three dietary pattern indices have recently been identified, including the Healthy Eating Index-2005 (HEI-2005),[23] the Mediterranean Diet Scale (MDS),[24] and the Diet Quality Index-International (DQI-I).[25] Although studies on the above indices from developing countries are scant, there are data in relation to body mass index (BMI) and waist circumference (WC) from the US and European countries.[16–21] However, the results of previous studies are not consistent enough to confirm a strong inverse relationship between these diet quality indices with BMI and WC; hence assessment of their validity in other populations is necessary. Considering that the association of diet quality and obesity outcomes has not been evaluated in Iran, the current study was designed to examine the ability of MDS, HEI-2005, and DQI-I to predict obesity and abdominal obesity and to compare predictive ability of the indices

Materials and Methods

Design and study population

This study is a part of the Tehran Lipid and Glucose Study (TLGS), an ongoing urban population-based prospective cohort study investigating non-communicable chronic disease risk fac-

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tors in district No. 13 of Tehran, the capital of I.R. Iran.[26,27] TLGS enrolled 15005 participants (3 to 75 years old) between March 1999 and December 2002. Every three years, study participants have been invited to update their demographic, lifestyle, medical and dietary information and biochemical measurements. We followed two approaches in the current study: a) evaluation of the association of diet quality indices with BMI and WC in a cross-sectional design and b) evaluation of the association of the diet quality indices with BMI and WC after 6.7 years of follow-up. Of the total participants recruited at baseline, dietary data were collected randomly for 1474 individuals, 820 of whom were ≥ 19 years of age. Pregnant or lactating subjects (n = 6), or those who did not have relevant dietary data on diet quality scores (n = 54), those who changed their diet intentionally (n = 46), did not have anthropometric data (n = 2), and over- or underreported (n = 4) were excluded, leaving us with 708 subjects (314 males and 394 females) for cross-sectional analysis. Over- or under-reporting subjects were considered to be those in the top and bottom 1% of energy intake to estimated energy requirement ratio.[28] Of the 708 subjects, 467 enrollees (214 males and 253 females) completed the follow-up period.

The study protocol was approved by the Ethics Committee of the Research Institute for Endocrine Sciences of Shahid Beheshti University of Medical Sciences and informed written consent was obtained from each subject.

Dietary intake assessment

At baseline, dietary intake data were collected via two, 24-hr dietary recalls conducted at approximately a 10-day interval, face to face, by the same trained dietary interviewers who had at least 3–5 years of experience in the Nationwide Food Consumption Survey project and the TLGS[29] according to a standardized protocol. Interviews lasted 20 min on average. The first recall was performed at subjects' homes and the second at the nutrition unit of the TLGS. Subjects were asked whether the recall days were typical days. Investigators reviewed both 24-hr dietary recalls and any questions raised were resolved with participants. The portion size or household measures for each food item were converted to grams.[30] Mixed dishes in 24-hr dietary recalls were converted into their ingredients according to each subject's report on the amount of the food item consumed. All consumed food items were analyzed for their energy and nutrient content using a nutrient database (Nutritionist III, Mosby Nutritract software, version 7.0, N-Squared Computing, Salem, OR, USA), which was modified according to the Iranian Food Composition Table.[31]

Diet quality scores

Mediterranean Diet Scale (MDS)

The MDS was determined by using a 9-point scale proposed by Trichopoulou[32] to evaluate the level of conformity of the individual's diet to the Mediterranean dietary pattern. Sex-specific median intakes of food groups were calculated. The components of MDS were modified as follows: the fruit and nuts component was divided into two groups; the alcohol component was removed; red meat was added to processed meat and its ratio to white meat was considered as a negative point; whole grains and refined grains were separated; and polyunsaturated fatty acid (PUFA) was substituted for monounsaturated fatty acid (MUFA) intake (Appendix 1).

Healthy Eating Index-2005 (HEI-2005)

The HEI-2005 score developed by Guenther,[23] evaluates adherence of the dietary intake of subjects according to MyPyramid[33] and dietary guidelines.[34] For the current study we modified the scoring system in two ways. We omitted alcohol because our data were unreliable and we simplified the scoring for sodium as described below. As there were no valid data on table salt intake, the sodium component was derived in grams and from the sodium content of foods. The deciles of sodium intake from foods were calculated; 10 points were assigned to the lowest decile and 0 to the highest decile (Appendix 1).

Diet Quality Index-International (DQI-I)

According to Kim et al.,[25] the DQI-I was constructed based on four aspects of a healthy diet that included variety, adequacy, moderation, and balance, each of which has specific elements. Not having reliable data on sodium intake, we scored sodium according to the distribution of population intake. Individuals who consumed sodium over the 85th percentile had 0 points, whereas those less than the 15th percentile had 6 points (Appendix 1).

Measurement of non-dietary factors

Weight and height were measured according to standard protocol, with shoes removed and light clothing. BMI was defined as weight (kg)/height (m)^2. WC was measured at the level of the umbilicus. At baseline subjects reported their physical activity rate using the Lipid Research Clinic (LRC) questionnaire,[35] and were categorized as having light, moderate or strenuous physical activity levels.

Statistical analysis

Baseline characteristics of the TLGS participants were computed and tested for a trend across quartiles of diet quality indices by the Pearson chi-square test for dichotomous variables and linear by linear association for ordinal variables based on weighted data. For the cross-sectional approach of the study, a multivariate analysis of variance (MANOVA) was used to detect an association between BMI and WC both as dependent variables with diet indices as covariates at baseline. For the follow-up approach of the study, MANOVA was used to determine the impact of the dietary indices at baseline on the both BMI and WC after 6.7 years of follow-up with adjustment of baseline values for BMI and WC. Age, sex, energy intake, physical activity and smoking status were included as confounding variables. The parameter estimate and standard error for each diet index was reported.

To calculate sample size, a random subsample, including 20% of the total sample was selected for evaluating the association between dependent variables, BMI and WC, and variables for dietary indices at baseline via multiple regression. We controlled for confounders that included age, sex, energy intake, physical activity, and smoking status. We based our sample calculation on R2 for confounders and R2 changes for variables of dietary indices adjusting for confounders with 0.05 of type I error and 80% power. R2 is the amount added to the overall R-squared value by these variables; it was 0.030 for BMI and 0.028 for WC. Finally, sample sizes of 447 and 480 were calculated for BMI and WC, respectively. Statistical significance was set at $P < 0.05$ (two-tail) for all tests. Data analyses were carried out using SPSS software (version 15.0, SPSS Inc., Chicago, IL) and NCSS software.

Results

Baseline characteristics of participants according to MDS, HEI-2005, and DQI-I quartiles are shown in Table 1. Subjects in the higher levels of adherence to HEI-2005 and DQI-I were older in comparison to those from lower levels ($P < 0.05$; Q1 vs. Q3 of HEI-2005; Q1 and Q2 vs. Q4 of DQI-I). There were more smokers among those in the lowest levels of HEI-2005 and DQI-I ($P < 0.05$) than among those in the highest levels. With increase in adherence to healthier dietary patterns, the percentages of subjects with high levels of physical activity increased ($P < 0.05$; Q1 of HEI-2005 and Q4 of DQI-I). There were more female (30.8%) subjects in the highest quartile of HEI-2005 than males (18.2%, $P < 0.05$). The education status of participants did not show any meaningful trend across different levels of diet quality indices.

Of 192 subjects who had BMI < 25kg/m^2 and of 283 subjects who were free of abdominal obesity at baseline, 39.6% became either overweight or obese and 43.1% developed abdominal obesity. The prevalence of overweight, obesity, and abdominal obesity as well as the mean BMI and WC increased after 6.7 years of follow-up ($P < 0.001$, Table 2).

In cross-sectional and follow-up multivariate analyses of variance, none of the diet quality indices was significantly associated with BMI and WC (Tables 3 and 4). Regression coefficients for a 1-unit increase in MDS score showed no relationship between MDS and BMI (0.1124) and WC (0.015) at baseline and after 6.7 years of follow-up (BMI: -0.087 and WC: -0.134). Similar results were observed for HEI-2005. The regression coefficients for a 1-unit increase in HEI-2005 score for BMI was 0.030 and for WC, it was 0.023 at baseline and after 6.7 years, the scores were -0.002 for BMI and 0.013 for WC. The β coefficients for a 1-unit increase in DQI-I resulted in a 0.009 increase for BMI and

Table 1. Baseline characteristics of the TLGS participants by levels of adherence to MDS, HEI-2005, and DQI-I.

Variables	MDS				HEI-2005				DQI-I			
	Q1	Q2	Q 3	Q 4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Range	≤ 3	4	5	6≤	≤ 51	52–57	58–62	≥ 63	≤ 54	55–59	60–63	≥ 63
n	160	108	97	102	117	116	117	117	116	117	117	117
Age (%)												
19–30 yr	41.2	19.8	17.6	21.4	23.7	32.1	18.3	26.0	31.1	28.2	20.6	19.8
31–40 yr	31.5	19.7	22.0	26.8	33.9	18.1	26.0	22.0	25.2	29.1	22.8	22.8
41–50 yr	28.5	28.5	22.8	20.3	25.2	26.0	26.8	22.0	26.0	22.8	30.9	20.3
> 50 yr	36.0	25.6	20.9	17.4	14.0*	22.1	31.4*	32.6	12.8*	17.4*	26.7	43.0*
Sex (%)												
Male	32.7	23.4	22.0	22.0	25.7	29.4	26.6	18.2	23.4	27.1	25.2	24.3
Female	35.6	22.9	19.8	21.7	24.5	20.9*	23.7	30.8*	26.1	23.3	24.9	25.7
Education status (%)												
< High school	31.7	26.8	19.1	22.4	23.5	22.4	30.1	24.0	20.8	25.1	26.2	27.9
High school	36.7	19.5	18.6	25.2	28.1	26.2	19.5	26.2	30.0	25.7	22.4	21.9
Academic	28.3	26.4	35.8*	9.4	24.5	28.3	26.4	20.8	17.0	26.4	28.3	28.3
Smoking status (%)												
Smokers	37.5	22.9	18.8	20.8	39.6	20.8	16.7	22.9	35.4	22.9	20.8	20.8
Non-smokers	34.4	22.5	21.1	22.0	23.2*	25.2	25.9	25.7	23.7	25.2	25.9	25.2
Physical activity (%)												
High	29.1	21.4	23.1	26.5	17.9	27.4	24.8	29.9	21.4	19.7	28.2	30.8
Moderate	29.5	21.3	26.2	23.0	23.0	31.1	26.2	19.7	21.3	31.1	23.0	24.6
Low	37.8	23.3	18.7	20.1	27.9*	22.3	25.1	24.7	26.9	25.8	24.7	22.6

TLGS= Tehran Lipid and Glucose Study, MDS= Mediterranean Diet Scale, HEI-2005= Healthy Eating Index-2005, DQI-I= Diet Quality Index-International. *$P < 0.05$ for trend across levels of sociodemographic variables, using Pearson chi-square for dichotomous variables and linear-by-linear association for ordinal variables

Table 2. Anthropometric outcomes at baseline and after 6.7 years follow-up: Tehran Lipid and Glucose Study.

	Baseline	After 6.7 years
Overweight (%)	36.2	43.8
Obesity (%)	21.4	28.2
BMI (kg/m^2)	26.1 ± 4.8	27.8 ± 4.8
Abdominal obesity (%)	37.1	61.9
WC (cm)	85.9 ± 12.6	92.2 ± 12.6

BMI= body mass index, WC= waist circumference

Table 3. Parameter estimate (PE) of BMI and WC at baseline for diet quality indices by gender: Tehran Lipid and Glucose Study*.

Variable	BMI			WC		
	PE	SE	P	PE	SE	P
MDS	0.131	0.130	0.312	0.047	0.323	0.884
HEI-2005	0.029	0.026	0.272	0.042	0.065	0.518
DQI-I	0.010	0.029	0.732	0.028	0.072	0.697

BMI= body mass index, WC= waist circumference, SE= standard error, MDS= Mediterranean dietary scale, HEI-2005= healthy eating index-2005, DQI-I= diet quality index-international. *Age, sex, and energy intake were adjusted. Diet quality indices were included as covariates and BMI and WC were included simultaneously as dependent variables in multivariate analysis of covariance models.

Table 4. Parameter estimate (PE) of BMI and WC for diet quality indices at baseline and after 6.7 years: Tehran Lipid and Glucose Study*.

Variable	BMI							WC						
	Baseline			Follow-up			Time × index	Baseline			Follow-up			Time × index
	PE	SE	P	PE	SE	P	P	PE	SE	P	PE	SE	P	P
DS	0.112	0.131	0.393	0.007	0.324	0.983	0.089	0.015	0.134	0.911	-0.039	0.324	0.903	0.829
HEI-2005	0.030	0.026	0.255	0.059	0.066	0.370	0.555	0.023	0.027	0.390	0.059	0.065	0.370	1.000
DQI-I	0.009	0.030	0.751	0.040	0.073	0.581	0.202	-0.007	0.030	0.816	0.014	0.073	0.854	0.578

BMI= body mass index, WC= waist circumference, SE= standard error, MDS= Mediterranean dietary scale, HEI-2005= healthy eating index-2005, DQI-I= diet quality index-international. *Age, sex, and energy intake were adjusted. Diet quality indices were included as covariates and BMI and WC at baseline and after 6.7 years were included simultaneously as dependent variables in repeated measures of multivariate analysis of covariance models.

Table 5. Parameter estimate (PE) of change of BMI and WC for change of diet quality indices by gender: Tehran Lipid and Glucose Study*.

Variable	BMI change			WC change		
	PE	SE	P	PE	SE	P
MDS change	0086	0.124	0.487	0.569	0.469	0.227
HEI-2005 change	-0.022	0.011	0.043	-0.061	0.041	0.135
DQI-I change	-0.008	0.014	0.577	0.012	0.055	0.830

BMI= body mass index, WC= waist circumference, SE= standard error, MDS= Mediterranean dietary scale, HEI-2005= healthy eating index-2005, DQI-I= diet quality index-international. *Age, sex, and change of energy intake were adjusted. Change of diet quality indices was included as covariates and change of BMI and WC were included simultaneously as dependent variables in multivariate analysis of covariance models.

a -0.007 decrease for WC at baseline; the corresponding values were -0.010 (BMI) and 0.009 (WC) after 6.7 years of follow-up.

Discussion

In this population-based cohort study, we compared the performance of MDS, HEI-2005, and DQI-I in the prediction of BMI and WC. We found no significant relationship between diet quality indices, obesity and abdominal obesity.

The ability of diet quality indices to predict obesity and abdominal obesity depends on how well these indices correlate with changes in energy balance as the primary focus in obesity. The structure of indices is the determining factor in this area. The indices do not allocate negative scores to energy intakes above energy requirements.

The MDS is structured to assess the adherence of a Greek population to the Mediterranean dietary pattern and its association to survival.[24] As the Mediterranean food guide pyramid shows, populations of Mediterranean countries are recommended to have daily intakes of whole grain, olive oil, fruit, vegetable, and non-fat or low-fat dairy products; weekly intakes of fish, poultry, olives, pulses, nuts, potatoes, eggs, and sweets; and monthly intakes of red meat.[36] Considering the differences in genetic predisposition, environmental factors and disease pattern in different ethnicities, it seems necessary to develop and promote country-based dietary indices to address the specific characteristics of dietary patterns in relation to disease.[37] In this regard, the Iranian food pattern cannot be judged by the original MDS; therefore, we have modified the MDS according to the Iranian diet[38] to better detect the features of the Mediterranean type diet. For example, Iranians have high intakes of grains as the main source of energy, but most grains are of the refined type. It has been shown that refined grains (white rice and bread) and hydrogenated fats are main features of dietary intake in Middle-Eastern populations.[38] Since this is not in agreement with the Mediterranean food guide pyramid recommendation, we have divided the grains component of MDS into two separate groups of whole and refined, which are considered as positive and negative components, respectively. Although olive oil is one of the main constituents of the Mediterranean diet, a high proportion of unsaturated fatty acids in our country contributes to PUFA rather than MUFA. The low intake of olive and olive oil in our population (the median was zero) has led us to substitute MUFA by PUFA. This was documented in the US and other populations as well.[39]

In our study, BMI and WC were not found to be predicted by MDS, which was similar to the results of other studies.[20,40] However, some studies showed an inverse association.[41,42] Fiber, nuts, fat sources, and energy density are the cornerstone of the physiologic mechanism of the current dietary pattern in that they induce satiety and fat oxidation. As our dietary pattern did not conform to the Mediterranean diet, it did not show the beneficial effects. The median intakes of fish, nuts, and whole grain were zero, which indicated a low frequency consumption of these foods. As the healthy levels of intake for the specific dietary components were not available, we have used the median cut-off values to calculate MDS in our study. This may not have provided a healthy intake level per se but as half of the subjects scored positively and half negatively on each component, this ensured that each item was well differentiated and in the same way for all subjects.[43]

Gao et al. modified the HEI by considering the energy and physical activity in constructing their own "HEI-05" and reported an inverse association between HEI with WC and BMI.[44] This association was also found for the original HEI in the Third National Health and Nutrition Examination Survey.[45] The adjusted odds ratio for subjects who had a poor diet in comparison to a good one was 1.8 for obesity in a sample of 2708 individuals. An inverse association between HEI and risk of abdominal obesity was seen.[17] HEI-2005 also showed a standardized regression coefficient of -0.20 for BMI among low-income women who were in early postpartum.[46] The clinical effect size, not considerable in HEI studies, is an important point and should be considered in associations. In our study, HEI-2005 did not predict BMI or WC after 6.7 years. Intakes of fruit, grains, and vegetables are scored in this index with special focus on whole fruits, whole grains, and dark vegetables as sources of fiber. High HEI-2005 scores are indicative of a dietary pattern high in plant foods with high fiber content. Total calories from solid fat and added sugar (SOFAAs) is another component of HEI-2005 that is weighted as 20% of the total score. Discretionary fat and added sugar play an important role in developing obesity and abdominal obesity. The energy density approach focuses on food and nutrient intakes in proportion to energy intake. Although this approach results in balance among food group intakes, it does not consider extra energy consumption.

DQI-I has been evaluated in relation to obesity in few cross-sectional studies.[19,47] In the current study, DQI-I showed no significant association with anthropometric indices, whereas Gregory found a positive association between BMI and WC with DQI-I.[19] In another cross-sectional study in adolescents, DQI-I did not show any relationship with BMI and obesity status.[47] DQI-I however showed an inverse association with weight gain over an eight-year period. Controversial reports exist on the DQI-I reflection of overall diet quality and its association with cardiovascular risk factors.[19,48,49]

According to the scoring systems of the HEI-2005 and DQI-I, persons consuming over the recommended amounts for food groups receive full points. Therefore these scores do not show the extent to which a person deviates from the recommended values, which can be considered a limitation for these indices.

In the present study, the range of indices including HEI-2005 and DQI-I was narrow, which indicated that scores in the top and bottom quartiles were not far from each other and could not clearly distinguish differences in dietary patterns, and could attenuate the association of diet and outcome. This finding was similar to that reported in another study, in which the lowest category of HEI was 54.5 and the highest was 72.9.[18]

The strengths of our study are its prospective design, the large-size population-based cohort, and the long follow-up duration. The current study is among the first follow-up studies performed in countries undergoing nutrition transition, and its prospective design makes it easy to interpret the association of diet quality indices with BMI and WC.

The main limitations of the current study were first, because dietary intake was assessed through few numbers of dietary recalls, measurement errors were inevitable which might have cause an underestimation of associations. As dietary variations are important in epidemiologic studies, increasing the number of dietary recalls would reduce the with-in person variation. However, the 24-hr dietary recalls were gathered through an in-depth interview conducted by trained dietary interviewers according to protocols. As obesity, unlike certain other diseases, is affected by dietary intakes within the recent past, alteration in dietary pattern during the study period is another limitation that must be mentioned. Finally, the present study had a high rate of loss to follow-up. However, there were no significant differences in mean baseline anthropometric measurements and biochemical assessments between the subgroups of the cohort that provided follow-up assessments and those lost at baseline (data not shown); hence, we believe that our loss to follow up was unlikely to have influenced the findings of the study.

This study reports new findings in the field of diet quality indices in Iran. It supports no relationship with BMI and WC after 6.7 years of follow-up. Due to the obesity and abdominal obesity pandemics, the study suggests constructing diet quality indices that would capture these cardiovascular risk factors.

Conflict of interest

None of the authors had any personal or financial conflicts of interest.

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Appendix 1

Components	MDS			HEI-2005			DQI-I		
	Criteria	Point	Score range	Criteria	Point	Score range	Criteria	Point	Score range
Overall food group variety	—	—	—	—	—	—	Consumption of ≥1 serving from each food group/d	3	0–15
Within-group variety from protein source	—	—	—	—	—	—	≥3 different sources/d	5	0–5
							2 different sources/d	3	
							From 1 source/d	1	
							None	0	
Total vegetables	≥Median	1	0 or 1	≥1.1 cup equiv/1000 kcal	5	0–5	≥100% recommendations*	5	0–5
	<Median	0		Otherwise	P		Otherwise	P	
Dark-green and orange vegetables and legumes	—	—	—	≥0.4 cup equiv/1000 kcal	5		—	—	—
	—	—	—	Otherwise	P				
Total fruits	≥Median	1	0 or 1	≥0.8 cup equiv/1000 kcal	5	0–5	≥100% recommendations*	5	0–5
	<Median	0		Otherwise	P		Otherwise	P	
Whole fruit	—	—	—	≥0.4 cup equiv/1000 kcal	5	0–5	—	—	—
				Otherwise	P				
Total grains	—	—	—	≥3.0 oz equiv/1000 kcal	5	0–5	≥100% recommendations*	5	0–5
				Otherwise	P		Otherwise	P	
Whole grains	≥Median	1	0 or 1	≥1.5 oz equiv/1000 kcal	5	0–5	—	—	—
	<Median	0		Otherwise	P				
Refined grain	<Median	1	0 or 1	—	—	—	—	—	—
	≥Median	0							
Diary	<Median	1	0 or 1	≥1.3 cup equiv/1000 kcal	10	0–10	—	—	—
	≥Median	0		Otherwise	P				
Meat and beans	—	—	—	≥2.5 oz equiv/1000 kcal	10	0–10	—	—	—
				Otherwise	P				
Red to white meat ratio	<Median	1	0 or 1	—	—	—	—	—	—
	≥Median	0							
Fish	≥Median	1	0 or 1	—	—	—	—	—	—
	<Median	0							
Nuts	≥Median	1	0 or 1	—	—	—	—	—	—
	<Median	0							
Legumes	≥Median	1	0 or 1	—	—	—	—	—	—
	<Median	0							
Oils	—	—	—	≥12 grams/1000 kcal	10	0–10	—	—	—
				Otherwise	P		—	—	—
Protein	—	—	—	—	—	—	≥100% recommendations†	5	0–5
							Otherwise	P	
Calcium	—	—	—	—	—	—	≥100% recommendations†	5	0–5
							Otherwise	P	
Vitamin C	—	—	—	—	—	—	≥100% recommendations†	5	0–5
							Otherwise	P	
Iron	—	—	—	—	—	—	≥100% recommendations†	5	0–5
							Otherwise	P	
Fiber	—	—	—	—	—	—	≥100% recommendations‡	5	0–5
							Otherwise	P	
Total fat	—	—	—	—	—	—	≤30% of energy/d	6	0–6
							>30–35% of energy/d	3	
							>35% of energy/d	0	
Saturated fat	—	—	—	≤7% of energy/d	10	0–10	≤7% of energy/d	6	0–6
				≥15% of energy/d	0		>7–10% of energy/d	3	
				Otherwise	P		>10% of energy/d	0	
Cholesterol	—	—	—	—	—	—	≤300 mg/d	6	0–6
							>300–400 mg/d	3	
							>400 mg/d	0	
Sodium¶	—	—	—	1st decile	10	0–10	<15th percentile	6	0–6
				10th decile	0		≥85th percentile	0	
				Otherwise	P		Otherwise	P	
Empty calorie foods	—	—	—	—	—	—	≤3% energy/d	6	0–6
							>3–10% energy/d	3	
							>10% energy/d	0	
SoFAAS	—	—	—	≤20% of energy	20	0–20	—	—	—
				≥50% of energy	0				
				Otherwise	P				
Macronutrient ratio (CHO:protein:fat)	—	—	—	—	—	—	55–65:10–15:15–30	6	0–6
							65–68:9–16:13–32	4	
							50–70:8–17:12–35	2	
							Otherwise	0	
Fatty acid ratio	≥Median PUFA/SFA	1	0 or 1	—	—	—	PUFA/SFA = 1–1.5; MUFA/SFA = 1–1.5	4	0–4
	<Median PUFA/SFA	0					PUFA/SFA = 0.8–1.7; MUFA/SFA = 0.8–1.7	2	
							Otherwise	0	

MDS= Mediterranean Diet Scale; HEI-2005= Healthy Eating Index-2005; DQI-I= Diet Quality Index-International; P= proportionately; SoFAAS= Total calories from solid fat and added sugar; CHO= Carbohydrate; PUFA= Polyunsaturated fatty acid; SFA= Saturated fatty acid; MUFA= Monounsaturated fatty acid. *Based on three energy levels introduced in the Food Guide Pyramid (1992). †According to dietary reference intake recommendations.
‡>20, 25 and 30 g for the three energy levels introduced in the 1992 Food Guide Pyramid, respectively. ¶Based on the distribution of sodium content of foods consumed by the study subjects.