

Original Research Article

Uniformity of and Compliance to the Healthy Eating Index for Meal Plans of Two Commercial Diets

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Abstract

Commercial weight-loss organizations gross billions annually, yet few offer an objective measure of diet quality and/or uniformity of day-to-day nutrient intake. The Healthy Eating Index (HEI), a scoring system to evaluate a set of foods, is ideally suited to provide such a measure. Our objective is to determine HEI scores for two typical meal plans from manufacturer's manuals and evaluate the nutritional quality and consistency. Meal plans to be used are basically: low fat, high carbohydrate (MP 1) and high fat, low carbohydrate (MP 2). Five randomly chosen meal plans were selected from the manufacturer's manuals which list complete recipes for all daily meals and supplements. Nutrient content will be determined using the Nutrition Data System for Research (NDSR). HEI component values and scores will be converted with SAS software. These results will be "graded" on a scale of 0-100 for diet quality. Average daily HEI scores will be compared for uniformity and the five-day average and standard deviation calculated. A random numbers table was used to select 5 of 21 meal plans. For monitoring daily intakes, the analytical method used for HEI was population ratio for the means. MP 1 had an HEI score of 87, classified as "good." MP 2 had an HEI score of 50, classified as "poor." MP 1 complied with consistency of nutrients having a day-to-day variation of 2 HEI points. MP 2 was less consistent with a day-to-day variation of 8 HEI points. We conclude that HEI scores allow evaluation of nutritional quality as well as determining uniformity of nutrient intake, both of which are currently unavailable to dieters. This information could influence the choice of meal plans for dieters and manufacturers might consider incorporation into their promotional literature.

ABBREVIATIONS

HEI: Healthy Eating Index; MP: Meal Plan

INTRODUCTION

In 2019 the US weight loss and diet control market was valued at \$72 billion [1] an amount equivalent to 4 years total funding for the Nationwide School Breakfast and Lunch Programs or more than 10 years revenue at Disneyland. There are almost as many available weight-reduction diet plans as there are reasons for individuals to begin one [2]. Major factors influencing choice of a plan include taste, convenience, and cost, effectiveness of weight management, healthfulness, culture, food contents, and marketing [3]. One additional factor is support, that being persons or references that aid the individuals in the maintenance of their dietary regimes [4]. One such aid is a prescribed eating plan suggested in the diet manual of manufacturers. Recipes are formulated to conform to standards set by the manufacturer as described in the marketing of the diet. Two typical formulations are low fat, high carbohydrate and high fat, low carbohydrate with intermediate protein for both. The questions we pose are: what is

the quality of the diets and how uniform is the consistency of the formulations over a period of time? To accomplish this, we have chosen examples of these two types of formulations. Randomly selected meal plans from manufacturer's diet manuals were analyzed. The Healthy Eating Index (HEI) scores [5] calculated for each and compared for quality and uniformity.

MATERIALS AND METHODS**The Healthy Eating Index**

As transcribed from the USDA website: The HEI is a scoring system to evaluate a set of foods. The scores range from 0 to an ideal of 100. The overall HEI-2015 score is made up of 13 components that reflect the different food groups and key recommendations in the 2015-2020 Dietary Guidelines for Americans [6]. These 13 components and scoring system are summarized in Table 1, as redrawn from Krebs-Smith et al [5] (Table 1).

The HEI has most frequently been used for assessing and analyzing diet quality in surveillance, epidemiologic and intervention research and with individuals in clinical settings

TABLE 1: ¹HEI-2015 Components & Scoring Standards.

Component	Maximum Points	Standard for Maximum Score	Standard for Minimum Score of Zero
Adequacy:			
Fruits ²	5	≥0.8 cup equiv. per 1,000 kcal	No Fruit
cup equiv. per 1,000 kcal		No Whole Fruit	Total Vegetables ⁴
Vegetables		Greens and Beans ^{4,4}	5
Legumes			≥0.2 cup equiv. per 1,000 kcal
per 1,000 kcal		No Whole Grains	Dairy ⁵
Total Protein Foods ⁶	5	≥2.5 oz equiv. per 1,000 kcal	No Protein Foods
1,000 kcal			Fatty Acids ⁸
SFAs ≤1.2		No Sea Food or Plant Protein	10
Grains	10	≤1.8 oz equiv. per 1,000 kcal	≥4.3 oz equiv. per 1,000 kcal
gram per 1,000 kcal		≥2.0 grams per 1,000 kcal	Added Sugars
energy		Saturated Fats	10
			≤8% of energy
			Whole Fruits ³
			5
			≥1.1 cup equiv. per 1,000 kcal
			No Dark Green Vegetables or
			Whole Grains
			10
			≥1.3 cup equiv. per 1,000 kcal
			No Dairy
			Sea Food an
			Plant Protein ^{6,7}
			5
			(PUFAs + MUFAs)/SFAs ≥2.5
			≥0.8 oz equiv. per (PUFAs + MUFAs)/
			Refined
			Sodium
			10
			≤6.5% of energy
			≥16% of energy
			≥26% of
1: Intakes between the minimum and maximum standards are scored proportionately.		2: Includes 100% fruit juice.	
3: Includes all forms except juice.		4: Includes legumes (beans and peas).	
5: Includes all milk products, such as fluid milk, yogurt, and cheese, and fortified soy beverages.		6: Includes legumes (beans and peas).	
7: Includes seafood, nuts, seeds, soy products (other than beverages), and legumes (beans and peas).		8: Ratio of poly- and monounsaturated fatty acids (PUFAs and MUFAs) to saturated fatty acids (SFAs).	

for the purpose of nutritional counseling [7]. Less frequently, the HEI has been used to assess food supply such as menus in fast-food restaurants [8] and recently, the nutritional quality of the Federal School Lunch and Breakfast programs [9]. The objective of our study is to extend this analysis through determination of the uniformity of and compliance with daily HEI's for two commercial meal plans.

Software

The menu analysis is extensive using the full power of the Nutrition Data System for Research (NDSR) software of which the 2019 version contains 174 nutrients, nutrient ratios and other food components [10]. HEI values were obtained from NDSR results using the SAS code described on the National Cancer Institute's website [11].

Menus

Focus is on representation of two common types of commercial diets –no attempt is made to endorse or denounce either type. Meal plan 1 (MP 1) includes daily menus for breakfasts, lunches and dinners and typifies a low fat, high carbohydrate diet [12]. This type of nutrient formulation is the

basis for the Ornish, Macrobiotic and TLC diets, among others [13] although some incorporate animal protein. The other is high fat, low carbohydrate, mainly animal protein (Diet 2) [14]. This type of nutrient formulation is the basis for the Atkins, Paleo and Keto diets, among others [13]. The other is high fat, low carbohydrate (MP 2) [14]. This type of nutrient formulation is the basis for the Atkins, Paleo and Keto diets, among others [13]. To obtain the HEI's, we have selected, using a random numbers table, five of the 21 suggested daily menus from our designated commercial diet manuals [12,14] which contain detailed content (ingredients and portion size) for breakfasts, lunches, dinners, and snacks. A thumbnail sketch of each is shown in table 2.

For clarification purposes, it should be noted that the diet manuals are each structured differently. For MP 1, twenty one daily recipes were listed with no recommendations for the order in which they are to be eaten. Therefore, the meal chosen by random numbers corresponded to the order in the list. For example, the "13" in the first column (Table 2 -top) refers to recipe "13" in the manual. For MP 2, twenty one daily recipes were listed but order in which they are eaten was specified (week and day). An example (Table 2-bottom) is the "Wk 1 M" in the first column. Individual components of the HEI's for the 5 meal

Table 2: Meal Plans.

	Breakfast	Lunch	Dinner
Menu 1	Honeydew, Toasted	Brown rice	Vegetable platter [13]
			bread with spread
			Squash, Apples
			Sweet potato
Menu 2	Granola, Yogurt	Fruit salad	Spaghetti, tufu [8]
			Orange juice
			Bread-pudding
			Cucumber salad,
			fruit-ice
Menu 3	Grains mussili	Zucchini, Spinach	Crudite salad, [21]
			Grapefruit
			Eggplant
			Bulgar- pilof
Menu 4	7 grain cereal	Cauliflower -	Brussel sprouts [18]
		breadfruit,	Orange juice
		Raspberry ice	salad, Raisin-
			Carrot soup
Menu 5	Fruit coffee cake	Cucumber-yogurt	Eggplant, Brown rice [14]
			Orange juice
			Cantaloupe
*No Snacks or Supplements			
MP 1* Indicating [meal number] from diet manual ¹²			

plans are tabulated along with the average of components of all five plans. The composite HEI's are calculated and plotted on a radar chart as described by Chia et al [14].

Statistics

Non-repeating randomization of meal plans was achieved using a random numbers table. For estimating usual intake we used the model of two or more recalls per person (meal plans in our case) that distinguish day-to-day variation from variation between individuals. The bivariate method uses the NCI Method measurement error methodology to jointly estimate usual intake for a food or nutrient dietary constituent and energy, taking into account the correlation between the two dietary constituents [15]. This method can be used to estimate each component of the HEI score.

RESULTS AND DISCUSSION

Component-derived values from the NDSR analyses of both meal plans are presented in Table 3 which are used as the basis for calculating the scores for individual components of the HEI's which appear in table 3.

Chart 1 illustrates the composite HEI's derived from Table 3. Radar charts are graphical methods of displaying multivariate data in the form of two dimensions [16]. This type of plot is particularly amenable to presentation of HEI's due to the number of variables and scoring system (different maximum scores 5 or 10). Chart 1 effectively illustrates compliance scores with the dietary components as well as to portray the differences between the two meal plans (Chart 1).

Discussion will focus on compliance to guidelines and to

uniformity of HEI scores. Regarding compliance, MP 1 has an HEI score of 87 out of 100 which is considered as "good" or a grade of "B". Exemplary diet like the DASH has an HEI of 100 (grade of "A") [17]. The cumulative HEI-2015 score for Americans is 59 out of 100 or a grade of "F" [6]. This snapshot of overall diet quality indicates that average diets of Americans do not conform to dietary recommendations. MP 2 with an HEI score of 50 out of 100 resembles the national average. It is quite possible that selection of other menus or inclusion of all 21 meal plans would influence some of the 13 component scores, but it is unlikely that the overall HEI could reach 70 points or a grade of "C". This is due to the fact that ketogenic metabolism takes place only if carbohydrates are minimized and percentage fat is high [18] which makes the whole grain category (10 points) difficult to satisfy and exceeds the maximum calories in the saturated fat category (10 points). Likewise, since carbohydrate restriction requires adequate water, sodium (10 points) is added to prevent electrolyte imbalance. In addition, fruits and vegetables are not major contributors in this type of diet making an additional 20 points questionable.

In fact, knowing the proportion of major nutrients in formulating the MP's and the components used to create the HEI, compliance can be determined with just one day's information (although the exact number of points for the 21 days would not be established), MP 1 will always receive a grade of "B" (80+) and possibly "A", while MP 2 will always receive grades of "D" or "F". If mono- and/or poly- unsaturated fats replaced saturated fats in MP 2, and with a vitamin/mineral supplement, the index could be elevated.

Regarding uniformity MP 1, HEI scores were relatively

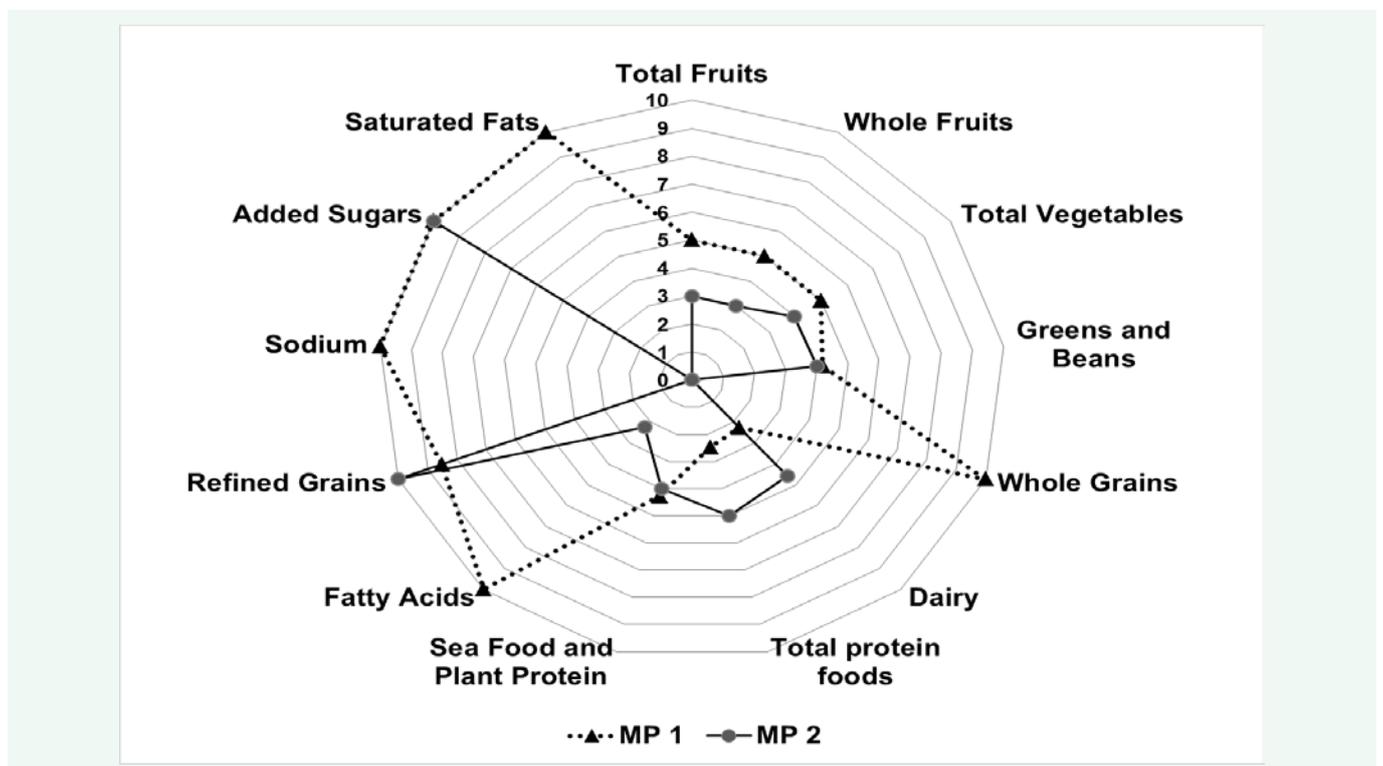


Figure 1 Chart 1 Compliance Scores to the HEI for the Dietary Components of Meal Plans.

consistent over the 5 meals plans showing only a small standard deviation. A more surprising result occurred with MP 2. Values in Tables 3 and 4 showed greater inconsistency. It would be supposed that manufacturers formulate meal plans that would be rather uniform in composition, however our findings suggest otherwise. As with the compliance data, it is possible that our random sample of 5 meal plans represented extreme values and that a complete analysis of the 21 total meals in the commercial diet manual would have yielded more consistency but not negate overall differences between the two meal plans which was found to be more uniform in MP 1 than in MP 2.

Strength of our study includes the manner of data entry. Daily menus for breakfast, lunch and dinner were entered into the NDSR program as would be a 24 hour dietary recall but unlike the type used in epidemiology we are able to bypass typical pitfalls associated with human responses such as under or over-estimation of portion size, missed or “phantom” foods, weekday vs weekend eating or data entry errors as well as socioeconomic factors and BMI status [19]. Here we have exact ingredients and portion sizes, copied directly from the meal plans. Consequently, the HEI’s derived from these entries will represent maximum scores that could be achieved by participants assuming 100% fidelity to the meal plans. The information gleaned from both the compliance and uniformity of food quality could be part of the decision-making criteria for the choice of a meal plan [20].

CONCLUSION

To conclude, we have evaluated two common weight-loss meal plans- low fat, high carbohydrate (MP 1) and high fat, low carbohydrate (MP 2) for compliance to the 2015-HEI and uniformity of food quality using 5 meal plans listed in manufacturer’s manuals. Compliance was “good” for MP 1 and “poor” for MP 2 and that overall compliance can be determined with as little as one day’s menu. Uniformity was consistent for MP 1 but relatively inconsistent for MP 2. As mentioned throughout the manuscript, it is unlikely that the average HEI scores generated from 5 of 21 meal plans would be the same if all 21 meal plans were analyzed. However, it is our contention that although scores may be slightly different, our conclusions remain unaltered.

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