

Evaluating the Food Environment Application of the Healthy Eating Index-2005

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Background: The Healthy Eating Index-2005 (HEI-2005), a tool designed to evaluate concordance with the 2005 Dietary Guidelines, has been used to monitor the quality of foods consumed by Americans. Because the HEI-2005 is not tied to individual requirements and is scored on a per 1000 kcal basis, it can be used to assess the overall quality of any mix of foods.

Purpose: The goal of this paper is to examine whether the HEI-2005 can be applied to the food environment.

Methods: Two examples were selected to examine the application of the HEI-2005 to the food environment: the dollar menu displayed at a fast-food restaurant (coded and linked to the MyPyramid Equivalents Database and the Food and Nutrient Database for Dietary Studies) to represent the community level and the 2005 U.S. Food Supply (measured with food availability data, loss-adjusted food availability data, nutrient availability data, and Salt Institute data) to represent the macro level.

Results: The dollar menu and the 2005 U.S. Food Supply received 43.4 and 54.9 points, respectively (100 possible points). According to the HEI-2005, for the offerings at a local fast-food restaurant and the U.S. Food Supply to align with national dietary guidance, substantial shifts would be necessary: a concomitant addition of fruit, dark-green vegetables, orange vegetables, legumes, and nonfat milk; replacement of refined grains with whole grains; and reduction in foods and food products containing sodium, solid fats, and added sugars.

Conclusions: Because the HEI-2005 can be applied to both environmental- and individual-level data, it provides a useful metric for studies linking data across various levels of the socioecologic framework of dietary behavior. The present findings suggest that new dietary guidance could target not only individuals but also the architects of our food environment.

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Introduction

Public health researchers are increasingly aware that alterations in the food environment are necessary to allow all individuals the opportunity to achieve healthier diets. That is, individuals cannot be expected to make healthy choices if those options are not readily available in the home, at work, at school, and in the community. For this reason, researchers are developing robust measures of the food environment to investigate the effects of the food environment on individual dietary behavior, inform policymaking, and reduce the prevalence of obesity through targeted interventions.¹

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It would be beneficial to have a common metric for assessing the food environment that could be used across all levels of the socioecologic model. Many of the measures available are instruments for gathering data, such as checklists and inventories, but there are relatively few that provide a summary assessment of the quality of foods in a particular environment.² The Healthy Eating Index-2005 (HEI-2005) is a tool designed to measure diet quality and has been used by the U.S. Department of Agriculture (USDA) to monitor diets of the population as part of their management and evaluation of nutrition assistance programs.^{3,4} The HEI-2005 operationalizes diet quality based on standards derived from the 2005 Dietary Guidelines for Americans⁵ and the MyPyramid food guide.⁶

The HEI-2005 includes 12 components (Table 1), each reflecting a key aspect of diet quality, that are scored separately and then summed.⁷ All of the components are assessed on a density basis—that is, on amounts per 1000

kcal of energy or percentage of energy rather than on the absolute amounts of foods or nutrients consumed—because recommendations vary according to energy requirements. By assessing multiple dietary components simultaneously, on a density basis, the HEI-2005 captures the balance among different types of foods and, therefore, measures the quality rather than the quantity of the diet.

Validity and reliability testing of the HEI-2005 are described elsewhere.^{8,9} Even though most tests were conducted at the individual level, the evaluation did not test the degree to which the HEI-2005 corresponded to meeting individual requirements because that is not its purpose. Rather, the tests determined that the index can be used to examine the quality of any mix of foods. For example, the evaluation tested whether the index scored menus appropriately, using accepted standards of high-quality diets, such as menus from MyPyramid, the Dietary Approaches to Stop Hypertension (DASH) Eating Plan, Healthy Eating Pyramid, and the American Heart Association. Then, to provide real-life examples of various mixes of foods, the evaluation assessed 1-day diets reported by individuals.⁹

To date, the HEI-2005 primarily has been applied to individual-level diets for the purposes of population monitoring¹⁰ and epidemiologic research.^{11,12} However, USDA Food and Nutrition Service has also applied the HEI-2005 to review the quality of the food package provided through their food distribution program on Indian reservations.¹³

The goal of this paper is to examine whether the HEI-2005 can be applied to the food environment. Two examples were selected for analysis: the dollar menu from a

Table 1. Healthy Eating Index-2005 components and standards for scoring^{11,a}

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Total fruit (includes 100% juice)	5	≥0.8 cup/1000 kcal	No fruit
Whole fruit (not juice)	5	≥0.4 cup/1000 kcal	No whole fruit
Total vegetables	5	≥1.1 cups/1000 kcal	No vegetables
Dark-green and orange vegetables and legumes ^b	5	≥0.4 cup/1000 kcal	No dark-green or orange vegetables or legumes
Total grains	5	≥3.0 cups/1000 kcal	No grains
Whole grains	5	≥1.5 oz/1000 kcal	No whole grains
Milk ^c	10	≥1.3 cups/1000 kcal	No milk
Meat and beans	10	≥2.5 oz/1000 kcal	No meat or beans
Oils ^d	10	≥12 grams/1000 kcal	No oil
Saturated fat	10	≤7% of energy ^e	≥15% of energy
Sodium	10	≤0.7 gram/1000 kcal	≥2.0 grams/1000 kcal
Calories from solid fat, alcohol, and added sugar (SoFAAS)	20	≤20% of energy	≥50% of energy

^aIntakes between the minimum and maximum levels are scored proportionately, except for saturated fat and sodium (see note e).

^bLegumes counted as vegetables only after meat and beans standard is met

^cIncludes all milk products, such as fluid milk, yogurt, and cheese

^dIncludes nonhydrogenated vegetable oils and oils in fish, nuts, and seeds

^eSaturated fat and sodium get a score of 8 for the intake levels that reflect the 2005 Dietary Guidelines, <10% of energy from saturated fat, and 1.1 grams of sodium/1000 kcal, respectively

local fast-food restaurant (all menu items cost one dollar) to represent the community level and the 2005 U.S. Food Supply to represent the macro level.

Methods

Basic Algorithm for Determining the HEI-2005

To test the application of the HEI-2005 to the food environment, the same basic steps that one would follow when examining individual-level diets were followed (Figure 1): (1) identify the set of foods under consideration; (2) determine the amount of each relevant dietary constituent in the set of foods; (3) derive pertinent ratios of dietary constituents to energy and score each HEI-2005 component using the relevant standard (as listed in Table 1).

Identify the set of foods under consideration. When looking at individual diets, the set of foods under consider-

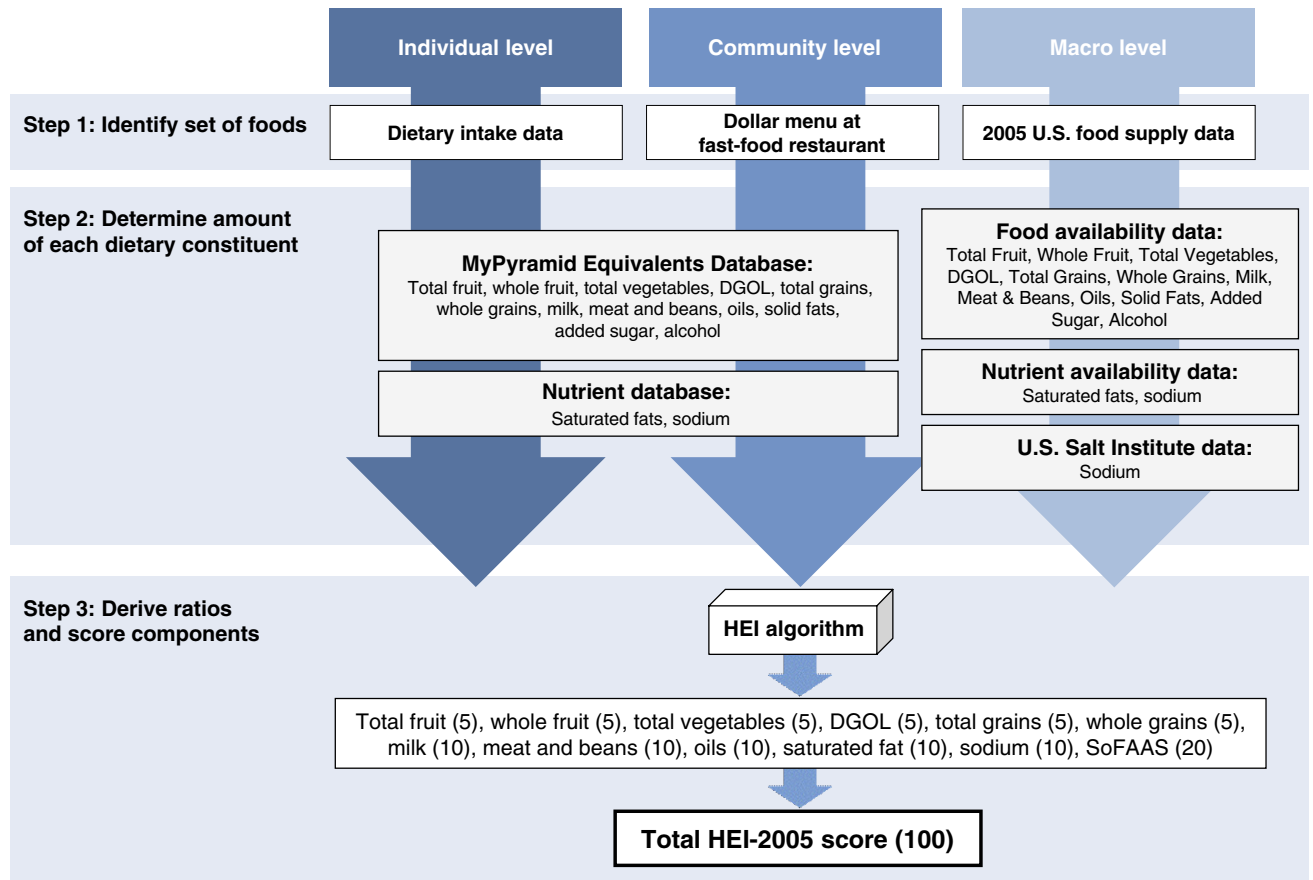


Figure 1. Steps for determining the HEI-2005 at the individual, community, and macro level. DGOL, dark-green and orange vegetables and legumes; HEI-2005, Healthy Eating Index-2005; SoFAAS, calories from solid fats, alcoholic beverages, and added sugars

ation may be the amount of food consumed in 1 day or over a longer period of time. When examining food environments, the set of foods could be the sum of choices available in a particular environment—such as a restaurant menu—or the total amount of food supplied by that environment over a period of time—such as the entire U.S. food supply for 1 year.

Determine the amount of each relevant dietary constituent. Determining the amounts of each dietary constituent contained in the total quantity of foods under consideration requires linking the list of foods to relevant databases. Values for energy, saturated fat, and sodium can be obtained through nutrient composition databases or package labeling. However, determining the values for the other relevant dietary constituents requires a database that translates the foods into amounts of fruits, vegetables, lean meat, and so on. This means that any food mixtures that contain ingredients from several food groups (pizza, for example), must be disaggregated into component ingredients. One publicly available database designed for this purpose is the MyPyramid Equivalents Database (MPED).¹⁴

The MPED links to the USDA's Food and Nutrient Database for Dietary Studies (FNDDS)¹⁵ and has been used to

evaluate the U.S. diet in relation to dietary guidance such as MyPyramid. It translates the amounts of foods, as eaten, into MyPyramid equivalents. MyPyramid encourages the consumption of the most nutrient-dense foods within each group—that is, without excess fat or sugar. Therefore, to be consistent with MyPyramid, the MPED apportions even discrete commodities like whole milk into the skim milk fraction ("milk equivalent") and the solid fat fraction (grams of solid fat).

Derive pertinent ratios of energy intake and score each component. Deriving the HEI-2005 score involves creating density values. To do this, when examining the food environment, the amount of each dietary constituent is summed over all the foods in the set and divided by the total energy; then this ratio is compared with the standard. Using the fruits component as an example:

$$\left(\frac{\sum(F)_{\text{set}}}{\sum(E)_{\text{set}}}\right) \rightarrow \text{Assign score}_{\text{set}}$$

where F = total cups of fruit in set of foods

E = total energy content of set of foods

For most components, higher levels result in higher scores. However, for three components—saturated fat; so-

dium; and calories from solid fats, alcoholic beverages, and added sugars (SoFAAS)—lower levels result in higher scores because lower levels are more desirable. Further information regarding how to derive HEI-2005 scores can be obtained from previous publications.^{4,8,9} The SAS code for deriving the scores can be obtained from riskfactor.cancer.gov/tools/hei/tools.html.

Most components of the HEI-2005 are weighted equally in accordance with the directive found in the 2005 Dietary Guidelines to take all the guidance as a whole. Fruit, vegetables, and grains each have two components (total and a subgroup) that get 5 points each, so these three food groups effectively are allotted 10 points each. The one exception is calories from SoFAAS, which is weighted twice as heavily as any other component (20 points), because solid fats, alcoholic beverages, and added sugars have a dual effect on diet quality. They add energy without adding nutrients and, because they are currently consumed in amounts that far exceed the discretionary calorie allowances, they substantially displace nutrient-dense foods in the diet.

Community-Level Food Environment Example: Dollar Menu at Fast-Food Restaurant

To examine the application of the HEI-2005 to the community-level food environment, the dollar menu at a local fast-food restaurant was used as an example. Items available from food service establishments are ready to eat and therefore they can be evaluated using resources developed for individual food intake surveys. Specifically, foods can be coded using the USDA survey food codes¹⁵ and linked to the MPED and FNDDS for determining the amount of each relevant dietary constituent.

All foods available for breakfast, lunch, and dinner were recorded, based on the offerings posted at the cash register at each time. The same menu was posted for lunch and dinner, so in the current analysis those foods were included twice. An FNDDS food code and appropriate amount (weight, count, or volume) was recorded for each food listed. When a food code was not available, the item was purchased, measured, and then FNDDS food codes were identified for these individual items and amounts.¹⁶ The energy reported in the restaurant's nutrient information was compared with the FNDDS energy value for all items to ensure equivalency. This food list was linked to the FNDDS and the MPED, and the HEI-2005 components were scored using the publicly available SAS code.

Macro-Level Food Environment Example: 2005 U.S. Food Supply

To examine the macro-level food environment, the HEI-2005 scores for the nation's 2005 food supply were calculated. The USDA's Economic Research Service (ERS) calculates the annual food supply in the U.S. by tracking flows of more than 250 individual agricultural commodities through domestic marketing channels. The food supply is measured

as the sum of the annual domestic production, beginning inventories, and imports minus exports, industrial nonfood uses, farm uses, and end-of-year inventories.¹⁷

Loss-adjusted food availability data. As traditionally reported, the food supply data overstate the amount of food actually eaten by the population by capturing substantial quantities of nonedible portions, such as rinds and pits, and edible portions lost to human use through waste and spoilage. However, the ERS has developed the loss-adjusted food availability (LAFAD) measure to account for these losses.¹⁷ The data are reported in terms of daily per capita amounts of commodities consistent with MyPyramid equivalents; thus, it is not necessary to use the MPED. However, to allow calculation of the HEI-2005, some adjustments are necessary.

Total fruit, whole fruit, total vegetables, dark-green and orange vegetables and legumes, milk, and meats and beans. For these components, the values were taken straight from the LAFAD (in cups and meat equivalent ounces).

Total grains and whole grains. The LAFAD contains average daily per capita ounces of wheat flour, rye flour, rice, corn products (other than popcorn and sweet corn), oat products, and barley products, as well as a sum of all those products, for each year. It does not contain data for popcorn, nonmilled wheat, buckwheat, and quinoa. The ERS estimates that these miscellaneous grains add an additional 0.6 ounces to the total daily per capita amount consumed and considers them all whole grains.¹⁸ Therefore, their procedure was followed to estimate total grains (total grains = all total flour and cereal products + 0.6 ounces).

The ERS assumes that 5% of all wheat flour is whole. They do not account for rye, barley, and oats when estimating whole grains, because these grains are present in such small quantities in the food supply (Hodan Wells, personal communication, 2009). For purposes of the current study, it was assumed that all rye, barley, and oats are eaten as whole grains. Therefore, whole grains were calculated as follows: whole grains = 5% of wheat flour + all rye, barley, and oat products + 0.6 ounces.

Oils. The LAFAD value for daily per capita grams of added fats reported as "salad and cooking oils" was used for oils.

Calories from solid fats. To measure calories from solid fats, the LAFAD value for daily per capita grams of added fats (other than oils) was used. These fats included butter, margarine, shortening, lard, edible beef tallow, other edible fats, and other dairy fats from heavy cream, light cream, sour cream, half-and-half, and cream and Neufchatel cheese. Grams were converted to calories (kcal from solid fat = grams × 9 kcal/gram). Amounts of solid fats from other meat and poultry products and from fluid milk and other cheeses could not be ascertained and are not included.

Calories from added sugars. The LAFAD values for total daily per capita teaspoons of added sugars were used.

These added sugars include all cane and beet sugar, total corn sweeteners, high-fructose corn sugar, glucose, dextrose, honey, and edible syrups. To estimate calories from added sugars, teaspoons of added sugars were converted to calories (kcal from added sugars = teaspoons \times 16 kcal/teaspoon).

In addition to food group intake, the HEI-2005 requires assessment of energy, saturated fat, sodium, and calories from alcoholic beverages. The LAFAD provides loss-adjusted energy estimates for each year, which were used in the current calculations; however, it does not provide estimates for saturated fat, sodium, or calories from alcoholic beverages.

Nutrient Availability Data

Saturated fat. The ERS does provide estimates for the nutrient content of the unadjusted food supply in the nutrient availability data (NAD), supplied by USDA's Center for Nutrition Policy and Promotion.¹⁹ Because these data are not adjusted for waste and spoilage, the total daily per capita energy is significantly higher than that associated with the LAFAD (in 2005, 3900 kcal and 2718 kcal, respectively). It was assumed that saturated fat would represent the same proportion of total calories in the LAFAD as it does in the NAD, an assumption that is consistent with food supply data measured for a range of commodity groups with and without loss adjustment.²⁰ Thus, to estimate saturated fat, a simple ratio was developed to calibrate the saturated fat in the NAD to the LAFAD (for 2005: 53 grams of saturated fat/3900 kcal = 37 grams of saturated fat/2718 kcal).

U.S. Salt Institute Sales Data

Sodium. Although the NAD provide an estimate for sodium, that estimate primarily reflects the intrinsic sodium in food commodities and does not include salt added to foods or used in food processing, with the exception of canned vegetables and cheese. Salt is a major source of sodium in the U.S. diet and can be tracked via the Salt Institute's annual data on total salt sold for human consumption.²¹ For the data from the Salt Institute, the reported tons of salt were divided by the resident U.S. population and then converted to grams of sodium/person/day. From the NAD total, the sodium from canned vegetables and from salt in cheese was removed, so as not to overcount sodium. Therefore, to estimate total sodium, these two sources of data were combined, with some adjustments (total sodium = [sodium/person/day from Salt Institute] + [sodium/person/day from NAD - sodium/person/day in canned vegetables - sodium/person/day from salt in cheese]).

Food Availability Data

Calories from alcoholic beverages. The ERS food availability data—which represent the unadjusted food supply—include gallons of beer, wine, and spirits. To estimate calo-

ries from alcoholic beverages, the gallons of alcoholic beverages were converted to daily per capita calories (kcal of alcohol = (gallons of beer/year \times 128 fluid ounces/1 gallon \times 145 kcal/12 ounces) + (gallons of wine/year \times 128 fluid ounces/1 gallon \times 115 kcal/5 ounces) + (gallons of spirits/year \times 128 fluid ounces/1 gallon \times 95 kcal/1.5 ounces) \times 1 year/365 days).²² No loss or waste of these beverages was assumed.

Multiple Databases

Energy. The LAFAD provides data on the sum of energy from all commodities in that database. Because alcoholic beverages are not included in LAFAD, the calories from alcoholic beverages (just described) were added to the energy value from LAFAD to derive total energy.

Calories from SoFAAS. The calories from alcoholic beverages, added sugars, and solid fat were added (all three described above) to derive total calories from SoFAAS.

Results

The fast-food dollar menu received a score of 43.4 of 100 possible points (Figure 2). Although some healthier choices are available, most of the items are high in saturated fat, sodium, and sugar, low in vegetables and fruits, and devoid of whole grains. Full points were received for whole fruit because all fruit on the menu was whole fruit rather than juice.

A single modification, switching to whole grain for most bread products, would add nearly 5 points to the score. Offering exclusively sugar-free beverages would add an additional 3 points to the total score, largely through an improvement in the calories from SoFAAS score. However, because the removal of sugar-sweetened beverages decreases total calories and the scores are density-based, the effect on the component scores varies: total fruit and total vegetable scores go up (or improve) slightly, whereas saturated fat and sodium scores go down (or worsen) slightly.

The U.S. Food Supply received 54.9 of 100 possible points (Figure 2). Scores were low for most of the components—total fruit, whole fruit, total vegetables, dark-green and orange vegetables and legumes, whole grains, milk, saturated fat, sodium, and calories from SoFAAS. Of the 12 components, only three, namely total grains, meat and beans, and oils received optimal or near-optimal scores.

Discussion

The HEI-2005 score functions on a density basis with a single set of standards, so it can be applied to community- and macro-level food environments as well as individual-level diets. According to the HEI-2005, for the offerings

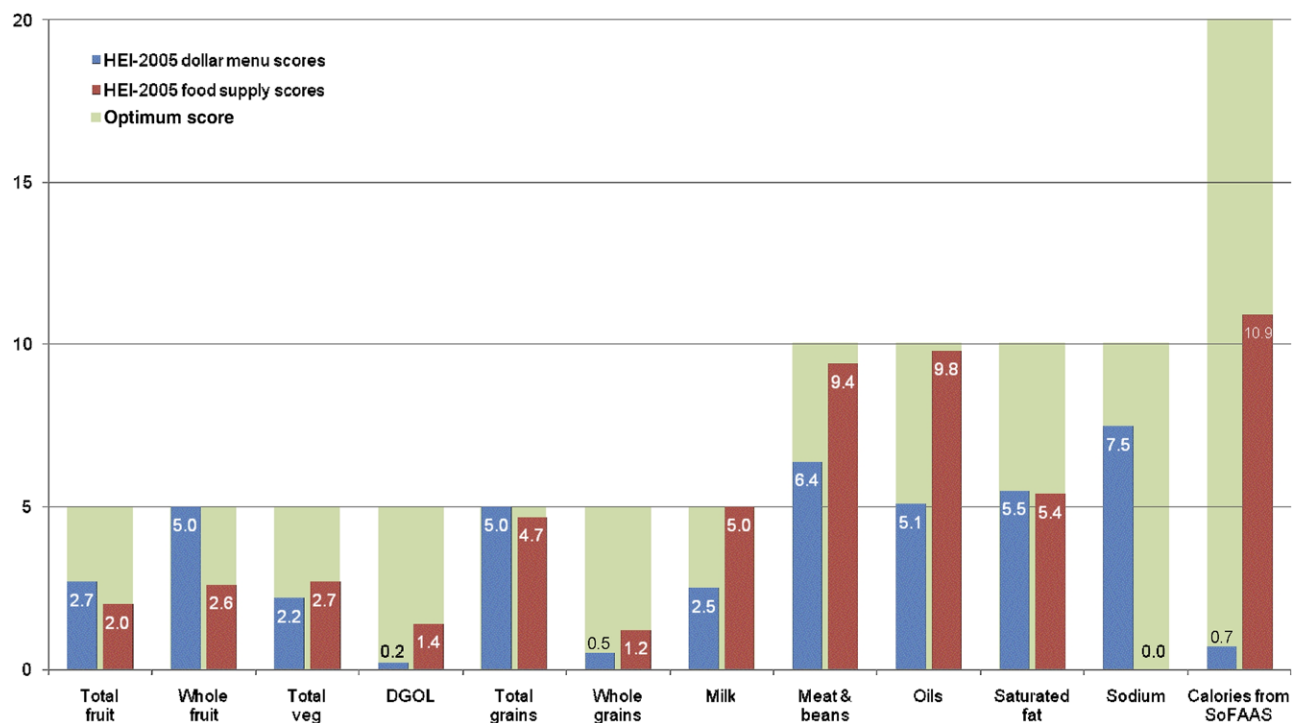


Figure 2. HEI-2005 component scores for a dollar menu at a fast-food restaurant and for the 2005 U.S. Food Supply, in relation to optimal scores

Dollar menu items. Breakfast: sausage biscuit; sausage burrito; sausage pancake sandwich; bagel and cream cheese; hash browns; fruit and yogurt parfait; fruit and walnut salad; cinnamon rolls; small coffee (12 oz); sweet tea (32 oz); and soft drink (16 oz). Lunch and dinner: double cheeseburger; chicken sandwich; chicken nuggets; small fries; side salad; apple slices and caramel dip; fruit and yogurt parfait; sugar cookies; sundae; fried apple pies; sweet tea (32 oz); and soft drink (16 oz).

For most components, higher levels result in higher scores. Note however that for three components, saturated fat; sodium; and calories from SoFAAS, lower levels result in higher scores because lower levels are more desirable.

DGOL, dark-green and orange vegetables and legumes; SoFAAS, calories from solid fats, alcoholic beverages, and added sugars

on a local fast-food dollar menu and the 2005 U.S. Food Supply to align with dietary guidance, substantial shifts would be necessary: a concomitant addition of fruit, dark-green vegetables, orange vegetables, legumes, and nonfat milk; replacement of refined grains with whole grains; and reduction in foods and food products containing sodium, solid fats, and added sugars. These conclusions are the same as those drawn previously regarding individual-level diets (the U.S. population's HEI-2005 total score for 2003–2004 was 57.5).¹⁰

Because the HEI-2005 can be applied to individual- as well as environmental-level data, it may provide a useful metric for studies linking data across levels of the socio-ecologic model.²³ Such studies would allow researchers to consider possible upstream factors that may contribute to imbalances in individuals' diets. Using existing databases, the HEI-2005 can readily be applied to food service establishments or the U.S. food supply. Additional resources for researchers are available (see riskfactor.cancer.gov/tools/hei/tools.html), and these can be planned to facili-

tate expansion of research across different levels of the food environment. However, future applications, such as the evaluation of food stores, would require considerable expansion of existing databases to include many more foods available in the marketplace.

Health professionals could use the HEI-2005 to evaluate the quality of the menus, offerings, or foods purchased or sold by their institutions. Especially in facilities with limited food options—such as schools, hospitals, or nursing homes—the food environment is particularly influential with respect to eating behaviors.²⁴ The HEI-2005 is a highly specific index, so a high score can be achieved by only a truly exemplary food environment. The score is also sensitive to change, as illustrated by the substitution of sugar-free beverages at the fast-food restaurant, and could be used to evaluate changes made to improve the quality of menus and/or foods sold. Because the HEI-2005 is a more comprehensive measure of diet quality than a checklist (that may dichotomize the presence or absence of fruits, vegetables, or other foods), it can allow

drawing various conclusions. Application of the HEI-2005 to the food supply could be extended further. Multiple years of data would allow examination of historical trends. Data from other countries with varying food systems would facilitate qualitative comparisons of the overall diet (using the total scores) as well as individual components, as has been done with data from the European Union.²⁵

The dollar menu was selected because it provided a simple example of the community-level food environment. For a food service establishment, the set of foods under consideration could be the foods offered—that is, all the foods on the dollar menu investigated here—or the foods sold—for example, total foods sold in a given period. An HEI-2005 score based on a menu represents the healthfulness of choices offered, whereas scores for the total foods sold would give an indication of the restaurant's overall influence on diets in the community, because the foods offered would be differentially weighted by the sales of each item. However, sales data, which would have reflected both personal choices and marketing strategies, were more difficult to obtain in this case than a menu. Future work may draw on available sales data.

The limitations related to the scoring and weighting of the HEI-2005 for food environment-level data are the same as those related to the individual-level data. However, the nuances of the food supply data necessitate several caveats. On one hand, the scores would have been slightly higher if it were possible to determine the amount of oil in nuts and oily fish, to account for commodities sold directly from farmers to consumers, or to estimate any waste of alcoholic beverages. On the other hand, scores would have been somewhat lower if it had been possible to include the extraneous fat in meat and poultry products, fluid milk, and cheeses with the calories from solid fats, or the amount of sodium intrinsic to vegetables. All of these issues are assumed to be minor limitations.

The HEI-2005 was designed to evaluate concordance with the 2005 Dietary Guidelines for Americans, by using standards drawn from MyPyramid. The recommendations in MyPyramid are remarkably consistent with the DASH Eating Plan and other guides for the general population²⁶ and recommendations to control obesity, diabetes, heart disease, stroke, hypertension, cancer, and osteoporosis.²⁷ Therefore, the HEI-2005 can serve as a measure of diet quality consistent with these other guides as well. The present findings suggest that new dietary guidance standards could target not only individuals but also the architects of our food environment.

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