RESEARCH
Monograph

Applications of the Healthy Eating Index for Surveillance, Epidemiology, and Intervention Research: Considerations and Caveats

Sharon I. Kirkpatrick, PhD, MHSc, RD; Jill Reedy, PhD, MPH, RD; Susan M. Krebs-Smith, PhD, MPH; TusaRebecca E. Pannucci, PhD, MPH, RD; Amy F. Subar, PhD, MPH, RD; Magdalena M. Wilson, MPH; Jennifer L. Lerman, MPH, RD, LDN; Janet A. Tooze, PhD, MPH

ARTICLE INFORMATION

Article history:
Submitted 17 October 2017
Accepted 23 May 2018

Keywords:
Healthy Eating Index
Dietary patterns
Diet quality
Diet indexes
Statistical modeling

Supplementary materials:
PowerPoint presentation available at www.jandonline.org

https://doi.org/10.1016/j.jand.2018.05.020

ABSTRACT

The Healthy Eating Index (HEI) is a measure of diet quality that can be used to examine alignment of dietary patterns with the Dietary Guidelines for Americans. The HEI is made up of multiple adequacy and moderation components, most of which are expressed relative to energy intake (ie, as densities) for the purpose of calculating scores. Due to these characteristics and the complexity of dietary intake data more broadly, calculating and using HEI scores can involve unique statistical considerations and, depending on the particular application, intensive computational methods. The objective of this article is to review potential applications of the HEI, including those relevant to surveillance, epidemiology, and intervention research, and to summarize available guidance for appropriate analysis and interpretation. Steps in calculating HEI scores are reviewed and statistical methods described. Consideration of salient issues in the calculation and interpretation of scores can help researchers avoid common pitfalls and reviewers ensure that articles reporting on the use of the HEI include sufficient details such that the work is comprehensible and replicable, with the overall goal of contributing to knowledge on dietary patterns and health among Americans.
J Acad Nutr Diet. 2018;118(9):1603-1621.

ALTHOUGH MUCH NUTRITION RESEARCH HAS taken a reductionist approach with a focus on particular nutrients, food groups, or other dietary constituents, the complexity of the overall diet and its relations with health and disease outcomes are increasingly being recognized and embraced. For example, the 2015-2020 Dietary Guidelines for Americans (DGA) focused on eating patterns, noting that such patterns represent the totality of the foods and drinks habitually consumed by individuals and that these dietary components may act in synergistic and cumulative ways to predict health status and disease risk.[1] The development of the DGA was informed by a review of the growing evidence on eating patterns and health outcomes, including cardiovascular disease, diabetes, cancer, and overweight and obesity.[2,3]

The Continuing Professional Education (CPE) quiz for this article is available for free to Academy members through the MyCDRGo app (available for iOS and Android devices) and through www.jandonline.org (click on "CPE" in the menu and then "Academy Journal CPE Articles"). Log in with your Academy of Nutrition and Dietetics or Commission on Dietetic Registration username and password, click "Journal Article Quiz" on the next page, then click the "Additional Journal CPE quizzes" button to view a list of available quizzes. Non-members may take CPE quizzes by sending a request to journal@eatright.org. There is a fee of $45 per quiz (includes quiz and copy of article) for non-member Journal CPE. CPE quizzes are valid for 1 year after the issue date in which the articles are published.

Various indexes have been developed to characterize dietary patterns and diet quality.[4-6] Such measures use criteria established a priori according to recognized principles of a healthy diet.[6] Commonly used indexes include those based on the Dietary Approaches to Stop Hypertension and Mediterranean diet patterns, as well as the Healthy Eating Index (HEI) and Alternate HEI.[7-14] The HEI in particular is a tool that measures alignment with the DGA.[7-10] The most recent iteration of the HEI[15] measures alignment with the 2015-2020 DGA. Prior versions corresponding to the 2005 and 2010 DGA have been widely used in nutrition research.[16] For example, an article published during spring 2017 reported that the 2005 version has been used in studies described in more than 185 scientific publications since its release in 2008, whereas the 2010 version, released in 2013, has been used in studies described in more than 100 articles.[16] The HEI has been used for varying purposes, including documenting the diet quality of the US population and assessing differences in diet quality among population subgroups (eg, Guenther and colleagues[8] and Wilson and colleagues[17]), elucidating influences on diet quality (eg, Savoca and colleagues[18]), evaluating associations between diet quality and disease risk and mortality (eg, Liese and colleagues,[5] George and colleagues,[19] Harmon and colleagues,[20] and Reedy and colleagues[21]), and examining the effect of interventions on diet quality (eg, Nansel and colleagues[22]).

The HEI is made of up multiple adequacy and moderation components, most of which are expressed relative to energy intake (ie, as densities) and then scored according to standards.[7,9,15] Due to the scoring of multiple components, as well as characteristics of dietary intake data more broadly, calculating and using HEI scores can involve unique statistical considerations and, depending on the particular purpose, intensive computational methods.[10,23-25] The objectives of this article are to review potential applications of the HEI and to summarize available guidance for appropriate analysis and interpretation of scores. Both analytic methods for which code has been developed as well as potential approaches that require further development are described.

Although the HEI can be used to assess the food supply and menu offerings within various food environments (eg, fast-food restaurants),[26-29] the focus of the current article is on the use of the HEI for assessing and analyzing diet quality in surveillance, epidemiologic, and intervention research (ie, cases in which dietary intake data for the purpose of characterizing diet quality are available for groups of individuals sampled from the population). The use of the HEI with individuals in clinical settings for the purpose of nutrition advising or counseling is also briefly described.

HEI

As noted, the HEI measures alignment with the DGA, allowing examination of overall diet quality in relation to federal dietary guidance, as well as patterns in terms of balance among multiple components.[7,9,15] Since the 2005 iteration, the HEI has employed scoring that operates on a density basis (eg, amount per 1,000 kcal, ratio of fatty acids)[7,9,15] (Table). As a result of this density feature, the HEI can be used to examine diet quality from the perspective of the relative mix of foods and drinks consumed and in terms of how calories are allocated; in other words, diet quality is assessed independent of quantity.[9] This density-basis used in the 2005, 2010, and 2015 versions of the HEI represents a departure from the earlier HEI developed by the US Department of Agriculture (USDA) Center for Nutrition Policy and Promotion in 1995,[30] which is not addressed in this article. The HEI addressed here is also distinct from similarly named indexes employed in other countries (eg, Woodruff and colleagues[31]). The abbreviation HEI as used in this article thus refers to the three density-based versions of the index developed in partnership by researchers from the Center for Nutrition Policy and Promotion and the National Cancer Institute (NCI) and known as the HEI-2005, HEI-2010, and HEI-2015.[7-10,15] These versions share a common foundation, with nuances (Table) to reflect the evolution of dietary guidance, as expressed by the DGA, between 2005 and 2015.[1,32,33]

The HEI-2005, HEI-2010, and HEI-2015 have each been shown to capture diet quality independently of energy intake and to distinguish among subgroups with known differences in diet quality.[8,10,34] Further, associations have been observed between higher HEI scores and lower risk of death from all causes, cancer, and cardiovascular disease.[5,19-21] The HEI is appropriate for the assessment of diet quality among populations to which the USDA Food Patterns[35] apply. It is not applicable to children younger than age 2 years or those consuming breastmilk or infant formula.[9]

THE HEI SCORING ALGORITHM

The crux of each version of the HEI is a scoring algorithm that identifies the components along with their weights (ie, the maximum score allocated to a given component) and scoring standards (ie, the levels of intake used to assign scores to each component). For each version, both adequacy and moderation components are considered. The specifics of each iteration's algorithm are summarized in the Table and detailed elsewhere.[7,9,15] The most recent version, the HEI-2015, includes 13 components: nine adequacy components and four moderation components[15] (Table). The prior two versions each included 12 components.[7,9] Changes across the versions are briefly noted in the next section and described in detail elsewhere.[9,15]

Each component is typically scored to a maximum of 10 points; for components divided into two (eg, Total Fruits and Whole Fruits), each subcomponent is allocated 5 points. Standards for assigning maximum points for a component are based on the least-restrictive recommendations (ie, those that are easiest to achieve) among those varying by energy level, sex, and age.[9] The standards utilized may be lower (for adequacy components) and higher (for moderation components) than the recommendation for any given individual due to the use of the least-restrictive recommendations. For the 2015 version of the HEI, only the 1,200 to 2,400 kcal patterns were used (compared with the range of 1,000 to 3,200 kcal, used for some components in prior versions),[35] lending to a more consistent rationale for maximum standards across components and avoiding standards based on energy levels at the higher end of needs.[15] Minimum scores for the adequacy components are based on zero consumption per 1,000 kcal.[15] For sodium (a moderation component), the standard is based on the approach used for the Dietary Reference Intakes Tolerable Upper Intake Level,[7,36] with zero points corresponding to $\geq$2.0 g/1,000 kcal. The standards allow for the application of points for each component such that the total HEI score can range from zero to 100. A score of zero on particular components is possible for a given individual, although a total score of zero is unlikely.

The application of the scoring algorithm allows the computation of scores for each HEI iteration at the level of an individual person (eg, based on data from 24-hour recalls [24HR], food records [or diaries], or a food frequency questionnaire [FFQ]). However, as discussed below, depending on the application, alternative computational methods may be preferred to better reflect true usual diet quality among groups of persons.

Evolution of the HEI

Here, consistency across the versions of the HEI and key differences are reviewed briefly to inform a subsequent illustration of how scores may be expected to change with the application of different versions due to nuances in the components and their scores and scoring standards. As can be seen in the Table, there are many common components across the three versions, with differences reflecting refinements in guidance from 2005 through 2015.

Beginning with the most recent iterations, changes between the 2010 and 2015 versions are modest and relate mainly to how sources of empty calories (for the purposes of the HEI, defined as calories from added sugars, solid fats, and