Using Healthy Eating Index (HEI-2015) to Present Dietary Quality Thus Help Building Healthier Eating Pattern

Team 19
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Motivation

In the United States, 39.8% of adults and 18.5% of children suffer from obesity in 2015-2016 [1]. Besides obesity, it's also widely believed that nutrition and chronic disease are closely related. Most applications today that attempt to encourage healthy eating behavior focused more on input improvement while limited the output to simple energy and nutrition info. Our application utilizes the scientific evidences supported Dietary Guidelines for Americans 2015-2020 (DGAs) [3], deliver Healthy Eating Index (HEI-2015) [2], a measure to assess the compliance with the DGAs, to the end users. To our knowledge, the only application that adopted HEI concept [4] failed to present easy to interpret results.

Data Overview

The data sources for this project are the most recent released Food and Nutrient Database for Dietary Studies (FNDDS) and the Food Patterns Equivalence Database (FPED). Both data sources are published by the U.S. Department of Agriculture for research purposes, thus we can assume the data is reliable, which is important to mitigate the misleading possibility. The two datasets combined to have 732,349 rows and take up 80.4 MB of memory. We preprocessed the main food items by adding 4 levels of subcategories to enable an easier input.

HEI Scoring Algorithm

Three steps involved for deriving the HEI scores. The main purpose for our application is to describe individual's eating pattern thus the 3 steps are:

Step1. Identify set of foods

We ask users to input their food items designed sequential selection boxes. Then process the food items to FNDDS dataset to get (Food ID, Portion ID, Quantity) output before passing to the next step.

Step2. Decide the amount of each dietary constitute

Map each food item to a FPED dataset, if failed, disaggregate the food to ingredients then map the ingredients to FPED. Continue this procedure until all the food items can be mapped to 37 food pattern (FP) components. Do the same mapping process for nutrients by using FNDDS dataset. Fig 1 shows an example of this step in detail. Banana and beans mapped directly while Lasagna needs to be disaggregated first.

Then sum across foods for every FP component and nutrient.

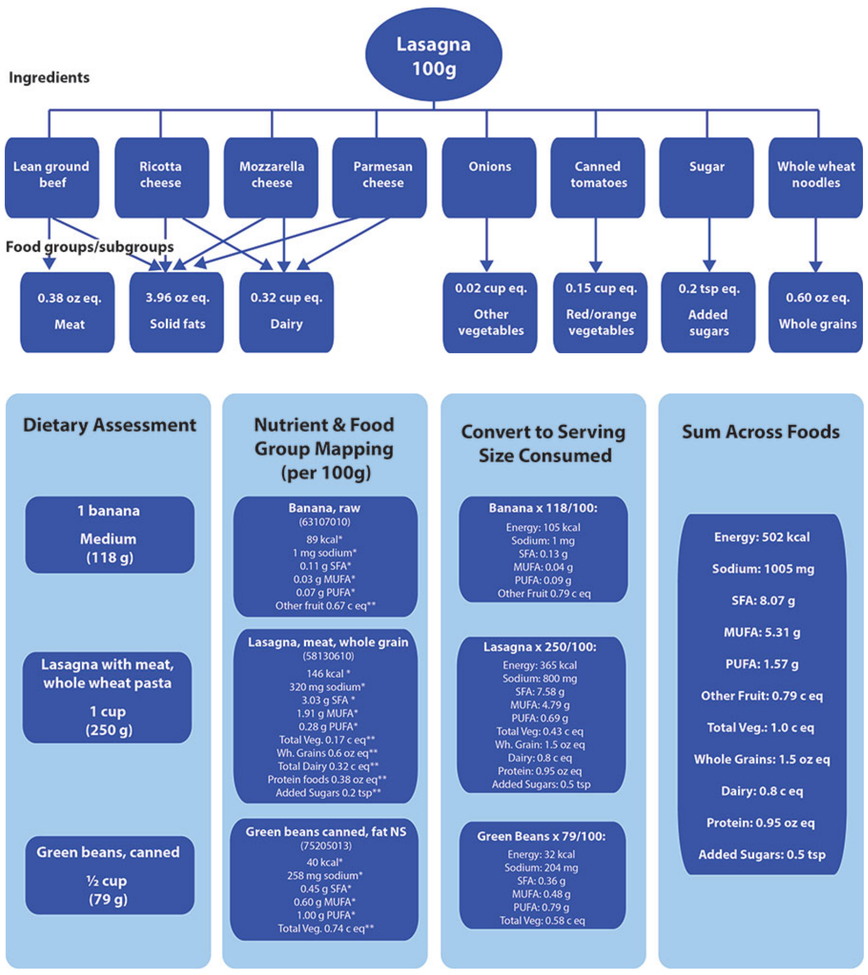

Fig 1. Example of food linkage from reported intakes [3].

Step3. Derive ratios and score components

HEI scores are based on density values or ratios of intake per total energy. This standards for scoring can be find here: HEI-2015 Dietary Components, Constituents, and Scoring Standards.

If we are calculating the "Fatty Acid" component for the example in Fig 2. First, we derive:

$$\frac{MUFAs + PUFAs}{SFAs} = \frac{5.31g + 1.57g}{8.07g} = 0.85 < 1.2$$

<=1.2 is the standard for minimum, thus the Fatty Acid score for this intake is 0. For value in between minimum and maximum standards, the score is proportionally determined.

Approach

Our Application's structure is illustrated in Fig 2. Two datasets were stored in a SQLite database; Python and Flask handles the framework construction and HEI scoring; User input and HEI output were transferred from and to the JavaScript for visualization by D3.

Fig 2. System structure of the HEI calculator.

Results

At the input stage, user will pick values from 4 category boxes then identify the food item. The associated portion description will be populated to select, followed by the quantity input. Multiple food items can be added or deleted.

A radar chart was selected to present HEI score due to the capability of showing multi-dimentional data. Fig 3 shows two sample displays with mouseover tooltip on point and on area, respectively. When mouse over a point, it will show the HEI score and scoring standards for that specific HEI component, as well as circle coloring by value (left); When mouse over a blob area (right), a list of simple recommendations will appear, any HEI component that did not meet the 60% ratio (score to max score) criteria will receive a line of recommendation.

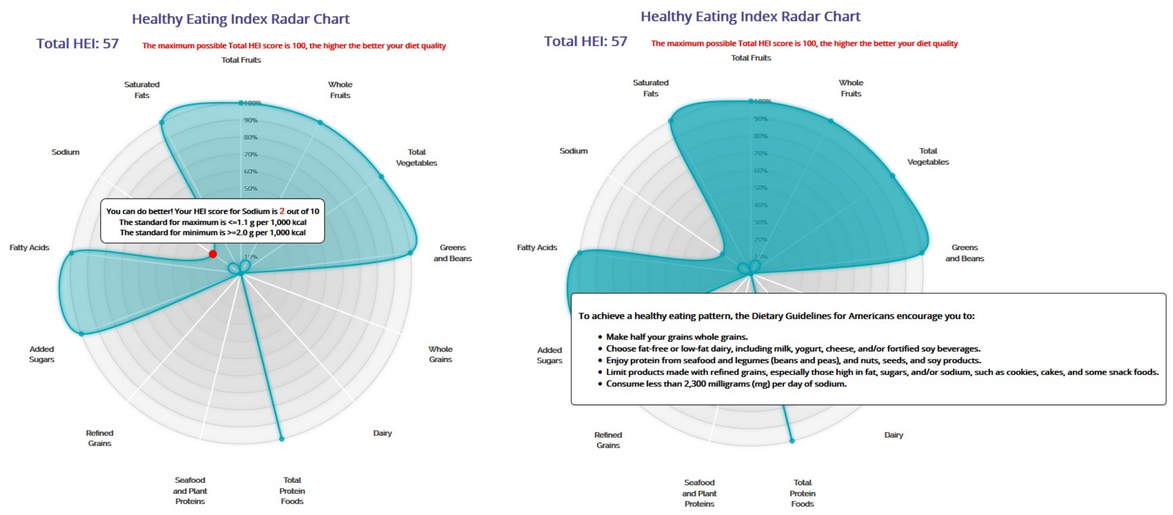

Fig 3. Sample HEI Radar Chart with tooltip.

HEI is a quality measure independent of quantity, to give user quantitative information, we also include a brushable bar chart allows user to have an easy to digest view of the nutritional content, Fig 4 is a sample bar chart.

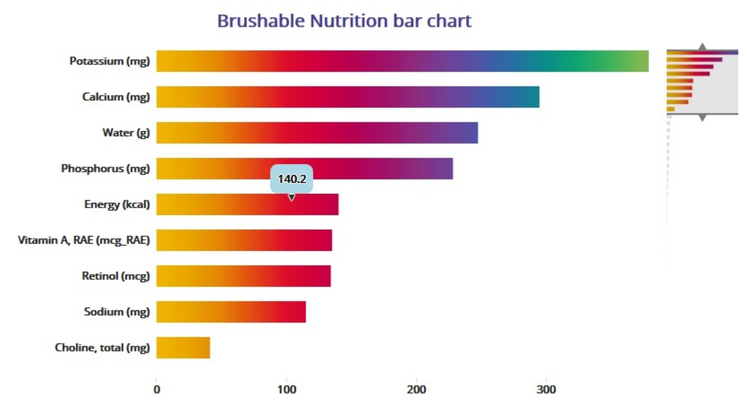

Fig 4. Sample Nutrition Bar Chart with tooltip.

Experiments & Evaluations

In order to test the effectiveness of the application, we asked fellow classmates to test the application and surveyed them on how informational the application was and if it impacted their desire to eat healthier. Total 12 respondents received:

8 of them did not consider themselves to be healthy eaters;

11 participants said that the application was intuitive for displaying the HEI score;

6 classmates said the application made them want to eat healthier and 5 of them did not originally consider themselves healthy eaters.

Even though the sample size is small, we believe the feedback from test pool is positive.

Additionally, we fixed several items based on user's feedback:

Fixed issue that one must refresh to load new data on chart;

Added option that when go back to homepage, previous input is still preserved;

Enabled score-based recommendation;

Fixed issue on Firefox.

[1] CM Hales, MD Carroll, CD Fryar and CL Ogden (2017). "Prevalence of obesity among adults and youth: United States, 2015–2016". *NCHS data brief.* No.288.
[2] National Cancer Institute. The Healthy Eating Index – Population Ratio Method. https://epi.grants.cancer.gov/hei/population-ratio-method.html. Updated August 29, 2017 [accessed Nov 04, 2019].
[3] U.S. Department of Health and Human Services and U.S. Department of Agriculture. *2015 – 2020 Dietary Guidelines for Americans*. 8th Edition. December 2015. Available at https://health.gov/dietaryguidelines/2015/guidelines/.
[4] Dietary intake data for (24-hour recalls OR food records) were collected and analyzed using the Automated Self-Administered 24-hour (ASA24) Dietary Assessment Tool, version (2018), developed by the National Cancer Institute, Bethesda, MD. https://epi.grants.cancer.gov/asa24/