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Methods for calculating dietary energy density in a nationally representative sample

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Abstract

There has been a growing interest in examining dietary energy density (ED, kcal/g) as it relates to various health outcomes. Consuming a diet low in ED has been recommended in the 2010 Dietary Guidelines, as well as by other agencies, as a dietary approach for disease prevention. Translating this recommendation into practice; however, is difficult. Currently there is no standardized method for calculating dietary ED; as dietary ED can be calculated with foods alone, or with a combination of foods and beverages. Certain items may be defined as either a food or a beverage (e.g., meal replacement shakes) and require special attention. National survey data are an excellent resource for evaluating factors that are important to dietary ED calculation. The National Health and Nutrition Examination Survey (NHANES) nutrient and food database does not include an ED variable, thus researchers must independently calculate ED. The objective of this study was to provide information that will inform the selection of a standardized ED calculation method by comparing and contrasting methods for ED calculation. The present study evaluates all consumed items and defines foods and beverages based on both USDA food codes and how the item was consumed. Results are presented as mean EDs for the different calculation methods stratified by population demographics (e.g. age, sex). Using United State Department of Agriculture (USDA) food codes in the 2005-2008 NHANES, a standardized method for calculating dietary ED can be derived. This method can then be adapted by other researchers for consistency across studies.

Keywords: energy density; National Health and Nutrition Examination Survey, NHANES; What We Eat in America, WWEIA; USDA

1. Introduction

Energy density (ED), or the amount of energy (in kilocalories) per amount of food (in grams), is a property of food. As such, ED can be calculated for mixed dishes, meals, and the total diet by dividing total kilocalories by total grams. ED is influenced by various food components, such as the macronutrient and water content. Water

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has the greatest influence on the ED of a food because it adds substantial weight without adding energy. Of the macronutrients, fat is most influential because of its high energy content (9 kcal/g) relative to either protein or carbohydrate (both 4 kcal/g). In recent years, there has been a growing interest in evaluating dietary ED as a risk factor for obesity, diabetes, and other diseases. Organizations including the joint American Institute for Cancer Research / World Cancer Research Fund, the USDA, and 2010 Dietary Guidelines for Americans have recommended consumption of a diet low in ED as a dietary approach to disease prevention, particularly for the prevention of obesity [1,2]. A diet lower in ED tends to be higher in water-rich foods such as fruits and vegetables, has more fiber and is lower in fat than other types of diets. Several experimental studies have demonstrated that lowering the ED of a food also leads to decreased energy intake during a meal [3,4]. Though consumption of low-ED foods has many benefits, individuals commonly consume foods as mixed dishes and in meals, and identifying low-ED foods alone does not capture the total diet. Therefore, it is important to assess the ED of the entire diet when evaluating the association between ED and disease.

The majority of studies evaluating the relationship between ED and disease are epidemiological in nature. Several population-based studies have examined the association between dietary ED and weight status. Most, but not all, studies have found a positive relationship between ED and body mass index (BMI) [5-8], including data from both men and women [5] and across several racial and ethnic groups [8]. One potential reason for the mixed results across studies may be related to differing methods for assessing dietary ED.

The *What We Eat in America* (WWEIA) component of the National Health and Nutrition Examination Survey (NHANES) is an excellent source of nationally representative dietary data, and serves as the basis for several studies about dietary ED [9]. The WWEIA component of NHANES has detailed information about each food and beverage consumed by individuals (including but not limited to energy, gram weight, macro- and micronutrient content for each item consumed) however, the WWEIA data does not include a variable for ED. As such, researchers who are interested in evaluating the relationship between ED and any disease outcome must calculate dietary ED on their own. Previous reports have identified several potential ways to calculate dietary ED in a nationally representative sample of US adults [10]. Dietary ED can be calculated using only foods, beverages, or a combination of foods and beverages. The majority of studies calculate ED using what is known as the "food-only" method – calculating dietary ED using only the grams of food consumed and excluding beverages. However, even this "food only" method is not standardized. The wide variety of items consumed by a population includes items that may be considered either a food or a beverage. For example: meal replacement shakes may be considered to be a food by one researcher, but as a beverage by another. The classification of items as "foods" or "beverages" is crucial. Due to their high water content, beverages can substantially influence dietary ED. Therefore, when assessing the relationship between dietary ED and various disease outcomes, it is important for researchers to use a consistent, standardized method to calculate ED. The goal of the present study is to provide information that will inform the selection of a standardized method for calculating dietary ED in future studies.

1.1. Methods & Materials

The National Health and Nutrition Examination Survey (NHANES) is a large, cross-sectional survey conducted by National Center for Health Statistics. NHANES is designed to monitor the health and nutritional status of non-institutionalized civilians in the US; data are collected on a continual basis and released in two-year increments. Complete details regarding the NHANES sampling methodology, data collection, and interview process are available on the NHANES website (http://www.cdc.gov/nchs/nhanes.htm). Data from the 2005-2008 survey cycles were combined for this manuscript.

Adults who participated in NHANES provided one day (24-hours) of dietary recall data during their visit to the mobile examination unit as part of the *What We Eat In America* (WWEIA) survey [9]. Dietary recall data were collected in-person by trained interviewers using the USDA's Automated Multiple-Pass Method (AMPM), http://www.ars.usda.gov/Services/docs.htm?docid=7710. For each food or beverage reported during the interview, detailed information regarding when and where the item was consumed, how much was consumed, the name of the eating occasion, as well as whether the food or beverage was consumed in conjunction with any