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Assessing dietary exposure to caffeine from beverages in the U.S. population using brand-specific versus category-specific caffeine values

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ABSTRACT

Recent reports on caffeine intakes in the United States have highlighted the importance of obtaining accurate and valid measures of caffeine exposure. The objective of this study is to compare two methods of assigning caffeine values to beverages: brand-specific values versus an aggregate single value representing a broader range of products within a beverage category (i.e., category-specific). The two methods yielded some small, but statistically significant differences in the estimation of caffeine intake from coffee, tea, and carbonated soft drinks (CSDs) for all ages combined and within several of the adult age groups (i.e., 35–49, 50–64, and ≥65 years). These differences, while small, suggest that detailed brand-specific data, particularly for CSDs, commercially pre-packaged or bottled teas, coffee, and specialty coffee drinks, provide more accurate estimates of caffeine exposure for some age groups. Despite these differences, these data provide some assurance that studies using a single aggregate caffeine value provide reasonable measures of caffeine exposure, particularly for studies conducted over a decade ago when there were fewer caffeinated products and brand-specific data available. As the caffeinated beverage marketplace continues to evolve, the use of more detailed, brand-specific data will likely strengthen the assessment of caffeine exposure in the United States.

1. Introduction

Over the past few years, there has been a renewed interest in understanding caffeine exposure in the U.S. population primarily because of the lack of available recent population data associated with a changing marketplace. As a result, new reports have emerged showing that caffeine intakes from beverages in the U.S. population overall have remained relatively stable (Ahluwalia et al., 2014; Institute of Medicine and National Academy of Sciences, 2014) or have increased slightly (Mitchell et al., 2014) from intakes previously reported (120 mg versus 165 mg/day) (Knight et al., 2004). Over the last decade, all of these reports confirm that coffee remains the single largest contributor to caffeine intakes in the United States and its contribution to caffeine intake appears to have increased. Coffee generally contains more caffeine per fluid ounce than other caffeinated beverages and it is consumed more frequently by a larger percentage of the U.S. population than any other caffeinated beverage. The abundance and variety of specialty coffees introduced into the marketplace over the last decade may explain why consumption of coffee is more prevalent. Many of these specialty varieties can contain different mounts of caffeine than home-brewed varieties. Increases in coffee consumption either with a higher caffeine content or at an increased volume or frequency may provide a partial explanation for the observation that a larger percentage of total caffeine intake was attributable to coffee in the most current survey (Mitchell et al., 2014) than in the previous one (64% vs. 53%) (Knight et al., 2004).

In addition, energy drinks and energy shots were introduced in the United States in the late 1990s and were not considered in earlier studies examining intakes of caffeine in the United States. Recent reports, however, have shown that despite the introduction and subsequent growth of these products, less than 5% of the population consumes energy drinks and/or energy shots (Institute of Medicine and National Academy of Sciences, 2014; Mitchell et al., 2014).

Abbreviations: ATIP, Agriculture Technology Innovation Partnership; CSD, carbonated soft drink; ILSI North America, North American Branch of the International Life Sciences Institute; KWP, Kantar Worldpanel; NFP, Nutrition Facts Panel; NHANES, National Health and Nutrition Examination Survey; USDA, U.S. Department of Agriculture.

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Concomitant decreases in carbonated soft drink (CSD) consumption have been observed, while tea intake has remained relatively stable. Likewise, the increase in caffeine intakes between these recent reports and the report from over a decade ago may be attributable to a slightly greater number of caffeine occasions. Knight et al. (2004) reported 1.4 caffeinated beverage occasions versus 1.8 beverage occasions in the more recent report (Mitchell et al., 2014).

The methodology used to assign caffeine values to the wide variety of products in a dynamic marketplace may have a significant impact on the assessment of exposure to caffeine. Identifying which products contain caffeine and obtaining valid and reliable estimates of the caffeine content can be particularly challenging, especially in cases where the caffeine content is not readily available on the product itself (e.g., most coffee and tea products). Historically, most beverage caffeine intake data have been calculated by the assignment of a single, generic value for a broad range of products calculated as an average across a caffeinated beverage category (Branum et al., 2014; Frary et al., 2005). In some cases, the actual value of a product that has the greatest market share (Knight et al., 2004) is assigned rather than brand-specific values for each product name and type. This is largely due to the absence of detailed brand-specific data within many databases. These databases – including the U.S. Department of Agriculture (USDA) National Nutrient Database for Standard Reference (U.S. Department of Agriculture and Agricultural Research Service, 2011) and the Food and Nutrient Database for Dietary Studies (FNDDS 2010–2011) (U.S. Department of Agriculture and Agricultural Research Service, 2014), which are the most widely used publicly available reference databases – rely mostly on generic, single values that represent a broad range of products rather than brand-specific values.

"A Partnership for Public Health: *Branded Food Products Database*" is a public–private partnership among the USDA, the Agriculture Technology Innovation Partnership (ATIP) Foundation, and the North American Branch of the International Life Sciences Institute (ILSI North America) to augment the current USDA National Nutrient Database to include branded and private-labeled food composition data. Nutrients that are present on the Nutrition Facts Panel will be included in the database. Caffeine data are among the list of attributes to be included in the database. Moving forward, it will be important to understand how this expanded database will affect the measurement estimation of dietary intakes of nutrients and other food and beverage components, including caffeine.

With the ongoing interest in caffeine intakes and current initiatives to augment databases with more comprehensive food composition data, a clearer understanding of how these enhancements may impact assessment is of considerable interest. In our most recent report, we acknowledged the many challenges of developing a caffeine database and made considerable effort to create a database with a high proportion of brand-specific values for the beverages consumed in the survey (Mitchell et al., 2014). This is in contrast to our previous report published over 10 years ago, where a single aggregate value was estimated from a much broader range of products within a beverage category (Knight et al., 2004). The purpose of this study is to compare mean caffeine intakes for the U.S. population calculated using these two different approaches. This comparison will help broaden our understanding of the impact of a detailed, brand-specific caffeine database versus the assignment of a single aggregate value for a particular beverage category (category-specific) when assessing average caffeine intake in the United States.

2. Materials and methods

2.1. Survey description

Kantar Worldpanel (KWP) is a global consumer panel company focused on the continuous measurement and analysis of consumer behaviors. The Beverage Consumption Panel is the survey that was used for this study, which includes a sample of panel members who are surveyed annually. This continuous survey has been conducted for over 30 years and targets U.S. consumers aged 1 year and older. The respondents for these analyses were recruited from a pool of about 1 million volunteer panel members with the goal to complete 40,000 surveys annually. A final sample of 42,851 respondents completed the survey from October 2010 through September 2011. Complete survey details including a description of the pool of respondents, recruitment, and sample selection have been previously described in detail (Mitchell et al., 2014).

2.2. Data collection

Respondents completed an online beverage diary consisting of 7 consecutive days, recording all beverages consumed using a web-based form. Respondents were asked to enter all of the beverages they consumed once a day for each of the 7 days. The data collection included type, brand, preparation, location (home or away from home), and amount of all of the beverages consumed. Respondents were also asked to record their demographic information and were given a small monetary incentive upon completion of the survey. Complete details of data collection are described in Mitchell et al. (2014).

2.3. Caffeine database development

A list of all beverages consumed as part of the KWP survey was generated and provided to the Pennsylvania State University Diet Assessment Center for the development of a caffeine database. Caffeinated beverages were grouped into six general categories: coffee (e.g., specialty coffee drinks, iced coffee, and brewed, instant, and decaffeinated coffee), tea (e.g., green tea, white tea and other varieties, and iced tea), CSDs (both caffeinated fruit-flavored and cola beverages), chocolate drinks (including milk and cocoa), energy drinks, and energy shots. A few other beverages containing caffeine, including fruit juice, flavored water, and sports drinks, were also included in the energy drink category because the number of identified consumers was too low to create a separate category. Of the 554 types of caffeinated beverages identified 28% were CSDs, 22% were coffee, 12% were energy drinks, 5% were chocolate beverages and 1% were energy shots.

Caffeine values (Table 1) were obtained from several resources. Sources used included the USDA Food and Nutrient Database for Dietary Studies (version 4.1), the USDA National Nutrient Database for Standard Reference, Release 24 (U.S. Department of Agriculture and Agricultural Research Service, 2011), and the Nutrition Data System for Research (Nutrition Coordinating Center, 2011). Other sources included food and beverage companies, websites (e.g., Energy Fiend, 2012, which contains brand-specific data for caffeinated beverages), and a report published by the Yale Rudd Center for Food Policy and Obesity (Harris et al., 2011). Default values were used only in cases where no brand was specified or when caffeine values could not be determined for a specific brand. In general, default values were either the default value used in one of the food and nutrient database sources such as the National Nutrient Database for Standard Reference or were products that have the greatest market share. For example, most home-brewed coffee was assigned a default value of 11.9 mg caffeine per fluid ounce, which is equivalent to the value in the USDA Standard Reference database for regular, brewed coffee. The proportion of beverages assigned default values is dependent on the beverage category. This proportion is low (<20%) for commercial, bottled drinks (e.g., CSDs and energy drinks) but higher for coffee and tea (40–50%).

2.4. Data analysis and measures

Caffeine intakes calculated using the detailed brand-specific caffeine values compiled from the database described above were compared with estimates of caffeine intakes derived using a single aggregate caffeine value assigned to beverage categories (category-specific). These category-specific values are equivalent to the default values (i.e., the caffeine value assigned when a branded caffeine value could not be determined from the resources available) used in the development of the brand-specific database. The database values used for both analyses are presented in Table 1.

Using the two approaches for estimating caffeine content of beverages consumed, caffeine values expressed as milligrams of caffeine per fluid ounce were merged with the Beverage Caffeine Panel survey data to calculate the caffeine intake per survey respondent for each of the 7 days of recorded beverage intake. These data were then averaged and expressed as milligrams of caffeine consumed per day. Respondents who completed all days of the beverage diary but reported less than 21 total beverage occasions were excluded from the analysis. Other data exclusions were specific to the children's data. Children with body weights that were below the 3rd percentile or above the 97th percentile based on weight for age were excluded (Centers for Disease Control and Prevention, 2000). Children with total fluid intakes greater than 2 standard deviations above the mean fluid intake within a specific age year were also excluded.

Survey weights were applied to the respondent-level (sample) data using the current U.S. Census (U.S. Census Bureau, 2012). The survey weighting procedure was applied monthly to ensure balance across all demographic characteristics to obtain U.S. population estimates of caffeine intakes.

Mean caffeine intakes were calculated as mg/day by both methods (detailed brand-specific database versus category-specific are presented in Table 2). Data were log transformed to approximate normality and *t*-tests were used to determine statistically significant differences ($P < 0.05$) between mean caffeine intakes derived by the two