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The Healthy Beverage Index Is Associated with Reduced Cardiometabolic Risk in US Adults: A Preliminary Analysis

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ABSTRACT

Background and objective Beverage recommendations exist, but few evaluate overall beverage intake quality. Our objective was to develop a scoring algorithm for assessing beverage intake quality among US adults (aged ≥19 years), and to examine the association between overall beverage quality and cardiometabolic risk.

Design We developed a scoring algorithm, similar to the Healthy Eating Index-2010, using recommendations for total beverage energy, meeting fluid requirements, and consuming within recommended limits for beverage subgroups (eg, low-fat milk, fruit juice). Multiple scoring systems were evaluated. The final scoring system, which consisted of 10 components, was applied to the average of 2 days of 24-hour dietary intake data for adults (aged ≥19 years) from the National Health and Nutrition Examination Survey (NHANES), 2005-2010.

Statistical analyses performed Poisson regression models stratified by sex and body mass index multivariables were used to examine the cross-sectional association between the Healthy Beverage Index (HBI) score and cardiometabolic outcomes.

Results The 10-item index had a mean±standard deviation score of 63±16 from a possible 100 points. Each 10-point higher HBI score was associated with lower odds ratios for hypertension (men and women); high fasting insulin level, high fasting glucose level, and high low-density lipoprotein cholesterol level (women and overweight/obese men), low high-density lipoprotein cholesterol level (women), and high C-reactive protein level (men).

Conclusions We found positive associations between higher HBI scores and more favorable lipid profiles; hypertension risk; and, among men, C-reactive protein levels. These preliminary results suggest that the HBI could be a valuable tool to evaluate overall beverage intake quality in adults. More research is needed to understand whether improvements in beverage quality and, thus, HBI score, are associated with beneficial changes in health.
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WATER CONSUMPTION IS ASSOCIATED WITH numerous health benefits,[1-3] and increasing water consumption may be an important strategy for obesity prevention and treatment.[4,5] The consumption of milk, coffee, tea, and other unsweetened beverages is associated with health benefits.[6,7] Adequate fluid intake is also important for optimal urinary, gastrointestinal,[1,8] and cognitive function[9,10]; maintaining blood-glucose homeostasis[11,12]; and possibly reduced mortality risk.[13] Alternatively, sugar-sweetened beverage (SSB) consumption has been associated with weight gain and obesity,[14,15] and reducing SSB intake may lower blood pressure, body weight, and risk of diabetes and cardiovascular diseases.[16-19]

Beverage intake guidelines have been suggested,[7,20,21] and although the 2010 US Dietary Guidelines for Americans recommend "drink water instead of sugary drinks,"[22] no tools currently exist that measure overall beverage intake quality. A great deal of attention has been directed at SSB intake, albeit with some controversy,[18,23] and a "broader focus" (ie, moving beyond just SSBs) has been suggested.[24] Yet water and other beverages have received less attention,[1,5,12] in part due to methodologic challenges.[1]

A Healthy Beverage Index (HBI), similar to the Healthy Eating Index,[25] could be used to evaluate overall beverage intake quality, and to determine whether improvements in beverage intake patterns are associated with improvements in health. Nutrition and dietetics practitioners could also use this index as a counseling tool to promote healthy beverage

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selection. Thus, our first objective was to develop a scoring system to provide an index of overall beverage intake quality, including an indicator of total fluid intake adequacy, using existing quantitative beverage and fluid intake recommendations.[7,20] Our second objective was to evaluate the validity of the HBI by examining the association between the HBI score and cardiometabolic outcomes among adults.

MATERIALS AND METHODS

Study Population

Dietary and cardiometabolic data from adults (aged ≥19 years) were drawn from the combined nationally representative National Health and Nutrition Examination Survey (NHANES) 2005-2010 (N=16,252). Detailed descriptions of the sampling methods and survey designs are provided elsewhere.[26] This study was deemed exempt from institutional review board approval.[27]

Dietary Intake and Beverage Groups

NHANES dietary intake data were collected in person by a trained technician using the automated multiple-pass method.[28,29] An average of two nonconsecutive 24-hour recalls was used.

All beverages reported as consumed were grouped in accordance with the Beverage Guidance System into eight groups: water; unsweetened coffee and tea; low-fat (<1.5% and soy) and skim milk (hereafter low-fat milk); diet beverages (including noncalorically sweetened coffee and tea); 100% fruit juice; alcohol (including beer, wine, and liquor); whole milk (≥1.5% fat); and SSBs (including soda, fruit drinks, sweetened coffee and tea, and other beverages [eg, meal replacement drinks]). The panel that developed the Beverage Guidance System based their recommendations on evidence of adverse and beneficial health effects of beverages, the contributions of the various beverages to energy intake, and to intake of essential nutrients.[7] Because the purpose of our study was to evaluate adherence to beverage intake guidelines,[7,20,22] not total fluid intake, liquids consumed as part of a food item (eg, soup) were excluded.

HBI Components

Using the Beverage Guidance System and recommendations from the Dietary Guidelines for Americans,[22] we identified 10 components that would serve as the basis for the HBI. Eight of the 10 components came from the Beverage Guidance System, but were converted from a measure of fluid intake (in fluid ounces) to percentage of fluid intake. We removed the upper limit on water consumption because it is reasonable for adults to consume 100% of their total daily fluid intake from water. The same conversion (from fluid ounces to percentages) was made for all other levels of beverages detailed in the Beverage Guidance System except Level 5 ("caloric beverages with some nutrients"). For our purposes, we separated this level into three individual components: whole-fat milk, 100% fruit juice, and alcohol consumption (per Popkin and colleagues[7]). Lastly, we identified two additional components, including meeting total fluid requirements, which we defined as consuming 1 mL liquid for each 1 kcal food consumed per the Institute of Medicine,[20,30] and consuming between 10% and 14% of energy from beverages.

The final 10 components were water comprises at least 20% of daily fluid intake; unsweetened coffee and tea comprise 0% to 40% of fluid requirements; <1.5%, skim, and/or soy milk (low-fat milk) comprise 0% to 16% of fluid requirements; artificially sweetened beverages comprise 0% to 16% of fluid requirements; 100% fruit juice comprises 0% to 8% of fluid requirements; alcohol accounts for zero to one (women) or zero to two (men) drinks; no consumption of 2% or full-fat milk; 0% to 8% of fluid requirements come from SSB; total energy from beverages is <14%; and the individual met their total daily fluid requirements. A full description of the individual components can be found in Table 1.

HBI Scoring System

In developmental phases, each HBI component was given equal weight contributing 10 possible points to the overall score. However, beverage patterns scored this way did not distinguish more vs less desirable components of the overall score nor did it distinguish components that had stronger independent associations with adverse health outcomes.[18,20,30] Thus, components that represented aspects of beverage intake that were more critical to health (eg, water contributing at least 20% of total fluid intake[7] or meeting total fluid requirements) were weighted more heavily than those that represented less-concerning beverage intake behaviors (eg, consuming >250 mL [8 oz]) 100% fruit juice). A full description of the final HBI scoring criteria can be found in Table 1. The HBI score ranges from 0 to 100, with a higher score indicating better adherence to beverage guidelines and healthier beverage intake pattern.

Cardiometabolic Outcomes

Anthropometric data and blood samples were collected during the physical exam component of NHANES following standardized procedures.[31-33] In brief, waist circumference was measured just above the iliac crest to the nearest 0.1 cm. Fasting total serum cholesterol levels were measured enzymatically in a series of coupled reactions that hydrolyze cholesterol esters. Serum high-density lipoprotein (HDL) cholesterol was directly measured and values in 2005-2006 and 2007-2008 were adjusted by the Centers for Disease Control and Prevention to account for an undesirable bias when compared with the reporting laboratory's HDL cholesterol quality controls.[34,35] Fasting serum triglyceride values were measured using a series of enzymatic reactions. Low-density lipoprotein (LDL) cholesterol was then calculated from measured values of total cholesterol, triglycerides, and HDL cholesterol using the Friedewald calculation.[36]

Glucose and insulin were assayed in fasting blood samples with glucose determined by a hexokinase-mediated reaction and insulin levels by a two-site enzyme immunoassay enzyme-linked immunosorbent assay. C-reactive protein (CRP) values were quantitated by latex-enhanced nephelometry. Blood pressure was measured after 5 minutes rest in a seated position with the average of all available blood pressure measurements (up to four) used.

From all available continuous measures, the following dichotomous outcomes were defined: high waist circumference, men: >102 cm (40 in), women: >89 cm (35 in); hypertension, ≥140/90 mm Hg[37]; high fasting glucose concentration, ≥5.55 mmol/L (100 mg/dL); high fasting