Nutrition 32 (2016) 799–805

Contents lists available at ScienceDirect

Nutrition

journal homepage: www.nutritionjrnl.com

Applied nutritional investigation

Alcoholic beverage consumption contributes to caloric and moisture intakes and body weight status

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ARTICLE INFO

Article history:
Received 17 August 2015
Accepted 16 January 2016

Keywords:
Alcohol and calories
Diuretic
Gender and alcohol
Alcohol and moisture
Alcohol and obesity

ABSTRACT

Objectives: This study provides cross-sectional information on alcoholic beverages as potential sources of moisture and calories for drinkers in the United States. Associations between number of drinks per day and body weight status were also studied.
Methods: Multivariable regression models were used to ascertain associations while controlling for potential confounders.
Results: Compared to nondrinkers, daily moisture intake increased as the number of drinks increased. Increase in daily moisture intake of drinkers remained significant even after correcting for diuretic effects of ethanol (men: 270.6 g [95% confidence interval (CI), 115.7–425.4], $P = 0.001$) and (women: 193.0 g [95% CI, 76.8–309.4], $P = 0.002$). The increase in daily moisture intake after correcting for diuretic losses were men: 3.9% to 9.6%; and women: 4.1% to 12.8% depending on number of drinks. The increase in calorie intake was 6.7% to 16.2% of men's, and 6.4% to 16.0% of women's daily intake. Compared to nondrinking counterparts, men who consumed 2 or more drinks per day were more likely to be overweight whereas men who consumed 4 or more drinks per day were more likely to be obese (odds ratio: 1.63 [95% CI, 1.10–2.40], $P = 0.015$). Women at all levels of drinking were less likely to be obese (odds ratio: 0.70 [95% CI, 0.55–0.88], $P = 0.004$) compared to nondrinking counterparts.
Conclusion: Alcoholic beverages contribute to moisture intake despite the diuretic effect of their ethanol content. Calorie intake increase with increasing alcohol intake among men and women but only men associate with increased likelihood of overweight and obesity. Women drinkers associate with lower body mass index and are less likely to be overweight or obese.

Introduction

Many regular dining, business, and social occasions include alcoholic beverage consumption and may contribute significantly to the intakes of calories, moisture, and some antioxidants, as well as some heavy metal toxicants [1]. Alcoholic drinks are largely made up of water and a proportionate amount of ethanol depending on the proof [1]. The average ethanol content of one drink ranges between 10 and 14 g due to the varying concentration of ethanol in the beverages [1–3]. The concentration of ethanol in alcoholic beverages is usually stated as percent by volume, between 4% and 5% in beer, about 7% in malt liquor, 12% in wine, and 40% in distilled spirits such as gin, rum, vodka, and whisky. The remainder is largely moisture (water) with minor quantities of volatile and dissolved substances [1,4]. Thus, alcohol consumption, in particular beer and wine, may contribute significantly to the moisture intake of drinkers. However, retention of moisture from alcoholic beverages may be decreased by the diuretic effects of their ethanol content [4,5]. Substantial amounts of moisture from alcoholic beverages could be retained in the body after diuretic losses. Despite in-depth studies on alcohol-induced diuresis, there is lack of information on how alcoholic beverages contribute to moisture intake.

There are conflicting reports on alcoholic beverage consumption and its associations with caloric intake and body weight status [3]. Thus it is vital to reexamine associations while controlling for more confounding variables than had been controlled in earlier studies. Alcohol comes second to dietary fat as the richest source of calories, providing 7.1 kcal/g, noting

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http://dx.doi.org/10.1016/j.nut.2016.01.013
0899-9007/

that 1.0 mL of ethanol contains 0.79 g of ethanol [1,6]. Studies providing sex-specific quantitative information on alcohol consumption and its associations with calories, moisture, and body weight status are uncommon. Men and women differ in the types and quantities of alcoholic drinks consumed, and it will be informative to provide quantitative estimates of intakes [1,7].

The goal of this study was to determine associations between alcoholic beverage consumption and daily intakes of moisture and calories, and the effect on body mass index (BMI) in a nationally representative sample of men and women in the United States. In addition to controlling for age, BMI, physical activity, and smoking as done by researchers who studied associations between drinking, caloric intake, and BMI [3,4,8], the present study controlled for education, income, race/ethnicity, and marital status in a nationally representative sample.

Methods and materials

Sources of data and sample

The alcohol behavior data from the U.S. National Health and Nutrition Examination Survey 2007–2010 (NHANES 2007–2010) were analyzed for this study. The NHANES survey uses stratified multistage probability cluster sampling design, and data are released together with analytical weights, guidelines, and related notes to ensure unbiased and reliable estimates of population averages [9]. In the NHANES 2007–2010 dietary survey, samples that were representative of the non-institutionalized U.S. civilian population provided information [9]. In the present study, participants' dietary data were matched with data in the alcohol behavior sample to obtain a combined data set after satisfying inclusion criteria: Age 20 to 60 y with complete alcohol behavior and sex information. This age range was included due to age restriction on alcohol use and the complex influence of aging on alcohol consumption. The final combined data set comprised 6217 participants: 3029 males and 3188 females. The Ethics Review Board of the National Center for Health Statistics approved the survey procedures and informed consent was obtained from all participants [9]. Like all NHANES data released for public use, the alcohol data were deidentified.

Assessing alcohol consumption

Usual number of drinks and corresponding daily quantities of alcohol consumed by participants were determined using the alcohol questionnaire component of the NHANES 2007–2010 [10]. The alcohol questionnaire captures usual number of drinks per day, which provides more reliable data than spot alcohol measurements. Trained personnel in a private dietary interview setting conducted the alcohol consumption interviews to ensure confidentiality and reliability. Dietary interviews were conducted using a computer-assisted personal interviewing system [10]. This dietary interview applies several precautionary measures, including the use of food models, household measures, and repeated measures to improve sensitivity and validity. Self-reported alcohol consumption data had been found reliable in many studies [3,11–13]. In the present study, a drink was defined as 12 oz (~355 mL) beer, 5 oz (~140 mL) wine, or 1.5 oz (~45 mL) distilled spirit such as gin [2,3,10]. The average ethanol content of one drink of alcoholic beverage is about 13.0 g [2,3]. Participants were grouped by usual number of drinks per day and were categorized as non-drinkers if they reported none or fewer than 12 drinks in the past 12 mo [10,11].

Assessing calorie intake and obesity

Caloric content of meals consumed the previous day were determined using the 24-hour dietary recall component of the NHANES 2007–2010. Dietary calorie intake was calculated from quantities of carbohydrate, fat, protein, and alcohol consumed in the past 24 h. Calorie intake from alcohol was calculated by multiplying the grams of alcohol consumed by 7.1, noting that 1 g of ethanol provides 7.1 kcal [1,6]. Total alcoholic calories were calculated from the total grams of alcohol consumed.

The NHANES 2007–2010 body measures data files contained participants' height and body weight data for calculation of BMI. The National Heart, Lung, and Blood Institute expert panel's BMI classification was used to group participants into the following categories: underweight, BMI <18.5 kg/m^2; normal weight, BMI $=$ 18.5 to 24.9 kg/m^2; overweight, BMI 25.0 to 29.9 kg/m^2; or obese, BMI $\geq$30 kg/m^2 [14].

Assessing moisture intake and contribution from alcohol

Dietary moisture intake was calculated as the sum from drinking water and food moisture, including moisture from alcoholic beverages. Due to alcohol-induced diuresis, especially depression of vasopressin, a study using data from the 1994 U.S. Nationwide Current Survey of Food Intake by Individuals recommended that 10 mL of water be deducted from crude moisture intake per gram of alcohol consumed to correct for the diuretic effect of ethanol [4,5]. In the present study, alcohol induced diuretic loss of water was calculated by multiplying the grams of alcohol consumed by 10. The resulting value was deducted from the total moisture intake to adjust for diuretic losses.

Analysis strategy and confounding variables

The outcome variables for this study were calories, moisture, and body weight status using BMI cut-offs. The main predictor variable was alcohol consumption, applied as number of drinks per day and grams of alcohol consumed. To enable reliable estimations of calories and moisture intakes from alcoholic beverages, we controlled for the following potential confounding variables in our regression analyses: participants' age, body weight, education, income, physical activity, marital status, smoking, and race/ethnicity. Education was divided into three categories: less than high school degree, high school degree, and greater than high school degree. Race/ethnic groups were defined into three categories: black (non-Hispanic), Mexican-American plus other Hispanics, and white (non-Hispanic). The white (non-Hispanic) category included other ethnic groups whose population sizes were too small for reliable partitioning. Marital status was dichotomized into married or other. Married included those living with a partner whereas other included never married, separated, widowed, and divorced. Participants who reported use of 100 cigarettes, 20 pipes, or 20 cigars in their lifetime and who currently smoke were classified as smokers [15,16]. Those who do not smoke were classified as non-smokers. Physical activity level was dichotomized as less than moderate and moderate or higher.

To account for NHANES complex survey design and to apply survey sampling weights, STATA 12.1 (STATA Corporation, College Station, Texas, USA) was used to estimate all descriptive and inferential statistics [17]. In all descriptive and inferential analyses, the NHANES 2007–2010 sample weights were applied [10,18]. Descriptive statistics were initially performed to provide background information on participants, including their distribution across levels of alcohol intake. Daily caloric and moisture intakes, categorized by number of drinks per day, were compared with the intake of non-drinkers using multiple regression models. Multivariable linear regression models were used to estimate increases in calories and moisture intakes of drinkers using the difference with non-drinkers as the reference. Indicator variables were generated for each drinking category to determine quantitative differences and for the estimation of likelihood ratios. Moisture from alcohol was estimated as the difference in total moisture intake between drinkers and non-drinkers and per number of drinks. Differences in total moisture intake without alcoholic moisture was also determined. Significant differences in calories and moisture intakes in relation to number of drinks were tested using the native t test component of the multivariable regression models. Polytomous logistic regression models were used to estimate likelihood ratios for overweight and obesity among drinkers with normal weight participants and non-drinkers as the referent groups. The referent groups for the categorical confounding variables were high school degree, married, non-smoker, moderate to higher physical activity, and white (non-Hispanic). All categorical confounding variables were entered as indicator variables. Age, BMI, calories, moisture, and income were entered as continuous variables during the analyses. Although people with large and small frames can have similar BMI, they are not likely to consume the same quantity of alcohol, moisture, or calories. Therefore, dietary calories, and moisture intakes were adjusted for body weight instead of BMI [19]. In all analyses, statistical significance was tested at $P < 0.05$.

Results

Compared to non-drinkers, higher proportions of drinkers also smoke (Table 1). The average daily quantity of alcohol consumed by males (28.7 g [range, 11.2–52.5 g]), and females (14.9 g [range, 7.1–41.5 g]) equated to two drinks and one drink per day, respectively. Whereas one drink supplied on average of 14 g of alcohol among males, it supplied about 9 g of alcohol among females. From Table 2, the average alcohol content of males' three drinks (34.7 $\pm$ 2.3 g) equated to the average content of females' four drinks (34.6 $\pm$ 2.5 g). Females' alcohol intake ranged between 63% and 76% that of males'. The proportion of this sample, ages 20 to 60 y, who consumed at least 12 alcoholic drinks per year was 79.4%, being 86.7% among males and 72.0% among females.