Demographic Factors and Beverage Consumption Patterns: Health literacy, education and income level

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ABSTRACT

Over the past several decades, the prevalence of overweight and obesity has increased to 68% of American adults[1]. During this same time period, there has been an increase in sugar-sweetened beverage consumption. This increase in added sugar consumption, particularly from sugar-sweetened beverages, has been theorized as a possible contributor to the obesity epidemic[2,3,4]. Sugar-sweetened beverages are the number one source of added sugars in the American diet and organizations such as the American Heart Association have addressed this issue of added sugar consumption due to its association with negative health outcomes[5]. A variety of demographic factors have been linked to increased added sugar consumption[6]. Health literacy is another variable which may influence beverage consumption patterns, specifically sugar-sweetened beverage consumption. To date only one study has investigated this association, and the authors reported an inverse relationship between health literacy scores and sugar-sweetened beverage consumption[7]. Therefore, the purpose of this investigation was to determine what demographic variables serve as predictors of consumption of sugar-sweetened beverages, water, milk, and total beverage calories. This could allow for appropriate interventions to be developed targeting healthier beverage consumption patterns in specific sub-populations.

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Ch. 1: Introduction

The prevalence of obesity within the United States has continued to increase over the last thirty years. According to the most recent statistics, 68% of Americans are classified as overweight (body mass index [BMI] 25-29.9 kg/m^2) or obese (BMI $\geq$ 30 kg/m^2). Obesity alone characterizes the weight status of more than 30% of Americans[1].

An increase in sugar-sweetened beverage consumption has also occurred over the last thirty years and has been theorized as a possible contributor to the obesity epidemic[2,3,4]. Beverages classified as sugar-sweetened beverages include regular soft drinks, fruit drinks, sports drinks, energy drinks, and coffee or tea sweetened with sugar. A scientific statement issued by the American Heart Association provides recommendations for added sugar intake due to the fact that high intake of added sugars is related to increased risk of high blood pressure, high triglyceride levels, inflammation, and other heart disease and stroke risk factors. The top source of added sugars in the American diet is sugar-sweetened beverages[5]. It has been found that during acute meal settings, caloric beverages do not affect food intake. However, caloric beverages were found to increase total meal kilocalorie (ie, energy) intake when compared with water or energy-free, artificially-sweetened beverages[6]. The finding that liquid calories are not regulated accurately by the body as calories from solid foods has also been identified as a possible reason for the association between obesity and sugar-sweetened beverage consumption[6,7]. This poor regulation could be due to the fact that beverages are consumed and emptied from the stomach faster than solid foods. Another explanation is that appetite-regulated hormonal responses depend on the food form (ie, solid versus liquid). Satiety signals are more abundant when fat or protein is consumed as compared to carbohydrates, and carbohydrates are a

main ingredient in many caloric beverages which could explain the poor regulation of these types of beverages[6]. Taken together, this information has led to increased awareness of the role of added sugars and sugar-sweetened beverages in health and obesity[5]. There have also been public health recommendations for a reduced consumption of sugar-sweetened beverages and an increased consumption of non-sugar-sweetened beverages such as milk and water, due to this evidence[8,9].

The recently published 2010 Dietary Guidelines for Americans report that 36% of the added sugars consumed in the American diet come from regular soda, energy drinks, and sports drinks. The guidelines also state that adults aged 19 and older consume approximately 400 kilocalories/day from beverages alone[9]. This is four times as much as the American Heart Association suggests. They recommend that most women and men consume no more than 100 or 150 calories (equivalent to approximately six or nine teaspoons/day) from added sugars each day, respectively. This is based on their recommendation that added sugars should not account for more than half of a person's daily discretionary or "left over" calories (which vary depending on activity level and energy needs)[5]. The most common culprits for these extra beverage calories, in order from highest to lowest consumption, include regular soda, energy and sports drinks, alcoholic beverages, milk, 100% fruit juice, and fruit drinks. Due to the large number of calories being consumed from beverages, the Dietary Guidelines recommend a decrease in intake of sugar-sweetened beverages to few or no regular sodas and sports, energy, and juice drinks. It is recommended that water, fat-free milk, 100% fruit juice, and unsweetened tea or coffee are chosen in place of the aforementioned beverages[9].

Intake of added sugars, such as those found in sugar-sweetened beverages, is reported to be inversely related to age, educational status, and family income and higher among men than women. Men with less than a high school education averaged about 21 teaspoons of added sugars/day and women averaged about 14 tsp/d[10]. With an increase in education to a college degree or higher, average daily added sugar intake decreased to approximately 17 tsp/d and 11 tsp/d, respectively[10]. These differences were also seen when race/ethnicity and education were analyzed together; with higher education there was decreased consumption of added sugars. A difference among race/ethnicities has also been reported. Asian Americans and Hispanics had the lowest intakes of added sugars while African Americans had the highest[10]. This is important to note because health disparities related to factors like socioeconomic status and race/ethnicity are well documented for various conditions such as cardiovascular disease, diabetes, and cancer. These populations are at increased risk because they are less likely to get preventative care or have access to quality healthcare when they become ill[11]. Furthermore, these qualities have been identified for populations at risk for limited health literacy.

Health literacy is another possible demographic factor which may influence beverage consumption patterns, specifically sugar-sweetened beverage consumption. To date, only one study has investigated this topic and reported that health literacy and sugar-sweetened beverage consumption were inversely related. These authors also reported that higher health literacy scores were positively related to higher intakes of food groups including whole fruits and total vegetables[12].

Health literacy can be determined in several ways. Common tools for measuring health literacy, their administration time, and the skills that are assessed are presented in Table 1. The Test of Functional Health Literacy (TOFHLA) and its shortened version (S-TOFHLA) assess both reading comprehension and numeracy skills and are currently the only tools which measure a patient's comprehension of health information and their ability to properly apply it[13,14]. The Rapid Estimate of Adult Literacy in Medicine (REALM) and Wide-Range Achievement Test Revised (WRAT-R) both assess pronunciation skills, although the REALM uses medical words and the WRAT-R consists of non-medical words and an extra numeracy section[15,16]. The Health Activities Literacy Scale (HALS) consists of prose, quantitative, and document items in five sections including health promotion, health protection, disease prevention, health care and maintenance, and systems navigation. It takes one hour to complete which makes it the longest evaluation tool of those discussed; it may be less practical for a healthcare setting[14]. The Newest Vital Sign (NVS) is yet another health literacy tool that has six questions and only takes three minutes to complete[17]. NVS evaluates both document and quantitative skills and consists of an ice cream nutrition label[14] which makes is especially helpful in a nutrition setting.

In order to design intervention studies which target sugar-sweetened beverage consumption patterns in specific population segments, more information is needed regarding factors which contribute to beverage consumption patterns. The purpose of this study was to determine what demographic variables serve as predictors of sugar-sweetened beverage consumption, water consumption, milk consumption, and total beverage calories.

Table 1: Tools used to assess health literacy.

Tool	Administration Time (min.)	Skills Assessed
Test of Functional Health Literacy Assessment (TOFHLA)[13]	22	Reading comprehension Numeracy
Shortened Test of Functional Health Literacy Assessment (S-TOFHLA)[14]	12	Reading comprehension Numeracy
Rapid Estimate of Adult Literacy in Medicine (REALM)[15]	2-3	Pronunciation
Newest Vital Sign (NVS)[14,17]	3	Document Quantitative
Health Activities Literacy Scale (HALS)[14]	60	Prose Document Quantitative
Wide Range Achievement Test Revised (WRAT-R)[16]	3-5	Pronunciation Numeracy

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Ch. 2: Demographic Factors and Beverage Consumption Patterns: Health literacy, education and income level

ABSTRACT

The increasing prevalence of inadequate health literacy has led various government organizations to develop programs and set agendas related to combating this problem. Health literacy can be defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions". Limited health literacy has been linked to poor health outcomes and increased healthcare costs. An increase in calories consumed from beverages, specifically sugar-sweetened beverages, has also been seen over the last few decades. Caloric beverage consumption has been linked to weight gain due to the increase in total energy intake. To date, only one investigation has addressed the relationship between health literacy and sugar-sweetened beverage consumption. Additional research in this area could be used to develop interventions aimed at improving health outcomes of low-literate populations. Therefore, the purpose of this investigation was to determine which demographic characteristics serve as predictors of sugar-sweetened beverage consumption, water consumption, milk consumption, and total beverage calories. This study included 344 individuals, who were primarily white or black women with a mean age of 35.2 ± 0.5 years. Assessments included height, weight, resting blood pressure, demographic characteristics, habitual beverage consumption, and health literacy, as measured by the reading comprehension section of the shortened Test of Functional Health Literacy Assessment (S-TOFHLA) (scores range 0-36). Although income and education level varied widely throughout the sample, the majority of study participants had adequate health literacy (34.2 ± 0.2). Multivariate linear regression analyses found certain variables such as age,

gender, education level, income level, race category, BMI, and S-TOFHLA score to be predictors of water consumption (grams) (R^2=0.088, p=0.015), average daily sugar-sweetened beverage kilocalorie consumption (R^2= 0.186, p<0.001), average daily sugar-sweetened beverage consumption (fluid ounces) (R^2= 0.038, p=0.013). , average daily beverage consumption (kilocalories) (R^2= 0.103, p=0.035). Since milk consumption (kilocalories) was not found to be significantly associated (according to bivariate correlations) with any of the demographic characteristics investigated in this study, it was not evaluated further using a linear regression analyses. Due to the significant relationships among a variety of demographic factors including education level, income level, race category, BMI, and S-TOFHLA score with beverage consumption, there is potential for developing effective interventions to decrease sugar-sweetened beverage consumption which target specific populations.

Keywords: beverage patterns, sugar-sweetened beverages, health literacy, income level, education level, water, milk

Background

Approximately 9 out of 10 American adults have difficulty using the health information that is available every day in grocery stores, doctor's offices, and the media[1]. Due to the widespread nature of this problem, government and national organizations such as the Centers for Disease Control and Prevention (CDC), United States Department of Health and Human Services (DHHS), Institute of Medicine (IOM), and National Institutes of Health (NIH) are currently addressing the issue of health literacy[2,3, 4,5]. Furthermore, one of the proposed objectives for Healthy People 2020 is to improve health literacy[6]. Health literacy is most commonly defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions"[7]. Health literacy can also be more broadly defined as a person's ability to understand and navigate the health care system effectively. Health literacy not only requires basic literacy but also information and understanding of general health topics[8].

Limited health literacy has been correlated to poor health outcomes and increased healthcare costs due to decreased use of preventative services[8]. Adequate health literacy is important for self-management of chronic conditions such as diabetes and high blood pressure[9]. Those most at risk for low health literacy include racial and ethnic minorities, older adults, and individuals who have less than a high school degree or general equivalency diploma (GED), low income, or who didn't speak English as their first language, and those with poor health status[1].

Beverage Consumption Patterns and Health

Over the past forty years, beverage consumption patterns have changed dramatically. An increase in calories consumed from beverages has occurred. Data obtained from the National Health and Nutrition Examination Survey (NHANES) 1988-1994 and 1999-2004 show that 63% of those surveyed had consumed a sugar-sweetened beverage that day. This analysis also revealed that daily calorie consumption from sugar-sweetened beverages was 294 kcal[10]. Caloric consumption from all types of beverages in 2002 totaled 458 kcal/d which means that 21% of calories are coming from beverages alone[11]. From 1999-2004, young adults with less than a high school education and people with lower income had the highest contribution of daily calories from sugar-sweetened beverages[10]. A study conducted in New York City also found that U.S.-born blacks, Puerto Ricans, and Mexicans/Mexican Americans were twice as likely to consume more than one soda per day compared to whites. Frequent soda consumption was higher in those adults who were overweight or obese and was related to sedentary behaviors[12]. In addition, a review of the health literacy literature also found that education level, age, ethnicity, and income were related to heath literacy[13].

Health Literacy and Beverage Consumption

To our knowledge only one study has evaluated the relationship between health literacy and sugar-sweetened beverage consumption[14]. These authors reported that health literacy and sugar-sweetened beverage consumption were inversely related. Specifically, an extra 119 kcal/day was consumed by individuals within the lowest health literacy group as compared to the adequate health literacy group. In addition, dietary quality was assessed via the Healthy Eating Index (HEI) to determine if health literacy impacted dietary quality. The authors found that health

literacy was related to five of the HEI component scores, indicating that, for example, the lower an individual's health literacy, the lower their consumption of fruits and vegetables. Even though socioeconomic status and education levels are often used to predict dietary quality and sugar-sweetened beverage consumption, this investigation showed that health literacy had the strongest relationship with sugar-sweetened beverage consumption and total HEI scores[14]. Given the limited information on this topic, and the potential related public health issues, additional research in this area is warranted.

Rationale

If health literacy is an important predictor of overall beverage consumption, water consumption, and/or sugar-sweetened beverage consumption, interventions targeting these factors could be developed. Interventions for low literate populations have already been examined in the areas of arthritis[15], diabetes[16], and a low-fat diet[17,18]. These studies illustrate how it is possible to employ certain strategies to conduct successful interventions for individuals with less than adequate health literacy. If individuals are better able to understand the health/nutrition information presented to them on a daily basis, this could encourage healthier lifestyle behaviors, which could reduce the incidence of chronic disease and hospital visits[19] in low-literate populations.

Due to the fact that health education materials, specifically those related to nutrition, are usually at or above a 10th grade reading level[20] it is necessary for health professionals including dietitians to realize the implications of low health literacy on nutrition. Nutrition labels are a perfect example of this. Studies have shown that individuals, even those with adequate health literacy, have a difficult time reading and understanding nutrition labels[21]. If individuals, especially those

with inadequate health literacy and chronic diseases, are unable to understand nutrition labels they will be unable to properly manage their chronic disease, and more likely to experience significant health complications. This issue may be related to beverage consumption, as individuals with low health literacy are better able to understand nutrition information/nutrition labels it may help reduce consumption of sugar-sweetened beverages, which in turn could decrease chronic disease risk. In addition, research in this area could help increase awareness among health providers as to the importance of delivering health information in a way that is sensitive to individuals with less than adequate health literacy. Therefore, the purpose of this study was to determine which demographic characteristics serve as predictors of sugar-sweetened beverage consumption, water consumption, milk consumption, and total beverage calories.

Methods

This study was conducted as a joint collaboration between Virginia Tech and the University of Nebraska Medical Center. Data was collected during the fall of 2008. The overall purpose of the study was to evaluate water consumption of families and determine parent's perceptions of water consumption and how it impacts health. To be eligible for the study, individuals needed to be an adult parent between the ages of 19-65 years with at least one child between the ages of 2-17 years living at home. The study consisted of one laboratory session, which lasted about 60 minutes. Assessments included height, measured in meters without shoes using a wall mounted stadiometer; weight, measured in light clothing without shoes, to the nearest 0.2 kg using a physician's balance scale (Seca, Hanover, MD); and resting blood pressure; completion of a water consumption survey, beverage intake questionnaire (BEV-Q)[22] and an abbreviated version

of the S-TOFHLA[23]. The BEV-Q assesses habitual intake of nineteen different commonly

consumed beverages. The abbreviated version of the S-TOFHLA was used in this study due to

its ability to test reading comprehension, availability in both English and Spanish, and quick

administration time. This abbreviated version consists of 36 reading comprehension questions

from the original S-TOFHLA where each question is worth one point. These S-TOFHLA scores

were assessed based on a score of 0-16 points being inadequate health literacy, 17-22 points

being marginal health literacy, and 23-36 points being adequate health literacy[16]. The water

consumption survey was used to assess perceptions regarding water consumption and also

collected demographic information (ie, age, race/ethnicity, education level, and income level)

from study participants. These tools were all self-administered. Upon study completion,

participants were compensated with a $10 Wal-Mart gift card.

Statistical analyses were conducted using SPSS statistical analysis software (version 12.0 for

Windows, 2003, SPSS, Inc, Chicago, IL). Pearson bivariate correlational analyses were used to

asses possible relationships between the continuous variables of BMI, age, or S-TOFHLA score

and habitual daily sugar-sweetened beverage consumption (kcal and fluid ounces), water

consumption (grams), milk consumption (kcal), and average daily beverage consumption (kcal).

One-way analysis of variance (ANOVA) was used to determine possible associations of

categorical variables including BMI category, S-TOFHLA category, education level, income

level, and race category and the aforementioned beverage categories. Post hoc tests were

conducted using Student-Newman-Keuls (SNK). Significant relationships were then entered

into multivariate linear regression models to determine the relationships between several

independent variables (ie, demographic factors) and one dependent variable (ie, sugar-sweetened

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beverage consumption). Independent t-tests were also performed to analyze gender differences

in beverage consumption. Significance is reported at levels of 0.05, 0.01, and 0.001.

Results

A total of 344 individuals completed the study. Of these, 334 had S-TOFHLA scores. For the

purpose of this study, only those participants with S-TOFHLA scores were included. Sample

demographic characteristics are presented in Table 2.

The study sample consisted mostly of females with the mean age of 35 years. About 70% of

participants were overweight or obese according to their calculated BMI. Over half the sample

reported their race as either white or black; however, Native American/American Indian, Native

Hawaiian or Pacific Islander, multiracial, Hispanic, and Asian races were also represented. In

addition, 81% of study participants indicated they had at least completed high school with some

reporting having more than a four year college degree. Income varied widely with the majority,

21%, of participants having an annual total household income of $30,000-$59,999. The

overwhelming majority of participants had adequate health literacy (S-TOFHLA $\geq$ 23).

<u>Water Consumption</u>

The amount of water habitually consumed (gm) was found to be significantly associated with

education level (p=0.020), income level (p=0.017), and race category (p<0.001). In addition,

habitual water consumption (gm) differed according to S-TOFHLA category, education levels,

income levels, and race category. Those with inadequate health literacy (S-TOFHLA $\leq$ 16)

consumed significantly more water grams ($\bar{x} = 1422 \pm 0$) as compared to those with marginal

health literacy (S-TOFHLA 17-22) ($\bar{x}$ = 341 ± 108). Participants with a four year college degree

or more consumed significantly more water ($\bar{x}$ = 1062 ± 84 and 1068 ± 67, respectively) than

those who did not graduate from high school ($\bar{x}$ = 763 ± 82). The two highest income categories

consumed significantly more water   ($\bar{x}$ = 1050 ± 64 and 1095 ± 88, respectively) than the

lowest income category ($\bar{x}$ = 800 ± 81). Whites ($\bar{x}$ = 1088 ± 53) and American Indian/Native

Alaskans ($\bar{x}$ = 968) in this sample drank significantly more water than blacks ($\bar{x}$ = 725 ± 54).

Sugar-Sweetened Beverage Consumption

Significant correlations were found between S-TOFHLA scores and habitual daily sugar-

sweetened beverage kilocalories (r= -0.164, p=0.003) as well as with age and habitual daily

sugar-sweetened beverage kilocalories (r= -0.154, p= 0.029). Also, it was found that men

consumed more habitual daily sugar-sweetened beverage kilocalories than women (t= 3.29,

p=0.001). Mean daily sugar-sweetened beverage consumption (kcal) was significant according

to level of education (p<0.001), level of income (p=0.05), and race category (p<0.001). Group

differences according to levels of education and race category were also seen in relation to

habitual sugar-sweetened beverage consumption (kcal). Significantly higher consumptions were

seen in those who had not graduated high school ($\bar{x}$ = 354 ± 53), graduated high school ($\bar{x}$ = 372

± 54), or had some college/two year college degree ($\bar{x}$ = 349 ± 44) as compared with those who

attained a four year college degree ($\bar{x}$ = 180 ± 30) or higher ($\bar{x}$ = 120 ± 21). In addition, blacks (

$\bar{x}$ = 426 ± 52) and American Indian/Native Alaskans ($\bar{x}$ = 346 ± 49) consumed significantly

more sugar-sweetened beverage calories than the other race category ($\bar{x}$ = 226 ± 32) and whites (

$\bar{x}$ = 159 ± 19).   With regard to habitual daily sugar-sweetened beverage consumption (fl. oz.),

race category was the only significant relationship (p=0.021). However, the p-value approached

significance in the association between BMI and mean daily sugar-sweetened beverage fluid ounces (r= 0.107, p=0.054) and was included in the regression model.

Total Beverage Consumption

Both S-TOFHLA scores (r= -0.141, p=0.01) and age (r= -0.154, p= 0.005) were significantly correlated with average daily habitual total beverage kilocalories. Gender was also associated with daily habitual total beverage kilocalories with men consuming significantly more daily beverage calories than women (t= 2.83, p= 0.005). Significant differences were seen with average total beverage consumption (kcal) and education level (p=0.006), income level (p=0.021), and race category (p=0.001). Group differences according to education level, income level, and race category were also noted. The lowest income group was found to consume more calories from beverages ($\bar{x}$ = 618 ± 126) than the highest income category ($\bar{x}$ = 304 ± 31). Those with more than a four year college degree had lower total habitual daily beverage calorie consumption ($\bar{x}$ = 332 ± 31) as compared to those with a four year college degree ($\bar{x}$ = 570 ± 128), with some college/two year degree ($\bar{x}$ = 621 ± 62), those who graduated high school ($\bar{x}$ = 690 ± 81), and those who did not graduate from high school ($\bar{x}$ = 676 ±84). Also, blacks consumed significantly more daily beverage calories ($\bar{x}$ = 771 ± 81) than whites ($\bar{x}$ = 437 ± 51) and other races ($\bar{x}$ = 528 ± 54).

BMI category (underweight, normal weight, overweight, obese) treated as a categorical variable was not found to be associated with any of the beverage categories and was therefore not used in any of the regression models described below. Also, milk consumption (kcal) was not found to

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be associated with any of the factors examined in this study and was therefore not included in the regression analyses.

Linear Regression Models

Multivariate linear regression models were created based on the significant associations detailed above. As presented in Table 3, regression models for water (gm/day), sugar-sweetened beverage (kcal/day and fl. oz./day), and total beverage (kcal/day) consumption were generated. The models were able to account for more variability in mean daily habitual sugar-sweetened beverage consumption (kcal) (R^2=0.186, p<0.001) and average daily beverage kilocalories (R^2=0.103, p=0.035) than in the models for water consumption (gm) (R^2=0.088, p=0.015) and average daily sugar-sweetened beverage consumption (fl. oz.) (R^2=0.038, p=0.013). However, none of the models accounted for a high amount of variability. When looking at the significant variables in the regression models it was found that when compared with blacks, whites consumed 0.40 less sugar-sweetened beverage calories per day, 0.18 less sugar-sweetened beverage fluid ounces per day, and 0.30 less water grams per day. American Indians/Native Alaskans consumed 0.28 less sugar-sweetened beverage kilocalories, 0.15 less sugar-sweetened beverage fluid ounces per day, and 0.18 less average daily beverage kilocalories when compared to blacks. In addition, the other race category consumed 0.20 less sugar-sweetened beverage kilocalories per day and 0.13 less sugar-sweetened beverage fluid ounces per day when compared to blacks. The other demographic variables that were analyzed in the linear regression models including age, gender, education level, income level, and S-TOFHLA score were not found to be significant within their respective models.

Discussion

Similar to other studies, we found that higher educational attainment was associated with lower habitual sugar-sweetened beverage consumption (kcal) and that an increase in average daily beverage kilocalories was linked to lower income level[14,24]. Data from one investigation found mean habitual sugar-sweetened beverage consumption (kcal) to be 277 for those with some high school, 208 for those with a high school diploma, 171 for those with some college, 160 for those with an associate's or bachelor's degree, and 87 for those with more than a bachelor's degree[14]. These findings mirror our reported mean habitual sugar-sweetened beverage consumption (kcal) of 354 for those who did not graduate from high school, 372 for those who graduated from high school, 349 for those with some college or a two year college degree, 180 for those with a four year college degree, and 120 for those with more than a four year college degree. Although our mean consumptions are higher, both investigations follow the same general pattern of decreased consumption with increased education. Comparable results were also found when added sugar consumption (tsp/d) was measured in relation to education level[24]. In addition, data on added sugar consumption showed increased added sugar consumption with decreased income[24]. Those findings are similar to our data in which a decrease in average daily beverage calories is associated with an increase in income from the lowest income group to the highest income group (304 kcal to 618 kcal). Previous investigations have also reported associations between education and/or income levels with obesity[25,26,27]. These associations could be due to the fact that energy-dense foods tend to be less expensive than nutrient-dense foods and therefore are consumed at a higher level in those at lower income levels[26]. Available food dollars are directly linked to added sugar intake[25] and added sugar intake may be a possible contributor to obesity.

Our findings regarding race, specifically that American Indian/Native Alaskan are a group that consumes more beverage calories and sugar-sweetened beverage calories than some other race groups, are consistent with previously conducted studies in which American Indian women reported frequent soda and sugar-sweetened beverage consumption[28]. However, broader studies looking at total sugar-sweetened beverage consumption for this group as a whole have not been conducted[24].

With regard to age and gender, previous investigations have reported an inverse relationship between age and sugar-sweetened beverage consumption and a higher consumption of sugar-sweetened beverages in men than women. Our sample found men consumed approximately 448 sugar-sweetened beverage calories per day while women consumed 259 sugar-sweetened beverage calories. Data from another study found men to consume 302 calories from sugar-sweetened beverages and women to consume 158 calories from sugar-sweetened beverages daily[14]. The same pattern was seen when added sugar consumption was analyzed; men consumed 20 tsp/d compared to 14 tsp/d consumed by women[24]. Our analyses show a significant inverse correlation between age and mean daily habitual sugar-sweetened beverage consumption (kcal) and average daily beverage consumption (kcal). This is similar to results which show younger men and women (18-39 years) consume more added sugars (26 tsp/d, 18 tsp/d, respectively) compared to older men and women ($\geq$ 60 years) (12 tsp/d, 10 tsp/d, respectively)[24].

Although health literacy has been linked to various poor health outcomes[8], only one study has evaluated the relationship between health literacy and sugar-sweetened beverages[14]. The authors

reported higher sugar-sweetened beverage consumption (kcal) in those with lower health literacy compared to those with higher health literacy which is similar to our findings. The lowest health literacy group in the other study consumed approximately 230 kcal/d from sugar sweetened beverages and our sample men for the lowest health literacy group was 574 kcal/d. The middle health literacy group (possible limited health literacy[14] or marginal health literacy) consumed 197 kcal/d and 397 kcal/d, respectively. Lastly, the lowest consumptions were seen in the adequate health literacy groups in both investigations. Our reported mean was 286 kcal/d while the other study reported 111 kcal/d of sugar-sweetened beverages in their adequate health literacy group[14].

The regression analyses demonstrate that the multiple significant demographic predictors used to determine water consumption, sugar-sweetened beverage consumption, and total beverage consumption were able to account for some variability in these beverage outcomes. This suggests that being able to determine what factors influence an individual's beverage choices may allow for interventions and public health messages to be more tailored. Addressing multiple factors when looking at increasing healthy beverage consumption patterns may improve the chance of creating a successful intervention.

A major strength of this study is that we had a relatively large sample size taken from two different geographic locations. Also, the use of a valid and reliable questionnaire specifically related to beverage consumption to determine beverage consumption patterns is unique because the role of beverage consumption is continuing to be further evaluated in regard to negative health outcomes such as obesity. In addition, our reported mean beverage calorie consumption

were similar to those reported by NHANES from data collected from 1999-2004. The NHANES data suggests total beverage calories were approximately 458 kcal/d[11] and the mean in this sample was 581 kcal/d. Average sugar-sweetened beverage consumption from NHANES was 294 kcal/d[10] while mean consumption in this sample was 289 kcal/d. Total milk calories were also comparable between NHANES data and this investigation, with reported calories being 185 kcal/d[10] and 157 kcal/d, respectively. Lastly, water (fl. oz.) was reported by NHANES to be 45 fl.oz./d[11] and by our study to be 31 fl.oz./d. This illustrates that our sample was fairly representative of the nation as a whole in terms of beverage consumption patterns which may speak to the generalizability of these findings.

The limitations of this analysis are recognized. Although this sample varies in race, education, and income, there is little variation among health literacy scores. This could be due to the difficulty associated with recruiting low-literate populations for research studies. It is also possible that tools, such as the S-TOFHLA, were not properly administered to study participants. Study participants were supposed to complete the test on their own, but it is possible that help was given by research staff. In addition, only the reading comprehension section of the S-TOFHLA was given and then used to calculate health literacy scores. Leaving out the numeracy section may have increased the health literacy scores. Finally, self-reported data such as the water consumption survey and BEV-Q could be susceptible to reporting error.

Due to the recent trends in increased weight status and sugar-sweetened beverage consumption it is necessary to develop successful interventions based on the factors which influence caloric beverage consumption. Mentions of high added sugar consumption from the American Heart

Association, Office of the Surgeon General, and the Dietary Guidelines committee illustrate the need for American's to change their dietary habits in order to avoid negative health outcomes. Although we were unable to find demographic variables from our sample that were significantly associated with milk consumption, which warrants more research, we were able to determine significant predictors for the other beverage categories. Findings from this analysis demonstrate what sub-groups may be particularly prone to higher sugar-sweetened beverage consumption, allowing for health providers and government organizations to target health messages to certain members of the population.

Table 2: Sample demographic characteristics (n=334).

Variable	Frequency (n)	Percent (%)	Mean ± SEM	Range
Age			35.2 ± 0.5	18-65
Gender				
Male	51	15.3		
Female	282	84.4		
BMI (kg/m^2)			30.6 ± 0.4	17.2-57.5
BMI Category (kg/m^2)				
Underweight (<18.5)	4	12		
Normal Weight (18.5-24.9)	82	24.6		
Overweight (25-29.9)	99	29.6		
Obese (≥ 30)	143	42.8		
Race				
White	115	34.4		
Black	95	28.4		
American Indian/Native American	76	22.8		
Other[a]	47	14.1		
Education Level				
Did not graduate HS	43	12.9		
HS graduate	78	23.4		
Some college/ 2 yr. degree	99	29.6		
4 yr. college graduate	41	12.3		
More than 4 yr. degree	65	19.5		
Income Level				
$<10,000 - 29,999	51	15.3		
$30,000 - 59,999	44	21.3		
$60,000 or more	63	18.9		
S-TOFHLA Score			34.2 ± 0.2	13-36
Adequate health literacy (23-36)	329	98.5		
Marginal health literacy (17-22)	3	0.9		
Inadequate health literacy (0-16)	2	0.6		

[a]Other includes Asian, Native Hawaiian or Pacific Islander, Multiracial, and Hispanic.

Table 3: Using demographic variables, BMI, and S-TOFHLA scores to predict sugar-sweetened beverage intake (kcal/day, fl oz/day), water intake (grams/day), and total beverage intake (kcal/day).

Demographic Variables	SSB (kcal/d)		SSB (fl. oz./d)		Water (gm/d)		Total Beverage (kcal/d)	
	b	p-value	b	p-value	b	p-value	b	p-value
Age	0.007	0.932	--	--	--	--	-0.038	0.650
Gender	-0.152	0.045	--	--	--	--	-0.056	0.482
BMI	--	--	0.094	0.091	--	--	--	--
Race[a]								
White	-0.401	<0.001	-0.175	0.009	0.302	0.008	-0.157	0.177
Am. Indian/ Native Alaskan	-0.279	0.001	-0.150	0.021	0.096	0.277	-0.175	0.055
Other[b]	-0.203	0.022	-0.128	0.040	0.124	0.176	-0.098	0.291
Education level	-0.133	0.216	--	--	0.021	0.848	0.064	0.568
Income level	-0.001	0.991	--	--	0.065	0.497	-0.175	0.086
S-TOFHLA score	0.026	0.764	--	--	--	--	-0.136	0.133
R-squared	0.186		0.038		0.088		0.103	
Model significance	p< 0.001		p= 0.013		p= 0.015		p= 0.035	

[a]Black was used as the base group for the race variable.
[b]Other includes Asian, Native Hawaiian or Pacific Islander, Multiracial, and Hispanic.

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Ch. 3: Conclusions and Future Directions

The results of this investigation show the increased need for beverage consumption patterns to be addressed based on demographic factors such as education level, income level, and/or race/ethnicity. Specifically, those with increased income tended to consume more water and less sugar-sweetened beverages, leading to a lower overall total beverage kilocalorie (energy) consumption. Individuals with higher educational attainment also tended to consume more water and had lower total beverage kilocalorie consumption. Blacks consumed more total beverage kilocalories than whites and other races and less water than whites and American Indian/Native Alaskans. In addition, the combination of a variety of significant associations between different demographic factors and specific beverages determined significant predictors of water, sugar-sweetened beverage (kcal), and daily beverage (kcal) consumption. Many associations reported were consistent with existing literature regarding amounts of calories consumed, consumption of added sugars, and the relationship between health literacy and sugar-sweetened beverages[1,2,3,4]. Several studies have examined factors that influence added sugar intake, and these findings were similar to that reported in the literature[5,6,7].

In order to continue in this line of work to improve habitual beverage consumption patterns, future investigations should investigate mechanistic links between increased sugar-sweetened beverage consumption and obesity as well as ways to intervene on beverage consumption behaviors. The heightened awareness of the issue of health literacy and its relationship to obesity and chronic disease is evident in recent publications by major health organizations. The most recent United States Dietary Guidelines and the American Heart Association have addressed sugar-sweetened beverages in their recommendations[3,8]. Examples of the broader

public health impact of these guidelines have been recently reported in the media. The mayor of

Boston has placed a ban on beverage sales in public buildings that includes regular sodas, pre-

sweetened ice teas, coffee drinks, energy drinks, juice drinks, and sports drinks in order to make

it easier for the citizens of Boston to make healthier choices[9]. San Francisco has also made

strides to promote healthier beverage choices by placing hydration stations (water fountains

specifically made for reusable water bottles) in a newly renovated portion of their airport. The

goal is to help reduce waste from plastic water bottles; however, it may also increase water

consumption among individuals who travel and work within the airport[10].

Due to this, there needs to be development of large scale population based interventions targeting

healthier beverage consumption patterns among individuals with limited health literacy and

lower education and income levels, since those populations have been reported at higher risk for

poor beverage consumption patterns. For example, an intervention targeting a low health literate

population could employ community-based participatory research techniques to increase the

relevance of the information delivered and ensure its delivery is appropriate. Past interventions

have aimed at making information more available to low-literate populations with some success.

This has been done in a variety of ways including utilizing pictographs, booklets, pamphlets,

videos, and changing readability levels of pre-existing materials[11]. Once the effectiveness of

these types of interventions are determined, necessary changes can be made and local and

national programs can be developed. In addition, there are economic benefits to low-income

families in that water can put less strain on a family's budget than sugar-sweetened beverages.

Overall, this work is important because of the rise of obesity and chronic disease especially

among health disparate individuals. Beverage consumption is an area that can be targeted as a way to encourage individuals to adopt healthier behaviors.

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APPENDIX A: Institutional Review Board Approval

VirginiaTech

Office of Research Compliance
Institutional Review Board
2000 Kraft Drive, Suite 2000 (0497)
Blacksburg, Virginia 24061
540/231-4991 Fax 540/231-0959
e-mail moored@vt.edu
www.irb.vt.edu

FWA00000572(expires 1/20/2010)
IRB # is IRB00000667

DATE: August 7, 2008

MEMORANDUM

TO: Brenda M. Davy
              Valisa Respress

              Approval date: 8/7/2008
              Continuing Review Due Date:7/23/2009
              Expiration Date: 8/6/2009

FROM: David M. Moore

SUBJECT: **IRB Expedited Approval:** "Health Literacy and Parental Perceptions About Water Consumption and Its Impact on Health" , IRB # 08-459

This memo is regarding the above-mentioned protocol. The proposed research is eligible for expedited review according to the specifications authorized by 45 CFR 46.110 and 21 CFR 56.110. As Chair of the Virginia Tech Institutional Review Board, I have granted approval to the study for a period of 12 months, effective August 7, 2008.

As an investigator of human subjects, your responsibilities include the following:

1. Report promptly proposed changes in previously approved human subject research activities to the IRB, including changes to your study forms, procedures and investigators, regardless of how minor. The proposed changes must not be initiated without IRB review and approval, except where necessary to eliminate apparent immediate hazards to the subjects.
2. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.
3. Report promptly to the IRB of the study's closing (i.e., data collecting and data analysis complete at Virginia Tech). If the study is to continue past the expiration date (listed above), investigators must submit a request for continuing review prior to the continuing review due date (listed above). It is the researcher's responsibility to obtain re-approval from the IRB before the study's expiration date.
4. If re-approval is not obtained (unless the study has been reported to the IRB as closed) prior to the expiration date, all activities involving human subjects and data analysis must cease immediately, except where necessary to eliminate apparent immediate hazards to the subjects.

Important:
If you are conducting **federally funded non-exempt research**, please send the applicable OSP/grant proposal to the IRB office, once available. OSP funds may not be released until the IRB has compared and found consistent the proposal and related IRB applicaton.

cc: File

Invent the Future

VirginiaTech

DATE: September 1, 2008

MEMORANDUM

TO: Brenda M. Davy
               Valisa Respress

FROM: David M. Moore

Approval date: 8/7/2008
Continuing Review Due Date:7/23/2009
Expiration Date: 8/6/2009

SUBJECT: **IRB Amendment 1 Approval:**   "Health Literacy and Parental Perceptions About
               Water Consumption and Its Impact on Health" , IRB # 08-459

This memo is regarding the above referenced protocol which was previously granted approval by the
IRB on August 7, 2008. You subsequently requested permission to amend your IRB application.
Since the requested amendment is nonsubstantive in nature, I, as Chair of the Virginia Tech
Institutional Review Board, have granted approval for requested protocol amendment, effective as of
September 1, 2008. The anniversary date will remain the same as the original approval date.

As an investigator of human subjects, your responsibilities include the following:

1.   Report promptly proposed changes in previously approved human subject research
      activities to the IRB, including changes to your study forms, procedures and
      investigators, regardless of how minor. The proposed changes must not be initiated
      without IRB review and approval, except where necessary to eliminate apparent
      immediate hazards to the subjects.
2.   Report promptly to the IRB any injuries or other unanticipated or adverse events
      involving risks or harms to human research subjects or others.
3.   Report promptly to the IRB of the study's closing (i.e., data collecting and data
      analysis complete at Virginia Tech). If the study is to continue past the expiration
      date (listed above), investigators must submit a request for continuing
      review prior to the continuing review due date (listed above). It is the researcher's
      responsibility to obtain re-approval from the IRB before the study's expiration date.
4.   If re-approval is not obtained (unless the study has been reported to the IRB as
      closed) prior to the expiration date, all activities involving human subjects and
      data analysis must cease immediately, except where necessary to eliminate
      apparent immediate hazards to the subjects.

cc: File

Invent the Future

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VirginiaTech

MEMORANDUM

DATE: July 8, 2010

TO: Brenda M. Davy, Valisa Respress

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires June 13, 2011)

PROTOCOL TITLE: Health Literacy and Parental Perceptions About Water Consumption and Its Impact on Health

IRB NUMBER: 08-459

Effective August 7, 2010, the Virginia Tech IRB Administrator, Carmen T. Green, approved the continuation request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 7**
Protocol Approval Date: **8/7/2010 (protocol's initial approval date: 8/7/2008)**
Protocol Expiration Date: **8/6/2011**
Continuing Review Due Date*: **7/23/2011**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Invent the Future

Date*	OSP Number	Sponsor	Grant Comparison Conducted?

*Date this proposal number was compared, assessed as not requiring comparison, or comparison information was revised.

If this IRB protocol is to cover any other grant proposals, please contact the IRB office (irbadmin@vt.edu) immediately.

cc: File