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Lack of findings for the association between obesity risk and usual sugar-sweetened beverage consumption in adults – A primary analysis of databases of CSFII-1989–1991, CSFII-1994–1998, NHANES III, and combined NHANES 1999–2002

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Abstract

The relationship between obesity risk and sugar-sweetened beverage (SSB) consumption was examined together with multiple lifestyle factors. Statistical analysis was performed using population dietary survey databases of USDA CSFII 1989–1991, CSFII 1994–1996, CDC NHANES III, and combined NHANES 1999–2002. Totally, 38,409 individuals, ages 20–74 years, with accompanying data of dietary intake, lifestyle factors, and anthropometrics were included in the descriptive statistics and risk analysis. Analytical results indicate that obesity risk was significantly and positively associated with gender, age, daily TV/screen watching hours and dietary fat content, and negatively associated with smoking habit, education and physical activity; obesity risk was not significantly associated with SSB consumption pattern, dietary saturated fat content and total calorie intake. No elevated BMI values or increased obesity rates were observed in populations frequently consuming SSB compared to populations infrequently consuming SSB. Additionally, one-day food consumption data was found to overestimate SSB usual intake by up to 38.9% compared to the data of multiple survey days. *Conclusion:* multiple lifestyle factors and higher dietary fat intake were significantly associated with obesity risk. Populations who frequently consumed SSB, primarily HFCS sweetened beverages, did not have a higher obesity rate or increased obesity risk than that of populations which consumed SSB infrequently.

Keywords: Sugar; Beverage; Obesity; HFCS; Risk; Database

1. Introduction

The prevalence of obesity is increasingly recognized as a global health problem, and the WHO MONICA Project has associated the increasing dietary energy supply with the increase in personal weight in Western countries (Silventoinen et al., 2004). Several mechanisms on obesity prevalence have been proposed, but one obvious underlying mechanism is a positive balance between energy intake and energy expenditure. The consequence from excessive weight gain and obesity, defined by body mass index (BMI) equal to or over 30, is the increased risk of various diseases, including cardiovascular disease and diabetes. Obesity lowers quality of life, decreases productivity, and results in billions of dollars in associated health care costs. Currently, there are few indications that the increasing

Abbreviations: HFCS, high fructose corn syrup; SSB, sugar-sweetened beverage; CSFII, continuing surveys of food intakes by individuals; NHANES, national health and nutrition examination surveys; BMI, body mass index.

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prevalence of obesity has reached its plateau in the US (Blanck, 2006). Recent publications and commentaries have suggested that the consumption of added sugars from sucrose, high fructose corn syrup (HFCS), or sugar-sweetened beverage (SSB) is a direct causative factor for the development of obesity (Bray, 2004; Bray et al., 2004; Nielsen and Popkin, 2004). Although some reports draw simple correlations between obesity and SSB consumption using population trends and national food production data, these approaches do not take into account the actual consumption and event occurrence by individuals, nor do they account for many other physical/medical aspects linked with the event occurrence. Simple correlations must be examined carefully when used to predict direct causality of a non-communicable medical condition by using other criteria (Hill, 1965), such as prospective intervention studies. Other reports have provided a more direct analysis on causality of food intakes and body weight status by examining data or databases which contain individual records of food consumption and anthropometrics (Janket et al., 2003; Kvaavik et al., 2005; Schulze et al., 2004; Wu et al., 2004; Yang et al., 2003).

During the last 30 years, high fructose corn syrup has gradually replaced cane and beet sugar sucrose in most US beverage applications. HFCS, like sucrose, is compositionally made up of approximately equimolar amounts of fructose and glucose. HFCS typically comes in either 42% or 55% fructose content, with the remainder being mainly glucose. In sucrose, the two monosaccharides, fructose and glucose, are chemically bonded together while in HFCS, the glucose and fructose are a simple mixture. During ingestion and absorption, sucrose is hydrolyzed into fructose and glucose by stomach acid and cleaving enzymes in the digestive tract, so that sucrose does not actually appear in the bloodstream (Gray and Ingelfinger, 1966). Furthermore, the mixture of glucose and fructose act differently than a pure monosaccharide ingested singly (Riby et al., 1993). Nutritionally and metabolically, it is unlikely that the human body can distinguish whether the two monosaccharides come from sucrose or HFCS once absorbed into the bloodstream. It is also interesting to note that even when sucrose is used in soft drinks, as in Europe and Mexico, the sucrose is often more than 50% hydrolyzed into fructose and glucose, which helps to maintain a constant sweetness level during storage and also due to the fact that sucrose inverts (hydrolyzes) spontaneously in acidic beverage conditions (Birkhed, 1984; Marov and Dowlong, 1990; Riby et al., 1993).

Very limited long term prospective data are available to examine the association between HFCS and obesity. In general, it is very difficult and expensive to conduct a prospective population study to determine the effect of a single dietary component on obesity occurrence. In this study, we have used the approaches of descriptive statistics and Logistic regressions using multiple dietary intake survey databases to investigate the potential influence of multiple lifestyle factors and sugar-sweetened beverage (SSB) consumption on BMI profiles and obesity occurrence rates in the US adult population. To our knowledge, this is the first work using the five population databases nationally surveyed during 1988–2002 to examine a correlation between obesity, certain lifestyle factors, and SSB consumption.

2. Methods

2.1. Databases and subjects

US food intake data were analyzed from the two USDA Continuing Surveys of Food Intakes by Individuals (CSFII) 1989–1991 and 1994–1996, and the three CDC National Health and Nutrition Examination Surveys (NHANES) III 1988–1994, NHANES 1999–2000, and NHANES 2001–2002 (National Center for Health Statistics of CDC; The Food Surveys Research Group, 1989–1991; The Food Surveys Research Group, 1994–1996). From these five food intake databases, 38,409 adults, who had complete data records required for this analysis, were included in this study. Relationships were examined between lifestyle factors/SSB consumption and BMI/obesity occurrence. Data records were selected for analysis from adult population aged 20–74 years, as this population is more stable and not as subject to lifestyle or development changes radically affecting height and weight over short periods of time. Additionally, children and adolescents lack certain lifestyle data such as smoking habit, education level, etc., which would bias the risk analysis. Elderly adults are also subject to more health-related issues that may affect body weight and lifestyle patterns. In view of the relatively smaller sample sizes, we followed the recommendations from the analysis guide for NHANES data, and merged the databases of NHANES 1999–2000 and NHANES 2001–2002 together as "NHANES 1999–2002".

2.2. Term definition and data categorization

Among these databases, some inconsistencies of criteria for data collection exist. First, the number of days of survey periods was not always the same. NHANES databases only have one-day (24 h) food intake data, whereas CSFII 1994–1996 database has two-day and CSFII 1989–1991 database has three-day food intake data. Secondly, methods for collecting data on physical activity are different. In order to generate consistency, we categorized physical activity for each individual as active/vigorous, moderate, and minimal for each database, similar to the classification in NHANES 1999–2002. Thirdly, for TV/screen watching time, some databases include computer time, others do not, and NHANES III did not collect the data of TV watching time in the adult population. In this study, TV/screen time is divided into three levels: less than 2 h, 2–4 h, and more than 4 h. Fourthly, for education records, CSFII databases use highest school year attained, while NHANES 1999–2002 databases use categories (under high school, high school diploma, or more than high school). We used the latter for categorization of education level for all databases. Smoker was defined as a person who currently smokes cigarettes, cigars, and/or pipes. To analyze age effects, specific age groups were segmented into either 5 or 10-year intervals. Lastly, as defined by the CDC, obesity is characterized as an adult with a BMI $\geqslant$ 30.

Sugar-sweetened beverages (SSB) were defined as caloric soft drinks, colas, and sugar sweetened fruit beverages. Typically, these are predominately sweetened with HFCS in the US. Pure fruit juices and diet soft drinks were not included in this category. In total, 73 SSB products that met the SSB definition were found in the databases. The frequent consumers, or "users", of SSB were defined as those individuals who consumed any kind of SSB at least once during the defined survey period. Otherwise, individuals were categorized as infrequent SSB consumers, or "non-users".

2.3. Statistical method

SAS software (version 9.1, SAS Institute, Cary, NC) was employed as the statistical evaluation tool. Descriptive statistics on obesity rates, SSB intake amounts, sugars from SSB, daily energy, % fat calories, % saturated