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Water and LIfe. A Cross-Sectional Study on Determinants of Beverage Consumption and Water Access in One Tribal Community

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WATER AND LIFE. A CROSS-SECTIONAL STUDY ON DETERMINANTS OF BEVERAGE CONSUMPTION AND WATER ACCESS IN ONE TRIBAL COMMUNITY

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ABSTRACT

WATER AND LIFE. A CROSS-SECTIONAL STUDY OF DETERMINANTS OF BEVERAGE CONSUMPTION AND WATER ACCESS IN ONE TRIBAL COMMUNITY

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Increasingly, poor diet has been shown to be one of the most crucial factors associated with cause of death, even more critical than smoking. Research in the past two decades has consistently linked increased consumption of sugar-sweetened beverages (SSB) to the obesity epidemic contributing to a public health crisis all over the United States. Native Americans, among other minority groups, suffer obesity disproportionately from the rest of the US population, yet they continually fail to be included in research on the subject. Traditional research methods, sparse care coverage on reservations, consolidation of unique tribes into one classification, and failure to include cultural and historical contexts in research analysis have led to a failure to both clearly define the cause of the disparity, and furthermore, to provide for closing the gap.

This study utilized the results of a cross-sectional survey on drinking habits and water access in one tribal reservation to determine prevalence of SSB consumption and its relationship to identification as Native American. Multivariate logistic regression analysis, after accounting for covariates, identified characteristics which significantly impacted odds of consumption. Prevalence of daily SSB consumption was determined to be 69.4% ($\pm$ 4.7%). Odds of daily soda and SSB consumption were 3 to 4 times greater in Native Americans than other ethnicities. Non-natives were four times more likely to consume water daily. Body mass index was positively correlated with daily soda consumption, and older individuals experienced greater odds of heavy SSB consumption (>4 SSBs consumed per day). Individuals with less than a college education were at greater odds of daily SSB consumption. Contrary to the literature, gender and income were uncorrelated to consumption. This study was the first of its kind to establish a baseline statistic for prevalence and determinants of SSB consumption in a tribal community.

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INTRODUCTION

The Obesity Epidemic

Current research now suggests that poor diet is the largest contributor to chronic disease mortality, contributing more to chronic disease related deaths than does smoking [1]. Obesity, in particular, has been linked to increased mortality and increased morbidity of chronic disease, including (but not limited to) cancer, type II diabetes mellitus, cardiovascular disease, gallbladder stones, liver disease, and infertility[2,3]. According to the National Center for Health Statistics (NCHS), an estimated 39.8% of Americans and 18.5% of youth ages 2-19 were obese in 2016, an increase of 30% since 1999[4]. The swift increase in prevalence of obesity in past decades has led to its designation as an epidemic in the United States (US), and large-scale public health efforts have been designed to target weight reduction and nutrition since the late 1990s[2,5–7].

In particular, sugar sweetened beverage (SSB) consumption has been linked to obesity and associated chronic disease; these beverages are now purported to be the largest source of added sugar in the diets of adults and children in the United States, comprising up to 37% of additional sugars for adults and 31% for children[8]. The proportion of chronic disease related death and disability adjusted life years (DALY) attributable to SSB consumption is the greatest in the United States, second only to Central Latin America[1]. In the most recent *Dietary Guidelines for Americans*, published by the US Department of Agriculture (USDA) and US Department of Health and Human Services (HHS), limiting added sugars (the majority of which come from SSBs) is defined as one of the three core concepts in the guidelines to healthy eating[9].

Obesity and the Native American

While the obesity epidemic has penetrated every corner of the United States (US), Native Americans suffer disproportionately from this, among other health issues[10]. According to the literature, the life expectancy of Native Americans at birth is between 4 and 25 years less than that of the rest of the US population[11,12]. Specifically, Native Americans are 2 to 8 times more likely to suffer from obesity[10,13–17]. According to the Indian Health Service (IHS) and US National Death Index, diabetes is ranked the 4th leading cause of death in Native Americans, in contrast to 7th for the US population in total[18].

Though the fact that health disparities unduly affect Native American populations has been well established in the literature, attempts at identifying why are varied. The IHS has attributed these disparities to poverty, failures of the educational system, health care discrimination, and culture[17]. Theorists, government organizations, and social science researchers attribute these health disparities to the effects of colonization, historical traumas[i], and a lack of treatment programs that address health issues unique to Native American populations[10,19–23]. Other sources attribute this disparity to racist policies, geography, genetics, and epigenetics among others[24–28]. Furthermore, while there have been attempts to implicate current and historical occurrences as responsible for the current disparate state of health of Native Americans, most publications lack both clear identification of the root causes and paths toward solutions. The reality is that the multiplicity of factors which contribute to these disparities interject themselves at all levels of political, social, and individual life, which makes it difficult for siloed approaches at improving health to succeed. A failure to clearly understand and address the Native American health disparity at the appropriate levels, and a historical interference and resistance to culturally specific interventions until recently, has inevitably allowed the gap to persist, and even widen in some circumstances.

In addition to the plethora of contributors, there remains both a paucity and

[i] Braveheart defines historical trauma as "cumulative emotional and psychological wounding across generations, including the lifespan, which emanates from massive group trauma."[22]

inaccuracy of health data from Native American communities surrounding these health issues[17,29]. Many national level statistics fall short in terms of representation on reservations. As a result, in many cases, institutions group many tribes into one category, or even fail to highlight Native Americans as a distinct ethnic grouping at all[25]. The reality that last century has been wrought with repeated attempts at genocide of tribal peoples, coupled with the social perpetuation of Native Americans as an inferior, inhuman, and dying race or a "race on the brink of extinction" has only allowed national infrastructure to forget and forego promises made with regard to land, healthcare infrastructure, and other public services[30]. Historically, Native American communities have been ignored, unless and until natural resources under their control have been sought out for exploitation[31]. This maltreatment has perpetuated feelings of invisibility in Native American communities, which is implicated greatly in the disproportionate health issues these communities experience. Additionally, this has also led to Native Americans being discounted, even erased, in health care research, particularly at regional and national levels[32]. For instance, many death certificates have miscategorized Native Americans which has resulted in underreporting of morbidity and disease-related mortality[32]. The effects of these data issues have skewed descriptive statistics and analyses at the national level, and resulted in large-scale, but ineffective, public health efforts that are contextually insufficient and perhaps even irrelevant in the context of the health of Native Americans.

Culturally Responsive Solutions

To date researchers and government health organizations alike have acknowledged disparities in health in Native American populations and there is an emerging consensus, attributing these disparities to a wide range of culturally specific issues, including the effects of colonization[10,21,33–35] . Additionally, there is a recent appeal in the health sector for a need to incorporate population-specific, socially relevant determinants of health and to integrate culturally defined, specialized programs into the public health sector to address health inequalities and culturally specific health issues[10,21,33,36–41]. Federally defined determinants of health and health statistics are used to ascertain the needs of public healthcare systems, which serves the needs of a majority of the nation's Native American population through IHS. It is crucial that these measurements both accurately represent the communities which they are serving and address the particularity of these issues in distributed and specialized manners.

Due to the evolving understanding of the issues surrounding determinants of health, and in an effort to combat culturally specific health issues with culturally specific solutions, non-profit organizations have emerged in partnership with tribes and local healthcare institutions, with support from the federal sector to decentralize information gathering and empower local communities to seek what solutions best fit their unique contexts. In particular, for this study, the Notah Begay III (NBIII) Foundation partnered with the Confederate Tribes and Bands of the Yakama Nation, and Indian Health Services to begin to identify issues around SSB consumption and clean water access on the Yakama Reservation. NBIII awarded a grant to perform a community assessment of beverage consumption and self-reported water access to begin to outline the unique issues surrounding the impact of sugar sweetened beverage consumption on the Yakama reservation.

Purpose and Significance

The purpose of this research is threefold:

(1) To develop baseline statistics for prevalence of SSB consumption among those who identify as Native American in one tribal community

(2) To begin to understand the correlation between SSB consumption and various socio-demographic characteristics within the Native American subpopulation

(3) To compare this subpopulation to the literature, highlighting differences which could potentially impact program and policy development in tribal communities

This study contributes to the body of literature which specifically addresses health disparities in Native American communities. In the last 20 years, with rising obesity, the literature has been saturated with cross-sectional and longitudinal studies, as well as systematic reviews and meta-analyses which seek to determine the relationships between SSB consumption, socio-demographic characteristics, and health outcomes. However, many of those disproportionately affected by the health disparities which these very studies seek to address fail to be adequately represented in them. This research attempts to address that gap through the analysis of determinants of SSB consumption within the Native community. To date, there has not been a study of this caliber or specificity completed in the study area.

This thesis is divided into 5 sections: (1) Literature review; (2) Study Area; (3) Methods; (4) Results; and (5) Discussion. The literature review begins by outlining the broad and unique context within which the health of Native peoples is situated outlining historical conceptions of health within the tribes of the Lower Columbia River, and then moves to discuss the impact of historical events on both the food systems and health of these peoples. Next, we explicate the potential biophysical impacts of stress and historical trauma on the individual through a discussion of epigenetics and socio-political pathology. The literature review concludes with a discussion of the health impacts of SSB consumption, a detailed review of previous research around determinants of consumption, and a brief overview of targeted marketing and identification of the literature gap. This thesis then moves to describe socio-demographic and geographic properties of the study area, using data from the American

Community Survey (ACS) among other sources. The methods section details the logistic model used for analysis, as well as the survey collection and analysis procedures. The results details prevalence statistics stratified by demographic characteristics, regression analysis results for daily water, SSB, and Soda consumption and heavy SSB consumption. The results also detail statistics on the remaining survey questions related to water and SSB access. The results section is followed by a discussion of the prevalence statistics and regression analysis and a comparison to the literature. The discussion section concludes with a brief discussion of study conclusions, potentials for future research, and emerging policies and potential policy implications.

LITERATURE REVIEW

Native Americans and Health

In order to be able to understand the full context of health disparities in Native communities it is critical to first understand the unique historical, political and social contexts which have led to the present day Native American diet. Additionally, to conjure effective and lasting solutions to improve the health of Native peoples, we must retrace our steps to uncover the roots of the issues. This section details the history of changing food systems of the lower Columbia river tribes in the last century, the health impacts of colonialism, and emerging theories regarding the relationship between historical trauma and health disparities in Native communities.

Food Systems and the Lower Columbia River Tribes

Historically, while Europeans have focused on spatial fix[i] as a means for survival,

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[i] Spatial fix refers to the takings of land in order to expand capitalist enterprise to ensure temporary longevity to its inherently crisis-oriented nature. It is often used synonymously with globalization[129].

tribal peoples of the Americas tended to focus on optimizing use of resources within an area for sustainability and survival[42]. In particular, tribal peoples of the Lower Columbia River were nomadic and believed in moving with the seasons and the foods[43,44]. Ceremonies were centered around the first foods, and the foods were in some cases given human personas [43–45]. It is evident in accounts of traditional ecological knowledge that care and respect for the foods were central to the lives, health and well-being of tribal peoples [43,44,46–48]. Hunn and Selam[43] purport that the relationship between tribal peoples and animals was one of kinship. The peoples of the Lower Columbia River also believed some animals to be messengers, and lucky ones may even experience an animal speaking to them in their language. For the Cayuse, Umatilla, and Walla (among other tribes in the region), it was believed that each person possessed powers that were a result of the types of food that were consumed[49]. Therefore, it was believed that animosity or ill will when preparing or serving foods could produce illness in its consumer[49,50]. Additionally, a critical component of living well required enlisting the help of preternatural powers, which almost always manifested in the form of fish and other animals [44]. It is important to note that the health of the individual was intricately connected not only to the consumption of the food, but to the manner in which it was collected and prepared, in addition to the spiritual condition of the harvester at the time of harvest. This belief system lies in stark contrast to current food systems, which inevitably seek to commodify and objectify food sources, rendering them inferior and inanimate, which results their misuse, inhumane treatment, and poor management of environmental resources, all of which compose our current food system in the US.

The traditional diet of the tribes of the lower Columbia river basin was rich in protein, vitamins and other nutrients, and antioxidants, and low in sugars and salt[44,51,52]. In addition, foraging, hunting, and moving with the seasons provided much physical activity for the lower Columbia peoples. Prior to colonization in the region, there were little to no reported deaths among Natives of the region related to heart disease, diabetes and other chronic diseases which are prevalent in these communities today[44,53]. Post-colonial restructuring would greatly impact the food sources and mobility of these communities, greatly impacting their health.

In 1849, the Bureau of Indian Affairs was reassigned from the Department of War to the Department of the Interior. While relations had been defined by war in the previous century, this structural change signaled the move to assimilate tribes into sedentary, agricultural lifestyles forcing them to adopt western social, political, and environmental standards of living[43,44,46,47,54–56].

In 1855, a treaty was signed between the US Government and 14 bands of indigenous peoples of the Columbia River Basin[57]. This treaty forced the peoples to cede millions of acres of land, from which they were forcibly removed onto preselected suboptimal reservation land. This would forever restructure their way of life and systems of food, gravely impacting disease epidemiology and health.

Although the federal government recognized the cession of Indian land as a payment for foodstuffs and healthcare among other things, the government did a poor job, at best, to uphold its promises[43,47,58]. Public health infrastructure came decades later than promised, and was suboptimal, and wrought with discrimination and maltreatment. Foodstuffs were nutritionally inadequate. Additionally, while the treaty retained the tribes' right to fish in "usual and accustomed places", with thousands of Euro-Americans settling in the region, the peoples of the lower Columbia were categorically and violently denied access to traditional fishing and gathering sites and these sites were further decimated by ranching and agriculture. Finally, most devastating was the fact that tribal members were not considered US citizens, and therefore not afforded the ability to own land or vote while the area was largely being settled. This dramatically changed the lives and food systems of the native peoples in the region, forcing them into malnourishment and to live sedentarily and in abject poverty[44,47,59,60] . These conditions, coupled with the severe mental distress of the loss of over half of the population to infectious disease brought by European settlers, and a federal government that purposefully neglected to enforce treaty rights, and were slow to put in place systems of food, public health and sanitation seriously impacted the health of the tribal peoples of the Lower Columbia River basin.

To further force the assimilation of tribal peoples into western civilization, the

Dawes Act was signed into the legislature in 1887. This allowed the federal government to forcibly subdivide land on reservations and allocate partitions to individuals within tribes. It was also used to further appropriate the best plots of reservation land for agricultural use as the act stipulated that land in excess of that which was allotted to tribal members could be sold to European immigrant settlers[61]. The intent of the act failed for several reasons including the fact that the land given to tribal members was not fit for agriculture as was the original intent of the act. The land was eventually returned to tribes through the Indian Reorganization Act in 1934; however large portions of the best arable and livable land were held in century long leases for which tribal members were paid harrowingly low prices, some of which still remain intact to this day.

In the decades to come, beginning in the 1930s with a response to the Great Depression, the legislature would begin to address the abject poverty and lack of food in the United States through the establishment of food distribution programs. These programs further forced natives into assimilation as they provided foods common in the European diet which were consistently high in simple carbohydrates in the form of sugars and flour, and fats[53,62]. In 1973, the Food Distribution Program on Indian Reservations (FDPIR) was implemented, a program still implemented today, which research has shown provides food staples to tribal communities which are nutritionally insufficient per the US Department of Agriculture's (USDA) Healthy Eating Index (HEI) guidelines[63].

Today, as a direct consequence of poverty, many traditional foods (which are more nutritious than government provided “commodity” foods) have been commodified and are sold for profit rather than consumed by tribal members[43]. In conjunction with environmental degradation related to climate change, dam construction, agriculture, and development, these traditional foods are in some cases composing increasingly smaller proportions of the Native American diet[59,64].

Historical Trauma and the Health of Native Americans

Sobo et al[65] claim that in order to understand the full impact and origins of health disparities, data must be analyzed within relevant sociocultural contexts. In the case of Native Americans, repeated traumatic events that have resulted from colonialist social and political agendas, provide a unique sociocultural context that must be explicated in order to begin to ascertain the unique issues that may perpetuate health disparities in tribal communities. The lasting impact of these events can be identified in the behaviors, beliefs and lifestyles of tribal peoples, and has recently been termed historical trauma[21,40,66,67] .

Presently, Native Americans from every tribe and band in the United States, have suffered some form of extreme traumatic events in the time since the European colonization of what is now the United States, and these events have resulted in detrimental impacts on the mental, physical, spiritual and emotional health of Native American[40,66,68]. Additionally, these events have triggered social, economic, and political issues within tribal communities, resulting in domestic issues within families and effects that continue to perpetuate these traumas intergenerationally[69,70]. Historical events manifest at the national level and produce effects that perpetuate at the community, family, and individual levels (see Figure 1).

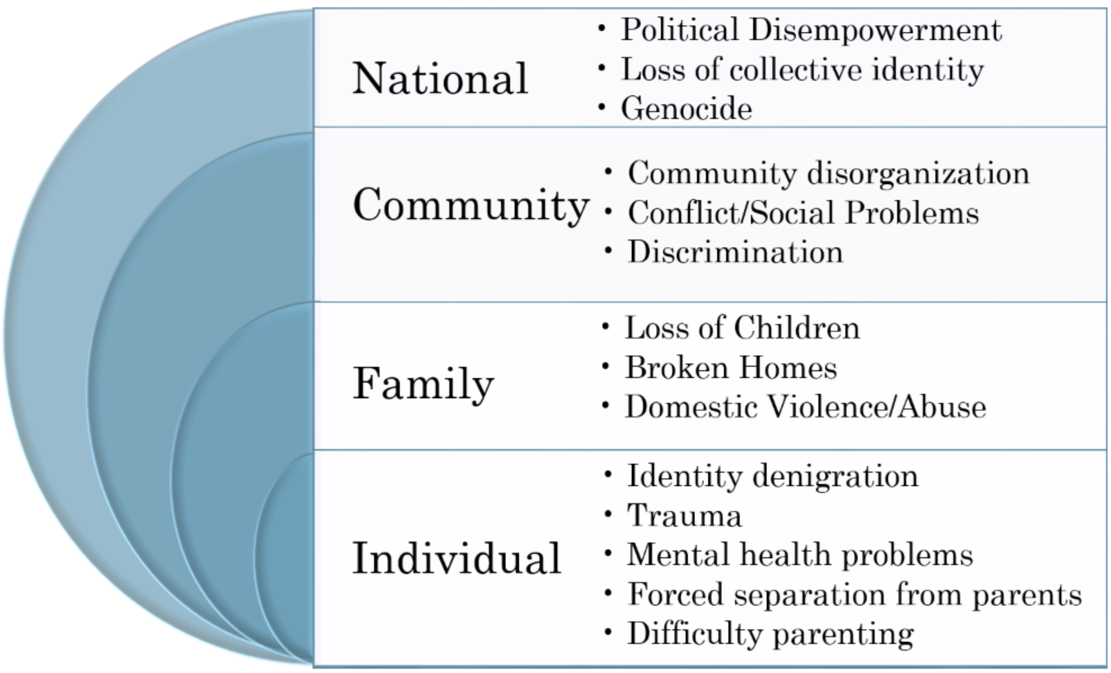

Figure 1 MULTILEVEL IMPACT OF HISTORICAL TRAUMA (ADAPTED FROM (KIRMAYER ET AL))[66]

Events at the national level that perpetuate historical trauma include genocide, massacres, imprisonment, forced boarding schooling, forced hospital admittance, prevention of spiritual and cultural practices, and radioactive dumping near reservations[40]. These events cause massive community disorganization and reorganization, and systematically deteriorate the traditional and subsistence lifestyles of tribal communities, including disruption and in some cases complete destruction of traditional food systems. With the advent of the treaty of 1855, the lower Columbia tribes and bands many of which lived in and traversed historically different terrains and spoke different dialects, were forced to reorganize under the rule of one chief, and move to sedentary reservation life where they would be afforded solely the opportunity to farm[43,44,71]. While not all were forcibly removed to the reservation, lack of resources afforded to the tribal people and racist policies (including the removal of rights of tribal members to own land and the privatization of traditional hunting and gathering places) posed significant barriers for the tribal peoples to continue their subsistence lifestyles. The reorganization of the communities, and the forced change in subsistence lifestyles, arguably resulted in tribal peoples' starvation, disease, domestic abuse, and intra-familial separation and violence[21,44].

Further government attempts at assimilation with the advent of boarding schools caused separation of families, and a generation of children raised without their biological parents[40] . Boarding schools excised any form of cultural or linguistic practices, and many traditions, languages, and cultural practices were lost or propelled to the brink of extinction in this generation. At the individual level, the identities of these children were denigrated at the most basic levels, and the practice of culture and tradition was associated with shame, which perpetuated many mental and emotional health issues that have been attributed as major causes of Native American health disparities that exist today[24]. The magnitude and impact of these and other traumatic events, and the reverberation of the effects among tribal communities and within individuals have made the contextual consideration of historical trauma imperative to the study of health disparities among Native Americans, and can be directly associated with the obesity and chronic disease suffered disproportionately in tribal communities today.

Socio-political Pathology and Epigenetics

Emerging biomedical and social science researchers are beginning to outline a clear relationship between oppression of minority groups and physical health[53]. Ferreira[72] describes a "physiology of oppression", otherwise termed socio-political pathology, in which recent findings that stress regulates cortisol and insulin provide a tangible link between stress and obesity. Additionally, studies have linked the experience of repeated stress with "fight or flight" neuroendocrine responses which release sugar into the blood. Tribal members, who suffer from the highest rates of lifetime and repeated traumatic events, are at particularly high risk for sustained high levels of sugar in the blood due to this bodily function, which can lead to insulin exhaustion and result in type II diabetes[52,53].

Furthermore, genetic research has made the case that Native American groups are more prone to obesity than other groups. One study of Pima Indians purported that tribal members were genetically more predisposed to contracting type II diabetes mellitus than other ethnic groups[73]. Another study outlined genetic variation attributable to varying degrees of storage of excess glucose as fat[74]. Additionally, various studies have now linked several more genes to susceptibility of type II diabetes[74].

Epigenetic[ii] research is also alluding to a stronger link between historical and intergenerational trauma and adverse health outcomes than previously identified in the scientific literature. One research study describes the potential impact of adverse childhood experiences (ACE) on the immune, endocrine, and parasympathetic nervous systems[28]. The study further detailed that, in response to stressful events, the body can regulate chemicals that transcribe genes which in turn code for survival responses in the body[28]. Figure 2 details the relationship between traumatic event exposure and adverse health outcomes through epigenetic modification. Epigenetic regulation can increase

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[ii] Epigenetics can be defined as the potential for environmental factors to impact gene expression[28]

cardiovascular risk, and the risk of becoming obese and contracting related chronic conditions such as type II diabetes, and cancer[75]. Additionally, epigenetic regulation can affect neurotransmitters in the brain which affect emotional states and result in increased risk of psychological disorder and suicide.

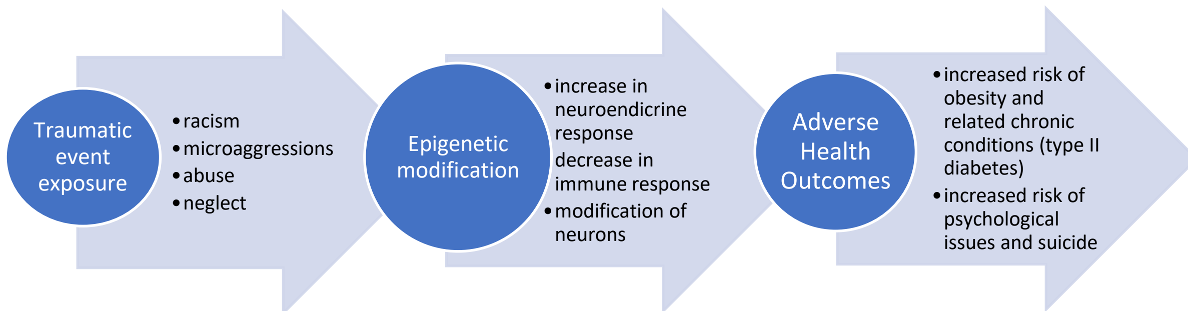


Figure 2 Epigenetic regulation in response to traumatic events. Adapted from Brockie et al[28]

SSB Consumption and Health

Currently in the United States, it is purported that 39.8% of adults and 17% of children are obese, maintaining a body mass index of 30 or above[4]. Research has shown that SSBs now compose the largest portion of added sugar to US diets, accounting for approximately 1/3 to 1/2 of total daily added sugar[76]. Additionally, trends have shown that in the last two decades, consumption of SSBs has increased dramatically (86% from 1970 to 1997) along with obesity prevalence (30% in the last decade)[52,77]. Particularly concerning, children are consuming SSBs earlier and more often, which research has determined is an indicator of adult chronic obesity, low self-esteem, and poor health outcomes as adults[78].

The literature has now established a clear link between SSB consumption and poor health outcomes[77,79]. Vartanian et al[77] performed a systematic review and meta-analysis of the literature relating to SSB consumption and health outcomes and determined that there is significant evidence of a link between SSB consumption and type II diabetes, metabolic syndrome, and hypocalcemia[77]. Te Morenga et al[80] performed a systematic review of 39 studies and found a significant link between increased SSB consumption and increased triglyceride and cholesterol levels, and blood pressure[80,81]. Multiple studies have also linked SSB consumption to increased cardiovascular risk, including increased risk of stroke and/or heart attack [79]. The World Health Organization (WHO) has determined that SSB consumption is directly linked to increased energy consumption and obesity, which is also linked to depression, hypertension, certain types of cancer, diabetes and general decline in quality of life[14,81–83].

Numerous biomedical explanations have emerged in conjunction with demographics analyses, and provide us a more comprehensive understanding of the relationship between SSB consumption and health. Though the advent of obesity is linked to many complex and interrelated processes, it is generally accepted that obesity is caused by a consistent positive energy balance, meaning more energy is consumed than burned in the body. This triggers the body to store excess sugar as fat.

Further complicating the issue is the fact that SSBs generally have extremely high sugar content condensed within a small volume of product. For instance, one 12oz soda has a sugar content equal to more than 100% of the American Heart Association's (AHA) daily recommended maximum intake of added sugar[76]. Additionally, studies have shown that the consumption of liquid calories is linked to decreased satiety and increased solid food calorie consumption [79].

The chemical composition of high fructose corn syrup (HFCS), a common form of sugar in soft drinks and other SSBs, has biomedical implications that have been linked to negative health outcomes. HFCS is a chemical more readily absorbable in the blood than sugar, which can adversely impact insulin sensitivity and is thus directly related to the development of type II diabetes in the body[79]. HFCS is also more readily converted to fat in the liver in a way which has been linked to increased insulin resistance, the main cause of type II diabetes. HCFS creates high levels of glucose in the blood which, over time, can create an inflammatory immune response in the blood which is directly related to the advent of heart attack[79,80].

Not only do SSBs mask large amounts of harmful calories in small liquid packages, they have also been linked to addiction. The *DSM-IV-TR* defines behavioral indicators of substance dependence as composed of three or more of the following traits: (1) tolerance and withdrawal; (2) frequent and repeated consumption; (3)

repeated failed attempts at quitting; (4) impacts on daily functioning; (5) increased time spent on use (6) giving up other activities to use; and (7) continued use despite adverse physical or psychological effects[84]. A recent study by Falbe et. al[85] found the presence of withdrawal symptoms and increased cravings in individuals during a SSB cessation program. Other literature has found that the effects of SSB consumption mimic the same neural feedback loop as addiction in the brain[86,87].

Demographic and Social Determinants of SSB consumption

In one of the first cross-sectional studies to look at the relationship between socio-demographic factors and SSB consumption, Rehm et al[88] conducted analyses on respondents of a 2005 New York City community health survey. Researchers performed multivariate logistic regression and linear regression analysis on results of the survey to identify the relationship between daily consumption and demographic variables. This study identified that approximately one quarter of the 9,916 study participants consume SSBs frequently (defined as one or more 12-oz beverages per day). The study reported significantly higher consumption among minority populations, and found a significant association between SSB consumption and increased TV viewing and decreased physical activity[88]. In this study, men were also more likely than women to consume SSBs.

In 2007, Mullie et al[89] surveyed 1852 military men on their beverage consumption. Researchers calculated prevalence of daily consumption and performed logistic regression analysis on survey results. In the study population a 36.3% prevalence of daily consumption of SSBs was observed. Daily consumption of SSBs was found to be negatively correlated with age, BMI, non-smoking, and income. SSB consumption was also found to be correlated with demographic background. No correlation was found relating to marital status, education, physical activity, or use of vitamins[89].

White et al[90] surveyed a random sample of 1,118 Oklahoma residents with children to determine the relationships between SSB consumption and social and demographic characteristics. They noted a prevalence of daily SSB consumption of 44.1% among study participants. Multiple logistic regression analyses determined a significant positive correlation between daily SSB consumption and lower levels of education, male gender, younger ages, perceptions of being unhealthy and drinking less than 8 cups of water a day. Heavy SSB consumption was defined as drinking 3 or more SSBs in one day and was negatively correlated to adult age, drinking greater than 8 cups of water a day, education, perceived healthiness of diet, and excellent, very good, or good perceived health status. The authors did not find a correlation between daily SSB consumption and frequency of fast food consumption, BMI, gender or ethnicity.

Park et al[91] conducted χ^2 tests and multivariate logistic regression analyses on SSB consumption data from the HealthStyles mail-in survey conducted in 2010. They noted a prevalence of daily SSB consumption of 31% among the 3,926 study participants. The authors determined odds of consumption were significantly increased in males, non-Hispanic Blacks, young adults, lower income participants, and those with less than college education. Odds of consumption also increased among those who reported neutrality in response to questions around the negative health effects of SSB consumption. Knowledge of calories in SSBs and marital status were found to be uncorrelated with SSB consumption[91].

In 2017, Qobadi et al[92] detailed the results of a cross-sectional analysis of SSB consumption using the 2012 BRFSS survey data. Authors performed χ^2 tests and logistic regression to ascertain correlation of predictors. They determined a prevalence of 41.1% daily SSB consumption among approximately 7,000 participants. After adjusting for covariates in the model, males, Blacks, frequent fast food consumers and smokers where at increased odds to consume SSBs daily. Additionally, those with lower education, less income, and diminished reported physical activity were more likely to consume SSBs daily. Marital and employment status were uncorrelated with daily SSB consumption[92].

Dhingra et al[93] performed cross-sectional analyses on data from the Framingham Heart study to analyze the relationship between SSB consumption and risk for metabolic syndrome. The study utilized multivariate linear and logistic regression analysis for continuous and dichotomous variables respectively, adjusting for a number of demographic and lifestyle factors including age, sex, physical activity, smoking, and dietary intake. The study concluded that indeed there was a positive correlation between degree of SSB consumption and prevalence of metabolic risk[93].

In 2014, Han et al[94] performed a series of trend and cross-sectional analyses on data from the National Health and Nutrition Examination Survey (NHANES) to identify variation among demographic groups in the United States. Researchers utilized multivariate logistic regression for dichotomous variables and Ordinary Least Squares (OLS) regression for continuous variables to analyze determinants of SSB consumption. The study determined that fruit drinks were the largest source of SSBs for children and soda for adults. Additionally, the study determined a significant positive correlation between increased SSB consumption and identification as African American or Hispanic minorities[94]. This study, along with the majority of published literature of this nature, failed to isolate Native Americans as a minority population. The study also determined that low-income children were more likely to be heavy consumers of SSBs and that children with less educated parents were more likely to consume SSBs. Finally, the study recommended that policy interventions target low income, minority populations[94].

Additionally in 2014, Thurber et al[95] published the first study to analyze SSB among Indigenous Australian children. Researchers utilized likelihood ratio (LR) χ^2 and multivariate logistic regression to ascertain correlation. In contrast to other published literature, this study found no relationship between SSB and gender or income. The study determined that consumption was high among indigenous children in remote areas, and highest among those residing in urban areas. Low education of the primary caregiver was also implicated with increased SSB consumption[95]. The authors noted the lack of published literature analyzing SSB consumption among indigenous persons.

In 2017, Tasevska et al[78] performed multivariate logistic regression analyses using order logit models on the results of a cross-sectional telephone survey to determine variables association with household SSB consumption. The results of the study agreed with the larger body of published literature identifying a significant relationship between SSB consumption and lower income and education. This study again identified a relationship between SSB consumption and identification as a minority, though only isolating Black and Hispanic ethnicities. The study found no significant correlation between gender and SSB consumption but found SSB consumption to increase with age. Furthermore, the study identified a positive association between moderate to high fast food consumption and heavy SSB consumption. The study also analyzed the relationship between parental consumption and predictors of child consumption and found a significant correlation between parental consumption and heavy SSB consumption in children. Researchers also found that increased consumption was correlated with television viewing in Hispanic children[78].

In addition to cross-sectional studies of determinants of SSB consumption, systematic reviews of the literature have compiled multiple analyses to draw out consensus among existing studies around determinants of SSB consumption. Malik et al[83] identified 30 studies in the literature relating to SSB consumption and weight gain and determined that study results indicate a positive relationship between SSB consumption and obesity. Additionally, researchers also found that longitudinal studies which included interventions aimed at reducing SSB consumption were successful in reducing obesity[83]. A systematic review of 46,876 papers by Paes et al[96] looked at determinants of SSB consumption in children. The reviewers isolated twelve determinants positively correlated with SSB consumption: youth preference, proximity to fast food, early introduction of solid food, TV viewing time, socio-economic status of the parent, formula feeding, age (younger), parent perceived barriers, using food as reward, child being cared for out of the home, SSB consumption of parents, and child snack consumption[96]. Parental ethnicity, gender, and body mass index (BMI) were not correlated. Parental co-habitation, parent modeling, school policy, and proximity to supermarket were all found to be negatively correlated to SSB consumption[96].

Vartarian et al[77] performed a meta-analysis and systematic review of the literature, focusing on SSB consumption and its relationship to increased energy intake. Their analysis determined that SSB consumption was correlated with increased energy intake which is not appropriately compensated for in consumer diets. People who consume considerable amounts of calories drinking SSBs, do not reduce their overall caloric intake to account for the added calories, causing a net positive energy intake which, over time, can lead to obesity and other health issues. The study also found a positive correlation between SSB consumption and health issues, including an 8-year longitudinal study which found double the prevalence of type II diabetes in women that consumed SSBs daily[77,97]. Interestingly, the study found conspicuous differences in the reported relationship between SSB consumption and increased energy intake depending on whether the respective studies were funded by the food industry (findings: no correlation) or not (findings: significant correlation)[77].

In most cases the literature has concluded a significant correlation between SSB consumption and lower income, lower educational level, lower socio-economic status (SES), and identification as African American or Hispanic[78,88,90,94–96]. Most studies also noted males more likely to consume SSBs daily, except when the focus was on children, in which case no correlation was found[78,89,95]. In all cases where data was collected, smokers were at higher risk of consuming SSBs daily[89,92]. All studies of determinants of consumption in children noted a correlation between parental consumption, parental SES and education, and child SSB consumption[95,96,98]. Many studies and reviews also found SSB consumption to be a significant predictor of obesity and health issues, particularly cardiovascular and diabetes [77,80,83,93,99]. Research studies which included analysis of degree of physical or sedentary activity found SSB consumption to be significantly correlated with increased daily television and decreased physical activity[83,88,91,92,96]. Every study that included questions related to proximity to or consumption of fast food noted a positive correlation between these determinants and SSB consumption[78,83,88]. Additionally, some studies found correlation between knowledge of the health effects of SSBs, healthy dietary habits, and daily consumption[78,91]. No correlation was found between marital or employment status[89,91,92]. Some studies found correlation between consumption and body weight, while others did not[91,92]. Only two studies addressed identification as Native American, only one of which used a predominantly Native American cohort for analyses[90,95]. This study determined that housing instability, lack of knowledge of traditional practices, financial instability, unemployment, and location (rural or urban) were all linked to increased SSB consumption[95].

Targeted Marketing, Chemical Fabrication and Indoctrination around SSBs

In addition to identifying demographic and social markers of SSB consumption, it is important to discuss the immensity of the SSB industry's presence in our culture and critically analyze the impacts of efforts, rooted in capitalistic approaches at increasing profit margins, on our daily lives. The logos of large SSB producers are on almost every billboard at every high school in the United States. One does not have to go far to find them, as they are everywhere. They have inundated the grocery aisles and stare us in the face at gas stations. During World War II, Coca-Cola signed a contract with the war department which enabled them to distribute SSBs to the military, and in addition bypass sugar content restrictions enforced at the time[25]. Early marketing and distribution attempts sought goals of ensuring that SSBs were readily available to everyone, everywhere. This marked the beginning of mass distribution of SSBs in the United States. Since 1977, there has been a reported greater than 135% increase in the consumption of SSBs in the United States[83].

Fast forward to 2010, and soft drink manufacturing was purported to be a $47.2 billion industry[100]. The immense amounts of profits which the SSB industry has had to work with in the last decades has only further complicated and exacerbated attempts at both inundating every political and social context in order to engineer social constructs around ever increasing consumption and fabricating products which appeal preferentially to our most basic natural instincts. Large SSB providers use strategic and targeted marketing to draw on the desires and target the olfactory system of the consumer. History has shown that SSBs have categorically been coupled with other addictive compounds, and emerging science is proving that SSBs trigger the same feedback loops in the brain as addiction[53,86]. Historically, humans have only recently been able to consistently obtain enough of a caloric intake for a prolonged amount of time to successfully reproduce and sustain offspring[86,101]. Prior to the last century, food access was less reliable seasonally and many researchers and social scientists postulate that this is related to the evolution of a natural preference for calorie dense foods such as carbohydrates and fat. The SSB industry has now developed artificial additives that directly appeal to taste transduction, which relates to the evolutionarily developed physical trait allowing humans and other vertebrae to select for foods with higher caloric value [86,102]. Increased profits have led to improved efforts at social engineering and refinement of products that in their most basic nature are addictive to humans. This success has propagated an enormous positive feedback loop for the SSB industry which ever increases their capacity to evolve against small scale grassroots and public health efforts attacking SSB consumption for the sake of community health. Additionally, recent policy studies have shown that price has more of an impact than campaigns and other public health efforts in terms of consumption aversion[103].

In conjunction with bearing a disproportionate burden of health disparities in the US, minorities have also been disproportionately targeted for marketing efforts. A recent study by the Yale Rudd Center for Food Policy and Obesity has determined that minority children are exposed to up to 80% more repeated soda advertisements than white children, and that Hispanic children were almost 2 times more likely to be exposed to soda and sports drink advertisements on Hispanic television than other youth[104]. Researchers found that soda and sports drink ads, on average, contained more minority main characters and were typically set in urban areas more likely to house minority populations[104].

Additionally, reservations provide a huge and isolated market for SSB sales. Reservations are largely situated in food deserts, which contain more readily accessible high calorie foods with low nutritional value, and less good quality and fresh foods. Not only do tribal residents experience decreased access to healthier foods, but they also experience increased cost of these foods, which limits their access economically [105]. One review of food access on reservations determined that 17 of 36 reservations in Washington state lacked a supermarket, and that sugars and sweets composed the largest proportion of available items in convenience stores[105]. Studies, such as this one, highlight the infrastructure which continues to propagate health disparities in tribal communities.

Literature Gap

Though there were many published studies and reviews on determinants of SSB consumption in the US population, and some studies which outlined African American and Hispanic subpopulations, only one study was found which specifically analyzed determinants of SSB consumption in indigenous communities. This study highlighted the lack of published literature related to SSB consumption and indigenous peoples, which seems counterintuitive considering the disproportionate burden of obesity in tribal communities. To our knowledge this study is the first to look at determinants of SSB consumption in a tribal community in the United States. This study adds to the literature an analysis of Native American ethnicity as a determinant of daily SSB, daily Soda, and heavy SSB consumption. This thesis analyzes odds of consumption while controlling for common covariates as defined by the literature: age, gender, income, self-reported BMI, and education level. Additionally, this study adds to the literature through an analysis of daily water consumption and its relationship to identification as Native American, controlling for covariates gender, age, self-reported BMI, level of education, income, and daily SSB consumption. Finally, this thesis adds a baseline prevalence of SSB consumption within one tribal community, and a comparison of study findings between Native Americans and the existing literature for the rest of the US population. This study also identifies national level health disparity statistics for Native Americans and discusses them in relationship to the self-reported survey results.

STUDY AREA

The Reservation of the Confederated Tribes and Bands of the Yakama Nation is located in South Central Washington. It is bordered to the West by Mount Adams, and to the East near Interstate 82. The reservation land consists of 1.4 million acres and encompasses parts of Yakima, Klickitat and Lewis counties[106]. The ceded area includes 10.8 million acres which extends almost as far North as Canada, and South to the Columbia River. The tribal peoples retain the right to hunt and fish in all “usual and accustomed places” in ceded areas[57,107]. In 2010, the reservation population was reported at 31,272, of whom 7,239 reported to be Native American[108]. This study targeted residents of the four most populated areas of the reservation (Toppenish, Wapato, White Swan, and Satus), but also included residents of outlying areas (see figure 3).

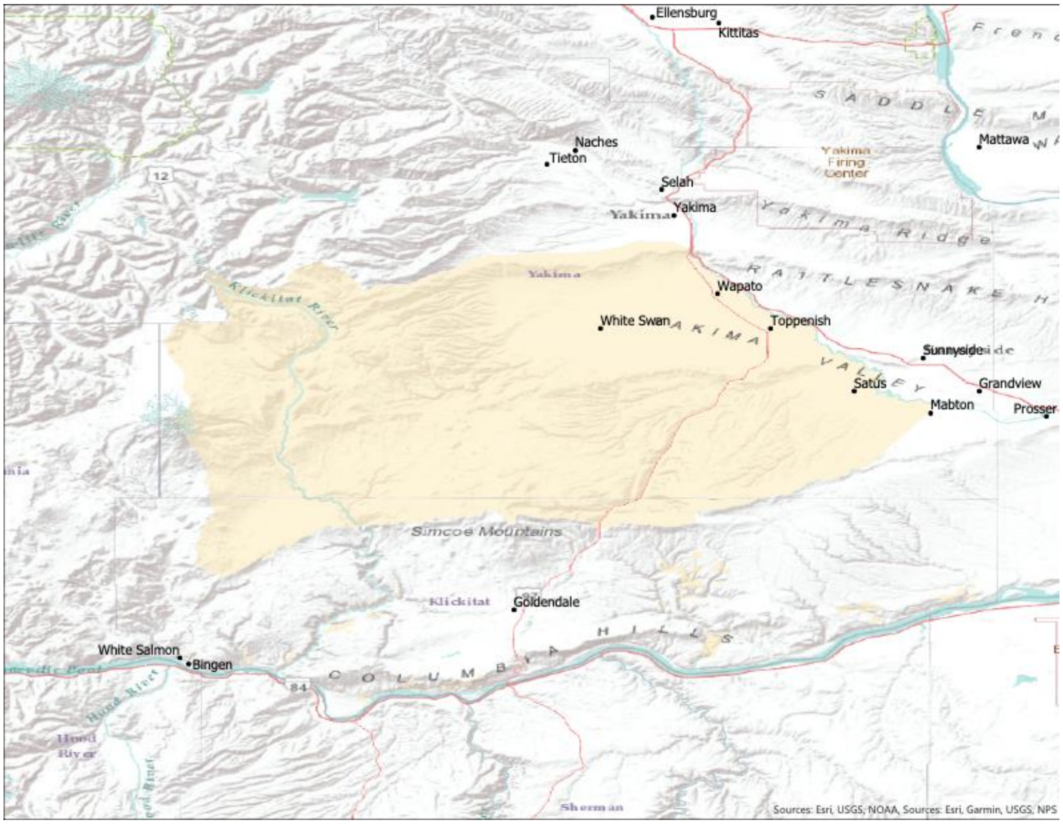


Figure 3 Map of the study target areas on the Yakama Reservation

According to the US Census Bureau's 2013-2017 American Community Survey[108], mean yearly household income for the Yakama reservation is $54,112 (+/- 2,932) with 59% of residents making less than $50,000 per year and 14.9% making less than $15,000 per year. Approximately 20% of adults live below the federal poverty line, as well as 30% of children[109]. Approximately, 63% (+/- 1.9%) of reservation residents have a high school education or higher, and 9.1% (+/- 1.2%) are purported to hold a bachelor's degree or higher. Over half of the population (66%) are over 18 years of age. More than half of reservation residents are White (60%), approximately 23% identify as Native American, and just over half (56.5%) of residents also report being of Hispanic ethnicity[108]. A large portion of the reservation is situated within a food desert[i], where more than one third of the population experiences reduced access to fresh produce and other healthy foods (see figure 4)[110]. According to the USDA[109], Yakima County reports an adult obesity rate of 29.6% (as of 2013), and an adult diabetes rate of 10.2%. The price of soda in Yakima County is approximately 1.13 times the national average[109]. Approximately 12.9% of residents are purported to be food insecure, greater than both the national prevalence of 11.8% and the Washington state prevalence of 10%[111].

[i] According to the US department of Agriculture a food desert is defined as over 1/3 of the population of a census tract with no access to a supermarket within 1 mile for urban areas, and 10 miles for rural areas.

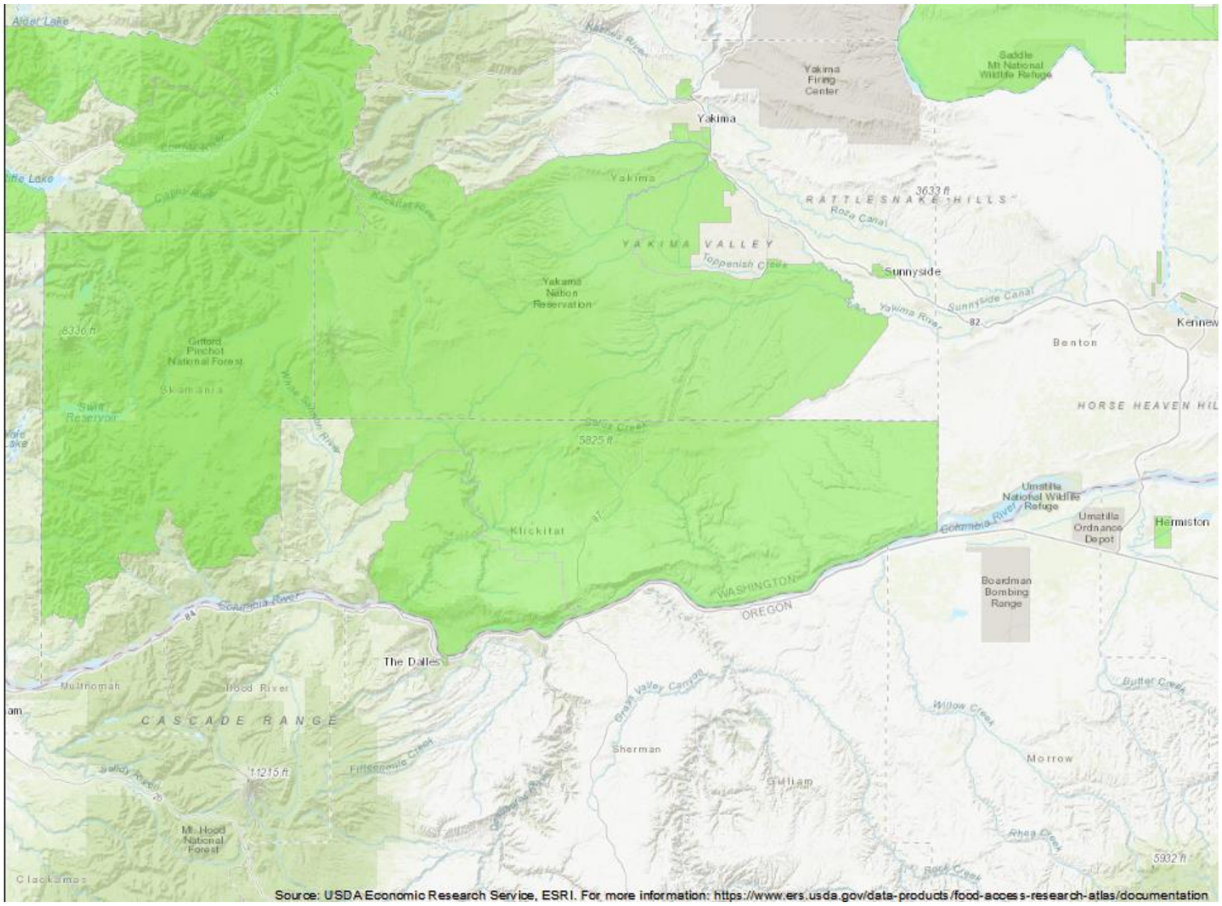


Figure 4 Yakama Reservation Food desert Map. All areas highlighted in green are areas where more than 1/3 of the population is more than 10 miles from a supermarket (or 1 mile for urban areas)

METHODS

Study Design

A community assessment was developed under the guidance of the Chi'ish Wat'uy committee to collect data relating to beverage consumption and water access in four target areas on the Reservation of the Confederated Tribes and Bands of the Yakama Nation and surrounding areas. The community assessment constituted the first of a four-part Water First! program funded by the Notah Begay III Foundation. The grant application was approved by Yakama Nation tribal council committee action in August of 2018. The grant was awarded to the Yakama Nation Wak'ishwi program in September of 2018 and funds were targeted at increased consumption of safe drinking water and reduction of SSB consumption, particularly in children under the age of 12. A Chi'ish Wat'uy planning committee was formed in October of 2018, whose main task was to oversee survey development and plan for community and other grant activities. The study was subject to oversight by the Central Washington University (CWU) Human Subjects Research Council (HSRC), and the survey and associated research was approved via exemption in December of 2018 (see approval letter in Appendix A).

The purpose of the survey was to provide baseline data around community SSB consumption, and to provide guidance to the Water first! committee, composed of community stewards and health department staff, surrounding focus areas for targeted efforts. A secondary purpose of the survey was to begin to mobilize the discussion of SSB consumption in the community and to begin to identify community leaders in the effort to combat SSB consumption and promote water drinking. The survey content included 3 sections: (1) a demographic section, (2) a beverage consumption section, and (3) a water access section. The demographic section was composed of questions related to area of residence, gender, ethnic identification, income, and education (see Appendix B). The beverage consumption portion of the survey was adapted from Behavioral Risk Factor Surveillance System (BRFSS) survey questions, as well as the BEVQ15 survey, a validated, standardized beverage intake questionnaire developed as an assessment tool to reliably document habitual beverage consumption habits[112,113]. Respondents were asked to document their own beverage consumption habits and those of any children currently in their care. Beverages were separated into the following categories: (1) Water; (2) flavored water, including non-diet Vitamin Water; (3) 100% juices (apple, orange); (4) Fruit-flavored drinks (lemonade, Sunny D, Tampico Punch, Snapple, Capri-sun and Kool-Aid); (5) Sport drinks (Gatorade or Powerade); (6) Regular soda or pop (Coke, Pepsi, Root Beer, Sprite); (7) Diet soda or pop (Diet Pepsi, Pepsi One, Diet Coke, Diet 7-Up) or other diet beverages (Crystal Light); (8) Sweetened coffee or tea drinks (lattes, mochas, Frappuccino, sweet tea); (9) Energy drinks (Rockstar, Red Bull, Monster); (10) Flavored milk (chocolate, strawberry, vanilla); and (11) Plain milk. Additionally, breast milk was added for the child consumption portion. Survey respondents were asked to report for the last 7 days, the consumption habits of both themselves and any children in their care. Consumption frequency was divided into the following options: (1) NEVER or less than 1 per week; (2) 1 per week; (3) 2-4 per week; (4) 5-6 per week; (5) 1 per day; (6) 2-3 per day; and (7) 4+ per day. The survey provided space for reporting consumption of up to 2 children, with additional pages available for those with more children.

The water access portion of the survey included questions regarding access to SSBs and clean water. First, respondents were asked where their children get sugary drinks, if they consume them. Next, the survey asked the type of water that the household normally drinks, allowing choice of the following options: (1) well water; (2) city water; (3) bottled water; and (4) Other. Those who reported other were asked to fill in a text description. Respondents were then asked to report the per household weekly expenditures on sugary drinks. Next, respondents were asked whether or not they drink the water where they live, and if not, why. Options presented for why not were presented: (1)I don't believe the water is safe to drink; (2) It smells bad; (3) It tastes bad; (4) I don't have water where I live; and (5) Other. The final question of the survey asked respondents to comment on what they understood the negative health effects of SSB consumption to be.

Surveys were disseminated anonymously at tribally sponsored community events in December 2018 and January of 2019. At one of the events, survey respondents received a stamp on an activity card if they elected to complete the survey. Respondents who filled their activity cards at the event were consequently eligible to receive a jacket as a prize for participation. A target sample size of greater that 300 was determined to be sufficient to perform statistical analyses on determinants of consumption.

Data analysis was performed using STATA 14 and R version 1.1.453. Demographic statistics were used for detailed prevalence estimates and as covariates in model analyses. SSB and water consumption prevalence estimates were calculated as percentages with 95% confidence intervals. Multivariate logistic regression analysis was performed to examine the relationship between daily SSB consumption and identification as Native American while controlling for age, gender, income, BMI, daily water consumption, and level of education.

Multivariate logistic regression is used to model the relationship between a dependent variable and a number of independent variables when the dependent variable is dichotomous. Logistic regression analysis determines coefficients that are related to the odds relative to a unit change in the independent variables, holding all other variables constant. This type of analysis allows one to determine both an effect and magnitude of a unit change in an independent variable on the probability of occurrence of the dependent variable, which in this study refers to odds of daily consumption of water, soda, and SSBs, and the odds of heavy consumption (> 4 SSBs/day). Coefficients with significant p-values are interpreted as correlated with the probability of the dependent variable outcome. Antilog conversion of regression coefficients produce odds ratios, which determine the magnitude of likelihood of consumption (daily or heavy) for the different variable groups, holding all other variable groups constant.

Other models considered were linear probability, multivariate probit regression, and multinomial logistic regression. Since the dependent variable was not continuous, logistic regression was determined to be most appropriate for variable analyses. Data for consumption was collected at varying frequencies of consumption to allow for multinomial logistic analysis, but to align with other studies for comparison purposes, we condensed these into one dichotomous variable for daily or heavy consumption. Finally, previously published studies on SSB consumption determined that logit models were preferable to probit, therefore a logit model was selected for analyses.

Statistical significance threshold for regression analysis coefficients was set to $p < .05$. Analysis of deviance was used to determine model goodness of fit in relation to each independent variable. Pearson's Chi-squared test was performed to determine goodness of fit in relation to acceptance of the null hypothesis that the model and observed values are not different. Statistical significance for Pearson's Chi-squared was confirmed at $p > .05$. Additionally, a Wald Chi-squared test was performed to again determine the global significance of covariates.

A binomial logistic regression was performed for each of the following dichotomous dependent variables: daily SSB consumption, daily soda consumption, and heavy SSB consumption, which was defined as the consumption of more than 4 SSBs daily. Based on the survey, SSBs where determined to be flavored water, 100% juice, fruit-flavored drinks, sports drinks, regular soda or pop, sweetened coffee or tea drinks, energy drinks, and flavored milk. An individual was considered a daily consumer if they indicated consumption greater than or equal to 1 per day in any of the aforementioned categories of SSBs. An individual was considered a heavy consumer if they indicated consumption of any of the SSBs as 4 or more per day.

Independent variables used in the model were age, BMI, Income, Native American ethnicity, daily consumption of water, education, and gender. Water access was originally intended to be included in the regression analysis as an independent variable. However, because of low response rate, water access was excluded from the analysis to maintain the integrity of the model. Additionally, the study intended to model child consumption of SSBs, and include parental daily consumption as an independent variable, but again, lack of data prevented this analysis.

The model assumed that the independent variables age and BMI were continuous variables. Gender and Income were treated as categorical variables, where females were the reference population for males, and low income was the reference population for moderate and high income. Income was split into tertials and categories for this variable were represented as low (< $14,999/year), moderate ($15,000 - $49,999/year), and high (> $50,000/year). Education, daily water consumption, and Native American ethnicity were modeled as dichotomous variables. A positive value for education was defined as greater than high school, and a positive value for Native American related to those individuals that selected part or all Native American on the survey Ethnicity question. The multivariate logistic regression model is represented in Equation 1.

$$Liquid\ Consumption_i = \beta_0 + \sum_{K=Low,Moderate,High} \beta_K * Income + \beta_2 * Gender + \beta_3 * BMI + \beta_4 * Education + \beta_5 * Daily\ Water\ Consumption + \beta_6 * Age + \beta_7 * BMI + \beta_8 * Native\ American + \varepsilon$$

Equation 1: Liquid Consumption Regression analysis equation.

Liquid consumption is the log odds ratio of the probability of daily or heavy consumption, and ε is the error term. Results were reported as adjusted odds ratios with confidence intervals calculated using the profile likelihood method[114].

Additionally, multivariate logistic regression analysis was performed using daily water consumption as the dichotomous dependent variable. The purpose of the Water first! program was to increase clean water access and consumption. This analysis was performed to determine the relationship between daily water consumption and identification as Native American while controlling for common sociodemographic covariates. An individual was considered a daily consumer if they indicated water consumption greater than or equal to 1 per day. An individual was considered a heavy consumer if they indicated water consumption as 4 or more per day. The model assumed that the independent variables age and BMI were continuous variables. Gender and Income were treated as categorical variables, where females were the reference population for males, and low income was the reference population for moderate and high income. Income was split into tertials and categories for this variable were represented as low (< $14,999/year), moderate ($15,000 - $49,999/year), and high (> $50,000/year). Education, daily SSB consumption, and Native American ethnicity were modeled as dichotomous variables. A positive value for education was defined as greater than high school, and a positive value for Native American related to those individuals that selected part or all Native American on the survey Ethnicity question. Equation 2 was used for model analysis.

$$Water\ Consumption = \beta_0 + \sum_{K=Low,Moderate,High} \beta_K * Income + \beta_2 * Gender + \beta_3 * BMI + \beta_4 * Education + \beta_5 * Daily\ SSB\ Consumption + \beta_6 * Age + \beta_7 * BMI + \beta_8 * Native\ American + \varepsilon$$

Equation 2. Water Consumption Regression analysis equation

Water consumption is the log odds ratio of the probability of daily consumption, and ε is the error term. Results were reported as adjusted odds ratios with confidence intervals calculated using the profile likelihood method[114].

RESULTS

Cohort Demographics

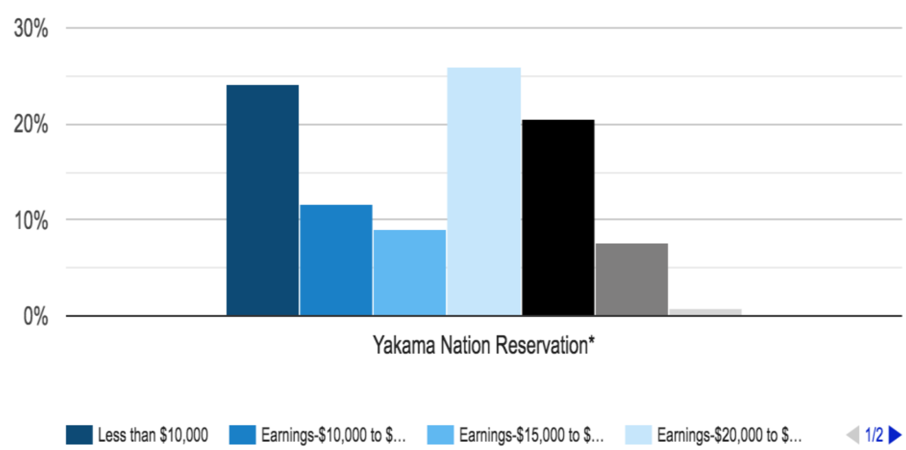
A total of 446 surveys were collected from residents of the target areas at all events combined. Of the 446 surveys, 25 were discarded because they were filled out by youth under the age of 18, to comply with IRB Exemption. Additionally, 25 of the surveys were so incomplete that they were not considered viable for the analysis. A total of 403 survey responses were coded for analysis. Participant descriptive statistics are presented in table 1.

Table 1 Participant demographics (with 95% confidence intervals)

Statistic	N	Mean	95% CI
Heavy SSB Consumption (4+ SSBs/day = 1, < 4 times daily = 0)	328	0.259	0.048
Daily SSB Consumption (>=1/day = 1, <1/day = 0)	363	0.694	0.047
Daily Soda Consumption (>=1/day = 1, <1/day = 0)	372	0.304	0.047
Daily Water Consumption (>=1/day = 1, <1/day = 0)	388	0.732	0.044
Female	372	0.685	0.047
Male	372	0.315	0.047
Low (<$14,999/year)	403	0.308	0.045
Moderate ($15,000-$49,999/year)	403	0.556	0.049

High (>$50,000/year)	403	0.136	0.034
Some College or More (Yes = 1, No = 0)	376	0.545	0.050
Age	356	46.680	1.674
BMI	336	31.725	0.764
Native American (Some/All = 1, None = 0)	403	0.866	0.033
Obese (BMI > 29.9 = 1, BMI <= 29.9 = 0)	336	0.524	0.053
Overweight (BMI >= 25 = 1, BMI < 25 = 0)	336	0.839	0.338

Study participants were predominantly female (68.5%) and identified as Native American (86.6%). Almost one third of participants (30.8% $\pm$ 4.5) reported to be of low income, making less than $15,000 per year, and over half (55.6% $\pm$ 4.9) reportedly earned between $15,000 and $50,000 per year. Income distribution of the survey population mimicked that of the ACS statistics (see figure 5).



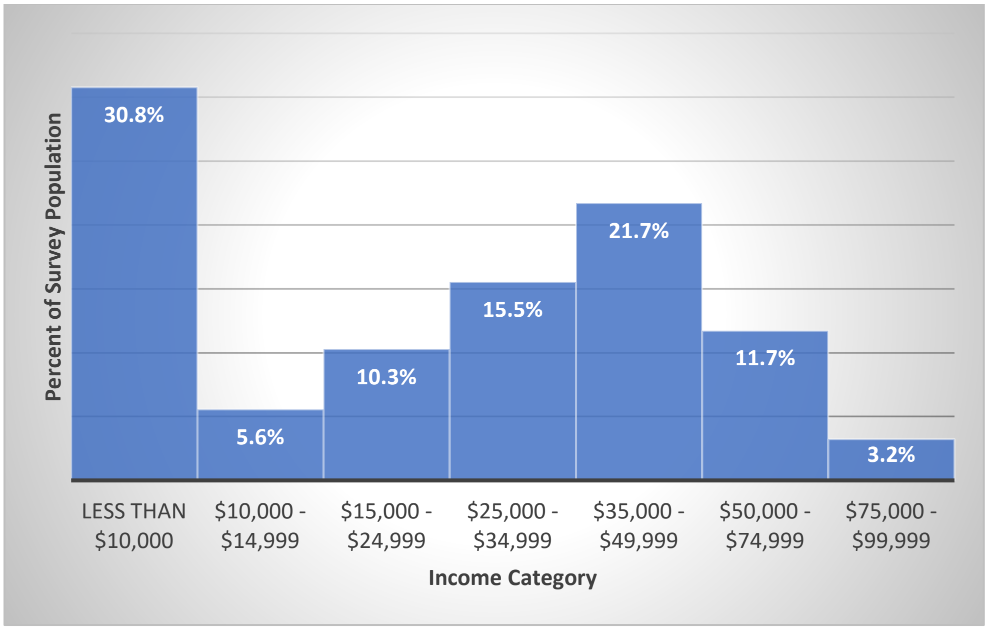


Figure 5 Comparison of Survey Responses for Income category (bottom) to ACS statistics for the Yakama Reservation[108] (top). Top image courtesy of http://towncharts.com

54.8% of respondents were over 45 years of age and the average age was 46.7 years. Average BMI was reported to be 31.73. Over half of participants (52.4% $\pm$ 5.3) reported being obese, with 83.9% ($\pm$33.8) participants having a BMI greater than the normal range. Just over half of study participants (54.5% $\pm$ 5) reported having more than a high school level of education. Education level for the survey results was reportedly similar to the ACS estimates for the Yakama Reservation (see figure 6).

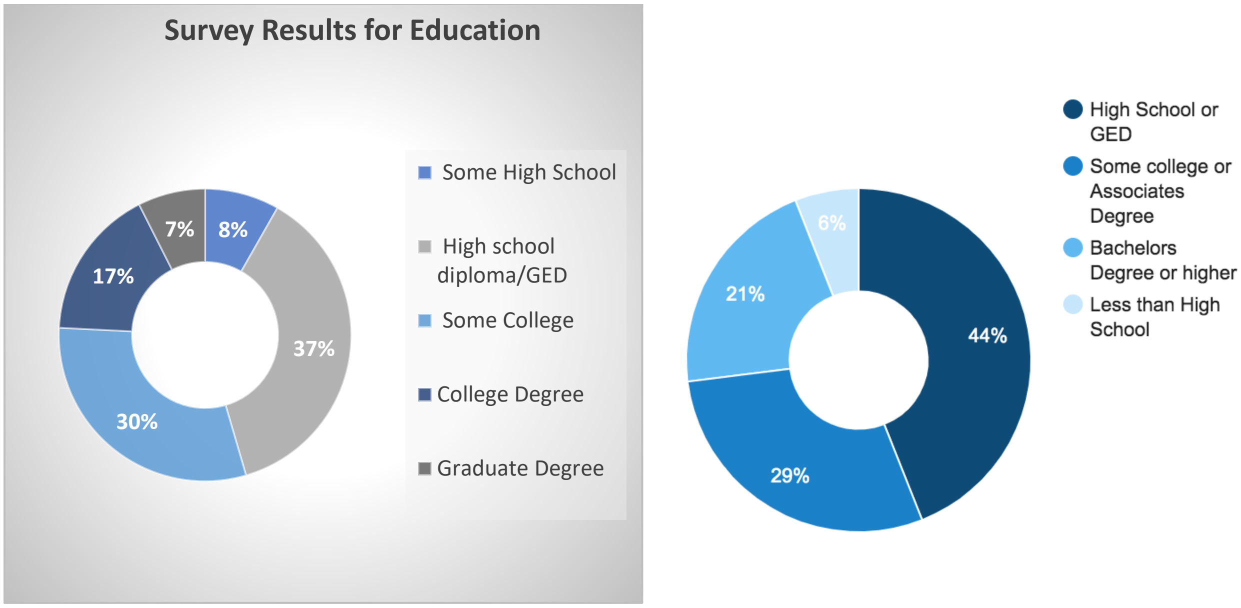


Figure 6 Education survey results (left) in comparison to the ACS results for the Yakama Reservation (right)[108]. Right image courtesy of http://towncharts.com

The prevalence of daily consumption of SSBs was found to be 69.4% (±4.7). Daily soda and water consumption prevalence was 30.4% (±4.7) and 73.2% (± 4.4) respectively. Daily heavy SSB consumption was reported at 25.9% (± 4.8). Consumption was also broken down by characteristic to analyze statistically significant differences in prevalence rates within the population (table 2).

Table 2 Prevalence statistics by consumption and demographic characteristic

	Daily Water		*Daily Soda*		*Daily SSB*		*Heavy SSB*	
Characteristic	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI

Age								
18-35	73.47	8.79	31.58	9.40	70.83	9.14	12.50*	6.95
35-54	75.61	7.62	32.77	8.47	67.80	8.47	23.08	8.14
55+	71.09	7.88	28.93	8.11	70.69	8.32	35.85*	9.17
Gender								
Female	76.71	5.26	29.83	5.82	70.82	5.85	26.29	5.93
Male	66.36	8.87	29.52	8.77	67.65	9.12	23.33	8.79
Education								
HS	68.67	7.08	36.88	7.50	72.08	7.11	31.21	7.67
College or more	77.00	5.85	25.79	6.24	66.67	6.74	20.12	6.06
Income								
low	67.80	8.47	37.17	8.95	72.32	8.32	28.71	8.87
moderate	76.04	5.69	27.75	6.09	69.46	6.35	25.14	6.30
high	73.58	11.98	26.00	12.28	62.50	13.84	22.73	12.53
BMI Grouping								
Normal Weight	72.97	14.51	25.00	14.35	70.27	14.93	26.47	15.05
Overweight	73.11	8.00	25.66	8.09	63.96	8.97	23.30	8.20
Obese	69.77	9.76	36.90	10.38	78.21	9.22	24.29	10.12
Severely Obese	67.35	13.27	43.75	14.18	74.00	12.28	25.00	12.94
Morbidly Obese	83.78	12.04	30.56	15.26	61.76	16.58	24.14	15.85
Ethnicity								
Native	71.13*	4.85	32.72*	5.12	70.57	5.03	25.96	5.10
Non-native	86.54*	9.37	14.58*	10.09	61.70	14.05	25.58	13.20

* statistically significant

The prevalence of heavy SSB consumption was significantly higher among those age 55 and older as compared to those age 18 to 35. Natives had a significantly lower prevalence of water consumption and increased prevalence of soda consumption than those that did not identify as Native American.

Survey Results

Of the adult respondents, 32.6% consumed sweetened coffee or tea once or more daily, 14.8% consumed energy drinks once or more daily, and 16.8% consumed sports drinks (e.g. gatorade, powerade) once or more daily (see figure 7). Just over one quarter of adults (26.7%) reported drinking water less than once a day.

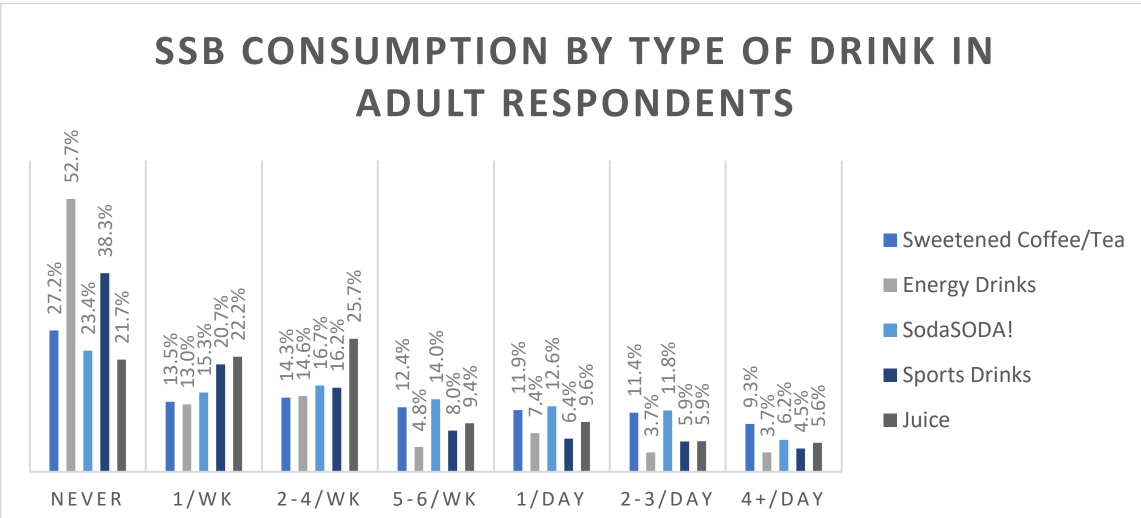


Figure 7 SSB consumption by type of drink in Adult Respondents

Of the survey responses to the water quality and access questions, 9% of participants reportedly did not drink the water where they live. Additionally, 54 respondents (13%) reported reasons why they do not drink the water where they live (see figure 8). The most common form of water consumption was bottled water (55%).

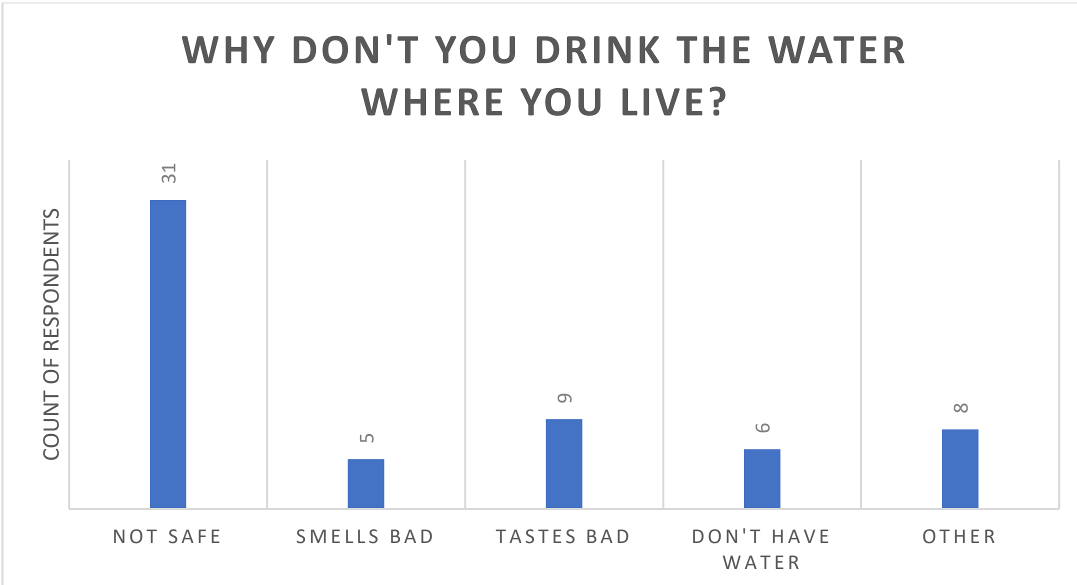


Figure 8 Responses to the survey question: Why don't you drink the water where you live?

Among children, juice had the highest rate of daily consumption at 34.4% (see figure 9). Over half of parents (56.7%) admitted that children acquire the majority of SSBs in the home. Almost one third (30.1%) of all children were reported to consume water less than once daily, while 42% of children consumed milk daily. Respondents reported that half of children don't drink soda at all.

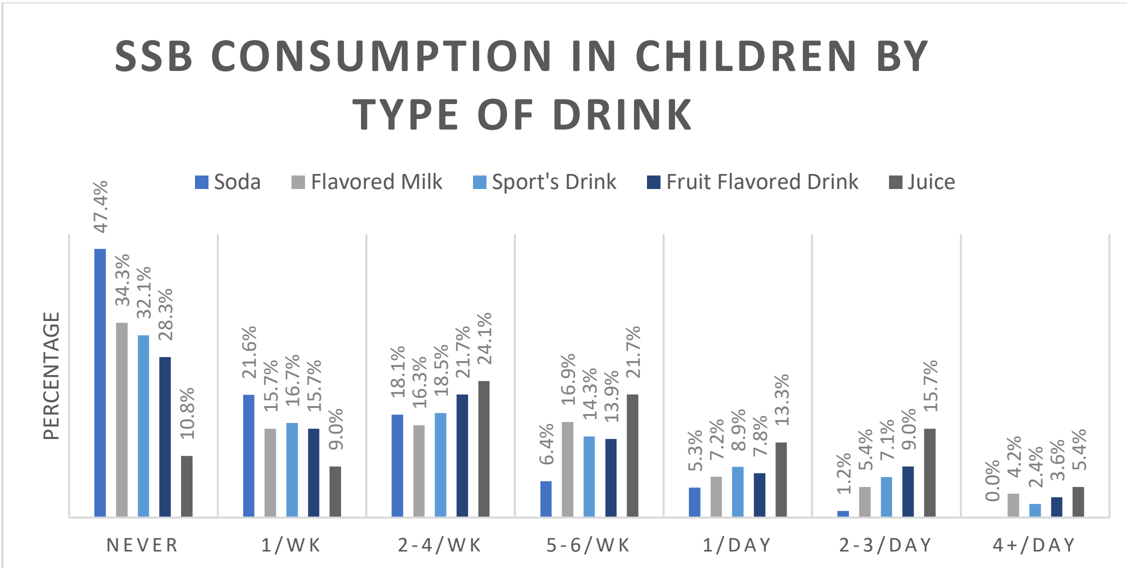


Figure 9 Reported consumption of top SSBs in children by type of drink

Over one third of respondents reported spending more than $10 a week on SSB consumption. The concluding question in the survey asked respondents to identify the negative effects of SSB consumption. Figure 10 depicts a word cloud of the categorized responses with the size of the word weighted by frequency of response.

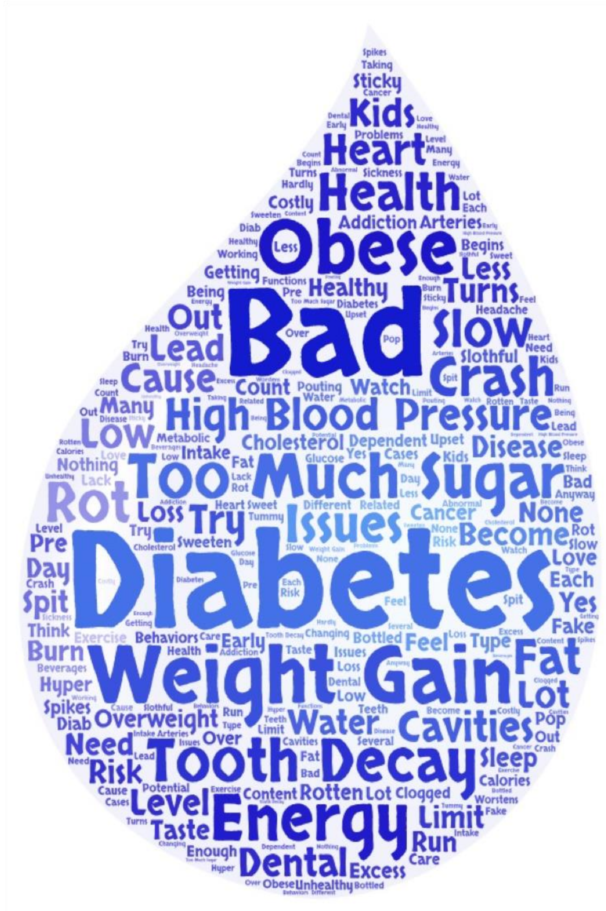


Figure 10 Reported health effects of SSB consumption weighted by number of responses

SSB Consumption Regression Results

Table 3 summarizes the results of the logistic regression analyses. After adjusting for covariates, study participants who identified as Native American were found to be exposed to double the odds of daily SSB consumption (OR: 2.22; CI: 1.01, 4.82) and 3 times the odds of daily soda consumption (OR: 3.29, CI: 1.34, 9.42) when compared to non-Natives. Those with a greater than high school education had a lower probability of consuming soda daily (OR: 0.56; CI: 0.31, 1.00) or being heavy SSB consumers (OR: 0.41; CI: 0.21, 0.80). Increased odds of daily soda consumption were correlated with increased BMI (OR: 1.05; CI: 1.01, 1.10). Daily water consumption was associated with increased probability of daily SSB (OR: 3.83; CI: 2.10, 7.09) and heavy SSB consumption (OR: 2.5; CI: 1.16, 5.92). Age was also correlated with increased probability of heavy SSB consumption (OR: 1.03; CI: 1.01, 1.05).

Table 3 SSB consumption adjusted odds ratios with confidence intervals

	Dependent variable:		
	Daily SSB OR[a] (CI)	Daily Soda OR[a] (CI)	Heavy SSB OR[a] (CI)
Intercept	0.49	0.04^{***}	0.08^{**}
	(0.08, 2.82)	(0.01, 0.24)	(0.01, 0.60)
Moderate Income ($15,000 - $49,999/year)	1.04	0.68	1.05
	(0.53, 2.02)	(0.37, 1.25)	(0.52, 2.17)
High Income (> $50,000/year)	0.89	0.66	0.58
	(0.35, 2.27)	(0.25, 1.68)	(0.17, 1.78)
Male	1.17	1.13	0.92
	(0.64, 2.20)	(0.62, 2.04)	(0.45, 1.85)
Education (Some College or more)	0.69	0.56^{*}	0.41^{***}
	(0.37, 1.27)	(0.31, 1.00)	(0.21, 0.80)
Daily Water	3.83^{***}	1.86^{*}	2.50^{**}
	(2.10, 7.09)	(0.99, 3.61)	(1.16, 5.92)
Age	1.00	1.00	1.03^{***}

	(0.98, 1.02)	(0.98, 1.01)	(1.01, 1.05)
BMI	1.00	1.05***	0.99
	(0.97, 1.05)	(1.01, 1.10)	(0.95, 1.04)
Native American	2.22**	3.29**	1.15
	(1.01, 4.82)	(1.34, 9.42)	(0.47, 3.08)
Observations	268	273	244
Log Likelihood	-152.80	-157.44	-122.29
Akaike Inf. Crit.	323.59	332.88	262.57

Note: *p < .05 **p <.01 ***p<0.001
Confidence Intervals in Parentheses
[a] adjusted Odds Ratio
Female was the reference population for Male gender
Low Income (< $15,000/year) was the reference for Moderate and High Income

Income and gender were not associated with increased odds of neither daily SSB or soda consumption, nor heavy SSB consumption. Additionally, BMI was uncorrelated with daily or heavy SSB consumption, and education and age were found to be uncorrelated with odds of daily SSB consumption. Age was also uncorrelated with daily Soda consumption.

Water Consumption Regression Results

Adjusted odds ratios with confidence intervals were calculated for water consumption (table 4). After controlling for covariates, those that identified as Native American were found to experience significantly lower odds of both daily (OR: 0.25; CI: 0.08, 0.66) and heavy (OR: 0.44; CI: 0.21, 0.91) water consumption. The odds of daily water consumption were lower in males than females (OR: 0.46; CI: 0.25, 0.87). Those participants who drank SSBs daily were almost 4 times as likely to drink water daily (OR: 3.83, 2.10, 7.12). Older individuals experienced higher odds of being heavy water consumers. Income, education and BMI were found to be uncorrelated with the odds of both daily and heavy water consumption. Finally, Gender and daily SSB consumption were not correlated with the odds heavy water consumption.

Table 4 Water consumption regression results

	Dependent variable:	
	Daily Water OR[a] (CI)	Heavy Water OR[a] (CI)
Intercept	1.54 (0.21, 12.04)	0.30 (0.06, 1.53)
Moderate Income ($15,000 - $49,999/year)	0.96 (0.48, 1.91)	1.35 (0.75, 2.46)
High Income (> $50,000/year)	0.58 (0.22, 1.56)	1.02 (0.43, 2.40)
Male	0.46** (0.25, 0.87)	0.65 (0.36, 1.13)
Education (Some College or more)	1.55 (0.81, 2.99)	0.95 (0.55, 1.64)
Daily SSB	3.83*** (2.10, 7.12)	1.39 (0.80, 2.43)
Age	1.01 (0.99, 1.03)	1.02** (1.00, 1.04)
BMI	1.03	1.02

	(0.98, 1.07)	(0.98, 1.05)
Native American	0.25^{**}	0.44^{**}
	(0.08, 0.66)	(0.21, 0.91)
Observations	268	268
Log Likelihood	-136.87	-175.49
Akaike Inf. Crit.	291.74	368.99

Note: $^{*}p < .05$ $^{**}p < .01$ $^{***}p < 0.001$
Confidence Intervals in Parentheses
[a] adjusted Odds Ratio
Female was the reference population for Male gender
Low Income (< $15,000/year) was the reference for Moderate and High Income

DISCUSSION

Discussion

To our knowledge, this is the first study which focused on SSB consumption and water access specifically within a tribal community in the United States. One other study in the literature found no statistically significant difference in SSB consumption between those that identify as Native American and other ethnicities, but this could have been due to lack of adequate participation[90]. The results of our study stand in stark contrast, as analyses determined that identification as Native American was significantly related to daily SSB and soda consumption. Additionally, this study determined that Native Americans are less likely than non-Natives to consume water on a daily basis. The results of this study do, however, correlate with other studies which indicate increased odds of daily SSB consumption within minority populations[78,88,91,92,95,115,116].

Overall prevalence of daily SSB consumption was determined to be 69.4%(+/-4.7%), significantly greater than any observed prevalence in the literature, which ranged from 30-65%. The prevalence of participants with a self-reported BMI in the overweight or greater range was 83.9%. The prevalence of obese individuals was 54%, almost twice the national average of 39.8%.

Consistent with the literature, study results found that those with less than college education were at increased risk of being heavy consumers of SSBs and consuming soda daily[88,90–92,94,95]. In addition, concurring with the literature, this study found no correlation between weight category and daily SSB consumption[116]. However, this study did identify an increased odds of daily soda consumption with increasing in BMI. These findings support research which has linked SSB consumption to obesity[79,81,82,117].

Interestingly, juxtaposing the literature, this study found no significant correlation between income and SSB consumption[89]. This could be a result of the uneven representation of income levels in the cohort. This could also be an indicator that SSB consumption permeates all income levels in tribal communities. Additionally, contradicting other publications, gender was uncorrelated to probability of SSB consumption[88,90,92,116]. However, males were found to have increased odds of daily and heavy consumption of water. In contrast to published consensus which found increased consumption in younger adults, our study also determined that older individuals were at higher risk of consuming SSBs heavily, while age was uncorrelated to daily SSB and soda consumption[88,89,91,92,116]. This could be due to the positive impact of increased efforts at reduction of SSB consumption in the community, and increased knowledge of the impact on health. Though not included in our analyses, many participants reported very low prevalence of consumption of sodas and other SSBs in their children, and many were aware of the negative health impacts.

Analyses also determined that the odds of drinking SSBs significantly increased in those who consumed water daily. This could be due to response bias, where participants tend to answer within a certain range on surveys with scaled responses. This could also be explained by accounting for drinking habits related to increased consumption of all beverages in some respondents.

Males were less likely to consume water on a daily basis, as were those who identified as Native American. According to the literature, this could be due to price differentials in stores, accessibility, and targeted advertising which promote SSB consumption and the lack thereof promoting water consumption[104,118,119]. Our study sought to determine the relationship between water consumption and access. However, because of lack of responses, variables related to water cleanliness and access were not included in the analyses. Though not included in the model analyses, 8% of survey respondents reported they do not drink the water where they live, while 10% reported they don't feel their water was safe to drink. It will be important to determine the relationship between perception of water safety and consumption to aid policy and healthcare intervention efforts. Finally, our study did find that older individuals were more likely to be heavy water consumers. This could be due to adherence to traditional values in the community around drinking water daily.

Study Limitations

There were several limitations to this study. Due to non-response to parts of the survey, some variables could not be included in the model analyses, particularly those surrounding access to clean water and caregiver reported beverage consumption in children. The study removed participants who did not complete all data elements required in model analysis, which could potentially introduce bias. This model targeted the tribal community in order to highlight differences in reporting among the general population, therefore, the results are not generalizable to the larger population. Finally, model selection was based on assumptions of variable characteristics which may not accurately represent real world circumstances.

Due to the nature of surveying procedures the study could have been subject to certain types of bias which may create a gap between reported and actual results. In particular, because this survey asked respondents to report their beverage consumption in the last seven days, there was the potential for recall bias which could have resulted in over or underestimation. Additionally, though the surveys were collected anonymously, the responses could have been subject to social desirability bias[120]. Furthermore, though this study found a 52.4% prevalence of obesity in the study population, self-reporting of weight could be subject to underreporting, particularly in women, as is common in health surveys, though less common in in-person surveys[121].

Also, because the study was cross-sectional there was no way to determine causal relationships between variables; a longitudinal study would be required for such analyses. Furthermore, the results did not take into account seasonal variability, which could also affect determination of significance correlation. Finally, there are number of other factors in the literature (e.g., dietary consumption, alcohol consumption tv viewing time, physical activity, perceived health) that were not addressed in this study which could have the potential to alter the model.

Conclusions, Future Work, and Policy Recommendations

Strikingly, our findings indicate that individuals who identify as Native American are not only 3-4 times more likely to be daily consumers of SSBs in relation to non-Natives, but that non-natives are 4 times more likely to be daily consumers of water than Native Americans in our study cohort. The fact that our analyses determined a significant correlation between SSB consumption and water consumption only serves to exacerbate the issue. Future research should seek to clarify the disparity in daily water consumption and in particular its relationship to water access and quality. Emerging research has demonstrated that culturally tailored solutions have greater, longer lasting impacts on health in tribal communities[34,41,122–125]. An in-depth qualitative analysis of the relationship between water and tribal communities, and a deeper understanding of traditional ecological knowledge around water and its effects on consumption could serve to extrapolate important recommendations for effective policies and programs. The NBIII Foundation is a leader in funding tribal assessments addressing water and SSB consumption, and studies of this nature could serve to bolster support for culturally specific, lasting solutions. Additionally, many public health efforts focus on reduction of SSB consumption, as opposed to promoting water consumption. Marketing and policy researchers have determined that price and availability are crucial elements in beverage choice, particularly in minority communities [92,104,126,127]. Bolstering the proven impact of marketing, tailored marketing strategies promoting water drinking could have immense positive impacts. Furthermore, marketing strategies which rely on traditional and tribally specific values could be all the more impactful. Local advocacy for increased access to water through mechanisms such as water placement in convenience stores, decreasing the cost of water, procurement of water filtration systems, and SSB taxation could have additional impacts on community-based health efforts.

SSB taxation in particular has been noted in the literature to have a significant impact at reducing consumption, with the greatest reduction attributed to low-income communities[127]. In 2015, the Navajo nation introduced a 2% junk food tax on foods with little to no nutritional value. This has generated over $4 million in revenue, which has been re-allocated to invest in community driven wellness programs[128]. Since 2005, more than 1000 wellness projects have been started on the Navajo reservation relating to food and water initiatives and healthy lifestyles[128]. Contrary to popular belief, research has shown that there is widespread support of this tax. Future policies which incorporate an SSB tax which could be used to fund community projects that promote health could have the potential for a significant positive impact.

JOURNAL ARTICLE

A CROSS-SECTIONAL STUDY ON BEVERAGE CONSUMPTION IN ONE TRIBAL COMMUNITY

By Christina White

ABSTRACT

Objective. This study utilized the results of a cross-sectional survey on drinking habits and water access in one tribal reservation to determine prevalence of SSB consumption and its relationship to identification as Native American.

Methods. This study utilized the results of a cross-sectional survey on drinking habits and water access in one tribal reservation to determine prevalence of SSB consumption and its relationship to identification as Native American. Multivariate logistic regression analysis, after accounting for covariates, identified characteristics which significantly impacted odds of consumption.

Results. Prevalence of daily SSB consumption was determined to be 69.4% (± 4.7%). Odds of daily soda and SSB consumption were 3 to 4 times greater in Native Americans than other ethnicities. Non-natives were four times more likely to consume water daily. Body mass index was positively correlated with daily soda consumption, and older individuals experienced greater odds of heavy SSB consumption (>4 SSBs consumed per day). Individuals with less than a college education were at greater odds of daily SSB consumption and gender and income were uncorrelated to consumption.

Conclusion and Implications. Prevalence and determinants of SSB consumption among those that identify as Native American are different than the rest of the United States population. This study confirmed that Native communities suffer higher rates of obesity. It is the first to provide a baseline prevalence and analyses of consumption habits in a tribal community.

Keywords: sugar-sweetened beverages, water, obesity, Native American, multivariate logistic regression

Chapter 1 INTRODUCTION

Current research now suggests that poor diet is the largest contributor to chronic disease mortality, contributing more to chronic disease related deaths than does smoking [1]. Obesity, in particular, has been linked to increased mortality and increased morbidity of chronic disease, including (but not limited to) cancer, type II diabetes mellitus, cardiovascular disease, gallbladder stones, liver disease, and infertility[2,3]. According to the National Center for Health Statistics (NCHS), an estimated 39.8% of Americans and 18.5% of youth ages 2-19 were obese in 2016, an increase of 30% since 1999[4]. The swift increase in prevalence of obesity in past decades has led to its designation as an epidemic in the United States (US), and large-scale public health efforts have been designed to target weight reduction and nutrition since the late 1990s[2,5–7].

In particular, sugar sweetened beverage (SSB) consumption has been linked to obesity and associated chronic disease; these beverages are now purported to be the largest source of added sugar in the diets of adults and children in the United States, comprising up to 37% of additional sugars for adults and 31% for children[8]. The proportion of chronic disease related death and disability adjusted life years (DALY) attributable to SSB consumption is the greatest in the United States, second only to Central Latin America[1]. In the most recent *Dietary Guidelines for Americans*, published by the US Department of Agriculture (USDA) and US Department of Health and Human Services (HHS), limiting added sugars (the majority of which come from SSBs) is defined as one of the three core concepts in the guidelines to healthy eating[9].

Native American Health Disparities

While the obesity epidemic has penetrated every corner of the United States (US), Native Americans suffer disproportionately from this, among other health issues[10]. According to the literature, the life expectancy of Native Americans at birth is between 4 and 25 years less than that of the rest of the US population[11,12]. Specifically, Native Americans are 2 to 8 times more likely to suffer from obesity[10,13–17]. According to the Indian Health Service (IHS) and US National Death Index, diabetes is ranked the 4th leading cause of death in Native Americans, in contrast to 7th for the US population in total[18].

Though the fact that health disparities unduly affect Native American populations has been well established in the literature, attempts at identifying why are varied. The IHS has attributed these disparities to poverty, failures of the educational system, health care discrimination, and culture[17]. Theorists, government organizations, and social science researchers attribute these health disparities to the effects of colonization, historical traumas[i], and a lack of treatment programs that address health issues unique to Native American populations[10,19–23]. Other sources attribute this disparity to racist policies, geography, genetics, and epigenetics among others[24–28]. Furthermore, while there have been attempts to implicate current and historical occurrences as responsible for the current disparate state of health of Native Americans, most publications lack both clear identification of the root causes and paths toward solutions. The reality is that the multiplicity of factors which contribute to these disparities interject themselves at all levels of political, social, and individual life, which makes it difficult for siloed approaches at improving health to succeed. A failure to clearly understand and address the Native American health disparity at the appropriate levels, and a historical interference and resistance to culturally specific interventions until recently, has inevitably allowed the gap to persist, and even widen in some circumstances.

In addition to the plethora of contributors, there remains both a paucity and

[i] Braveheart defines historical trauma as "cumulative emotional and psychological wounding across generations, including the lifespan, which emanates from massive group trauma."[22]

inaccuracy of health data from Native American communities surrounding these health issues[17,29]. Many national level statistics fall short in terms of representation on reservations. As a result, in many cases, institutions group many tribes into one category, or even fail to highlight Native Americans as a distinct ethnic grouping at all[25]. The reality that last century has been wrought with repeated attempts at genocide of tribal peoples, coupled with the social perpetuation of Native Americans as an inferior, inhuman, and dying race or a "race on the brink of extinction" has only allowed national infrastructure to forget and forego promises made with regard to land, healthcare infrastructure, and other public services[30]. Historically, Native American communities have been ignored, unless and until natural resources under their control have been sought out for exploitation[31]. This maltreatment has perpetuated feelings of invisibility in Native American communities, which is implicated greatly in the disproportionate health issues these communities experience. Additionally, this has also led to Native Americans being discounted, even erased, in health care research, particularly at regional and national levels[32]. For instance, many death certificates have miscategorized Native Americans which has resulted in underreporting of morbidity and disease-related mortality[32]. The effects of these data issues have skewed descriptive statistics and analyses at the national level, and resulted in large-scale, but ineffective, public health efforts that are contextually insufficient and perhaps even irrelevant in the context of the health of Native Americans.

Culturally Responsive Solutions

To date researchers and government health organizations alike have acknowledged disparities in health in Native American populations and there is an emerging consensus, attributing these disparities to a wide range of culturally specific issues, including the effects of colonization[10,21,33–35] . Additionally, there is a recent appeal in the health sector for a need to incorporate population-specific, socially relevant determinants of health and to integrate culturally defined, specialized programs into the public health sector to address health inequalities and culturally specific health issues[10,21,33,36–41]. Federally defined determinants of health and health statistics are used to ascertain the needs of public healthcare systems, which serves the needs of a majority of the nation's Native American population through IHS. It is crucial that these measurements both accurately represent the communities which they are serving and address the particularity of these issues in distributed and specialized manners.

Due to the evolving understanding of the issues surrounding determinants of health, and in an effort to combat culturally specific health issues with culturally specific solutions, non-profit organizations have emerged in partnership with tribes and local healthcare institutions, with support from the federal sector to decentralize information gathering and empower local communities to seek what solutions best fit their unique contexts. In particular, for this study, the Notah Begay III (NBIII) Foundation partnered with the Confederate Tribes and Bands of the Yakama Nation, and Indian Health Services to begin to identify issues around SSB consumption and clean water access on the Yakama Reservation. NBIII awarded a grant to perform a community assessment of beverage consumption and self-reported water access to begin to outline the unique issues surrounding the impact of sugar sweetened beverage consumption on the Yakama reservation.

Purpose and Significance

The purpose of this research is threefold:

(1) To develop baseline statistics for prevalence of SSB consumption among those who identify as Native American in one tribal community

(2) To begin to understand the correlation between SSB consumption and various socio-demographic characteristics within the Native American subpopulation

(3) To compare this subpopulation to the literature, highlighting differences

which could potentially impact program and policy development in tribal communities

This study contributes to the body of literature which specifically addresses health disparities in Native American communities. In the last 20 years, with rising obesity, the literature has been saturated with cross-sectional and longitudinal studies, as well as systematic reviews and meta-analyses which seek to determine the relationships between SSB consumption, socio-demographic characteristics, and health outcomes. However, many of those disproportionately affected by the health disparities which these very studies seek to address fail to be adequately represented in them. This research attempts to address that gap through the analysis of determinants of SSB consumption within the Native community. To date, there has not been a study of this caliber or specificity completed in the study area or aimed at the target population.

METHODS

Study Design

A community assessment was developed under the guidance of the Chi'ish Wat'uy committee to collect data relating to beverage consumption and water access in four target areas on the Reservation of the Confederated Tribes and Bands of the Yakama Nation and surrounding areas. The purpose of the survey was to provide baseline data around community SSB consumption, and to provide guidance to the Water first! committee, composed of community stewards and health department staff, surrounding focus areas for targeted efforts. A secondary purpose of the survey was to begin to mobilize the discussion of SSB consumption in the community and to begin to identify community leaders in the effort to combat SSB consumption and promote water drinking. The survey content included 3 sections: (1) a demographic section, (2) a beverage consumption section, and (3) a water access section. The demographic section was composed of questions related to area of residence, gender, ethnic identification, income, and education. The beverage consumption portion of the survey was adapted from Behavioral Risk Factor Surveillance System (BRFSS) survey questions, as well as the BEVQ15 survey, a validated, standardized beverage intake questionnaire developed as an assessment tool to reliably document habitual beverage consumption habits[112,113]. Respondents were asked to document their own beverage consumption habits and those of any children currently in their care. Beverages were separated into the following categories: (1) Water; (2) flavored water, including non-diet Vitamin Water; (3) 100% juices (apple, orange); (4) Fruit-flavored drinks (lemonade, Sunny D, Tampico Punch, Snapple, Capri-sun and Kool-Aid); (5) Sport drinks (Gatorade or Powerade); (6) Regular soda or pop (Coke, Pepsi, Root Beer, Sprite); (7) Diet soda or pop (Diet Pepsi, Pepsi One, Diet Coke, Diet 7-Up) or other diet beverages (Crystal Light); (8) Sweetened coffee or tea drinks (lattes, mochas, Frappuccino, sweet tea); (9) Energy drinks (Rockstar, Red Bull, Monster); (10) Flavored milk (chocolate, strawberry, vanilla); and (11) Plain milk. Additionally, breast milk was added for the child consumption portion. Survey respondents were asked to report for the last 7 days, the consumption habits of both themselves and any children in their care. Consumption frequency was divided into the following options: (1) NEVER or less than 1 per week; (2) 1 per week; (3) 2-4 per week; (4) 5-6 per week; (5) 1 per day; (6) 2-3 per day; and (7) 4+ per day. The survey provided space for reporting consumption of up to 2 children, with additional pages available for those with more children.

Surveys were disseminated anonymously at tribally sponsored community events in December 2018 and January of 2019. A target sample size of greater that 300 was determined to be sufficient to perform statistical analyses on determinants of consumption.

Data analysis was performed using STATA 14 and R version 1.1.453. Demographic statistics were used for detailed prevalence estimates and as covariates in model analyses. SSB and water consumption prevalence estimates were calculated as percentages with 95% confidence intervals. Multivariate logistic regression analysis was performed to examine the relationship between daily SSB consumption and identification as Native American while controlling for age, gender, income, BMI, daily water consumption, and level of education.

Statistical significance threshold for regression analysis coefficients was set to $p < .05$. Analysis of deviance was used to determine model goodness of fit in relation to each independent variable. Pearson's Chi-squared test was performed to determine goodness of fit in relation to acceptance of the null hypothesis that the model and observed values are not different. Statistical significance for Pearson's Chi-squared was confirmed at $p > .05$. Additionally, a Wald Chi-squared test was performed to again determine the global significance of covariates.

A binomial logistic regression was performed for each of the following dichotomous dependent variables: daily water, daily SSB, daily soda, and heavy SSB consumption, which was defined as the consumption of more than 4 SSBs daily. SSBs where determined to be flavored water, 100% juice, fruit-flavored drinks, sports drinks, regular soda or pop, sweetened coffee or tea drinks, energy drinks, and flavored milk. An individual was considered a daily consumer if they indicated consumption greater than or equal to 1 per day in any of the aforementioned categories of SSBs. An individual was considered a heavy consumer if they indicated consumption of any of the SSBs as 4 or more per day.

Independent variables used in the model were age, BMI, Income, Native American ethnicity, daily consumption of water, education, and gender. Water access was originally intended to be included in the regression analysis as an independent variable. However, because of low response rate, water access was excluded from the analysis to maintain the integrity of the model. Additionally, the study intended to model child consumption of SSBs, and include parental daily consumption as an independent variable, but again, lack of data prevented this analysis.

The model assumed that the independent variables age and BMI were continuous variables. Gender and Income were treated as categorical variables, where females were the reference population for males, and low income was the reference population for moderate and high income. Income was split into tertials and categories for this variable were represented as low (< $14,999/year), moderate ($15,000 - $49,999/year), and high (> $50,000/year). Education, daily water/SSB consumption, and Native American ethnicity were modeled as dichotomous variables. A positive value for education was defined as greater than high school, and a positive value for Native American related to those individuals that selected part or all Native American on the survey Ethnicity question. Results were reported as adjusted odds ratios with confidence intervals calculated using the profile likelihood method[114].

INSTITUTIONAL REVIEW BOARD

The community assessment constituted the first of a four-part Water First! program funded by the Notah Begay III Foundation. The grant application was approved by Yakama Nation tribal council committee action in August of 2018. The grant was awarded to the Yakama Nation Wak'ishwi program in September of 2018 and funds were targeted at increased consumption of safe drinking water and reduction of SSB consumption, particularly in children under the age of 12. A Chi'ish Wat'uy planning committee was formed in October of 2018, whose main task was to oversee survey development and plan for community and other grant activities. The study was subject to oversight by the Central Washington University (CWU) Human Subjects Research Council (HSRC), and the survey and associated research was approved via exemption in December of 2018.

RESULTS

A total of 446 surveys were collected from residents of the target areas at all events combined. Of the 446 surveys, 25 were discarded because they were filled out by youth under the age of 18, to comply with HSRC Exemption. Additionally, 25 of the surveys were so incomplete that they were not considered viable for the analyses. A total of 403 survey responses were coded for analysis.

Study participants were predominantly female (68.5%) and identified as Native American (86.6%). Almost one third of participants (30.8% $\pm$ 4.5) reported to be of low income, making less than $15,000 per year, and over half (55.6% ± 4.9) reportedly earned between $15,000 and $50,000 per year.

Over half (54.8%) of respondents were over 45 years of age and the average age was 46.7 years. Average BMI was reported to be 31.73. Over half of participants (52.4% ± 5.3) reported being obese, with 83.9% (±33.8) participants having a BMI greater than the normal range. Half of the participants (54.5% ± 5) reported having more than a high school level of education.

The prevalence of daily consumption of SSBs was found to be 69.4% (±4.7). Daily soda and water consumption prevalence was 30.4% (±4.7) and 73.2% (± 4.4) respectively. Daily heavy SSB consumption was reported at 25.9% (± 4.8). Consumption was also broken down by characteristic to analyze statistically significant differences in prevalence rates within the population (table 1).

Table 1 Prevalence statistics by consumption and demographic characteristic

	Daily Water		*Daily Soda*		*Daily SSB*		*Heavy SSB*	
Characteristic	Mean	95% CI	Mean	95% CI	Mean	95% CI	Mean	95% CI
Age								
18-35	73.47	8.79	31.58	9.40	70.83	9.14	12.50*	6.95
35-54	75.61	7.62	32.77	8.47	67.80	8.47	23.08	8.14
55+	71.09	7.88	28.93	8.11	70.69	8.32	35.85*	9.17

Gender								
Female	76.71	5.26	29.83	5.82	70.82	5.85	26.29	5.93
Male	66.36	8.87	29.52	8.77	67.65	9.12	23.33	8.79
Education								
HS	68.67	7.08	36.88	7.50	72.08	7.11	31.21	7.67
College or more	77.00	5.85	25.79	6.24	66.67	6.74	20.12	6.06
Income								
low	67.80	8.47	37.17	8.95	72.32	8.32	28.71	8.87
moderate	76.04	5.69	27.75	6.09	69.46	6.35	25.14	6.30
high	73.58	11.98	26.00	12.28	62.50	13.84	22.73	12.53
BMI Grouping								
Normal Weight	72.97	14.51	25.00	14.35	70.27	14.93	26.47	15.05
Overweight	73.11	8.00	25.66	8.09	63.96	8.97	23.30	8.20
Obese	69.77	9.76	36.90	10.38	78.21	9.22	24.29	10.12
Severely Obese	67.35	13.27	43.75	14.18	74.00	12.28	25.00	12.94
Morbidly Obese	83.78	12.04	30.56	15.26	61.76	16.58	24.14	15.85
Ethnicity								
Native	71.13*	4.85	32.72*	5.12	70.57	5.03	25.96	5.10
Non-native	86.54*	9.37	14.58*	10.09	61.70	14.05	25.58	13.20

* statistically significant

The prevalence of heavy SSB consumption was significantly higher among those age 55 and older as compared to those age 18 to 35. Natives had a significantly lower prevalence of water consumption and increased prevalence of soda consumption than those that did not identify as Native American.

Survey Results

Of the adult respondents, 32.6% consumed sweetened coffee or tea once or more daily, 14.8% consumed energy drinks once or more daily, and 16.8% consumed sports drinks (e.g. gatorade, powerade) once or more daily. Just over one quarter of adults (26.7%) reported drinking water less than once a day.

Of the survey responses to the water quality and access questions, 9% of participants reportedly did not drink the water where they live. Additionally, 54 respondents (13%) reported reasons why they do not drink the water where they live. The most common form of water consumption was bottled water (55%).

Among children, juice had the highest rate of daily consumption at 34.4%. Over half of parents (56.7%) admitted that children most often obtain SSBs in the home. Almost one third (30.1%) of all children were reported to consume water less than once daily, while 42% of children consumed milk daily. Respondents reported that half of children don't drink soda at all.

SSB Consumption Regression Results

Table 2 summarizes the results of the logistic regression analyses. After adjusting for covariates, study participants who identified as Native American were found to be exposed to double the odds of daily SSB consumption (OR: 2.22; CI: 1.01, 4.82) and 3 times the odds of daily soda consumption (OR: 3.29, CI: 1.34, 9.42) when compared to non-Natives. Those with a greater than high school education were half as likely to consume soda daily(OR: 0.56; CI: 0.31, 1.00) or be heavy SSB consumers (OR: 0.41; CI: 0.21, 0.80). Increased odds of daily soda consumption were correlated with increased BMI (OR: 1.05; CI: 1.01, 1.10). Daily water consumption was associated with increased probability of daily SSB (OR: 3.83; CI: 2.10, 7.09) and heavy SSB consumption (OR: 2.5; CI: 1.16, 5.92). Age was also slightly positively correlated with increased probability of heavy SSB consumption (OR: 1.03; CI: 1.01, 1.05).

Table 2 SSB consumption adjusted odds ratios with confidence intervals

	Dependent variable:		
	Daily SSB OR[a] (CI)	Daily Soda OR[a] (CI)	Heavy SSB OR[a] (CI)
Intercept	0.49	0.04^{***}	0.08^{**}
	(0.08, 2.82)	(0.01, 0.24)	(0.01, 0.60)
Moderate Income ($15,000 - $49,999/year)	1.04	0.68	1.05
	(0.53, 2.02)	(0.37, 1.25)	(0.52, 2.17)
High Income (> $50,000/year)	0.89	0.66	0.58
	(0.35, 2.27)	(0.25, 1.68)	(0.17, 1.78)

Male	1.17	1.13	0.92
	(0.64, 2.20)	(0.62, 2.04)	(0.45, 1.85)
Education (Some College or more)	0.69	0.56*	0.41***
	(0.37, 1.27)	(0.31, 1.00)	(0.21, 0.80)
Daily Water	3.83***	1.86*	2.50**
	(2.10, 7.09)	(0.99, 3.61)	(1.16, 5.92)
Age	1.00	1.00	1.03***
	(0.98, 1.02)	(0.98, 1.01)	(1.01, 1.05)
BMI	1.00	1.05***	0.99
	(0.97, 1.05)	(1.01, 1.10)	(0.95, 1.04)
Native American	2.22**	3.29**	1.15
	(1.01, 4.82)	(1.34, 9.42)	(0.47, 3.08)
Observations	268	273	244
Log Likelihood	-152.80	-157.44	-122.29
Akaike Inf. Crit.	323.59	332.88	262.57

Note: *p < .05 **p <.01 ***p<0.001
Confidence Intervals in Parentheses
[a] adjusted Odds Ratio
Female was the reference population for Male gender
Low Income (< $15,000/year) was the reference for Moderate and High Income

Income and gender were not associated with increased odds of neither daily SSB or soda consumption, nor heavy SSB consumption. Additionally, BMI was uncorrelated with daily or heavy SSB consumption, and education and age were found to be uncorrelated with odds of daily SSB consumption. Age was also uncorrelated with daily Soda consumption.

Water Consumption Regression Results

Adjusted odds ratios with confidence intervals were calculated for water consumption (table 3). After controlling for covariates, those that identified as Native American were found to experience significantly lower odds of both daily (OR: 0.25; CI: 0.08, 0.66) and heavy (OR: 0.44; CI: 0.21, 0.91) water consumption. The odds of daily water consumption were lower in males than females (OR: 0.46; CI: 0.25, 0.87). Those participants who drank SSBs daily were almost 4 times as likely to drink water daily (OR: 3.83, 2.10, 7.12). Older individuals experienced higher odds of being heavy water consumers. Income, education and BMI were found to be uncorrelated with the odds of both daily and heavy water consumption. Finally, Gender and daily SSB consumption were not correlated with the odds heavy water consumption.

Table 3 Water consumption regression results

	Dependent variable:	
	Daily Water OR[a] (CI)	Heavy Water OR[a] (CI)
Intercept	1.54 (0.21, 12.04)	0.30 (0.06, 1.53)
Moderate Income ($15,000 - $49,999/year)	0.96 (0.48, 1.91)	1.35 (0.75, 2.46)
High Income	0.58	1.02

(> $50,000/year)	(0.22, 1.56)	(0.43, 2.40)
Male	0.46**	0.65
	(0.25, 0.87)	(0.36, 1.13)
Education (Some College or more)	1.55	0.95
	(0.81, 2.99)	(0.55, 1.64)
Daily SSB	3.83***	1.39
	(2.10, 7.12)	(0.80, 2.43)
Age	1.01	1.02**
	(0.99, 1.03)	(1.00, 1.04)
BMI	1.03	1.02
	(0.98, 1.07)	(0.98, 1.05)
Native American	0.25**	0.44**
	(0.08, 0.66)	(0.21, 0.91)
Observations	268	268
Log Likelihood	-136.87	-175.49
Akaike Inf. Crit.	291.74	368.99

Note: *p < .05 **p <.01 ***p<0.001
Confidence Intervals in Parentheses
[a] adjusted Odds Ratio
Female was the reference population for Male gender
Low Income (< $15,000/year) was the reference for Moderate and High Income

DISCUSSION

To our knowledge, this is the first study which focused on SSB consumption and water access specifically within a tribal community in the United States. One other study in the literature found no statistically significant difference in SSB consumption between those that identify as Native American and other ethnicities, but this could have been due to lack of adequate participation[90]. The results of our study stand in stark contrast, as analyses determined that identification as Native American was significantly related to daily SSB and soda consumption. Additionally, this study determined that Native Americans are less likely than non-Natives to consume water on a daily basis. The results of this study do, however, correlate with other studies which indicate increased odds of daily SSB consumption within minority populations[78,88,91,92,95,115,116].

Overall prevalence of daily SSB consumption was determined to be 69.4%(+/-4.7%), significantly greater than any observed prevalence in the literature, which ranged from 30-65%. The prevalence of participants with a self-reported BMI in the overweight or greater range was 83.9%. The prevalence of obese individuals was 54%, almost twice the national average of 39.8%.

Consistent with the literature, study results found that those with less than college education were at increased risk of being heavy consumers of SSBs and consuming soda daily[88,90–92,94,95]. In addition, concurring with the literature, this study found no correlation between weight category and daily SSB consumption[116]. However, this study did identify an increased odds of daily soda consumption with increasing in BMI. These findings support research which has linked SSB consumption to obesity[79,81,82,117].

Interestingly, juxtaposing the literature, this study found no significant correlation between income and SSB consumption[89]. This could be a result of the uneven representation of income levels in the cohort. This could also be an indicator that SSB consumption permeates all income levels in tribal communities. Additionally, contradicting other publications, gender was uncorrelated to probability of SSB consumption[88,90,92,116]. However, males were found to have increased odds of daily and heavy consumption of water. In contrast to published consensus which found increased consumption in younger adults, our study also determined that older individuals were at higher risk of consuming SSBs heavily, while age was uncorrelated to daily SSB and soda consumption[88,89,91,92,116]. This could be due to the positive impact of increased efforts at reduction of SSB consumption in the community, and increased knowledge of the impact on health. Though not included in our analyses, many participants reported very low prevalence of consumption of sodas and other SSBs in their children, and many were aware of the negative health impacts.

Analyses also determined that the odds of drinking SSBs significantly increased in those who consumed water daily. This could be due to response bias, where participants tend to answer within a certain range on surveys with scaled responses. This could also be explained by accounting for drinking habits related to increased consumption of all beverages in some respondents.

Males were less likely to consume water on a daily basis, as were those who identified as Native American. According to the literature, this could be due to price differentials in stores, accessibility, and targeted advertising which promote SSB consumption and the lack thereof promoting water consumption[104,118,119]. Our study sought to determine the relationship between water consumption and access. However, because of lack of responses, variables related to water cleanliness and access were not included in the analyses. Though not included in the model analyses, 8% of survey respondents reported they do not drink the water where they live, while 10% reported they don't feel their water was safe to drink. It will be important to determine the relationship between perception of water safety and consumption to aid policy and healthcare intervention efforts. Finally, our study did find that older individuals were more likely to be heavy water consumers. This could be due to adherence to traditional values in the community around drinking water daily.

Study Limitations

There were several limitations to this study. Due to non-response to parts of the survey, some variables could not be included in the model analyses, particularly those surrounding access to clean water and caregiver reported beverage consumption in children. The study removed participants who did not complete all data elements required in model analysis, which could potentially introduce bias. This model targeted the tribal community in order to highlight differences in reporting among the general population, therefore, the results are not generalizable to the larger population. Finally, model selection was based on assumptions of variable characteristics which may not accurately represent real world circumstances.

Due to the nature of surveying procedures the study could have been subject to certain types of bias which may create a gap between reported and actual results. In particular, because this survey asked respondents to report their beverage consumption in the last seven days, there was the potential for recall bias which could have resulted in over or underestimation. Additionally, though the surveys were collected anonymously, the responses could have been subject to social desirability bias[120]. Furthermore, though this study found a 52.4% prevalence of obesity in the study population, self-reporting of weight could be subject to underreporting, particularly in women, as is common in health surveys, though less common in in-person surveys[121]. Also, because the study was cross-sectional there was no way to determine causal relationships between variables; a longitudinal study would be required for such analyses. Furthermore, the results did not take into account seasonal variability, which could also affect determination of significance correlation. Finally, there are number of other factors in the literature (e.g., dietary consumption, alcohol consumption tv viewing time, physical activity, perceived health) that were not addressed in this study which could have the potential to alter the model.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Strikingly, our findings indicate that individuals who identify as Native American are not only 3-4 times more likely to be daily consumers of SSBs in relation to non-Natives, but that non-natives are 4 times more likely to be daily consumers of water than Native Americans in our study cohort. Future research should seek to clarify the disparity in daily water consumption and in particular its relationship to water access and quality. Emerging research has demonstrated that culturally tailored solutions have greater, longer lasting impacts on health in tribal communities[34,41,122–125]. An in-depth qualitative analysis of the relationship between water and tribal communities, and a deeper understanding of traditional ecological knowledge around water and its effects on consumption could serve to extrapolate important recommendations for effective policies and programs. The NBIII Foundation is a leader in funding tribal assessments addressing water and SSB consumption, and studies of this nature could serve to bolster support for culturally specific, lasting solutions. Additionally, many public health efforts focus on reduction of SSB consumption, as opposed to promoting water consumption. Marketing and policy researchers have determined that price and availability are crucial elements in beverage choice, particularly in minority communities [92,104,126,127]. Bolstering the proven impact of marketing, tailored marketing strategies promoting water drinking could have immense positive impacts. Furthermore, marketing strategies which rely on traditional and tribally specific values could be all the more impactful. Local advocacy for increased access to water through mechanisms such as water placement in convenience stores, decreasing the cost of water, procurement of water filtration systems, and SSB taxation could have additional impacts on community-based health efforts.

SSB taxation in particular has been noted in the literature to have a significant impact at reducing consumption, with the greatest reduction attributed to low-income communities[127]. In 2015, the Navajo nation introduced a 2% junk food tax on foods with little to no nutritional value. This has generated over $4 million in revenue, which has been re-allocated to invest in community driven wellness programs[128]. Since 2005, more than 1000 wellness projects have been started on the Navajo reservation relating to food and water initiatives and healthy lifestyles[128]. Future policies which incorporate an SSB tax which could be used to fund community projects that promote health could have the potential for a significant positive impact.

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Appendix A Human Subjects Exemption Approval

LEARN. DO. LIVE.

12/18/2018

Dear Christina White:

Thank you for submitting an exemption request for your study, ***Determinants of sugary drink consumption in a tribal community.***. The application as submitted was screened for exemption status according to the policies of CWU and the provisions of the applicable federal regulations. Your research was found to be subject to CWU oversight but exempt because it involves collecting anonymous survey data from adult volunteers [see 45 CFR 46.101b(2)]. This certification is valid for 12 months through 12/17/2019, as long as the approved procedures are followed.

Your responsibilities with respect to keeping this office apprised of your progress include the following:

1. Submit a Project Modification Request form for approval before modifying your study in any way (e.g., any change in recruitment, subjects, co-investigators, consent forms, any procedures), except formatting of documents. If there is a major change in purpose or protocol, you may be asked to submit a new application.
2. Submit a Termination Report form upon completion of your study.
3. Immediately contact the HSRC for further guidance should you encounter unanticipated problems with your research. Follow up with an Unanticipated Problems report may be required.

All of the HSRC forms are available on our website. Please refer to your HSRC study number (2018-048) in all related future correspondence with this office. If you have questions or concerns, please feel free to contact the office.

I have appreciated working with you; may you have a productive research experience.

Sincerely,

Sandra M. Martinez

Sandra M. Martinez, M.A.
Human Protections Administrator

c: HSRC File
Matthew Altman, HSRC Chair
Toni Sipic
Dawn Anderson, Graduate Studies and Research

Human Subjects Review Council
400 E University Way • Ellensburg WA 98926-4701 • Office: 509-963-3115
Black Hall, 225-17 • Email: hsrc@cwu.edu • Web: cwu.edu/hsrc

Appendix B Survey Questionnaire

Community Beverage Survey

GENERAL INFO

Zip Code of Residence: _______________

Gender: ☐ Male ☐ Female

Ethnicity:
- ☐ Native American
- ☐ African American
- ☐ Asian
- ☐ White
- ☐ Hispanic
- ☐ Other, Please Specify _______________

What is your highest level of education completed? (optional)
- ☐ Some High School
- ☐ High school diploma/GED
- ☐ Some College
- ☐ College Degree
- ☐ Graduate Degree

What is your yearly income level? (optional)

☐ Less than $10,000	☐ $50,000 - $74,999
☐ $10,000 - $14,999	☐ $75,000 - $99,999
☐ $15,000 - $24,999	☐ $100,000 - $149,999
☐ $25,000 - $34,999	☐ $150,000 - $199,999
☐ $35,000 - $49,999	☐ $200,000 or more

BEVERAGE INTAKE

For **yourself** and **each child** that you cared for in the **last 7 days**, please fill in approximate age, weight, and height and then for each type of drink answer "**How Often"** a cup/can/bottle is consumed. If you have cared for more than 4 children in the last 7 days please ask for an extra survey sheet.

	NEVER or less than 1 per week	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4+ per day
SELF Age: ________ Height: ___________ Weight ___________							
1. Water							
2. Flavored Water (Vitamin Water non-diet)							
3. 100% juices (Orange juice, apple juice or other)							
4. Fruit-flavored drinks (lemonade, Sunny D, Tampico Punch, Snapple, Capri-sun and Kool-Aid)							
5. Sport drinks (Gatorade or Powerade)							
6. Regular soda or pop (Coke, Pepsi, Root Beer, Sprite)							
7. Diet soda or pop (Diet Pepsi, Pepsi One, Diet Coke, Diet 7-Up) or other diet beverages (Crystal Light)							
8. Sweetened coffee or tea drinks (lattes, mochas, Frappuccino, sweet tea)							
9. Energy drinks (Rockstar, Red Bull, Monster)							
10. Flavored milk (chocolate, strawberry, vanilla)							
11. Plain Milk							

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BEVERAGE AND WATER ACCESS

If your children consume sugary drinks, where do they get them?

☐ Home
☐ School/Day care
☐ Church/Longhouse/Ceremonies
☐ Other ________________

What kind of water do you and your children normally drink?

☐ Well
☐ City water
☐ Bottled Water
☐ Other ________________

Per household, on average how much money do you spend per week on sugary drinks (e.g., 100% Juice, Sports Drinks, Pop, flavored Red Bull, Sweetened Coffee or Tea)?
☐ $0
☐ $1-$5
☐ $6-$10
☐ $10-$20
☐ $20 or more

Do you drink water where you live?

☐ Yes ☐ No

If not, why don't you drink water where you live? (Mark all that apply)

☐ I don't believe the water is safe to drink
☐ It smells bad
☐ It tastes bad
☐ I don't have water where I live
☐ Other ___________________________

What do you think are the health issues with drinking sugar-sweetened beverages?

____

____

____

	NEVER or less than 1 per week	1 per week	2-4 per week	5-6 per week	1 per day	2-3 per day	4+ per day
Child #3 Age: _______ Height: ______ Weight _____							
1. Water							
2. Flavored Water (Vitamin Water non-diet)							
3. 100% juices (Orange juice, apple juice or other)							
4. Fruit-flavored drinks (lemonade, Sunny D, Tampico Punch, Snapple, Capri-sun and Kool-Aid)							
5. Sport drinks (Gatorade or Powerade)							
6. Regular soda or pop (Coke, Pepsi, 7-Up, Sprite, Root beer)							
7. Diet soda or pop (Diet Pepsi, Pepsi One, Diet Coke, Diet 7-Up) or other diet beverages (Crystal Light)							
8. Sweetened coffee or tea drinks (lattes, mochas, Frappuccino, sweet tea)							
9. Energy drinks (Rockstar, Red Bull, Monster)							
10. Flavored milk (chocolate, strawberry, vanilla)							
11. Plain Milk							
12. Breast Milk							
Child #4 Age:________ Height: ______ Weight _____							
1. Water							
2. Flavored Water (Vitamin Water non-diet)							
3. 100% juices (Orange juice, apple juice or other)							
4. Fruit-flavored drinks (lemonade, Sunny D, Tampico Punch, Snapple, Capri-sun and Kool-Aid)							
5. Sport drinks (Gatorade or Powerade)							
6. Regular soda or pop (Coke, Pepsi, Root Beer, Sprite)							
7. Diet soda or pop (Diet Pepsi, Pepsi One, Diet Coke, Diet 7-Up) or other diet beverages (Crystal Light)							
8. Sweetened coffee or tea drinks (lattes, mochas, Frappuccino, sweet tea)							
9. Energy drinks (Rockstar, Red Bull, Monster)							
10. Flavored milk (chocolate, strawberry, vanilla)							
11. Plain Milk							
12. Breast Milk							

Appendix C Multivariate Logistic Regression Results

Table 4 SSB consumption logit regression results

	Dependent variable:		
	Daily SSB	Daily Soda	Heavy SSB
(Intercept)	-0.72	-3.28***	-2.58**
	(0.90)	(0.99)	(1.08)
Low Income	Ref	Ref	Ref
Moderate Income	0.04	-0.39	0.05
	(0.34)	(0.31)	(0.37)
High Income	-0.12	-0.41	-0.54
	(0.47)	(0.48)	(0.60)
Female	Ref	Ref	Ref
Male	0.16	0.12	-0.08
	(0.32)	(0.31)	(0.36)
Education (Some College or More)	-0.37	-0.58*	-0.88***
	(0.31)	(0.30)	(0.34)
Daily Water	1.34***	0.62*	0.92**
	(0.31)	(0.33)	(0.41)
Age	-0.001	-0.002	0.03***
	(0.01)	(0.01)	(0.01)

BMI	0.004	0.05^{***}	-0.01
	(0.02)	(0.02)	(0.02)
Native American	0.80^{**}	1.19^{**}	0.14
	(0.40)	(0.49)	(0.47)
Observations	268	273	244
Log Likelihood	-152.80	-157.44	-122.29
Akaike Inf. Crit.	323.59	332.88	262.57

Note: $^{*}p < .05$ $^{**}p < .01$ $^{***}p < 0.001$
Standard Errors in Parenthesis

Table 5 Water consumption logit regression results

	Dependent variable:	
	Daily Water	Heavy Water
Intercept	0.43	-1.19
	(1.03)	(0.83)
Moderate Income	-0.04	0.30
	(0.35)	(0.30)
High Income	-0.55	0.02
	(0.50)	(0.44)
Gender	-0.77^{**}	-0.44
	(0.32)	(0.29)
Education (Some College or more)	0.44	-0.05
	(0.33)	(0.28)
Daily Water	1.34^{***}	0.33
	(0.31)	(0.28)
Age	0.01	0.02^{**}

	(0.01)	(0.01)
BMI	0.03	0.02
	(0.02)	(0.02)
Native American	-1.40**	-0.83**
	(0.54)	(0.38)
Observations	268	268
Log Likelihood	-136.87	-175.49
Akaike Inf. Crit.	291.74	368.99

Note: *p < .05 **p <.01 ***p<0.001
Standard Errors in Parenthesis

Appendix D Analyses code

```
library(reshape2)
library(gvlma)
library(aod)
library(ggplot2)
install.packages("pastecs")
library(pastecs)
library(psych)
mdata <- melt(data = sdata, id.vars = "SRSODA", measure.vars =
c("INCM", "SEX"))

ggplot(sdata, aes(SRSODA)) + geom_bar(aes(fill= SEX))
```

```
sdata <- sdata[-c(404:438),]
sdata$BMI <- sdata$SWEIGHT*703/(sdata$SHEIGHT*sdata$SHEIGHT)
sdata$Obese <- ifelse(sdata$BMI >= 30 ,1,0)
sdata$Ovweight <- ifelse(sdata$BMI >= 25 ,1,0)
sdata$HSed <- ifelse(sdata$EDUC > 1  ,1,0)
sdata$Ced <- ifelse(sdata$EDUC > 2 ,1,0)
sdata$Cdeg <- ifelse(sdata$EDUC > 3 ,1,0)
sdata$dailySSB <- ifelse(sdata$SFWAT > 4 | sdata$SJUCE > 4 | sdata$SFFD
> 4 | sdata$SSD > 4 | sdata$SRSODA > 4 | sdata$SCTEA > 4 | sdata$SFMILK
> 4 | sdata$SED > 4,1,0)
sdata$heavySSB <- ifelse(sdata$SFWAT > 6 | sdata$SJUCE > 6 | sdata$SFFD
> 6 | sdata$SSD > 6 | sdata$SRSODA > 6 | sdata$SCTEA > 6 | sdata$SFMILK
> 6 | sdata$SED > 6,1,0)
sdata$dailySSBnj <- ifelse(sdata$SFWAT > 4| sdata$SFFD > 4 | sdata$SSD
> 4 | sdata$SRSODA > 4 | sdata$SCTEA > 4 | sdata$SFMILK > 4 | sdata$SED
> 4,1,0)
sdata$heavySSBnj <- ifelse(sdata$SFWAT > 6 | sdata$SFFD > 6 | sdata$SSD
> 6 | sdata$SRSODA > 6 | sdata$SCTEA > 6 | sdata$SFMILK > 6 | sdata$SED
> 6,1,0)
sdata$dailySoda <-ifelse(sdata$SRSODA > 4,1,0)
sdata$heavyW <- ifelse(sdata$SWAT > 6,1,0)
sdata$dailyW <- ifelse(sdata$SWAT > 4,1,0)
sdata$native <- ifelse(grepl("1", sdata$ETH),1,0)
sdata$sage2 <- sdata$SAGE^2

sdata$adjinc[sdata$INCM < 3] <- 0
sdata$adjinc[sdata$INCM > 2 & sdata$INCM < 6] <- 1
sdata$adjinc[sdata$INCM > 5] <- 2
sdata$lowincm <- ifelse(sdata$adjinc == 0, 1,0)
```

```
sdata$modincm <- ifelse(sdata$adjinc == 1, 1,0)
sdata$highincm <- ifelse(sdata$adjinc == 2, 1,0)

sdata$male <- ifelse(sdata$SEX == 1, 1,0)
sdata$female <- ifelse(sdata$SEX == 2, 1,0)

# fit <- lm(dailySSB ~ SAGE + sage2 + BMI + dailyW + INCM + EDUC + SEX
+ native, data=sdata)
# fit.r <- resid(fit)
# plot(fit.r ~ sdata$SAGE)
############# prevalence estimates ################
dailySSB_prev <- length(which(sdata$dailySSB ==
1))/sum(!is.na(sdata$dailySSB))


SSB_data <- data.frame(sdata$heavySSB, sdata$dailySSB,
sdata$dailySoda,sdata$dailyW,sdata$SEX,sdata$adjinc,sdata$Ced,sdata$SAG
E,sdata$BMI,sdata$Obese, sdata$native)
SSB_data$ageCat <- cut(SSB_data$sdata.SAGE, breaks=c(17,34,54,Inf),
labels=c("18-35","35-54", "55+"))
SSB_data$BMI_index <- cut(SSB_data$sdata.BMI, breaks=c(-
Inf,18.5,24.9,29.9,34.9,39.9,Inf), labels=c("Underweight","Normal
Weight", "Overweight", "Obese", "Severly Obese","Morbidly Obese"))

samp <- psych::describeBy(SSB_data, SSB_data$BMI_index, mat = TRUE)

stat.desc(SSB_data$sdata.heavySSB = 1)
by(sdata, sdata$INCM, summary)
```

```
library(Hmisc)
describe(heavySSB_data)

######## multiv logit regression for heavy SSB consumption
##############
heavySSB_data <-
data.frame(sdata$heavySSB,sdata$dailySSB,sdata$dailySoda,
sdata$dailyW,sdata$male, sdata$female,sdata$lowincm,sdata$modincm,
sdata$highincm,sdata$Ced,sdata$SAGE,sdata$BMI,sdata$native,sdata$Obese,
sdata$Ovweight)
#heavySSB_data$sdata.SEX <- factor(heavySSB_data$sdata.SEX)
#heavySSB_data$sdata.adjinc <- factor(heavySSB_data$sdata.adjinc)
heavySSB_logit <- glm(sdata.heavySSB ~ sdata.highincm + sdata.modincm +
sdata.lowincm + sdata.male + sdata.female + sdata.Ced + sdata.dailyW +
sdata.SAGE + sdata.Obese + sdata.native, data = heavySSB_data, family =
binomial("logit"))
summary(heavySSB_logit)

######## multiv logit regression for daily SSB consumption
##############
heavySSB_data <-
data.frame(sdata$heavySSB,sdata$dailySSB,sdata$female,sdata$dailyW,sdat
a$SEX,sdata$adjinc,sdata$Ced,sdata$SAGE,sdata$BMI,sdata$native)
heavySSB_data$sdata.SEX <- factor(heavySSB_data$sdata.SEX)
heavySSB_data$sdata.adjinc <- factor(heavySSB_data$sdata.adjinc)
heavySSB_logit <- glm(sdata.heavySSB ~ sdata.adjinc  + sdata.SEX +
sdata.Ced + sdata.dailyW + sdata.SAGE + sdata.BMI + sdata.native, data
= heavySSB_data, family = binomial("logit"))
summary(heavySSB_logit)
```

```
######## multiv logit regression for daily SSB consumption
##############
dailySSB_data <-
data.frame(sdata$dailySSB,sdata$female,sdata$dailyW,sdata$SEX,sdata$adj
inc,sdata$Ced,sdata$SAGE,sdata$BMI,sdata$native)
dailySSB_data$sdata.SEX <- factor(dailySSB_data$sdata.SEX)
dailySSB_data$sdata.adjinc <- factor(dailySSB_data$sdata.adjinc)
dailySSB_logit <- glm(sdata.dailySSB ~ sdata.adjinc  + sdata.SEX +
sdata.Ced + sdata.dailyW + sdata.SAGE + sdata.BMI + sdata.native, data
= dailySSB_data, family = binomial("logit"))
summary(dailySSB_logit)

######## multiv logit regression for daily soda consumption
##############
dailySoda_data <-
data.frame(sdata$dailySoda,sdata$dailyW,sdata$SEX,sdata$adjinc,sdata$Ce
d,sdata$SAGE,sdata$BMI,sdata$native)
dailySoda_data$sdata.SEX <- factor(dailySoda_data$sdata.SEX)
dailySoda_data$sdata.adjinc <- factor(dailySoda_data$sdata.adjinc)
dailySoda_logit <- glm(sdata.dailySoda ~ sdata.adjinc + sdata.SEX +
sdata.Ced + sdata.dailyW + sdata.SAGE + sdata.BMI + sdata.native, data
= dailySoda_data, family = binomial("logit"))
summary(dailySoda_logit)

######## multiv logit regression for daily water consumption
##############
dailyW_data <-
data.frame(sdata$dailySSB,sdata$dailyW,sdata$SEX,sdata$adjinc,sdata$Ced
```

```
,sdata$SAGE,sdata$BMI,sdata$native)
dailyW_data$sdata.SEX <- factor(dailyW_data$sdata.SEX)
dailyW_data$sdata.adjinc <- factor(dailyW_data$sdata.adjinc)
dailyW_logit <- glm(sdata.dailyW ~ sdata.adjinc + sdata.SEX + sdata.Ced
+ sdata.dailySSB + sdata.SAGE + sdata.BMI + sdata.native, data =
dailyW_data, family = binomial("logit"))
summary(dailyW_logit)

######## multiv logit regression for heavy water consumption
##############
heavyW_data <-
data.frame(sdata$dailySSB,sdata$heavyW,sdata$SEX,sdata$adjinc,sdata$Ced
,sdata$SAGE,sdata$BMI,sdata$native)
heavyW_data$sdata.SEX <- factor(heavyW_data$sdata.SEX)
heavyW_data$sdata.adjinc <- factor(heavyW_data$sdata.adjinc)
heavyW_logit <- glm(sdata.heavyW ~ sdata.adjinc + sdata.SEX + sdata.Ced
+ sdata.dailySSB + sdata.SAGE + sdata.BMI + sdata.native, data =
heavyW_data, family = binomial("logit"))
summary(heavyW_logit)

library(stargazer)
stargazer(heavySSB_data, type = "html", title="Descriptive Statistics
of Survey Population", digits=3,summary.stat = c("n", "mean", "sd"),
out="table1.doc",
          covariate.labels=c("Heavy SSB Consumption","Daily SSB
Consumption","Daily Soda Consumption","Daily Water
Consumption","Male","Female","Low (<$14,999)","Moderate ($15,000-
$49,999)","High (>$50,000)", "Some College or More","Age","BMI","Native
American", "Obese", "Overweight"))
```

```
stargazer2 <- function(model, odd.ratio = F, ...) {
  if(!("list" %in% class(model))) model <- list(model)

  if (odd.ratio) {
    coefOR2 <- lapply(model, function(x) exp(coef(x)))
    ciOR2 <- lapply(model, function(x) exp(confint(x)))
    seOR2 <- lapply(model, function(x) exp(coef(x)) * summary(x)$coef[,
2])
    p2 <- lapply(model, function(x) summary(x)$coefficients[, 4])
    stargazer(model, coef = coefOR2, ci= T,  ci.custom = ciOR2, p = p2,
...)

  } else {
    stargazer(model, ...)
  }
}

models <- list(dailySSB_logit, dailySoda_logit, heavySSB_logit)
stargazer2(models,
          type="html",
          dep.var.labels=c("Daily SSB","Daily Soda","Heavy SSB"),
          covariate.labels=c("Intercept","Moderate Income","High
Income","Gender",
                             "Education(Some College or more)","Daily
Water","Age","BMI","Native American"),
          out="star_linear_ssbOR.doc",
          intercept.bottom = F,
          intercept.top = T,
```

```
          odd.ratio = T,
          digits=2)

stargazer(dailyW_logit, heavyW_logit,
          type="html",
          dep.var.labels=c("Daily Water","Heavy Water"),
          covariate.labels=c("Intercept","Moderate Income","High
Income","Gender",
                             "Education(Some College or more)","Daily
Water","Age","BMI","Native American"),
          out="star_linear_water.doc",
          intercept.bottom = F,
          intercept.top = T,
          digits=2)

models <- list(dailyW_logit, heavyW_logit)
stargazer2(models,
           type="html",
           dep.var.labels=c("Daily Water","Heavy Water","Heavy SSB"),
           covariate.labels=c("Intercept","Moderate Income","High
Income","Gender",
                              "Education(Some College or more)","Daily
SSB","Age","BMI","Native American"),
           out="star_linear_waterOR.doc",
           intercept.bottom = F,
           intercept.top = T,
           odd.ratio = T,
           digits=2)
```

```
dailySSB_data <-
data.frame(sdata$dailySSB,sdata$female,sdata$dailyW,sdata$SEX,sdata$adj
inc,sdata$Ced,sdata$SAGE,sdata$BMI,sdata$native)
SSB_data$sdata.SEX <- factor(SSB_data$sdata.SEX)
SSB_data$sdata.adjinc <- factor(SSB_data$sdata.adjinc)
SSB_data$BMI_index <- factor(SSB_data$BMI_index)
SSB_data$ageCat <- factor(SSB_data$ageCat)
SSB_logit <- glm(sdata.dailySSB ~ sdata.adjinc - 1 + sdata.SEX +
sdata.Ced + sdata.dailyW + ageCat + sdata.Obese + sdata.native, data =
SSB_data, family = binomial("logit"))
summary(SSB_logit)
```