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Excess Sugar Consumption among Adults with Type 2 Diabetes in the US, 2021-2023: Behavioral and Demographic Correlates

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ABSTRACT

Nearly 1 in 6 adults in the US were diagnosed with type 2 diabetes mellitus (T2DM) between 2021 and 2023. Excess sugar consumption among diabetics adversely affects numerous metabolic pathways and processes. The US Centers for Disease Control and Prevention (CDC) recommends ≤10% of daily calories come from sugar. In this study, I sought to estimate the average proportion of daily calories consumed from sugar among US adult diabetics. I hypothesized that the risk of excess sugar consumption would be higher for [1] adult diabetics with lower income-to-poverty ratios compared to those with higher income-to-poverty ratios [2] adult diabetes with worse oral health compared to those with better oral health, and [3] adult diabetics with depression compared to those without. I utilized nationally representative data from the 2021-2023 National Health and Nutrition Examination Survey collected by CDC. I fit a weighted linear regression model to identify socio-demographic and health-related correlates of the proportion of daily calories consumed from sugar. I found that, overall, the proportion equaled 18.2% (95% confidence interval [CI]: 17.2% to 19.2%). Compared to adult diabetics who reported not feeling down, depressed, or hopeless nearly every day over the past two weeks, those who felt so nearly every day consumed an average of 8.3 percentage points more calories from sugar (95% CI: 0.7 to 15.8 percentage points). With greater patient education on nutrition, mental health support, and cardiovascular health initiatives, adult diabetics may be able to reduce sugar consumption to recommended levels.

INTRODUCTION

Between 2021 and 2023, the prevalence of type 2 diabetes mellitus (T2DM) equaled 15.8% among adults.[1] T2DM occurs when glucose (i.e., blood sugar) is too high.[2] Insulin, a hormone produced by the pancreas, facilitates entry of glucose into muscular, skeletal, and adipose cells through activation of the glucose transporter 4 (GLUT4) protein.[3] With T2DM, insulin does not keep blood sugar within the normal range of approximately 72 to 108 mg/dL.[4] T2DM increases the risk of obesity, dyslipidemia,[5] hypertension, chronic inflammation, depression, cancer, heart disease,[6] and vascular disease. T2DM also increases the risk of death from all causes, cancer, and vascular disease.[7]

Type 2 diabetics can develop cancer, as the kidney, liver, and pancreas deteriorate. Finally, the vascular system can deteriorate due to hardening and narrowing of the arteries through high blood sugar. The negative consequences of T2DM result in financial, mental, and physical disruptions. In 2022, Parker et al. estimated T2DM resulted in 307 billion dollars in direct medical costs and 106 billion dollars indirect medical cost.[8]

Excess sugar consumption affects numerous metabolic pathways and processes and, in doing so, directly damages organs. First, excess sugar limits the uptake of insulin in the pathways linked to cell growth and the kidney. This reduced uptake of insulin causes damage to kidney tissue and can lead to kidney failure.[9] Secondly, excess sugar causes dyslipidemia. Dyslipidemia can increase the risk of heart diseases and heart failure due to lack of sufficient blood.[9] Thirdly, the breakdown of fat (i.e., lipolysis) increases without sufficient insulin.[10] This results in fat usage for energy, compared to glucose, and can lead to the breakdown of muscles.[9]

Excess sugar commonly comes from nutrient-dense processed foods including fast food, candy, packaged snacks, and sugar-sweetened beverages. Highly processed foods often contain significant amounts of excess sugar and fats.[11] The American Medical Association (AMA), American Diabetic Association (ADA), and the Centers for Disease Control and Prevention (CDC) and the US Dietary Guidelines for Americans (DGA) each recommend that no more than 10% of daily calories come from sugar.[12,13] Lee et al. found 30% of adults aged 20 years and older consumed ≥15% of daily calories from sugar (i.e., 1.5 times the DGA) based on 2015-2018 National Health and Nutrition Examination Survey (NHANES) data.[13] According to Louie et al. the threshold for other countries including Canada, Australia, and Nordic countries was less than 10% of total energy intake.[14] Langlois & Garriguet found 17% of adult diabetics consumed 17% of daily calories from sugar compared to 20% in adult non-diabetics in 2004.[15] Additionally, a substantial proportion of diabetes remains undiagnosed. Harding et al. found the proportion of undiagnosed diabetes equaled 4.5% in the US population based on 2021-2023 NHANES data.[16]

Despite the dietary guidelines, we do not know the proportion of diabetics in the US who exceed the recommended daily sugar intake. We also do not know which socio-demographic, psycho-social, and health-related characteristics are associated with excess sugar consumption among diabetics.

I utilized nationally representative data from the 2021-2023 NHANES collected by the CDC. I focus on laboratory-verified diabetes as measured by HA1C to account for the nearly 5% of adults with undiagnosed diabetes. I account for a wide range of socio-demographic, psycho-social, and health-related characteristics to identify risk factors for excess sugar intake among diabetics. I hypothesized that the risk of excess sugar consumption would be higher for [1] adult diabetics with lower income-to-poverty ratios compared to those with higher income-to-poverty ratios [2] adult diabetes with worse oral health compared to those with better oral health, and [3] adult diabetics with depression compared to those without.

METHODS

Data: I utilized the 2021-2023 NHANES data collected by the CDC. NHANES began collecting nationally representative data of the non-institutionalized civilian population in 1959[17]. For the August 2021-August 2023 cycle, 11,933 participants were interviewed and 8,860 of these participants were also examined. The NHANES employs a four-stage sample design: primary sampling units, segments, dwelling units, and people[18].

All NHANES participants were eligible for two 24-hour dietary recall interviews (midnight to midnight). The first dietary recall interview was usually collected in person and the second interview was usually collected by telephone approximately one week later. The NHANES dietary interview collects detailed information on all foods and beverages consumed in the 24 hours prior to the interview, in order to estimate energy, nutrient, and food component intake. After the recall, participants also answered questions about usual intake.

Our outcome was daily calories consumed from sugar. For each dietary recall interview, I converted the number of grams of sugar to equivalent kilocalories by multiplying the former by 4. I then calculated the ratio of kilocalories consumed by sugar to total calories consumed. Finally, I set the outcome as the maximum ratio between the two dietary recall interviews: the initial in-person and subsequent telephone-based. For example, suppose a respondent consumed 5% of daily calories from sugar on the first dietary recall interview and 7% of daily calories from sugar on the second dietary recall interview. I assigned the higher of the two proportions (i.e., 7% in this case) as the outcome.

Socio-demographic characteristics included: age (18-39, 40-64, and ≥65 years old), sex (female, male), race/ethnicity (Hispanic, non-Hispanic Asian, non-Hispanic Black, non-Hispanic Other, and non-Hispanic White), educational attainment (less than high school graduate, high school graduate or equivalent, at least some college), health insurance coverage (no, yes), income-to-poverty ratio (<100%, 101-199%, 200-299%, ≥300% of the federal poverty level [FPL]). Health-related characteristics included body mass index (BMI) (underweight, normal weight, overweight, obese), self-rated health (poor, fair, good, very good, excellent), general oral health (poor, fair, good, very good, excellent), depression in the past 30 days (not at all, several days, more than half the days, and nearly every day), smoking status (never, former, current), alcohol consumption in the past year (never, every day or nearly every day, once a week to three to four times a week, once a month to two to three times a month, and less than a one time per month), systolic blood pressure (high, elevated, and normal), diastolic blood pressure (high and normal), pulse (low, normal, high), met leisure time physical activity recommendation (no and yes), hearing loss (a lot of trouble hearing, a little trouble hearing, moderate hearing trouble, good, excellent), ever told had diabetes (no and yes), and routine place of healthcare (no and yes).

Health insurance coverage was based on the survey question “Are you covered by health insurance or some other kind of health care plan?” Depression was based on the survey question “Over the last 2

weeks, how often have you been bothered by the following problems: feeling down, depressed, or hopeless". Meeting leisure time physical activity recommendation was based on the survey question "The next questions are about physical activities such as exercise, sports, or physically active hobbies that you may do in your leisure time. I am interested in two types of physical activity: moderate and vigorous-intensity. Moderate-intensity activities cause moderate increases in breathing or heart rate whereas vigorous-intensity activities cause large increases in breathing or heart rate. How often do you do moderate-intensity leisure-time physical activities?". Routine place of healthcare was based on the survey question "Is there a place that you usually go when you are sick or you need advice about your health?".

Statistical Analyses. First, I calculated the distribution of sample characteristics. Second, I calculated Cramer's V statistics to assess the strength of association among the categorical variables included in the analysis. Third, to characterize the strength of association between each categorical covariate and the proportion of daily calories consumed from sugar, I computed the weighted mean proportion for each level of a specific covariate. For each covariate, I then calculated the maximum absolute deviation of these level-specific means from the overall weighted mean proportion. Fourth, I estimated the weighted mean proportion of daily calories consumed from sugar for the overall adult T2DM population and by each characteristic. Fifth, I fit a weighted linear regression; the outcome was the proportion of daily calories consumed from sugar. Covariates included the aforementioned socio-demographic characteristics and health-related characteristics. The type I error rate was set at $\alpha=0.05$. I utilized R for all statistical analyses including the *tidyverse, survey, svyr, scales, haven, gtsummary*, and *gt* packages.[19]

RESULTS

Characteristics of Sample. Our sample consisted of 564 adults aged 18 years and older with HA1c ≥6.0 in 2021-2023. The sample was split approximately evenly across gender: 48% female and 52% male. By race, the sample was 21% Hispanic, 2.5% Non-Hispanic Asian, 16% Non-Hispanic Black, 8.2% Non-Hispanic other, and 53% Non-Hispanic White. More than half of respondents completed at least some college (53%), 25% were high school graduates, and 22% did not graduate from high school. Seven percent of respondents were uninsured. Nearly one in five respondents had an income-to-poverty ratio of <100% (17%), 29% had a ratio of 100-199%, 18% had a ratio of 200-299%, and 36% had a ratio of ≥300%. Nearly one in four respondents were overweight (24%) and 66% were obese. Regarding self-rated health, 8.5% reported poor, 32% reported fair, 43% reported good, 15% reported very good, and 1.8% reported excellent. Six percent of respondents reported feeling down, depressed, or hopeless over the past two weeks more than half the days and another 5.6% reported feeling so nearly every day. Thirty-five percent of respondents were former smokers and 17% were current smokers. Thirty-eight percent of respondents met the leisure time physical activity recommendation. Nearly four in ten respondents reported high systolic blood pressure (41%) and nearly three in ten respondents reported high diastolic blood pressure (29%).

Cramer's V statistics were computed to assess the strength of association among all categorical covariates included in the analysis (Appendix Figure 1). Most pairwise associations were weak (i.e., <0.2), which suggests that the covariates captured largely distinct dimensions of demographic, health, and behavioral characteristics. Some of the associations were moderate (e.g., income-to-poverty ratio and educational attainment), likely reflecting the relationship between these two covariates socially.

Daily Caloric Intake from Sugar Among Adult Diabetics by Characteristic. The proportion of daily calories consumed from sugar among all adult diabetics equaled 18.2% (95% confidence interval [CI]: 17.2% to 19.2%; Table 2). By age, the proportion equaled 18.0% among 18-39-year-olds (95% CI: 11.7% to 24.2%), 18.1% among 40-64-year-olds (95% CI: 16.7% to 19.4%), and 18.4% among ≥65-year-olds (95% CI: 17.3% to 19.6%). The proportion was 19.4% for females (95% CI: 18.1% to 20.7%) and 17.3% for males (95% CI: 15.9% to 18.7%). By race/ethnicity, the proportions were 18.9% for Hispanics (95% CI: 16.4% to 21.5%), 20.3% for non-Hispanic Blacks (95% CI: 17.3% to 23.2%), and 17.6% for non-Hispanic Whites (95% CI: 16.4% to 18.8%). The proportion equaled 20.4% for those whose total income was <100% of FPL (95% CI: 16.9% to 23.9%), 18.9% for those whose total income was between 100%-199% of FPL (95% CI: 16.7% to 21.0%), 18.7% for those whose total income was between 200-299% of FPL (95% CI: 16.1% to 21.3%), and 17.0% for those whose total income was ≥300% of FPL (95% CI: 15.7% to 18.4%). By educational attainment, the proportions were 20.2% for those with less than a high school diploma (95% CI: 17.1% to 23.3%), 17.8% for those who graduated from high school (95% CI: 16.1% to 19.5%), and 17.8% for those with at least some college (95% CI: 16.6% to 19.1%).

By BMI category, the proportion equaled 18.1% for those who were underweight (95% CI: 15.9% to 20.3%), 15.7% for those who were normal weight (95% CI: 12.7% to 18.8%), 17.9% who were overweight (95% CI: 15.9% to 20.0%), and 18.8% for those who were obese (95% CI: 17.6% to 20.0%). By self-reported health, the proportion equaled 19.3% for those reporting their health as poor (95% CI: 16.7% to 21.8%), 17.8% for those reporting their health as fair (95% CI: 16.0% to 19.7%), 17.5% for those reporting their health as good (95% CI: 15.9% to 19.1%), 18.9% for those reporting their health as very good (95% CI: 16.4% to 21.3%), and 13.4% for those reporting their health as excellent (95% CI: 10.9% to 15.9%). By frequency of depressive symptoms over the past two weeks, the proportion equaled 17.5% for those reporting feeling depressed not at all (95% CI: 16.3% to 18.7%), 19.3% for those reporting feeling depressed on several days (95% CI: 16.7% to 21.9%), 19.2% for those reporting feeling depressed on more than half the days (95% CI: 15.1% to 23.4%), and 23.0% for those reporting feeling depressed nearly every day (95% CI: 18.0% to 28.0%). The proportion equaled 18.4% for those who did not meet the leisure time physical activity recommendation (95% CI: 17.2% to 19.7%) and 17.8% for those who did meet this recommendation (95% CI: 15.8% to 19.7%).

The strongest associations with the proportion were observed for hearing loss, BMI category, race/ethnicity, general health, and frequency of depressive symptoms (Appendix Figure 2). The

associations with the proportion were weaker for demographic and access-related variables such as educational attainment.

Regression Results. The percentage of daily calories consumed from sugar among diabetics did not vary significantly across age groups (Table 3). Likewise, the percentage did not vary significantly by sex, race/ethnicity, educational attainment, health insurance status, poverty status, BMI, general oral health, smoking status, if consumed alcoholic beverages in the past 12 months, systolic blood pressure, pulse, and meeting leisure time physical activity recommendation.

In contrast, compared to adult diabetics who reported not feeling down, depressed, or hopeless nearly every day over the past two weeks, those who felt so nearly every day consumed an average of 8.3 percentage points more calories from sugar (95% CI: 0.7 to 15.8 percentage points). In contrast, compared to adult diabetics who had normal diastolic blood pressure, those who had high diastolic blood pressure consumed an average of 3.9 percentage points more calories from sugar (95% CI: 1.0 to 6.8 percentage points). Finally, compared to adult diabetics with normal pulse, those who had high pulse consumed an average of 12.0 percentage points more calories from sugar (95% CI: 0.7 to 23.3 percentage points).

DISCUSSION

In this nationally representative study, I reached three central findings. First, adult diabetics consumed, on average, 18% of daily calories from sugar, which was substantially higher than the 10% recommended by the CD[20]. Second, adult diabetics who reported feeling down, depressed, or hopeless nearly every day over the past two weeks consumed significantly more daily calories from sugar compared to those who did not. Third, adult diabetics with high diastolic blood pressure and high pulse also consumed significantly more daily calories from sugar compared to those who did not.

Our study aligns with the findings of an extensive literature on the association between diabetes and mental health. The prevalence of depression is nearly two times higher among type 2 diabetics than their non-diabetic counterparts.[21] Numerous longitudinal studies have found depression to be a risk factor for incident diabetes.[22] For example, in a 10-year longitudinal study of over 200,000 Korean adults, higher levels of insulin resistance were associated with increased risk of incident depression.[23] Utilizing 2005-2020 NHANES data, Zheng et al. found higher depression severity was associated with increased risk of incident diabetes.[24] Utilizing 2011-2019 Behavior Risk Factor Surveillance System data, Koyama et al. found the prevalence of depression was 29% among adults with diabetes compared to 18% among adults without diabetes.[25] Incorporating mental health services within diabetic care (e.g., collaborative care models) likely leads to improved mental health and improved diabetic care.[26]

Adults with high diastolic blood pressure and high pulse also consumed significantly more calories from sugar. Tsimihodimos et al. tested 2280 men and women in the Mexico City Diabetes Study and found that T2DM at baseline was a significant predictor of incident hypertension.[27] Similarly, hypertension at

baseline was a significant predictor of incident T2DM.[27] Numerous additional studies have found high pulse as a determinant for T2DM.[28–30] In a cohort study of 73,357 adults, Wang et al. found adults with higher resting heart rates were at increased risk of developing impaired fasting glucose.[31] Coopmans et al. also found that prediabetes and T2DM were associated with low heart rate variability, which is an indicator of cardiac autonomic dysfunction.[32]

Our results directly inform several public health policies to improve the nutrition of adult diabetics. First, employers and health insurance providers could offer subsidized or free nutritional classes or cover access to dieticians.[33] Second, municipalities could extend the federal mandate on calorie labeling at restaurants with fewer than 20 locations in multiple languages.[34,35] Third, the US could adopt a taxation of sugar sweetened beverages. Allais et al. found that when a tax on sugar sweetened beverages was instituted, average sugar content decreased between 7% and 31% in the UK, 6% in France, and 8% in the Netherlands.[36] Such taxation strategies could also reduce the sugar content in the US and generate revenue for nutritional programs.

I note several strengths of our study. First, it utilizes nationally representative data. NHANES directly measures blood pressure and pulse, utilizes laboratory-confirmed HA1C, and accurately reports on nutrition and food consumption.[37] Such measures, if based on self-report, could be subject to recall bias. Our study is subject to several limitations as well. NHANES does rely on self-report of socio-demographic characteristics including age and employment status, which could be subject to recall bias.

In conclusion, our nationally representative study found several potentially modifiable risk factors for excess sugar consumption among adult diabetics in the US including depression. Future longitudinal-based studies could assess the efficacy of behavioral and nutritional interventions on sugar consumption. With greater patient education on nutrition, mental health support, and cardiovascular health initiatives, adult diabetics may be able to reduce sugar consumption to recommended levels.

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APPENDIX

Table 1. Characteristics of Sample

Characteristic	**N = 564**[1]
Age	
18-39	28 (5.0%)
40-64	267 (47%)
65+	269 (48%)
Sex	
Female	270 (48%)
Male	294 (52%)
Race/Ethnicity	
Hispanic	117 (21%)
Non-Hispanic Asian	14 (2.5%)
Non-Hispanic Black	89 (16%)
Non-Hispanic Other	46 (8.2%)
Non-Hispanic White	298 (53%)
Education	
Less Than High School Graduate	124 (22%)

High School Graduate or Equivalent	142 (25%)
At Least Some College	298 (53%)
Insured	527 (93%)
Income to Poverty Ratio	
Less than 100%	85 (17%)
101% - 199%	142 (29%)
200% - 299%	91 (18%)
Greater than 300%	180 (36%)
Unknown	66
BMI	
Underweight	2 (0.4%)
Normal weight	57 (10%)
Overweight	131 (24%)
Obese	367 (66%)
Unknown	7
General Health	
Poor	48 (8.5%)
Fair	181 (32%)
Good	240 (43%)
Very good	85 (15%)
Excellent	10 (1.8%)

General Oral Health	
Poor	118 (21%)
Fair	136 (24%)
Good	173 (31%)
Very good	95 (17%)
Excellent	38 (6.8%)
Unknown	4
Feeling Down, Depressed, Hopeless, Past Two Weeks	
Not at all	328 (66%)
Several days	114 (23%)
More than half the days	30 (6.0%)
Nearly every day	28 (5.6%)
Unknown	64
Smoking Status	
Current	97 (17%)
Former	198 (35%)
Never	268 (48%)
Unknown	1
Past Twelve Months How Often Drink Alcoholic Beverage	
Never in the last year	131 (30%)
Less than one time per month	139 (32%)

Once a month to two/three times a month	74 (17%)
Once a week to three/four times a week	70 (16%)
Everyday or nearly everyday	21 (4.8%)
Unknown	129
Systolic Blood Pressure	
Normal	192 (36%)
Elevated	128 (24%)
High	220 (41%)
Unknown	24
Diastolic Blood Pressure	
Normal	389 (71%)
High	162 (29%)
Unknown	13
Pulse	
Low	50 (9.1%)
Normal	481 (87%)
High	20 (3.6%)
Unknown	13
Met Leisure Time Physical Activity Recommendation	189 (38%)
Unknown	65
Hearing Loss	

Deaf	2 (0.4%)
A lot of trouble	35 (6.2%)
Moderate hearing trouble	68 (12%)
A little trouble	125 (22%)
Good	210 (37%)
Excellent	124 (22%)
Ever told diabetes	
No	83 (15%)
Borderline	28 (5.0%)
Yes	453 (80%)
Routine Place Healthcare	539 (96%)

[1] n (%)

Table 2. Daily Caloric Intake from Sugar Among Adult Diabetics by Characteristic

Group	Mean	Lower 95% CI	Upper 95% CI
Overall			
	18.2%	17.2%	19.2%
Age			
18-39	18.0%	11.7%	24.2%
40-64	18.1%	16.7%	19.4%
65+	18.4%	17.3%	19.6%
Sex			
Female	19.4%	18.1%	20.7%
Male	17.3%	15.9%	18.7%
Race/Ethnicity			
Hispanic	18.9%	16.4%	21.5%
Non-Hispanic Asian	13.1%	8.6%	17.7%
Non-Hispanic Black	20.3%	17.3%	23.2%
Non-Hispanic Other	18.0%	14.7%	21.4%
Non-Hispanic White	17.6%	16.4%	18.8%
Income to Poverty Ratio			
Less than 100%	20.4%	16.9%	23.9%

101% - 199%	18.9%	16.7%	21.0%
200% - 299%	18.7%	16.1%	21.3%
Greater than 300%	17.0%	15.7%	18.4%
Educational Attainment			
Less Than High School Graduate	20.2%	17.1%	23.3%
High School Graduate or Equivalent	17.8%	16.1%	19.5%
At Least Some College	17.8%	16.6%	19.1%
Insured			
No	18.4%	12.4%	24.4%
Yes	18.2%	17.2%	19.2%
BMI			
Underweight	18.1%	15.9%	20.3%
Normal weight	15.7%	12.7%	18.8%
Overweight	17.9%	15.9%	20.0%
Obese	18.8%	17.6%	20.0%
General Health			
Poor	19.2%	15.5%	22.8%
Fair	19.1%	17.5%	20.7%
Good	17.5%	15.9%	19.1%
Very good	18.9%	16.4%	21.3%

Excellent	13.4%	10.9%	15.9%
General Oral Health			
Poor	19.3%	16.7%	21.8%
Fair	17.8%	16.0%	19.7%
Good	17.9%	16.0%	19.7%
Very good	17.8%	15.7%	20.0%
Excellent	19.2%	17.0%	21.3%
Depression			
Not at all	17.5%	16.3%	18.7%
Several days	19.3%	16.7%	21.9%
More than half the days	19.2%	15.1%	23.4%
Nearly every day	23.0%	18.0%	28.0%
Smoking Status			
Current	17.0%	14.4%	19.5%
Former	18.5%	16.5%	20.4%
Never	18.4%	17.2%	19.7%
Consumption of Alcoholic Beverages in the Past 12 Months			
Never in the last year	19.8%	17.9%	21.6%
Less than one time per month	18.4%	16.7%	20.1%
Once a month to two/three times a month	18.0%	15.4%	20.5%

Once a week to three/four times a week	15.5%	12.8%	18.3%
Everyday or nearly everyday	21.4%	12.3%	30.6%
Systolic Blood Pressure			
Normal	17.5%	16.1%	18.9%
Elevated	17.9%	15.9%	19.9%
High	19.2%	17.3%	21.1%
Diastolic Blood Pressure			
Normal	17.1%	16.0%	18.1%
High	20.7%	18.5%	22.9%
Pulse			
Low	19.0%	16.1%	21.9%
Normal	18.0%	17.0%	19.0%
High	21.1%	10.1%	32.1%
Met Leisure Time Physical Activity Recommendation			
No	18.4%	17.2%	19.7%
Yes	17.8%	15.8%	19.7%
Hearing Loss			
Deaf	9.1%	7.1%	11.0%
A lot of trouble	17.4%	13.6%	21.3%
Moderate hearing trouble	17.9%	15.9%	19.9%

A little trouble	17.0%	15.0%	19.0%
Good	18.6%	17.1%	20.0%
Excellent	19.3%	16.5%	22.1%
Ever Told Diabetes			
No	20.0%	17.7%	22.2%
Borderline	21.6%	18.5%	24.6%
Yes	17.7%	16.6%	18.8%
No Routine Place of Healthcare			
No	16.9%	13.3%	20.5%
Yes	18.3%	17.2%	19.3%

Table 3. Regression Results

Characteristic	Beta	95% CI	p-value
Age			
40-64	—	—	
18-39	0.371	-5.285, 6.026	0.897
65+	-0.072	-2.553, 2.408	0.954
Sex			
Female	—	—	
Male	-0.688	-2.949, 1.573	0.550
Race/Ethnicity			
Non-Hispanic White	—	—	
Hispanic	0.153	-3.162, 3.469	0.928
Non-Hispanic Asian	3.453	-5.272, 12.178	0.437
Non-Hispanic Black	3.738	-0.749, 8.225	0.102
Non-Hispanic Other	-2.635	-6.199, 0.928	0.147
Education			
High School Graduate or Equivalent	—	—	
Less Than High School Graduate	-0.887	-4.521, 2.746	0.631
At Least Some College	-1.245	-3.769, 1.279	0.333
Insured			
Yes	—	—	
No	0.897	-3.906, 5.700	0.714

Income to Poverty Ratio			
200% - 299%	—	—	
Less than 100%	2.172	-2.700, 7.045	0.381
101% - 199%	0.916	-2.765, 4.597	0.625
Greater than 300%	-0.611	-4.003, 2.782	0.723
BMI			
Normal weight	—	—	
Overweight	0.402	-3.462, 4.267	0.838
Obese	2.739	-0.917, 6.396	0.141
General Oral Health			
Good	—	—	
Poor	1.233	-2.169, 4.636	0.476
Fair	1.215	-1.954, 4.385	0.451
Very good	1.915	-1.230, 5.059	0.232
Excellent	3.742	0.555, 6.928	0.022
Feeling Down, Depressed, Hopeless, Past Two Weeks			
Not at all	—	—	
Several days	0.946	-1.790, 3.683	0.497
More than half the days	2.169	-2.496, 6.835	0.361
Nearly every day	8.256	0.690, 15.822	0.033
Smoking Status			

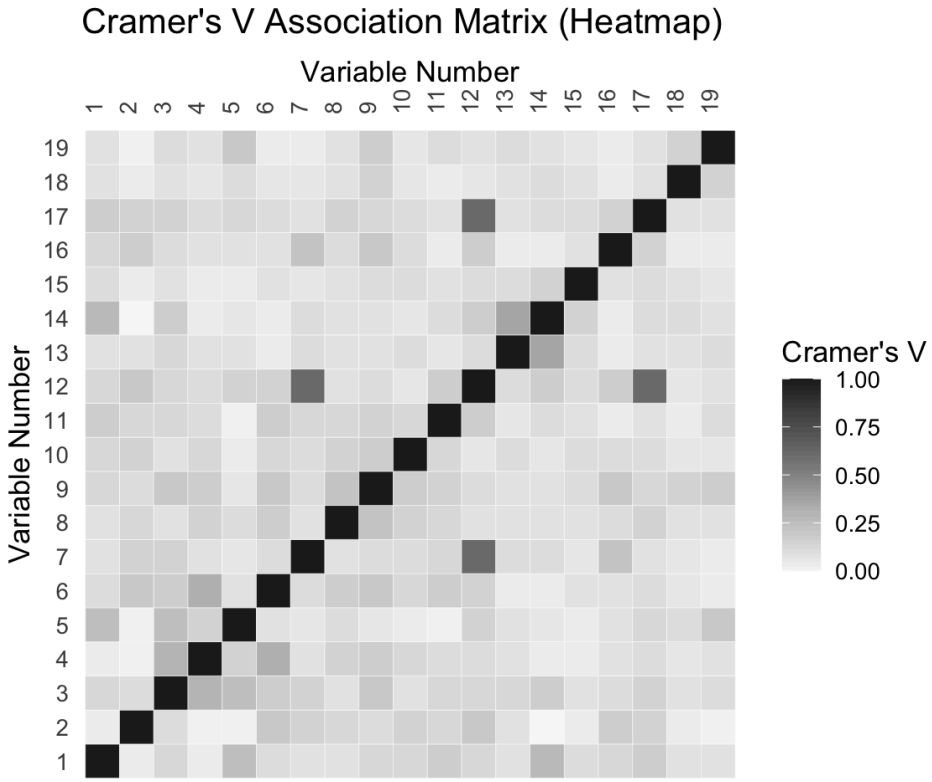
Never	—	—	
Current	-1.520	-5.023, 1.982	0.394
Former	0.815	-1.977, 3.607	0.566
Past Twelve Months How Often Drink Alcoholic Beverage			
Never in the last year	—	—	
Less than one time per month	-2.482	-5.386, 0.422	0.094
Once a month to two/three times a month	-2.479	-5.947, 0.989	0.161
Once a week to three/four times a week	-2.585	-6.591, 1.420	0.205
Everyday or nearly everyday	0.923	-5.087, 6.933	0.763
Systolic Blood Pressure			
Normal	—	—	
Elevated	0.622	-2.390, 3.634	0.685
High	0.195	-2.481, 2.872	0.886
Diastolic Blood Pressure			
Normal	—	—	
High	3.884	1.016, 6.751	0.008
Pulse			
Normal	—	—	
Low	1.899	-1.113, 4.911	0.216
High	12.023	0.707, 23.339	0.037
Met Leisure Time Physical Activity Recommendation			

Yes	—	—	
No	-0.229	-2.608, 2.151	0.850

Abbreviation: CI = Confidence Interval

Appendix

Appendix Figure 1. Correlation Among Covariates



Variable Number	Variable Description	Variable Number	Variable Description
1	Age Group	10	Depression (PHQ-2)
2	Sex	11	Smoking Status

3	Race / Ethnicity	12	Alcohol Consumption
4	Education	13	Systolic BP
5	Insurance Status	14	Diastolic BP
6	Income-to-Poverty Ratio	15	Pulse Category
7	BMI Category	16	Meets LTPA Recommendation
8	Oral Health	17	Hearing Loss
9	General Health	18	Diagnosed Diabetes
		19	Routine Healthcare Access

Appendix Figure 2. Association Strength Between Covariates and Sugar Intake