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The Association of Nativity and Time in the United States on Added Sugar Consumption

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A B S T R A C T

Background: Diets high in added sugar are associated with adverse health conditions. Immigrants may have different added sugar intake than nonimmigrants, which may contribute to differential health outcomes.
Objectives: We examined *1*) the cross-sectional association between added sugar intake and nativity and time in the United States and *2*) prospective association between added sugar intake and all-cause mortality by nativity.
Methods: Cross-sectional analyses were based on 17,489 adults (≥18 y) from the NHANES (2011 to March 2020) and prospective analyses were based on 31,291 adults (≥18 y) from NHANES 2003–2018. Multivariable linear regression models were used to assess the association between added sugar intake as a percent of energy, nativity (US-born compared with non-US-born), and time in the United States (<5 years, 5 to <15 y, 15–30 y, ≥30 y), after adjusting for important confounders. Multivariable Cox regression models were conducted to examine the association between added sugar intake and mortality.
Results: After adjusting for sociodemographic factors and BMI, individuals not born in the United States had 3.29% lower (95% CI: –3.69, –2.90, $P < 0.001$) added sugar intake as a percent of energy compared with those born in the United States. These associations were consistent across all race/ethnicities. As time in the United States increased, added sugar intake increased significantly (P-trend < 0.001) among non-US-born individuals. Added sugar intake was not significantly associated with lower risk of all-cause mortality in non-US-born individuals or US-born individuals, after adjusting for confounders.
Conclusions: Added sugar intake differed by nativity and time in the United States, underscoring the need to consider place of birth and length of time when characterizing dietary intake.

Keywords: added sugar, nativity, mortality, time in the United States, US adults

Introduction

The Food and Drug Administration defines added sugars as sugars that are added during the processing of foods, foods packaged as sweeteners, sugars from syrups and honey, and sugars from concentrated fruit or vegetable juices [1]. Added sugars do not include naturally occurring sugars. The Dietary Guidelines for Americans recommends that <10% of calories per day should come from added sugar [2]. However, 60% of individuals living in America are consuming more than the recommended 10% mainly due to added sugars in sweetened beverage [2,3]. Diets high in added sugars have been associated with many adverse health outcomes, such as hypertension, type 2 diabetes, stroke, heart diseases, and deaths due to diabetes [4–8].

Evidence suggests that cardiovascular health might decline as time in the United States increases. Immigrants who had been in the country <10 years had better baseline cardiovascular health and lower incidence of cardiovascular events, indicating that non-US-born individuals had lower blood pressure, lower

Abbreviations: FPED, Food Patterns and Equivalents Database; MPED, My Pyramid Equivalents Database; NCHS, National Center for Health Statistics.

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cholesterol, lower fasting blood sugar, and a healthier BMI compared with US-born individuals and immigrants who had been in the country for over 10 years [9]. These results suggest that nativity and time in the United States may be important predictors of cardiovascular health. Previous studies examined the association between added sugar intake and race/ethnicity in the United States [6,10–12]. However, it is unclear if nativity and time in the United States may be predictors of added sugar intake, an important dietary factor associated with adverse cardiovascular health. Furthermore, no study has examined whether added sugar intake is prospectively associated with all-cause mortality in US adults by nativity.

To address these gaps, the objective of this study is to *1*) examine the cross-sectional association between added sugar intake and nativity and time in the United States, and *2*) assess whether a greater intake of added sugar is prospectively associated with a higher risk of all-cause mortality by nativity in a nationally representative sample of US adults.

Methods

Data and study population

Analyses were based on adults (≥18 y) in the National Health and Nutrition Examination Survey (NHANES) [13]. NHANES is a biennial cross-sectional survey designed to assess the health and nutritional status of adults and children. The survey combines in-person interviews and physical examinations. Participants completed 24-h recall, provided information on sociodemographic characteristics, health behaviors, medical history, and submitted biospecimens for laboratory analyses at the mobile examination center. Then, the second dietary recall was completed by phone 3–10 days later. NHANES was approved by the National Center for Health Statistics (NCHS) Research Ethics Review Board. All participants provided an informed consent. Details on the NHANES study protocol can be found elsewhere [14].

For the cross-sectional analyses, adults who completed two 24-h recalls from 1 of the 4 cycles of the NHANES 2011–2020 (2011–2012, 2013–2014, 2015–2016, and 2017 to March 2020 cycles) were eligible for analyses. To increase diversity of the study population, this study focused on the most recent 4 cycles, where non-Hispanic Asian participants were included. From 28,843 participants in the 4 cycles of the NHANES with nonmissing survey weights, participants with missing dietary recalls or missing total energy intake were excluded (n = 1617) and participants under 18 y were also excluded (n = 9728). Then, participants were excluded if they had missing nativity or time in the United States (n = 0). Our final analytic sample for the cross-sectional analyses was 17,489.

For the prospective analyses, adults who completed two 24-h recalls from 1 of the 8 cycles of the NHANES 2003–2018 (2003–2004, 2005–2006, 2007–2008, 2009–2010, and subsequent 4 cycles) were eligible for analyses. More cycles (2003–2018) were pooled to increase sample size and follow-up years. From 53,459 participants in the 8 cycles of the NHANES with nonmissing survey weights, participants with missing dietary recalls or missing total energy intake were excluded (n = 2849). We also excluded those under 18 y (n = 19,319). Our final analytic sample for the prospective analyses was 31,291.

Added sugar intake

A validated USDA Automated Multiple-Pass Method was administered by trained interviewers for two 24-h dietary recalls [15,16]. Participants reported details on all foods and beverages consumed in the past 24-h period. We used the individual food file data from the NHANES 24-h dietary recalls. To calculate added sugar intake, data from the Food Patterns and Equivalents Database (FPED) and My Pyramid Equivalents Database (MPED) were merged with the NHANES individual food file data by USDA equivalent food codes. The FPED and MPED disaggregate foods and beverages reported in the 24-h dietary recalls to many food components and provide the amount of added sugars in each food and beverages as teaspoon equivalents [17]. Added sugar in teaspoons was then converted to grams by using the conversion of 4 g per 1 teaspoon. Then, total added sugar intake per individual was calculated by taking the grams of an item consumed and multiplying by the amount of added sugar in the item. Added sugar intake from all food and beverage items was summed, and the percentage of energy intake from added sugar was calculated by dividing the total number of calories from added sugar by total number of calories consumed that day. The two days of 24-h dietary recalls were then averaged to find the mean intake of added sugar as a percentage of energy.

Nativity and time in the United States

Participants reported nativity and time in the United States at the mobile examination center. Country of birth had 2 categories, "born in 50 US states or Washington, DC" and "born in other countries, including US territories," which was how nativity was determined. Participants born outside of the United States were asked the month and year when they came to the United States to live, and the responses were used to calculate the length of time these participants lived in the United States. These responses had 4 categories: "<5 years in the United States," "5 to <15 years," "15 to <30 years," and "≥30 years in the United States." These categories were used to determine time in the United States.

Covariates

For the cross-sectional analyses, we adjusted for age, sex, total energy intake, income, education, and BMI. Participants self-reported sociodemographic characteristics (age, sex, income, and education). In our analyses, age was adjusted as a continuous variable. Sex was adjusted by two categories, which were men or women. Income was adjusted for as a categorical variable with three poverty to income ratios (<1.30, 1.30 to <3.50, and ≥3.50), which was calculated by considering the family income and the poverty level guidelines specific to each survey year [18,19]. Education was adjusted for as a categorical variable (<ninth grade, 9th–12th grade, high school graduate, some college or associate degree, and college graduate or above). For the cross-sectional analyses, race/ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and other race) was not adjusted as a covariate but was stratified because it was highly correlated with nativity, especially for Hispanic and non-Hispanic Asian participants. Participants' BMI (in kg/m^2) was calculated using measured weight (in kg) and height (in cm) and adjusted as a continuous variable.

For the prospective analyses, we adjusted for the same set of covariates, but included health behaviors (smoking, alcohol consumption). Smoking (mean number of cigarettes smoked per day during the past 30 d) and alcohol consumption (mean number of alcoholic drinks per day in the past 12 mo) were analyzed as continuous variables.

Mortality

All-cause mortality data came from NCHS public use linked mortality files. From these files, we obtained vital status. The NCHS used enhanced linkage algorithm to link NHANES participant records to the records in the National Death Index [20]. Participants were followed from the time of physical assessment at the mobile examination to death or censoring until December 31, 2018.

Statistical analysis

All analyses were conducted using R Studio version 4.2.1 and used survey weights, which considered the complex survey design of NHANES. For the cross-sectional analyses, characteristics of the study population were examined by nativity (US-born, non-US-born) using means (standard errors) for continuous variables and proportions for categorical variables. For the prospective analyses, characteristics of the study population were examined by high added sugar (defined as >10% of total energy intake from added sugar) compared with normal added sugar intake (≤10% of total energy intake from added sugar).

Then, in NHANES 2011 to March 2020, we calculated mean intake of added sugar for the overall study population (adults ≥18 y) and according to subgroups: nativity (US-born compared with non-US-born), time in the United States (<5 y, 5 to <15 y, 15 to <30 y, and ≥30 y), race/ethnicity (Hispanic, non-Hispanic White, non-Hispanic Black, and non-Hispanic Asian), and combined nativity and race/ethnicity (non-US-born Hispanic, US-born Hispanic, non-US-born non-Hispanic White, US-born non-Hispanic White, non-US-born non-Hispanic Black, US-born non-Hispanic Black, non-US-born non-Hispanic Asian, and US-born non-Hispanic Asian). Multivariable linear regression models were conducted to study if added sugar intake differed by nativity or time in the United States, using nativity or time in the United States as the independent variable, and added sugar as the response variable, after adjusting for the following confounders: Model 1 adjusted for age, sex, and total energy intake. Model 2 adjusted for covariates in model 1 and education and income. Model 3 adjusted for covariates in model 2 and BMI. We selected covariates based on a prior study [21].

Next, we studied the association between added sugar intake and all-cause mortality by nativity using multivariable Cox proportional hazard regression models. Model 1 adjusted for age, sex, and total energy intake. Model 2 adjusted for covariates in model 1 and education, income, smoking status, and alcohol consumption. Model 3 adjusted for covariates in model 2 and BMI. We performed the same multivariable Cox proportional hazard regression models in the overall study population and by race/ethnicity. In the overall study population, a Kaplan–Meier survival curve was used to show differences in the probability of survival between high sugar consumers (those consuming >10% of total energy intake from added sugar) and normal sugar consumers (those consuming ≤10% of total energy intake from added sugar).

For the association between added sugar intake and mortality, analysis stratified by race/ethnicity was limited to Hispanic, non-Hispanic White, and non-Hispanic Black because there was not a sufficient sample size of non-Hispanic Asian individuals (n = 1,877) since non-Hispanic Asian individuals were not included until the 2011–2012 cycle. For both the cross-sectional and prospective analyses, we considered results from model 3 to be the main results.

Results

Association between added sugar intake and nativity and time in the United States

Of the 17,489 participants in NHANES 2011 to March 2020, 86% of the participants were born in the United States and 14% of the participants were not born in the United States (Table 1). Compared with those born in the United States, those not born in the United States were more likely to be younger, Hispanic or non-Hispanic Asian, be a college graduate or above, and less likely to have higher income, or be obese. Those born in the United States had a higher mean percent of energy from added sugar (13.5%) compared with those not born in the United States (10.6%) (P < 0.001) (Figure 1). In unadjusted analyses, there was not a major difference in mean percentage of energy from added sugar and time in the United States among non-US-born individuals (P = 0.38) (Supplemental Figure 1). Non-Hispanic Black individuals had the highest mean percent of energy from added sugar (15.0%), followed by non-Hispanic White (13.1%), Hispanic (12.6%), and non-Hispanic Asian (8.7%) (P = 0.38) (Supplemental Figure 2). Within each race, the greatest difference in added sugar intake was observed between US-born Black (15.4%) and non-US-born Black individuals (10.9%, Table 2), followed by non-Hispanic Asian, non-Hispanic White, and Hispanic individuals (P value for all tests <0.05).

In multivariable regression models adjusting for age, sex, and total energy intake, those not born in the United States had a 2.71% (95% confidence interval (CI): –3.11, –2.32, P < 0.001) lower added sugar intake as a percentage of energy compared with those born in the United States (Table 3). This association was slightly strengthened when we additionally adjusted for education and income (–3.33, 95% CI: –3.73, –2.94, P <0 .001). The association did not change when BMI was additionally adjusted (–3.29, 95% CI: –3.69, –2.90, P <0.001).

After adjusting for sociodemographic characteristics, greater length of time in the United States was associated with higher added sugar intake (P-trend <0.001). Compared with those who lived in the United States <5 years, those who lived in the United States 5–<15 years, 15 to <30 years, and ≥30 years had 0.49% higher (95% CI: –0.29, 1.28) 1.27% higher (95% CI: 0.41, 2.12), and 2.83% higher (95% CI: 1.33, 4.32) intake of added sugar as a percent of energy, respectively. These associations did not change when BMI was additionally adjusted (P-trend <0.001).

Within each race, non-US-born individuals had 1.62%–4.48% lower added sugar intake as a percentage of energy compared with US-born individuals across all groups in model 2 (Table 4). Among non-Hispanic blacks, non-US-born individuals had 4.49% (95% CI: –5.58, –3.40, P < 0.001) lower added sugar intake as a percentage of energy compared with US-born individuals, after adjusting for BMI.

TABLE 1
Characteristics of participants in the National Health and Nutrition Examination Survey (NHANES) 2011–2020 ($N = 17,489$).

	Overall study population	US-born	Non-US-born	*P* value
N, Unweighted Sample size	17,489	12,744 (86.0%)	4745 (14.0%)	
Mean age (y)	47.0 (0.35)	47.5 (0.37)	44.5 (0.48)	<0.001
Sex, *n* (%)				
Women	9186 (51.1)	6671 (51.0)	2510 (51.7)	0.37
Men	8312 (48.9)	6073 (49.0)	2235 (48.3)	
Race/ethnicity, *n* (%)				
Hispanic	4074 (17.4)	1630 (12.3)	2444 (48.8)	<0.001
Non-Hispanic White	6801 (61.3)	6523 (68.8)	278 (15.0)	
Non-Hispanic Black	4070 (12.0)	3697 (13.0)	373 (6.4)	
Non-Hispanic Asian	1877 (5.3)	327 (1.8)	1550 (26.7)	
Other race, including multi-Racial	667 (4.0)	567 (4.1)	100 (3.1)	
Education, *n* (%)				
Less than ninth grade	1277 (16.7)	411 (16.4)	866 (18.5)	<0.001
9-12th grade	2283 (11.7)	1656 (11.5)	627 (12.9)	
High School graduate	4046 (19.2)	3233 (19.4)	813 (18.3)	
Some college or AA degree	5483 (26.6)	4501 (27.7)	982 (20.3)	
College graduate or above	4389 (25.6)	2938 (24.9)	1451 (29.9)	
Income (federal poverty to income ratio), *n* (%)				
<1.30	5142 (25.5)	3657 (24.0)	1484 (35.2)	0.02
1.30 to <3.50	6019 (35.6)	4493 (35.6)	1521 (35.9)	
≥3.50	4837 (38.8)	3650 (40.4)	1196 (28.8)	
Mean total energy intake, kcal	4194.2 (19.6)	4223 (21.1)	4048.9 (43.5)	0.89
Mean added sugar as a percent of energy	13.0 (0.15)	13.5 (0.17)	10.6 (0.18)	<0.001
Time in the United States, *n* (%)				
<5 years	486 (14.2)	NA[1]	486 (14.2)	NA
5- <15 years	1145 (28.8)	NA[1]	1145 (28.8)	
15- <30 years	1522 (31.3)	NA[1]	1522 (31.3)	
≥30 years	1428 (25.6)	NA[1]	1428 (25.6)	
Body mass index, *n* (%)				
<18.5	300 (12.0)	221 (13.3)	79 (4.2)	0.03
18.5 to <25.0	4707 (29.2)	3215 (28.5)	1492 (33.2)	
25.0 to <30.0	5450 (27.0)	3711 (25.8)	1739 (33.9)	
≥30.0	6852 (31.9)	5457 (32.4)	1395 (28.6)	

Abbreviation: AA, associate's degree.
[1] NA = Time in the United States data not collected for US-born participants. US-born was defined as born in the United States (within 50 states).

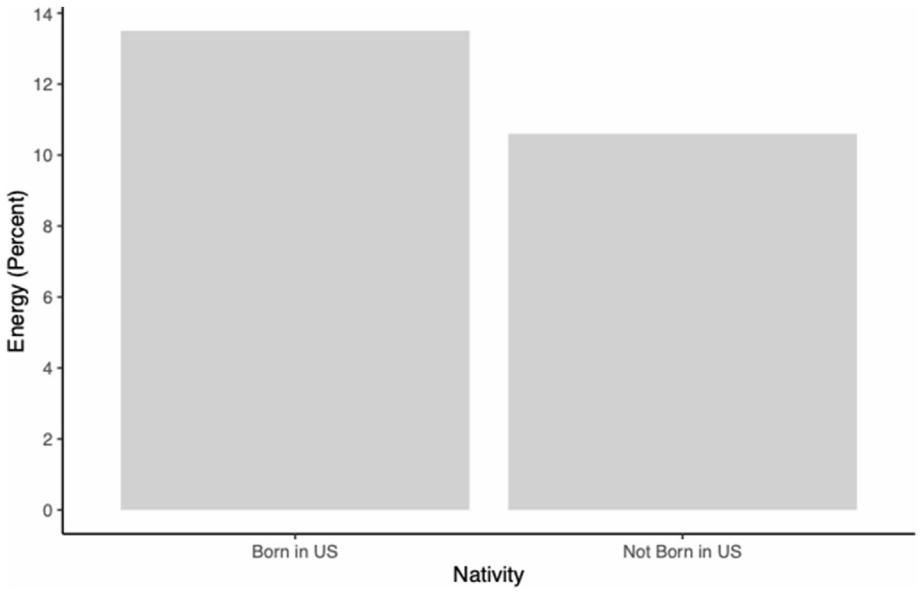

FIGURE 1. Mean percent of total energy intake from added sugar by nativity, National Health and Nutrition Examination Survey (NHANES) 2011–2020, Adults aged ≥18 y ($n = 17,489$). Nativity was defined as born in the United States (within 50 states) and not born in the United States. Added sugar intake mean (standard error, SE) 13.5% (0.17%) for those born in the United States and 10.6% (0.18%) for those not born in the United States. *P* value for difference <0.001.

TABLE 2
Mean percent of total energy intake from added sugar by nativity and race/ethnicity in National Health and Nutrition Examination Survey (NHANES) 2011–2020, in adults ≥18 y[1].

Mean (standard error)			
	Born in the United States	Not Born in the United States	*P* value
Hispanic	13.45 (0.35)	11.89 (0.20)	<0.001
Non-Hispanic White	13.15 (0.20)	10.89 (0.62)	0.001
Non-Hispanic Black	15.46 (0.21)	10.93 (0.49)	<0.001
Non-Hispanic Asian	11.26 (0.53)	8.13 (0.23)	<0.001

[1] Nativity was defined as born in the United States (within 50 states) and not born in the United States. No covariate was adjusted.

Association between added sugar intake and all-cause mortality

Of the 31,291 participants in NHANES 2011–2018, 61.5% were classified as high sugar consumers (defined as >10% of daily calories from added sugar) and 38.5% were classified as normal sugar consumers (defined as ≤10% of daily calories from added sugar) (Supplemental Table 1). Compared with normal sugar consumers, high sugar consumers were more likely to be younger, non-Hispanic Black, have lower education level, lower income, be underweight or normal weight, and have higher alcohol or cigarette consumption. Compared with US-born individuals, those not born in the United States had 12% lower risk of all-cause mortality per 1% higher intake of added sugar [hazard ratio (HR): 0.88, 95% CI: 0.80, 0.97], after adjusting for sociodemographic characteristics and health behaviors (Table 5). However, these results attenuated after adjusting for BMI (HR: 0.91, 95% CI: 0.80, 1.04).

In secondary analyses, in the overall study population, Kaplan–Meier survival curves showed that individuals with a

TABLE 5
Association between mean percent of total energy intake from added sugar (1% higher) and nativity and all-cause mortality in National Health and Nutrition Examination Survey (NHANES) 2011–2018, in adults ≥18 y (N = 17,498)[1].

Hazard ratios (95% confidence interval)				
	Born in the United States, *n* = 12,744	*P* value	Not born in the United States, *n* = 4745	*P* value
Model 1	1.03 (1.01, 1.04)	<0.001	0.98 (0.93, 1.02)	0.31
Model 2	1.00 (0.97, 1.04)	0.89	0.88 (0.80, 0.97)	0.01
Model 3	1.00 (0.97, 1.04)	0.89	0.91 (0.80, 1.04)	0.18

[1] Model 1 adjusted for age, sex, and total energy intake. Model 2 adjusted for covariates in model 1, and income, education, alcohol consumption, and smoking. Model 3 adjusted for covariates in model 2 and BMI. Nativity was defined as born in the United States (within 50 states) and not born in the United States.

TABLE 3
Association between mean percent of total energy intake from added sugar, nativity, and time in the United States in the National Health and Nutrition Examination Survey (NHANES) 2011–2020, in adults ≥18 y[1].

ß (95% confidence interval)			
	Model 1	Model 2	Model 3
Nativity (*n* = 17,489)			
US-born	1 (Ref)	1 (Ref)	1 (Ref)
Non-US-born	–2.71 (–3.11, –2.32)	–3.33 (–3.73, –2.94)	–3.29 (–3.69, –2.90)
P value	<0.001	<0.001	<0.001
Time in the United States (*n* = 4745)			
<5 years	1 (Ref)	1 (Ref)	1 (Ref)
5 to <15 years	0.82 (0.05, 1.60)	0.49 (–0.29, 1.28)	0.47 (–0.35, 1.29)
15 to <30 years	1.34 (0.52, 2.16)	1.27 (0.41, 2.12)	1.19 (0.34, 2.05)
≥30 years	2.15 (0.77, 3.52)	2.83 (1.33, 4.32)	2.67 (1.19, 4.18)
P-trend	<0.001	<0.001	<0.001

[1] Model 1 adjusted for age, sex, and total energy intake. Model 2 adjusted for covariates in model 1 and income and education. Model 3 adjusted for covariates in model 2 and BMI. US-born was defined as born in the United States (within 50 states). *P*-trend was calculated using time in the United States as an ordinal variable.

TABLE 4
Association between mean percent of total energy intake from added sugar intake and nativity in adults ≥18 y, stratified by race/ethnicity in National Health and Nutrition Examination Survey (NHANES) 2011–2020.[1]

	Hispanic		Non-Hispanic White		Non-Hispanic Black		Non-Hispanic Asian	
	Non-US-born vs US-born (ref)	*P* value	Non-US-born vs US-born (ref)	*P* value	Non-US-born vs US-born (ref)	*P* value	Non-US-born vs US-born (ref)	*P* value
Model 1	–1.18 (–1.99, –0.38)	0.004	–2.22 (–3.52, –0.92)	0.001	–4.35 (–5.42, –3.28)	<0.001	–2.67 (–3.81, –1.53)	<0.001
Model 2	–1.77 (–2.71, –0.38)	<0.001	–1.62 (–2.94, –0.31)	0.016	–4.48 (–5.59, –3.38)	<0.001	–2.56 (–3.76, –1.36)	<0.001
Model 3	–1.66 (–2.60, –0.72)	<0.001	–1.67 (–2.97, –0.35)	0.014	–4.49 (–5.58, –3.40)	<0.001	–2.57 (–3.76, –1.38)	<0.001

[1] Model 1 adjusted for age, sex, and total energy intake. Model 2 adjusted for covariates in model 1 and income and education. Model 3 adjusted for covariates in model 2 and BMI. Nativity was defined as born in the United States (within 50 states) and not born in the United States.

TABLE 6
Association between mean percent of total energy intake from added sugar (1% higher) and race/ethnicity and all-cause mortality in National Health and Nutrition Examination Survey (NHANES) 2011–2018, in adults ≥18 y (N = 14,954)[1].

Hazard ratios (95% confidence interval)						
	Hispanic, (n = 4081)	P value	Non-Hispanic White (n = 6802)	P value	Non-Hispanic Black (n = 4071)	P value
Model 1	1.01 (0.98, 1.04)	0.44	1.03 (1.02, 1.04)	<0.001	0.98 (0.97, 1.01)	0.17
Model 2	1.09 (0.99, 1.19)	0.07	1.00 (0.97, 1.04)	0.89	0.95 (0.89, 1.01)	0.11
Model 3	1.12 (1.03, 1.23)	0.01	1.00 (0.97, 1.04)	0.90	0.95 (0.89, 1.01)	0.12

[1] Model 1 adjusted for age, sex, and total energy intake. Model 2 adjusted for covariates in model 1, and income, education, alcohol consumption, and smoking. Model 3 adjusted for covariates in model 2 and BMI.

normal sugar consumption had a higher survival probability compared with individuals with a high sugar consumption (Supplemental Figure 3). In the overall study population, per 1% higher added sugar intake was associated with 2% higher risk of all-cause mortality (HR: 1.02, 95% CI: 1.01, 1.03, $P < 0.001$) (Supplemental Table 2). However, these associations were attenuated when income, education, alcohol consumption, and smoking status was adjusted [HR: 0.99, 95% CI: 0.97, 1.01, $P = 0.54$], and BMI was additionally adjusted [HR: 0.99, 95% CI: 0.98, 1.01, $P = 0.56$].

In race-stratified analyses, Hispanic individuals had a 9% (HR: 1.09, 95% CI: 0.99, 1.19) higher risk of all-cause mortality per 1% higher intake of added sugar, after adjusting for sociodemographic characteristics, and health behaviors (Table 6). These associations were strengthened when BMI was additionally adjusted (HR: 1.12, 95% CI: 1.03, 1.23). Associations were not statistically significant for non-Hispanic White or non-Hispanic Black.

Discussion

In this nationally representative sample of US adults, added sugar intake was lower among those not born in the United States compared with those born in the United States. These associations were consistent across all race/ethnicities. Greater length of time in the United States was associated with higher added sugar intake among those not born in the United States, after adjusting for sociodemographic characteristics. In prospective analyses, added sugar intake was not significantly associated with all-cause mortality in US-born or non-US-born individuals. However, added sugar intake was associated with higher risk of all-cause mortality in Hispanic individuals.

Our results were largely consistent with findings in prior studies. In previous studies that used NHANES and the National Health Interview Survey (NHIS), non-Hispanic Black individuals had the highest added sugar consumption, and Asian individuals had the lowest added sugar consumption [10–12]. Another NHANES study found that foreign-born non-Hispanic Black individuals had a better diet quality, as measured by the Alternative Healthy Eating Index-2010 and the Dietary Approaches to Stop Hypertension diet, compared with those born in the United States [22]. Similarly, in 599 women of Mexican-origin in Texas, US-born women had higher consumption of sugar-sweetened beverages than Mexico-born women. [23]. However, one study that used the 2010 National Health Interview Survey data reported that birthplace was not significantly associated with daily intake of sugar-sweetened beverages in Hispanic adults, but greater length of residence in the United States was associated with higher odds of daily sugar sweetened beverage intake in non-US-born Hispanic adults [24]. Food acculturation occurs after immigrants arrive to the United States, with those not born in the United States beginning to adopt the eating habits of Americans as time in the United States increases [25–27]. Our findings that added sugar intake was higher with greater length of time in the United States lend support to this hypothesis. Furthermore, this study extends results from prior studies by using relatively recent data.

In an earlier study that used data from NHANES III and 2005–2010 found a significantly higher risk of cardiovascular disease mortality with higher added sugar intake in Mexican Americans and non-Hispanic White individuals [6]. Our study provides updated estimates from this earlier study and showed that higher added sugar intake was associated with higher risk of all-cause mortality in Hispanics. In line with an earlier study, which found that those not born in the United States had a lower risk of having one cardiovascular disease risk factor compared with those born in the United States [28], we found that non-US-born adults had a lower risk of all-cause mortality with higher added sugar intake, after adjusting for sociodemographic characteristics and health behaviors. However, in this study, these associations were no longer significant after BMI was adjusted. Our results suggest that the association between added sugar intake and mortality among non-US-born adults is mediated by BMI, and place of birth is not a significant predictor of added sugar and mortality associations.

Lower added sugar intake in those not born in the United States can be explained by several reasons. We found that non-US-born individuals had higher education and healthier BMI than US-born individuals, suggesting that individuals not born in the United States may have distinctive cultures and food systems to encourage a healthier diet. Furthermore, it is possible that those not born in the United States have the same eating habits from their country after immigrating to the United States, continuing to share a similar diet to individuals within their own culture [29–31]. In our study, non-Hispanic Asian individuals had a lower added sugar intake in general, suggesting that they might have higher adherence to their traditional diets.

In our study, Hispanic individuals had a higher risk of mortality with higher added sugar intake. This could be because 17.7% of Hispanics are uninsured and, therefore, do not have access to healthcare and medications to treat health conditions that may result from higher added sugar intake [32]. Furthermore, previous studies have suggested that sugar-sweetened beverage consumption, the largest source of added sugar, was higher in Hispanic individuals than non-Hispanic Whites or non-Hispanic Asians [33–35]. In 2022, Hispanics were 60% more likely than

non-Hispanic White adults to be diagnosed with diabetes by a physician [36]. In 2020, Hispanics were 1.5 times more likely than non-Hispanic Whites to die from diabetes in 2020 [36], which supports our findings on the positive association between added sugar intake and mortality risk in Hispanic individuals. Additionally, in Hispanic adults, higher consumption of sugar-sweetened beverage was associated with prediabetes, higher fasting glucose, higher fasting insulin, hemoglobin A1c, and insulin resistance, which could contribute to shorter lifespan [37].

Our study has several strengths. We used nationally representative data with two d of 24-h dietary recalls. The NHANES had a rigorous quantification of added sugar in that FPED and MPED calculated amount of added sugar in a wide range of foods and beverages. Multiple cycles were used for cross-sectional and prospective analyses. NHANES 2011 to March 2020 data were used to analyze the association between nativity and added sugar consumption, and NHANES 2003–2018 was used to analyze the association between added sugar intake and mortality. Additionally, we adjusted for multiple important confounders.

Several limitations of this study are worth noting. Given the cross-sectional design, we could not infer causality between added sugar intake and nativity. We used nativity and time in the United States as a proxy for acculturation, but there may be other measures. In the future as more cycles are released, it may be helpful to include more NHANES cycles to increase the sample size of non-Hispanic Asians and follow-up years.

In conclusion, non-US-born individuals had a lower added sugar intake compared with US-born individuals. These findings were consistent across all race/ethnicities. Among non-US-born individuals, added sugar intake increased as time in the United States increased. Added sugar intake was not significantly associated with mortality in general, but greater intake of added sugar was associated with higher risk of all-cause mortality in Hispanic individuals. This study highlights the need to investigate differences in dietary intake after considering nativity and length of time in the United States, and to examine the factors that may contribute to such discrepancies.

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Author contributions

The authors' responsibilities were as follows – KG: conducted statistical analysis and drafted the manuscript; YS: contributed to interpretation of data and revised the manuscript critically; HK: was involved in all aspects of the study from study conception, study design, data analysis to writing of the manuscript; and all authors: read and approved the final manuscript.

Conflict of interest

HK reports financial support was provided by National Heart Lung and Blood Institute. All other authors report no conflicts of interest.

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Data availability

Data and codebook described in the manuscript are publicly available. Interested researchers can contact the corresponding author to request analytic code.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cdnut.2025.104563.

References

[1] Nutrition C for FS and A, Added sugars on the nutrition facts label, FDA [Internet], 2024 [cited August 13, 2024]. Available from: https://www.fda.gov/food/nutrition-facts-label/added-sugars-nutrition-facts-label.
[2] Home. Dietary Guidelines for Americans [Internet]. [cited August 13, 2024]. Available from: https://www.dietaryguidelines.gov/.
[3] CDC, Be smart about sugar. Healthy Weight and Growth. [Internet]. 2024 [cited August 13, 2024]. Available from: https://www.cdc.gov/healthy-weight-growth/be-sugar-smart/index.html.
[4] S. Janzi, S. Ramne, E. González-Padilla, L. Johnson, E. Sonestedt, Associations between added sugar intake and risk of four different cardiovascular diseases in a Swedish population-based prospective cohort study, Front. Nutr. Front. 7 (2020) 603653.
[5] S.M. Schaefer, A. Kaiser, G. Eichner, M. Fasshauer, Association of sugar intake from different sources with cardiovascular disease incidence in the prospective cohort of UK Biobank participants, Nutr. J. 23 (2024) 22.
[6] Q. Yang, Z. Zhang, E.W. Gregg, W.D. Flanders, R. Merritt, F.B. Hu, Added sugar intake and cardiovascular diseases mortality among US adults, JAMA Intern. Med. 174 (2014) 516–524.
[7] Diabetes. [Internet]. [cited August 13, 2024]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes.
[8] Vascular Heart, How does sugar affect your heart health? Scripps Health (2023) [cited August 13, 2024]. Available from: https://www.scripps.org/news_items/7679-how-does-sugar-affect-your-heart-health.
[9] F. Lê-Scherban, S.S. Albrecht, A. Bertoni, N. Kandula, N. Mehta, A.V. Diez Roux, Immigrant status and cardiovascular risk over time: results from the multi-ethnic study of atherosclerosis, Ann. Epidemiol. 26 (2016) 429–435.e1.
[10] L. DiFrancesco, V.L. Fulgoni, P.C. Gaine, M.O. Scott, L. Ricciuto, Trends in added sugars intake and sources among U.S. adults using the National Health and Nutrition Examination Survey (NHANES) 2001–2018, Front. Nutr. Front. 9 (2022) 897952.
[11] L. Ricciuto, V.L. Fulgoni, P.C. Gaine, M.O. Scott, L. DiFrancesco, Trends in added sugars intake and sources among US children, adolescents, and teens using NHANES 2001–2018, J. Nutr. 152 (2022) 568–578.
[12] F.E. Thompson, T.S. McNeel, E.C. Dowling, D. Midthune, M. Morrissette, C.A. Zeruto, Interrelationships of added sugars intake, socioeconomic status, and race/ethnicity in adults in the United States: national health interview survey, 2005, J. Am. Diet. Assoc. 109 (2009) 1376–1383.
[13] NHANES, About the National Health and Nutrition Examination Survey. [Internet]. 2024 [cited August 19, 2024]. Available from: https://www.cdc.gov/nchs/nhanes/about_nhanes.htm.
[14] CDC, NCHS—National Center for Health Statistics. [Internet]. 2024 [cited August 13, 2024]. Available from: https://www.cdc.gov/nchs/index.htm.
[15] A.J. Moshfegh, D.G. Rhodes, D.J. Baer, T. Murayi, J.C. Clemens, W.V. Rumpler, et al., The US Department of Agriculture automated multiple-pass method reduces bias in the collection of energy intakes, Am. J. Clin. Nutr. 88 (2008) 324–332.
[16] C.A. Blanton, A.J. Moshfegh, D.J. Baer, M.J. Kretsch, The USDA Automated Multiple-Pass Method accurately estimates group total energy and nutrient intake, J. Nutr. 136 (2006) 2594–2599.

[17] FPED overview: USDA ARS. [Internet]. [cited August 25, 2024]. Available from: https://www.ars.usda.gov/northeast-area/beltsville-md-bhnrc/beltsville-human-nutrition-research-center/food-surveys-research-group/docs/fped-overview/.
[18] Poverty Guidelines. [Internet]. ASPE. [cited August 19, 2024]. Available from: https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines.
[19] Prior HHS Poverty Guidelines and Federal Register References [Internet]. ASPE. [cited August 19, 2024]. Available from: https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines/prior-hhs-poverty-guidelines-federal-register-references.
[20] [Internet]. [cited August 19, 2024]. Available from: https://www.cdc.gov/nchs/data/datalinkage/public-use-linked-mortality-file-description.pdf.
[21] K. Pachipala, V. Shankar, Z. Rezler, R. Vittal, S.H. Ali, M.S. Srinivasan, L. Palaniappan, E. Yang, F. Juul, T. Elfassy, Acculturation and associations with ultra-processed food consumption among Asian Americans: NHANES, 2011–2018, J. Nutr. 152 (2022) 1747–1754.
[22] A.G.M. Brown, R.F. Houser, J. Mattei, C.D. Rehm, D. Mozaffarian, A.H. Lichtenstein, S.C. Folta, Diet quality among US-born and foreign-born non-Hispanic blacks: NHANES 2003–2012 data, Am. J. Clin. Nutr. 107 (2018) 695–706.
[23] J.R. Sharkey, C.M. Johnson, W.R. Dean, Nativity is associated with sugar-sweetened beverage and fast-food meal consumption among Mexican-origin women in Texas border colonias, Nutr. J. 10 (2011) 101.
[24] S. Park, H.M. Blanck, C.A. Dooyema, G.X. Ayala, Association between sugar-sweetened beverage intake and proxies of acculturation among U.S. Hispanic and non-Hispanic white adults, Am. J. Health. Promot. 30 (2016) 357–364.
[25] J. Van Hook, S. Quiros, M. Dondero, C.E. Altman, Healthy eating among Mexican immigrants: migration in childhood and time in the United States, J. Health Soc. Behav. 59 (2018) 391–410.
[26] G.W. Gustavsen, D. Dong, R.M. Nayga, K. Rickertsen, Ethnic variation in immigrants' diets and food acculturation—United States 1999–2012, Agric. Resour. Econ. Rev. 50 (2021) 43–62.
[27] M. Tseng, D.J. Wright, C.Y. Fang, Acculturation and dietary change among Chinese immigrant women in the United States, J. Immigr. Minor Health. 17 (2015) 400–407.
[28] C.D. Fryar, T.H. Fakhouri, M.D. Carroll, S.M. Frenk, C.L. Ogden, The association of nativity/length of residence and cardiovascular disease risk factors in the United States, Prev. Med. 130 (2020) 105893.
[29] D. Lillekroken, A. Bye, L. Halvorsrud, L. Terragni, J. Debesay, Food for soul-older immigrants' food habits and meal preferences after immigration: a systematic literature review, J. Immigr. Minor. Health 26 (2024) 775–805.
[30] L. Zheng, T. Alam, A. Khemlani, R. Armah, M. Horlyck-Romanovsky, Diet and dietary acculturation among immigrants from Sub-Saharan Africa living in the United States: a scoping review, J. Nutr. Educ. Behav. 56 (2024) S6.
[31] A. Trofholz, K. Richardson, N. Mohamed, C. Vang, J.M. Berge, How a racially/ethnically diverse and immigrant sample qualitatively describes the role of traditional and non-traditional foods in feeding their children, J. Immigr. Minor. Health 22 (2020) 1155–1162.
[32] Bureau UC. Census Bureau Releases New Report on Health Insurance by Race and Hispanic Origin. Census.gov. [Internet]. [cited August 13, 2024]. Available from: https://www.census.gov/newsroom/press-releases/2022/health-insurance-by-race.html.
[33] S.H. Lee, L. Zhao, S. Park, L.V. Moore, H.C. Hamner, D.A. Galuska, H.M. Blanck, High added sugars intake among US adults: characteristics, eating occasions, and top sources, 2015–2018, Nutrients 15 (2023) 265.
[34] A. Rosinger, K. Herrick, J. Gahche, S. Park, Sugar-sweetened beverage consumption among U.S. adults, 2011–2014, NCHS Data Brief 270 (2017) 1–8.
[35] A.M. Siega-Riz, D. Sotres-Alvarez, G.X. Ayala, M. Ginsberg, J.H. Himes, K. Liu, et al., Food-group and nutrient-density intakes by Hispanic and Latino backgrounds in the Hispanic Community Health Study/Study of Latinos, Am. J. Clin. Nutr. 99 (2014) 1487–1498.
[36] U.S. Department of Health and Human Services, Office of Minority Health, Diabetes and Hispanic Americans [Internet] (2024) [Last updated 2025 Feb 13; date cited 2025 Jan 17]. Available from: https://minorityhealth.hhs.gov/diabetes-and-hispanic-americans.
[37] J.-Y. Moon, S. Hua, Q. Qi, D. Sotres-Alvarez, J. Mattei, S.S. Casagrande, et al., Association of sugar-sweetened beverage consumption with prediabetes and glucose metabolism markers in Hispanic/Latino adults in the United States: results from the Hispanic Community Health Study/Study of Latinos (HCHS/SOL), J. Nutr. 152 (2022) 235–245.