INTERNATIONAL JOURNAL OF CIRCUMPOLAR HEALTH, 2021
VOL. 80, 1920779
https://doi.org/10.1080/22423982.2021.1920779



# Seasonal variation in added sugar or sugar sweetened beverage intake in Alaska native communities: an exploratory study

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**ABSTRACT**

Excess added sugar intake contributes to tooth decay risk in Alaska Native communities. The goal of this exploratory study was to determine if there is seasonal variation in total added sugar intake or in the leading sources of added sugars in a Yup'ik population. Data were collected in spring and winter from 2008-2010 using self-reported intake data measured by 24-hour recall and by hair biomarker (carbon and nitrogen stable isotope). Seventy Yup'ik participants ages 14–70 years were recruited from two communities and data were collected twice from a subset of 38 participants. Self-reported added sugar intake (g/day), biomarker-predicted added sugar intake (g/day), and leading sources of added sugar were calculated. Seasonal variation was evaluated using a paired sample t-test. Total added sugar intake was 93.6 g/day and did not significantly differ by season. Sodas and other sugar-sweetened beverages (e.g. Tang, Kool-Aid) were the leading sources and added sugar from these sources did not significantly differ by season (p=.54 and p=.89, respectively). No seasonal variation in added sugar intake was detected by either self-report or biomarker. Dietary interventions that reduce intake of added sugars have the potential to reduce tooth decay in Yup'ik communities.

**ARTICLE HISTORY**
Received 13 October 2020
Revised 1 March 2021
Accepted 15 March 2021

**KEYWORDS**
Tooth decay; biomarkers; oral health; diet; health status disparities

## Introduction

Tooth decay is the most common disease in adults in both the USA (US) and globally [1]. Excess added sugar intake and sugar-sweetened beverage (SSB) intake is one risk factor for tooth decay in both children and adults [2,3]. While SSB intake in the US has dropped in the last two decades, SSB intake remains high and is notably greater in low-income and minority populations [4,5].

Alaska Native adults are disproportionally affected by tooth decay [6]. Reasons for the high prevalence of tooth decay include a number of structural factors. Geographic location limits access to dental care and infrastructure for water fluoridation [7]. Communities also face high-cost or unavailable healthy foods, intergenerational exposure to colonial dietary systems, and obstacles to traditional food availability such as regulations on wildlife management [8–10]. Added sugar intake is another contributing factor. SSBs are among the most frequently consumed foods and beverages, and Alaska Native adults are three times more likely to consume three or more sugary drinks per day than white adults in the continental US [11,12]. One way to address the high prevalence of tooth decay in Alaska Native communities is by reducing added sugar intake.

Oral health interventions based on modifying diet are potentially influenced by seasonal variation in diet. The traditional Alaska Native (Yup'ik) diet consists of seasonally available foods such as berries and salmon which are harvested in late summer and fall [13]. While traditional foods can be stored for year-round consumption by freezing or smoking, previous research indicates that the primary sources of key nutrients and overall energy intake differ by season in Yup'ik communities [14]. Despite the known presence of seasonal shifts in traditional food intake, no studies have examined seasonal variation in non-traditional foods like added sugars and SSBs in Yup'ik communities. While some research in the US has shown that fluid intake does not differ with seasonal-related temperature fluctuations [15], other work suggests that children consume more sugary foods during the summer months

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[16]. If added sugar intake varies with season, understanding the pattern would allow researchers to account for it when implementing a long-term dietary intervention.

The goal of this exploratory study was to determine if there is seasonal variation in added sugar intake in Yup'ik communities using a self-reported measure of diet and an objective biomarker of added sugar intake [17]. A secondary goal was to determine if there is seasonal variation in the intake of the leading sources of added sugars. The study results are expected to inform future dietary-based interventions aimed at reducing added sugar intake and preventing oral health disparities in Alaska Native communities.

## Materials and methods

### Study setting

This is a secondary exploratory analysis of data from the *Negem Nallunailkutaa* ("The Foods' Marker") study [17–19]. Seventy participants of ages 14–70 years were recruited via posters and word of mouth in two coastal Yup'ik communities in south-west Alaska. Data were collected in each community at two time periods. In Community 1, the first data collection took place from October to December 2008 and the second data collection took place from May to June 2010. In Community 2, the first data collection took place from March to April 2009 and the second data collection took place from November to December 2009 (Supplementary Material). Written consent was obtained from adults. Minors signed an assent form and their parent or guardian signed a consent form. Participants received 75 USD at each time point ($150 total). This study was approved by the University of Alaska Fairbanks Institutional Review Board and the Yukon-Kuskokwim Health Corporation Human Studies Committee and Executive Board.

### Study Procedures and Data Management

During the first data collection period, there were four study procedures: administration of a 34-item demographic questionnaire, measurement of height and weight, collection of four 24-hour dietary recalls to measure self-reported added sugar intake (subjective measure), and collection of biological samples for the biomarker analyses to predict added sugar intake (objective measure). During the second data collection period, four additional 24-hour dietary recalls were collected and additional biological samples were collected for the biomarker analyses.

The demographic questionnaire was administered once and included items on age, sex, adherence to a traditional Yup'ik lifestyle, food assistance participation and household income. The English questionnaire was administered verbally. A native Yup'ik speaker was available to interview the participants who did not speak English. The demographic questionnaire data were entered into Excel and verified for accuracy prior to analysis. Height and weight were measured once and were used to calculate the body mass index (BMI).

At recruitment, participants completed the first of four unannounced 24-hour dietary recalls, which have been shown to measure dietary intake more accurately than other self-reported methods such as food frequency questionnaires [20]. The three subsequent recalls took place over the next 4 weeks. The recalls were on average 9±5 days apart, with a minimum of 2 days between recalls. The 24-hour recalls were administered by a trained and certified interviewer using algorithm-driven, computer-assisted software (Nutrition Data System for Research software 2008; University of Minnesota, Minneapolis, MN). Participants were asked to recall all foods and beverages consumed the day prior to the interview using a multiple-pass approach. Participants were given portion estimation tools (e.g. measuring cups, rulers, and food models or portion estimation guides; Fred Hutchinson Cancer Research Center, Seattle, WA). During the second data collection, four additional recalls were collected from a subset of the original participants using the same procedures. The 24-hour recall entries were verified and any missing foods were entered using coding rules for Alaska Native foods [21].

During the first data collection, blood and hair samples were collected from each participant to predict the added sugar intake using previously published protocols [17,22]. Of the 70 participants, 68 donated blood and 58 donated hair. During the second data collection, hair samples were collected from 33 participants. No blood samples were collected during the second data collection based on findings that non-invasive hair samples are sufficient for the biomarker analyses [18]. The biomarker sample is advantageous because it provides an objective estimate of intake free of self-report bias. It is a long-term measure of intake corresponding to 1 to 2 months of intake.

All biological samples were prepared for analysis of the stable isotope ratios of carbon and nitrogen at the Alaska Stable Isotope Facility as previously described [17–19]. To allow for comparison of stable isotope ratios between the first and second data collection period, the stable isotope ratio values for hair were converted to the stable isotope ratio values for blood using a regression model created from participants who donated both sample types during the first data collection [18]. Biomarker-predicted added sugar intake was calculated using previously validated models that predict added sugar intake in an Alaska Native population using a linear combination of carbon and nitrogen isotope ratios [17]. For this calculation, the stable isotope ratios measured from blood samples were used for all participants during the first visit. For samples collected during the second data collection period, the stable isotope ratio of blood estimated from the hair samples was used.

### *Data analyses*

Data collected from March through June were classified as spring and data collected from October through December were classified as winter.

The Nutrition Data System for Research Food and Nutrient Database was used to calculate self-reported added sugar intake (g/day) as the sum of all added sugars reported in each 24-hour recall. The % of total energy from the added sugars and the proportion of participants that exceeded 10% of the total energy from the added sugars were also calculated for comparability with the Dietary Guidelines Advisory Committee (DGAC) recommended limit of added sugar intake [23]. Self-reported added sugar intake was calculated separately for spring and winter by averaging the results from the four 24-hour recalls completed in each season. The self-reported added sugar intake was then compared between seasons using a paired sample t-test (α=0.05). Because self-reported added sugar intake did not significantly differ by season, overall added sugar intake was calculated by averaging the results from all eight 24-hour recalls. The same procedure was used to compare biomarker-predicted added sugar intake and calculate an overall measure.

All foods that contributed added sugar to the diet from the 24-hour recall were then categorised into food and beverage groups modelled from the What We Eat in America component of the National Health and Nutrition Examination Survey [24]. The food and beverage groups included candy, bread and bread products, multiple categories of desserts and other SSBs (e.g. Tang, lemonade and Kool-Aid). An Alaska Native dessert category was included to represent akutaq, a frequently consumed traditional Yup'ik mixed dish made from berries, fat and sugar. The percentage of total added sugars from each food group was calculated separately for spring and winter and then averaged for an overall measure.

To examine seasonal variation in the leading sources of added sugar, grams of added sugar from soda and other specific SSBs (Tang, Kool-Aid, lemonade, fruit juice, energy drinks, Gatorade and packaged sweet tea) were calculated separately for spring and winter by averaging the results from the four 24-hour recalls completed in each season. The added sugars from each beverage in each season were compared using a paired sample t-test (α=0.05). Overall added sugars from each beverage were then calculated by averaging the results from all eight 24-hour recalls. All analyses were completed using the statistical software JMP, version Pro 13.2.0 (SAS Institute, Inc., Cary, NC).

## Results

### *Descriptive statistics*

Of the 70 participants recruited, 38 participated in the study at both time points and were included in the analysis. The mean age of the study population was 41.3±18.2 years (range: 14 to 79 years), and 53% of participants were female (Table 1). A majority (63%) of participants reported that they followed a traditional Yup'ik lifestyle some time. Almost half (42%) of the

**Table 1.** Descriptive characteristics of Yup'ik individuals that completed dietary recalls in two seasons (n=38).

| Variable | Mean±SD, range or n (%) |
|---|---|
| Total | |
| Age (y) | 41.3±18.2, 14–79 |
| 14–19 | 6 (16) |
| 20–39 | 12 (32) |
| 40–59 | 15 (40) |
| 60–79 | 5 (13) |
| Sex | |
| Male | 18 (47) |
| Female | 20 (53) |
| Follows a Traditional Yup'ik Lifestyle | |
| A lot | 12 (32) |
| Some | 24 (63) |
| Not at all | 2 (5) |
| Receives Food Assistance[a] | |
| Yes | 16 (42) |
| No | 22 (58) |
| Household Income | |
| <$10,000 | 7 (18) |
| $10,000–24,999 | 6 (16) |
| $25,000–49,999 | 5 (13) |
| $50,000–99,999 | 5 (11) |
| Unknown/No Response | 15 (39) |
| Body Mass Index | 27.0±6.4, 19.7–45.8 |
| 18.5–24.9 | 17 (45) |
| 25.0–29.9 | 7 (18) |
| >30 | 11 (29) |
| No Response | 3 (8) |
| Daily Energy from Added Sugar (%) | 19.3±9.3, 3.1–36.6[b] |
| <10% | 7 (18) |
| ≥10% | 31 (82) |

[a]Received benefits from any food assistance service (Women, Infants, and Children, Supplemental Nutrition Assistance Program); [b]Average of eight 24-hour recalls completed. The % of energy from added sugar did not differ by season.

study population reported that they received some form of food assistance.

### Self-reported added sugar intake

Eighty-two per cent of participants had more than 10% of daily total energy from added sugars in both spring and winter (Table 1). The mean self-reported added sugar intake was 95.6±61.9 g/day in the spring and 91.5±49.4 g/day in the winter (Table 2). The self-reported intake was not significantly different between the two seasons (p=.51). The mean self-reported intake for the eight recalls completed in both seasons was 93.6 ±52.5 g/day. Added sugar intake was higher among younger age groups and males. It also decreased with adherence to a traditional Yup'ik lifestyle and was inversely related to BMI (Table 2).

### Biomarker-predicted added sugar intake

In the spring, the biomarker-predicted added sugar intake was 80.4±31.6 g/day and in the winter, it was 87.1±40.0 g/day. The biomarker-predicted added sugar intake was not significantly different between the two seasons (p=.11). The mean biomarker-predicted intake for both seasons was 84.9±34.8 g/day.

### Leading sources of added sugar

Table 3 reports the contribution of food and beverage groups to total added sugar intake. Soda was the leading source of added sugar (30.8%), followed by other SSBs (17.0%) and sugar-sweetened coffee and tea (15.2%). Candy was the leading food source of added sugars (7.8%), followed by bakery desserts (7.2%) and sugars (7.1%). Alaska Native dessert (akutaq) contributed 3.6% of the total added sugars. All other foods, including cereals and snacks, bread and bread products, mixed dishes, other desserts, condiments and sauces, fats and dressings and meat, contributed less than 4% of the total added sugars.

### Added sugars from SSBs

Added sugars from soda and other SSBs in the spring and winter are reported in Table 4. Added sugars from soda did not differ by season (p=.54). Similarly, the added sugars consumed from all other SSBs did not differ by season (p=.89). The mean intake of added sugars from soda across all eight 24-hour recalls was 28.1±38.1 g/d. The added sugars from all other SSBs were 15.9±28.3 g/day. The other SSBs that contributed the most added sugar were Tang (6.2 g/day), followed by Kool-Aid (4.4 g/day), lemonade (1.8 g/day), fruit

**Table 2.** Self-reported added sugar intake among Yup'ik individuals (g/day) reported by participant characteristic (n=38).

| Variable | Self-Reported Added Sugar Intake (g/day)Mean±SD | | | |
|---|---|---|---|---|
| | Spring[a] | Winter[a] | p | Mean[b] |
| Total | 95.6 ± 61.9 | 91.5 ± 49.4 | .51 | 93.6 ± 52.5 |
| Age (y) | | | | |
| 14–19 | 122.4 ± 51.2 | 95.6 ± 26.0 | .03* | 109.0 ± 38.3 |
| 20–39 | 125.1 ± 66.8 | 126.5 ± 50.2 | .54 | 125.8 ± 54.9 |
| 40–59 | 84.1 ± 53.1 | 84.1 ± 38.2 | .50 | 84.1 ± 41.0 |
| 60–79 | 27.7 ± 8.3 | 24.8 ± 15.0 | .39 | 26.3 ± 5.5 |
| Sex | | | | |
| Male | 112.1 ± 77.6 | 95.4 ± 61.3 | .04* | 103.8 ± 67.2 |
| Female | 80.8 ± 39.6 | 88.0 ± 36.9 | .81 | 84.4 ± 33.8 |
| Follows a Traditional Yup'ik Lifestyle | | | | |
| A lot | 79.7 ± 57.0 | 66.1 ± 40.3 | .22 | 71.1 ± 43.4 |
| Some | 100.7 ± 64.6 | 100.9 ± 49.8 | .51 | 100.8 ± 54.7 |
| Not at all | 151.7 ± 5.7 | 131.1 ± 47.8 | .31 | 141.5 ± 26.7 |
| Receives Food Assistance[c] | | | | |
| Yes | 100.8 ± 58.1 | 92.5 ± 45.6 | .20 | 96.6 ± 48.8 |
| No | 91.9 ± 65.6 | 90.8 ± 53.1 | .45 | 91.4 ± 56.1 |
| Household Income | | | | |
| <$10,000 | 99.8 ± 53.5 | 77.5 ± 2.2 | .09 | 88.7 ± 39.9 |
| $10,000–24,999 | 113.0 ± 89.7 | 95.4 ± 59.4 | .14 | 104.2 ± 73.9 |
| $25,000–49,999 | 116.5 ± 64.5 | 105.9 ± 58.2 | .18 | 111.2 ± 60.3 |
| $50,000–99,999 | 106.7 ± 62.9 | 106.2 ± 47.5 | .49 | 106.4 ± 49.9 |
| Unknown/No Response | 76.1 ± 54.3 | 86.8 ± 53.4 | .85 | 81.5 ± 50.2 |
| Body Mass Index | | | | |
| 18.5–24.9 | 121.5 ± 72.8 | 108.6 ± 55.3 | .10 | 115.1 ± 61.6 |
| 25.0–29.9 | 82.4 ± 30.1 | 76.8 ± 28.5 | .34 | 79.60 ± 23.8 |
| >30 | 64.9 ± 46.4 | 72.9 ± 50.2 | .86 | 67 .7 ± 45.1 |
| No Response | 101.8 ± 56.6 | 97.2 ± 20.7 | .46 | 99.5 ± 21.7 |

*p<.05; Paired sample t-test between spring and winter.
[a]Average of four 24-hour recalls completed within season; [b]Average of all eight 24-hour recalls completed; [c]Received benefits from any food assistance service (Women, Infants, and Children, Supplemental Nutrition Assistance Program).

**Table 3.** Per cent of the total added sugar intake contributed from food and beverage groups among Yup'ik individuals (n=38).

| Group | Description | % Total Added Sugars | | |
|---|---|---|---|---|
| | | Spring[a] | Winter[a] | Mean[b] |
| Soda | | 28.5 | 32.9 | 30.8 |
| Other SSBs | Powdered drinks, sports drinks, energy drinks, packaged drinks and packaged teas | 17.2 | 16.7 | 17.0 |
| Coffee and Tea | Sugars and creamers added to coffee and flavoured espresso | 17.4 | 13.1 | 15.2 |
| Candy | | 6.4 | 9.2 | 7.8 |
| Bakery Desserts | Donuts, pies, cakes, sweet rolls and cookies | 6.0 | 8.2 | 7.2 |
| Sugars | Syrups, jams and syrup-packed fruits | 7.0 | 7.5 | 7.1 |
| Ready to Eat Cereals and Snacks | Chips, crackers granola bars, cereal and oatmeal | 4.5 | 2.9 | 3.7 |
| Alaska Native desserts (Akutaq) | Yup'ik mixed dish made from berries, fat and sugar | 4.4 | 2.7 | 3.6 |
| Breads and Bread Products | Breads, buns, bagels, pancakes and french toast | 2.4 | 2.8 | 2.6 |
| Mixed Dishes | Tomato-based pastas, sandwiches, pizza and instant or frozen meals and appetisers | 2.4 | 2.1 | 2.3 |
| Other Desserts | Ice cream, gelatin and pudding | 1.8 | 0.8 | 1.3 |
| Condiments and Sauces | Condiments, sauces and pickled foods | 1.0 | 0.4 | 0.7 |
| Fats and Dressing | Whipped cream, mayonnaise, salad dressings and peanut butter | 0.5 | 0.4 | 0.5 |
| Meat | Lunch meat and canned meats | 0.3 | 0.3 | 0.3 |

SSB indicates sugar-sweetened beverage.
[a]Average of four 24-hour recalls completed within season; [b]Average of all eight 24-hour recalls completed.

juices (1.3 g/day), energy drinks (1.1 g/day), Gatorade (0.8 g/day), and packaged sweet tea (0.4 g/day).

## Discussion

The goal of the study was to evaluate seasonal variation in added sugar intake in Yup'ik communities. We also examined if there was seasonal variation in the leading sources of added sugar. There were two main findings. There was no seasonal variation in added sugar intake between spring and winter measured by either self-reported diet or biomarker-predicted intake. Furthermore, there was no seasonal variation in soda or other sugar-sweetened beverages intake, the two leading sources of added sugar for individuals in the study.

We found no significant variation in total added sugar intake between seasons. Research on seasonal variation in diet is limited. One study of a population of Inuit from Nunavut, Canada, found that while there were small shifts in traditional food intake during the year, foods obtained from the market were consumed consistently year-round [25]. However, research in children has found that added sugar intake is significantly greater during the summer months compared to the school year [16,26]. A possible explanation for our finding is that added sugars are available throughout the year in Yup'ik communities either through bulk purchasing and storage at home or regular purchasing at local stores, which keeps intake constant among adults. Further research should explore the possibility of seasonal variation in added sugar intake among Yup'ik children.

We also found no evidence of seasonal variation in intake of soda or other SSBs, the leading sources of added sugars. Soda and other SSBs comprised 30.8% and 17.0% of total added sugar intake, respectively. This is consistent with national data indicating that SSBs make up more than a third of all added sugars in the US diet [27]. These results suggest that the source of added sugar for Yup'ik individuals is similar to the general US population. Study participants consumed an average of 93.6 g of added sugar per day which is slightly higher than the mean intake of 88 g per day

**Table 4.** The mean added sugars (g/day) consumed from soda and other sugar sweetened beverages among Yup'ik individuals (n=38).

| Beverage Group | Self-Reported Added Sugar Intake (g/day)Mean±SD | | | |
|---|---|---|---|---|
| | Spring[a] | Winter[a] | p | Mean[b] |
| Soda | 26.0 ± 29.6 | 30.5 ± 32.0 | .54 | 28.1 ± 38.1 |
| Other SSBs | 15.7 ± 21.8 | 16.3 ± 18.8 | .89 | 15.9 ± 28.3 |
| Tang | 6.2 ± 15.3 | 6.3 ± 10.9 | .96 | 6.2 ± 19.2 |
| Kool-Aid | 5.8 ± 16.2 | 3.2 ± 7.3 | .37 | 4.4 ± 15.8 |
| Lemonade | 0.8 ± 4.8 | 2.8 ± 8.9 | .23 | 1.8 ± 12.7 |
| Fruit Juice | 1.3 ± 4.5 | 1.3 ± 3.1 | .93 | 1.3 ± 7.8 |
| Energy Drink | 0.3 ± 2.0 | 1.9 ± 5.8 | .12 | 1.1 ± 7.4 |
| Gatorade | 0.7 ± 3.6 | 0.9 ± 4.5 | .87 | 0.8 ± 6.0 |
| Packaged Sweet Tea | 0.5 ± 2.2 | 0.3 ± 1.7 | .58 | 0.4 ± 4.1 |

SSB indicates sugar-sweetened beverage; *p<.05; Paired sample t-test between spring and winter.
[a]Average of four 24-hour recalls completed within season; [b]Average of eight 24-hour recalls completed.

for US adults [28]. The American Heart Association recommends that women consume no more than 25 g of added sugar per day and men consume no more than 36 g per day. Our findings underscore the need for interventions aimed at reducing the added sugar intake in Yup'ik communities.

Interventions to reduce excess SSB intake in Indigenous communities range in scope from upstream policies that influence supply or demand to downstream approaches that focus on behaviour change within families and individuals [29]. SSB taxes may not be a feasible approach in Alaska Native communities for reasons including general discomfort with regulation, burden on communities facing high poverty levels, as well as resistance that is likely to come from stores operated by local governing councils and community members who have few alternatives [30]. A more acceptable approach is behavioural interventions. There has been at least one successful community-based intervention aimed at reducing SSB intake based on among Indigenous children in Canada [31]. Our group is currently finalising an intervention to reduce sugared fruit drinks in Alaska Native families through a community-based behavioural intervention as a way to reduce oral health disparities. Health education on the harmful effects of SSBs on oral health alone may only be moderately effective in changing behaviours [32]. Therefore, our proposed programme will provide families with education, but will also empower families to make the switch to healthier alternatives, such as non-nutritive sweeteners [33]. Our intervention focuses on children based on formative work, indicating a need for child-focused interventions that target sugared fruit drinks as a way to address the tooth decay epidemic in Yup'ik communities [34]. However, changing a child's dietary behaviours will also require attention from adults within the family, particularly because adults have a role as a gatekeeper and are responsible for modelling healthy behaviours [35]. In fact, the data we report here show that individuals ages 20–40 years had the greatest intake of added sugars, at 125.8 g per day, while the oldest subgroup of participants (ages 60–70 years) reported only 26.3 g per day. Future efforts should continue to develop innovative family-focused behavioural interventions that help to reduce community-wide SSB intake.

We found that the added sugar intake measured by the hair biomarker was not significantly different in the spring and winter. The biomarker estimate was also lower than the estimate from the 24-hour recall which could have been due to errors associated with self-reported diet. Previous work has shown that a hair-based biomarker can detect seasonal differences in traditional food intake in Yup'ik communities and that it may be a more sensitive index of seasonal variability in diet compared to self-reported intake [19]. In addition, research has shown an association between the hair-based biomarker and tooth decay in Yup'ik children [34]. Measuring added sugar intake by hair has the added benefits of minimising participant burden and reducing data collection time in the field. However, relying solely on hair data in the current study would not have provided information on the sources of added sugar. There is a need for researchers to align the method of measuring added sugar intake with measurement needs, but a hair-based biomarker may be useful for further research monitoring the seasonality of added sugar intake.

There were four main study limitations. First, this is a secondary analysis of data collected a decade ago. These are the only known data available to answer our study question and our findings are considered exploratory. Second, our sample size was small and of the 70 participants originally recruited, only 38 participated in the second data collection. While this limits statistical power, there were no significant differences in self-reported added sugar intake ($p=.43$) or the biomarker-predicted added sugar intake ($p=.74$) between these groups at the first data collection, which reduces the likelihood of selection bias. Third, our findings are only generalisable to Yup'ik adults ages 14–70 years. Future studies should be conducted to assess for seasonal variation in children and should further explore potential age-related variations in added sugar intake. Fourth, data were collected over 2 years and were not collected in every month of the year. There could have been underlying changes to the food environment during the study period and sugar intake could be different in months that were not measured.

Individuals in Alaska Native communities have high levels of added sugar intake, mostly from soda and other SSBs, which contributes to a high prevalence of tooth decay and other chronic diseases. We did not find evidence of seasonal variation in added sugar intake between spring and winter among participants in this exploratory study. Adults ages 20–40 years in our study had the highest added sugar intake. Many of these adults are of childbearing age and influence the beverage environment that directly impacts childhood dietary behaviours and oral health outcomes. Therefore, interventions aimed at reducing added sugar intake in children should be family focused. In addition to targeting families, efforts should be made to support policies that address the root causes of high added sugar intake. These include subsidising healthful market foods through retailer incentives and promoting access to traditional foods. Future research should investigate seasonal variation in added sugar intake among children.

## Disclosure statement

No potential conflict of interest was reported by the authors.

## Funding

This work was supported by the US National Institute of Dental and Craniofacial Research (NIDCR) under Grant nos. [R56DE025813 and U01DE027629]; National Center for Research Resources and the National Institute of General Medical Sciences of the NIH under [Grant no. P20RR016430]; and by the NIH National Institute of Diabetes and Digestive and Kidney Diseases under [Grant no. R01DK07442].

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