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Sugar-sweetened beverage consumption among adults in rural Appalachia

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ABSTRACT

Sugar-sweetened beverage (SSB) consumption is decreasing nationally, yet intakes remain high in certain sub-populations as new varieties of SSBs are introduced. This study aims to expand on SSB intake patterns among adults living in Appalachia to develop policy, systems, and environmental (PSE) interventions to reduce consumption. Baseline cohort surveys were conducted to examine beverage consumption patterns of adults in one rural Appalachian county in Kentucky using a validated BEVQ-15 instrument. Ages were collapsed into three generational groups – Millennials (22–38 years), Generation X (39–54 years), and Boomers/Silents (≥55 years). Over half (n = 81; 54%) of the sample (n = 150) were Boomers/Silents. Age was a significant predictor of SSB consumption, with Millennials drinking more daily calories of SSB compared to older adults (329.2 kcal v 157.0 kcal v 134.6 kcal, $p = 0.05$); a significant amount of those calories coming from non-soda SSBs. Millennials were twice as likely to drink sweetened fruit juice drinks ($p = 0.0002$) and energy drinks ($p = 0.01$) daily and consumed six times more daily calories from sweetened fruit juice drinks than the other groups (73.5 kcal v 11.1 kcal v 8.0 kcal, $p < 0.01$). To our knowledge, this is the first study to show beverage choices and consumption patterns in Appalachian adults vary by age and non-soda SSBs are significant sources of added sugar. These findings inform PSE interventions for reducing SSB consumption, such as tailored marketing approaches and technology-based strategies, within a unique setting, and offer insight for nutrition educators and public health professionals working within rural, remote communities.

1. Introduction

Sugar-sweetened beverages (SSBs) are the largest contributor of added sugars in the United States (U.S.) and high SSB consumption is associated with increased obesity risk for adults of all ages (Malik et al., 2006; Popkin & Hawkes, 2016). Evidence indicates adult SSB consumption is declining in the U.S. (Han & Powell, 2013; Rehm et al., 2016); however, recent reports suggest certain sub-populations are seeking new sources of SSBs as they emerge in the marketplace (Vercammen et al., 2020). Specifically, the trends in SSBs have changed across race, ethnicity, and socioeconomic status (Vercammen et al., 2020), in addition to an upward trend in consumption of non-soda SSBs, such as sweetened fruit juice drinks, coffees, and energy drinks (Park et al., 2015). Among rural locations, there is an increase in the amount of shelf space dedicated to these types of beverages which can exacerbate health disparities and poor health outcomes (Park et al., 2015).

Numerous factors may explain why certain populations consume more SSBs relative to others: food environment, price, marketing and advertising, clean drinking water, cultural norms, employment status, income, and education (Blecher et al., 2017; Gesualdo & Yanovitzky, 2019; Onufrak et al., 2014; Park et al., 2016). Specifically, age group comparisons reveal younger to middle-aged adults consume consistently high levels of SSB compared to older adults (Han & Powell, 2013; Imoisili et al., 2020). This may be due to exposure, marketing, accessibility, and affordability of high caloric beverages at a pivotal age (Sharkey et al., 2011), yet exact causal mechanisms in specific populations have yet to be determined.

Adults in Appalachia consume more than three times the national average of SSBs per day (Zoellner et al., 2012), with a limited exploration of the types of SSBs contributing to added sugar consumption among various ages of adults (Yuhas et al., 2020). This underscores both the significance of this public health problem and the need to further

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examine this disparity. Those in rural communities, like most of the Appalachian region, have higher consumption of SSBs than their urban counterparts (Sharkey et al., 2011). High SSB consumption is endemic among younger adults of lower incomes in rural areas with limited education and higher household food insecurity (Park et al., 2016; Rehm et al., 2008; Sharkey et al., 2011). A new approach is warranted, rather than individual-level interventions, to address system level structures encouraging SSB consumption. As noted by Kumanyika, an equity-oriented framework may be particularly appropriate when designing obesity interventions in socially disadvantaged populations, including SSB consumption interventions in rural settings (Kumanyika, 2019). Policy, systems, and environmental (PSE) strategies have shown to be a viable approach, creating sustainable impacts to improve health outcomes (Haynes-Maslow et al., 2019). In some communities, PSE strategies have reduced adult SSB consumption (Molitor & Doerr, 2020); however, many of these approaches have not been applied or studied in rural, Appalachian settings. With this lack of knowledge, it is difficult to design and implement PSE interventions, programs, and policies to curb sugar intake.

Current literature lacks an understanding of the types of SSBs being consumed among Appalachian adults, a priority health disparate population. Therefore, the primary aim of this study is to fill this gap with an understanding of SSB choices, intakes, and unique consumption patterns in adults of different generations living in one rural, Appalachian community in order to develop culturally responsive PSE interventions.

2. Materials and methods

This study is part of a High Obesity Program project funded through the Centers for Disease Control and Prevention to reduce obesity in partnership with local Cooperative Extension Service offices. A community-based prospective cohort design was used to examine behavior change over time; here we report baseline findings. The complete study methodology and design is published elsewhere (DeWitt et al., 2020). All enrolled participants provided written informed consent prior to survey administration. The University of Kentucky Institutional Review Board approved this study.

The setting for this study is Martin County, a rural county located in Eastern Kentucky within the Central Appalachian region. Martin County experiences persistent poverty, high rates of food insecurity, low educational attainment, and low quality of life. The median household income from 2015 to 2019 was approximately $41,013, with an estimated 34.4% of the population living in poverty. The county population is roughly 11,200, a decline of 13% from April 2010 and July 2019 with currently 17.1% of adults ≥ 65 years of age (Census, 2020). Our sample is comparable to other communities in the Appalachian region of Kentucky and the larger Central Appalachian region with limited household incomes ($36,412 and $36,993, respectively), persistent poverty (25.3% and 23.8%), aging populations ≥ 65 years (17.8% and 18.8%), and small populations that have steadily declined in the last 10 years (Pollard and Jacobsen, 2020).

2.1. Demographics

Age was obtained and coded into three generational-based groups: Millennials (22–38 years old), Generation X (Gen Xers) (39–54 years old) and Boomers/Silents (≥55 years) to improve sample distribution and align with previous studies (Imoisili et al., 2020; Park et al., 2016). Since two participants did not provide their age, 150 participants comprise the sample. Other demographics included gender, race, education, and household income. Income categories were collapsed into less than $20,000 and more than $20,000 due to sparsity of data within higher income categories. Similarly, educational levels were collapsed due to a sparsity of data above the high school level.

2.2. Beverage intakes

A validated instrument, the Beverage Intake Questionnaire (BEVQ-15) (Fausnacht et al., 2020; Hedrick et al., 2012), was used to assess habitual beverage intakes of participants. The questionnaire asked about participant beverage choices over the last month, including how often they consumed 15 beverages and how much they consumed each time. Consumption frequency and amount was asked about the following: bottled water, tap water, 100% fruit juice, sweetened juice including fruit juice and juice cocktail, whole milk 2% milk or chocolate milk, low-fat or fat free milk, nut or soy milks, regular soft drinks, energy drinks, diet soft drinks or artificially sweetened drinks, sweet tea with sugar, black coffee or tea, coffee or tea with cream and/or sugar, and any alcohol including beer, wine, or hard liquor. Daily SSB kilocalories (calories) and grams were calculated using validated equations (Hedrick et al., 2012).

2.3. Analysis

Data were entered into REDCap (Vanderbilt University, Nashville, TN, USA) and verified by trained study personnel to minimize data entry errors. Data were exported and analyses conducted using SAS 9.4 (SAS Institute, Cary, NC, USA). For all analyses, significance was set at $p < 0.05$. Demographics were compared using Chi-square test except for race which used Fishers Exact test. Since the distributions of all daily total beverage intake variables were not normally distributed and many participants reported no daily intake of some beverage types, variable analysis of variance models were run on square-root transformed values. Reported values and confidence intervals are reported in the original units. Pairwise comparisons were adjusted for multiple comparison using Tukey's method.

3. Results

Demographic characteristics of the sample (n = 150) are outlined in Table 1. The total sample was 66% female (n = 99) with a median age of 56 years. Over half of the study sample were Boomers/Silents (ages 55–84; n = 81; 54%). A significant difference was observed in educational attainment, with Gen Xers more likely to have a high school or post-high school education (p = 0.03) (Table 1). There were no statistically significant differences in gender, race, or household income between generational groups.

Among the youngest adults, total beverage intakes accounted for

Table 1
Demographic characteristics of cohort study participants, Martin County, KY (n = 150).

	Millennials (n = 21) n (%)	Gen Xers (n = 48) n (%)	Boomers/Silents (n = 81) n (%)	*P*-value
Age (median, range, in years)	27 (22–38)	47 (39–54)	66 (55–84)	
Gender				0.47
Male	8 (38.1)	19 (39.6)	24 (29.6)	
Female	13 (61.9)	29 (60.4)	57 (70.4)	
Race				0.21
White	21 (100)	46 (95.8)	81 (100)	
Non-white	0 (0)	2 (4.2)	0 (0)	
Education				0.03
Less than high school	8 (38.1)	14 (29.2)	43 (53.1)	
High school graduate	8 (38.1)	18 (37.5)	28 (34.6)	
Post high school	5 (23.8)	16 (33.3)	10 (12.3)	
Household Income				0.24
<$20,000	14 (70.0)	24 (51.1)	51 (63.8)	
>$20,000	6 (30.0)	23 (48.9)	29 (36.3)	

689.3 daily calories on average (95% CI: 4.9738, 911.9). In the older adult groups, beverages accounted for 370.7 daily calories (95% CI: 277.1, 478.0) for Gen Xers and 366.1 daily calories (95% CI: 293.3, 446.9) for Boomers/Silent adults ($p = 0.005$). Similarly, total SSB intake for Millennials was 329.2 daily calories (95% CI: 217.0, 464.8) which was significantly higher than the daily SSB intake for Gen Xers and Boomers/Silent adults (157.0 kcal, 95% CI: 105.5, 218.7 and 134.6 kcal, 95% CI: 97.3, 177.9, respectively) ($p = 0.004$). Pairwise comparisons show no significant differences between the two older generational groups, p's > 0.80. However, both Gen Xers and Boomers/Silent consume significantly fewer beverages and in turn SSB than Millennials (adj p's < 0.05) (Table 2). Total beverage intakes are reported in Table 2.

Primary SSB sources include regular soda, sweetened fruit juice drinks, sweet tea, coffee with cream and sugar, and energy drinks. For the entire sample, approximately 58% of beverage calories came from regular soda and 19% from sweetened fruit juice drinks. However, when examining the types of SSB beverages consumed by generational category, Millennials are over twice as likely to consume sweetened fruit juice drinks ($p = 0.0002$) and energy drinks ($p = 0.01$) daily than either Gen Xers or Boomers/Silent adults. Millennials also consume six times more daily calories from sweetened fruit juice drinks than Gen Xers or Boomers/Silents (73.5 calories vs. 11.1 calories vs. 8.0 calories, $p < 0.01$). Water and milk intakes were analyzed by age group with no significant findings.

4. Discussion

Despite declining SSB consumption trends nationwide, certain populations and geographic regions do not show these trends (Park et al., 2015; Vercammen et al., 2020) and may be seeking new SSB sources as they emerge in the food retail space. Our findings reinforce that the rural Appalachian region of the U.S. continues to exhibit SSB consumption significantly higher than the national average (Yuhas et al., 2020) and echo recent trends of SSB consumption habits among young and middle-aged adults in the U.S. (Vercammen et al., 2019). However, a key distinction in our Appalachian sample relative to other studies is the contribution of non-soda SSBs to added sugar consumption. Our findings differentiate consumption patterns among adult age groups, with Millennials consuming significantly more calories daily from non-soda SSB compared to older adults. Where previous reports have primarily examined adolescent SSB consumption (Lane et al., 2019; B. McCormick et al., 2021a) and determined regular soda being the primary source of SSB within Appalachia (Yuhas et al., 2020), Millennials in our sample are consuming significantly more sweetened fruit juice drinks and energy drinks than older adults. For rural communities, sweetened fruit juice drinks and energy drinks are relatively new as significant sources of added sugar in the diet (Yuhas et al., 2020). Sweetened fruit juice drinks, specifically, are an emerging source of sugar and calories in the diet among children, impacting beverage choices into adulthood (Lee et al., 2021). Thus, research needs to continue to examine types of SSBs being consumed in rural environments to apply tailored PSE approaches to reduce consumption.

With a better understanding of adults' beverage consumption patterns within rural communities, PSE changes can be implemented to meet food retail and community needs, as we previously noted the importance of an equity orientation to designing interventions in this Appalachian population (Cardarelli et al., 2020). Recent work has begun to examine PSE approaches for reducing rural Appalachian adolescent SSB consumption, yet few studies have explored community-level PSE approaches targeting adult behaviors in rural communities. (B. A. McCormick et al., 2021b). Specifically, our findings suggest non-soda SSBs should be a focus for these intervention within retail settings. Innovative in-store marketing and pricing interventions to reduce SSB consumption, including altered product placement, discounts, or promotional marketing, are environmental strategies. In most retail locations, SSBs are displayed in more locations throughout the store compared to low or no-calorie beverages and decreasing the number of displays may be efficacious for reducing SSB purchases and consumption for all ages (Cohen et al., 2018). Lowering the cost of water, increasing the price of SSBs, either simultaneously or independently, may curb purchasing habits and maintain or increase business owner profits (Nau et al., 2018). Recent studies also suggest beverage swaps and other incentives may persuade customers to trade higher sugar beverages for ones with low or no calories (Forwood et al., 2015; Juszczyk & Gillison, 2018; Wrieden & Levy, 2016). Alternatively, government jurisdictions have imposed taxes to curb SSB consumption, yet more research is needed in smaller, more rural and remote communities, especially those with poor water infrastructure and quality (Andress et al., 2019; Teng et al., 2019).

In Appalachia, drinking water quality is a key consideration for behavior change (Zoellner et al., 2012). Martin County has faced poor water infrastructure and an ongoing water crisis for decades (Unrine, 2020; Wigginton et al., 2008). Daily water consumption in our study community (706.3 g) is nearly 40% less than mean daily water intake (1,167 g) from a national sample (Rosinger et al., 2018), which is not surprising due to lack of access to safe, affordable water, and residents may perceive SSBs as a safe alternative. Moreover, the financial burden of relying on bottled water for consumption is unsustainable in a persistently impoverished community. Environmental disparities,

Table 2
Habitual Beverage Intakes in an Adult Cohort, Martin County, KY

	Millennials (n = 21) Mean (95% CI)	Gen Xers (n = 48) Mean (95% CI)	Boomers/Silents (n = 81) Mean (95% CI)	Overall (n = 150) Mean (95% CI)	Overall p-value	Adjusted Pairwise p-values Mill v Gen Xers	Mill v Boomer/ Silents	Gen Xers v Boomer/ Silents
Daily Water (g)	621.8 (383.0,918.0)	747.2 (565.8,953.7)	705.1 (567.5,857.6)	706.3 (604.2,816.4)	0.76			
Daily Beverage (kcal)	689.3 (497.8,911.9)	370.7 (277.1,487.0)	366.1 (293.3,446.9)	406.8 (347.8,470.3)	0.005	0.01	0.005	1.00
Daily Beverage (g)	2451 (1929,3035)	2278 (1939,2644)	2274 (2010,2553)	2299 (2104,2503)	0.84			
Daily SSB (kcal)	329.2 (217.0,464.8)	157.0 (105.5,218.7)	134.6 (97.3,177.9)	164.2 (132.2,199.7)	0.004	0.02	0.003	0.80
Daily SSB (g)	870.0 (570.5,1232.5)	449.4 (305.8,620.5)	424.9 (315.3,550.8)	485.9 (396.1,584.9)	0.02	0.04	0.02	0.97
Daily Milk (kcal)	186.3 (103.4,293.5)	112.3 (68.8,166.4)	110.9 (76.7,151.4)	120.8 (93.8,151.2)	0.27			
Daily Milk (g)	301.6 (168.4,473.2)	186.4 (115.5,274.0)	190.1 (133.5,256.7)	202.9 (158.8,252.4)	0.32			

Sugar-sweetened beverages (SSB); grams (g); kilocalories (kcal); Millennials (Mill).

centered around poor water infrastructure and the built environment, emphasize efforts to modify obesogenic behaviors may not simply be an individual issue. Therefore, environmental health concerns must be addressed when devising tailored strategies to promote healthy choices, specifically water instead of SSBs.

Driven by this study's findings, several PSE approaches for reducing SSB consumption have been implemented or considered for implementation in Martin County since survey administration. Community-developed in-store marketing tools were designed and installed in five convenience stores featuring low and no-calorie beverages, with significant increases in total sales of no-calorie beverages at all locations over a six-month period (Gillespie et al., 2021). Changes in beverage purchasing patterns over time in different age groups may be explored to further understand consumer purchasing behavior and food retailer preference in this rural community. Further, partnering with food retailers within this community to examine purchasing patterns over time would identify new venues for potential PSE change. Location-based behavior nudges via smartphone delivery methods are also being considered, potentially appealing to younger adult audiences. A similar technology-based approach has been successful in reducing SSB consumption among other populations in the Appalachian region (Zoellner et al., 2021). The impact of these PSE initiatives will be explored at future time points of our multi-year prospective cohort study.

4.1. Limitations

Although this study better defines SSB consumption in one rural, Appalachian county in Kentucky, we cannot generalize our findings to all other rural communities. We are unable to infer causality due to the cross-sectional survey design. Future iterations of the survey for our cohort may begin to define causal relationships, determine whether trends hold over time, and better explain impacts of interventions on beverage-related behaviors. In addition, data was self-reported, creating potential reporting biases. We aimed to minimize bias by using validated survey instruments. Finally, total energy intake was not captured, therefore, there is a lack of total energy estimation and adjustment in the analysis.

5. Conclusion

This study offers new context for beverage consumption patterns among adults of all ages in Appalachia. To our knowledge, this is the first study to show that beverage consumption patterns in Appalachian adults vary by age and include a significant percentage of non-soda SSBs. Understanding types of SSBs and individual consumption patterns will inform PSE interventions for health promoting behaviors in this important health disparate population. Our findings offer insight for nutrition educators and other public health professionals striving to cultivate behavior change in rural, remote communities.

CRediT authorship contribution statement

Heather Norman-Burgdolf: Conceptualization, Formal analysis, Writing – original draft. **Emily DeWitt:** Investigation, Writing – original draft, Project administration. **Kathryn M. Cardarelli:** Methodology, Writing – review & editing, Supervision, Funding acquisition. **Rachel Gillespie:** Investigation, Writing – review & editing, Data curation. **Stacey Slone:** Formal analysis, Resources, Data curation, Writing – review & editing. **Alison Gustafson:** Writing – review & editing, Methodology, Supervision, Project administration, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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