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Patterns of beverage use across the lifecycle

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ABSTRACT

Total beverage intake patterns have changed greatly over the past half century. The present research was conducted to evaluate historic and current patterns of beverage consumption of adults and children in the U.S. Data were drawn from food balance surveys along with two-day beverage intake averages and were weighted to be nationally representative. A marked slow continuous shift downward in total milk intake with a shift toward an increased proportion of reduced fat milk was determined. The biggest shifts in beverage consumption among children aged 2 to18 were an increase in sugar-sweetened beverages (SSBs) (from 87 to 154 kcal/d), a smaller increase in juices (+21 kcal/d), and a decrease in milk consumption (−91 kcal/d). Data among adults aged 19 and older indicated that SSB intake has more than doubled. Water intake was highly variable, with a marked increase in bottled water intake but no clear trend in total water intake. Overall trends by age were presented and indicated that age-related beverage intake, both in ounces and kcal/day, decreased sharply for adults aged 60 and older. Kcal/d values ranged from a low of 283 for those over age 60 to a peak of 533 for those aged 19 to39 to 367 for 2 to 6 year olds. The consumer shift toward increased levels of SSBs and alcohol, limited amounts of reduced fat milk along with a continued consumption of whole milk, and increased juice intake represent issues to address from a public health perspective.

1. Introduction

From the emergence of the genus *Homo* to *Homo sapiens* between 100,000 and 200,000 years ago until 11,000 to 12,000 years ago, water and breast milk were the only types of beverage believed to have been consumed [1,2]. It has only been in the last 12,000 years of that evolutionary history that humans began to consume other beverages. The history of beverage development has been described extensively and is presented in detail by Wolf, Bray et al. 2008. Fig. 1 provides a sense of what is known about the origins of beverages and shows when most major beverages entered the human food chain. Other researchers, in particular Mattes [3–5], have reported on the relatively recent addition of energy beverages to the adult diet, considered in context with the recent set of studies demonstrating weak caloric compensation of beverage calories.

While beverages are classified into just a few categories in Fig. 1, in reality, the number of beverages introduced per year over the past decade number more in any year than existed in total 50 years ago or earlier. Most of these new beverages are either sugar-sweetened or caffeinated and often both, but many have emerged with reduced caloric levels, a range of flavors, and often caffeine and other food constituents added. Because of the vast array of new niche-targeted beverages that have emerged, it is virtually impossible to fully understand their patterns of intake: too few in each niche are consumed to allow analyses to be undertaken. This paper highlights what is known about long-term trends and summarizes results from nationally representative surveys of food and beverage intake.

2. Methods

2.1. Food balance data

The source of data for Figs. 2 and 3 is the food balance or disappearance data [6]. These are data prepared by the Economic Research Service, U.S. Department of Agriculture (USDA). They represent the amounts per capita of food available for human consumption, which is local production plus imports minus exports. These data are adjusted for milling, carcass, and other losses at the processing level but not for losses or actual wastage beyond the food processors. All beverages are placed into fluid-gallon equivalents on an annual per capita basis.

2.2. Individual food consumption data

These data were collected from four nationally representative surveys of food intake in the U.S. population. The sample selected for analysis consisted of all persons aged two and older, who reported one day or two days of their intake. The USDA data come from the

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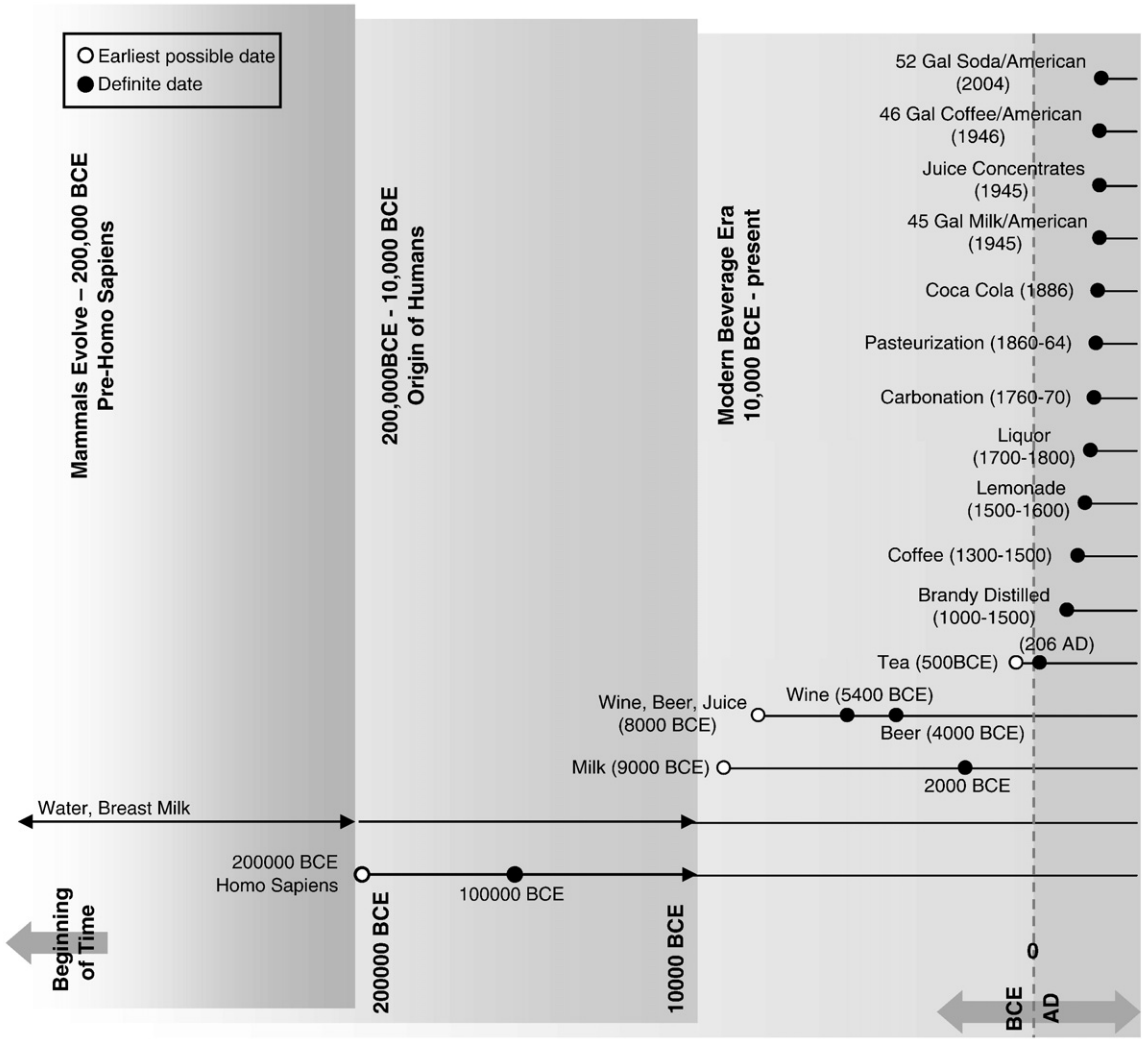

Fig. 1. Beverage history timeline.

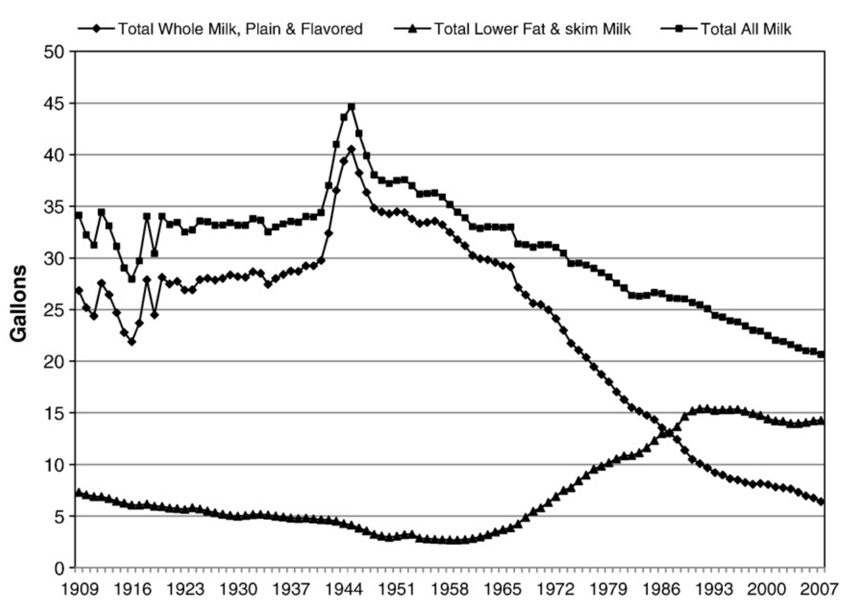

Fig. 2. Fluid milk available for consumption, US 1909 to 2007 (fluid gallons per capita).

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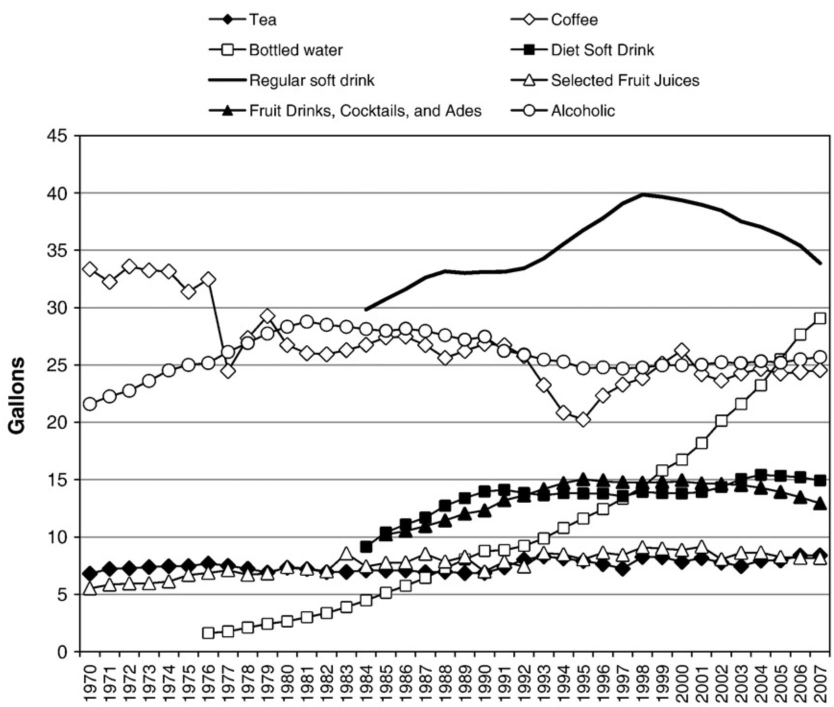

Fig. 3. Beverages available for consumption in the US, gallons per capita trends 1970–2007.

1977–1978 Nationwide Food Consumption Survey (NFCS 77), the 1989–1991 Continuing Survey of Food Intake by Individuals (CSFII 89), and the 1994–1996 Continuing Survey of Food Intake by Individuals (CSFII 96). Data from consecutive National Health and Nutrition Examination Surveys (NHANES) were also used as one combined set of data: the NHANES 2003–2004 and NHANES 2005–2006 (NHANES 03–06). The USDA and NHANES surveys were based on a multistage, stratified area probability sample of non-institutionalized U.S. households. Detailed information about each survey and its sampling design were published previously [7–11]. The major difference is that, while the NHANES sampling system is nationally representative, it does not represent each region by season and is not randomly distributed over the days of the week as were the earlier USDA surveys [12].

All dietary survey data utilized a comparable food composition table and collection methods developed by the USDA, the NFCS 77, and CSFII 89. Surveys contained information on dietary intake that was collected over three consecutive days using single-interviewer-administered 24-hour recall followed by a self-administered two-day food record. Dietary data from NFCS 77 and CSFII 89 surveys consisted of all foods eaten at home and away from home during the previous day (24-h recall) and the records of the foods eaten on the day of the interview and the following day (two-day records). The CSFII 96 survey collected interviewer-administered 24-hour recalls on two nonconsecutive days (3 to 10 days apart). The NHANES 03–06 surveys (a survey integrating USDA dietary methodology into the NHANES system) included two nonconsecutive days of 24-hour dietary recall data. The day-one interview was conducted by trained dietary interviewers in the Mobile Examination Center (MEC) and the day-two interview was collected by telephone 3 to 10 days following the MEC interview. For NHANES 03–06, the USDA's Automated Multiple-Pass Method, a five-step computerized dietary recall instrument, was used for collecting 24-hour dietary recall data, either in person or by telephone.

We used methods developed by our UNC team to link all the individual beverage food composition table numbers over time so that we could place identical beverages into the same beverage category [13]. Additional details on the beverage data as well as the added-sugar data are available in the literature [14–16].

Tea and coffee were special beverages in that for all surveys the milk, cream, and sugar added were typically measured separately. For our measurements, however, when milk, cream, or sugar was consumed at the same time as the coffee and tea, we assumed they were part of the tea and coffee. The adjustment for tea was minimal because few individuals added milk or cream, and the quantity of added sugar was usually small. For Southern iced tea, which is typically sweeter, sugar was included in the beverage measurement; likewise for coffee the changes in energy intake were often greater.

3. Results

3.1. The history of beverage use in the 20th century

In the U.S. there appear to be several major trends that emerged over the 20th century in beverage consumption. One is the dynamics of milk consumption. Across the globe, milk is the most consumed beverage but there are enormous variations geographically and temporally [17]. Fig. 2 shows USDA's quantities of fluid milk available for consumption since 1909 in gallons per year. According to these data, milk intake peaked in 1944–1945 and slowly decreased thereafter. Currently gallons available per capita are at the lowest point ever. This decrease is not solely driven by the emergence of sugar-sweetened beverages (SSBs); the slow decline in consumption in the U.S. emerged prior to major increases in SSBs.

The quantity of all beverages available for consumption in the U.S. has been recorded only since 1970. Fig. 3 provides trends for a larger set of beverages providing energy from food balance data beginning in 1970. Note that per capita availability of SSBs termed soft drinks reached a peak of over 39 gal per capita during the 1997–2000 period.

3.2. Beverage consumption patterns and trends

This section provides first an overview of the trends in key beverages and their consumption patterns and then focuses on age-specific patterns. For the overall trends two sets of data are provided: consumption for children aged 2 to18 and then for adults aged 19 and older. In both cases, all data are nationally representative. Table 1 presents per capita daily beverage intake for individuals in the U.S. The amount of water consumed per capita as a beverage is also included. The kcal of beverage category includes only beverages with calories as reported in the USDA and NHANES surveys.

Overall energy intake from beverages has decreased. For children total kcal from beverages providing energy decreased in the most recent period compared with earlier time periods while, for adults, this has not occurred.

3.2.1. Water

Consumption of water is probably the most underestimated or poorly measured of all beverages [18]. All national surveys systems used to have one or two questions probing water intake and more recently, in the integrated NHANES 2003–2006, they have included water intake as part of 24-hour recall data. The measurement of water for adults and children has shifted greatly in per capita mL/day terms. Elsewhere water consumption patterns and measurement are reviewed more carefully [18]. Depending on the year children consume about a half liter of water while adults consume up to double that amount.

Daily averages of water in mL/d have ranged from a high estimate of 835 for children and 1248 for adults from the 1988–94 NHANES II to current intake estimates of 552 for children and 1127 for adults in 2005–2006. Water intake from the tap or bottles was as low as 520 for children in the CSFII 89 and 736 for adults in the NFCS 77 survey (not presented for 1988–1994).

Table 1
Trends in beverage consumption patterns in children and adults, U.S., 1997–2006[a].

	1977–1978	1989–1991	1994–1998	2005–2006
A. Children aged 2–18: amount of beverage consumed in kcal per capita				
Unsweetened coffee and tea	0.7	0.5	0.3	0.2
Low fat milk	7.3	19.8	24.6	27.8
Diet drinks	0.2	0.7	1.1	1.2
Juices	33.1	47.9	55.6	53.7
Whole fat milk	241.8	187.1	156.6	130.0
Alcohol	1.2	0.4	1.6	4.5
Soda/fruit drinks	87.4	113.5	162.2	153.7
Other beverages providing energy	12.4	9.7	13.3	18.3
Total energy from beverages	384.2	379.5	415.4	389.5
Sample size	12060	12358	4008	7709
Water as a beverage (oz./capita)	624	520	531	552
B. Adults aged 19 and older: amount of beverage consumed in kcal per capita				
Unsweetened coffee and tea	8.6	8.1	8.2	4.7
Low fat milk	5.9	18.8	20.4	23.1
Diet drinks	0.3	1.4	1.8	4.3
Juices	28.8	35.5	35.3	36.3
Whole fat milk	97.6	73.0	58.3	53.1
Alcohol	44.9	45.5	65.0	115.2
Soda/fruit drinks	64.4	90.5	131.0	141.7
Other beverages providing energy	13.2	12.9	15.7	33.1
Total energy from beverages	263.7	285.7	335.8	411.6
Sample size	17342.0	10638	10014	4652.0
Water as a beverage (oz./capita)	736	792	856	1127

[a] Age and sex adjusted to 1965.

3.2.2. SSBs

Today there are a large and growing number of beverages that can be called SSBs. They range from carbonated and noncarbonated soft drinks to vitamin and other sugared waters, energy drinks, etc. Some have become super caffeinated.

3.2.3. Diet beverages

Since these provide essentially no calories, only Fig. 3 provides some sense of the pattern of intake. Reporting only began in 1984 and from that baseline of about 9.14 gal the level of per capita availability has increased to 14.94 gal.

3.2.4. Milks

The energy contribution of reduced fat milks has risen more slowly than the gallons available for consumption because of the reduced energy density of reduced fat milk. Surprisingly for children whole milk remains the major contributor. Hispanic children only consume whole milk while among other race-ethnic subpopulations there is a relatively higher proportion of milk derived from reduced fat products (unpublished results). From 1977 to 2006 reduced fat milk increased from 21 oz per day to 70 oz per day of individual intake for children 2 to18 and from 18 to 62 oz per day for adults [18].

3.2.5. Juices

While a small proportion of the population consumes fruit juices, the intake per consumer is high, particularly among children and young adults.

3.2.6. Alcoholic beverages

For adults intake of alcohol is predominantly beer. A large increase in energy intake from alcohol has occurred over time. Today after SSBs, alcohol is the major contributor of calories for adults and a tiny contributor of calories to children.

3.2.7. Unsweetened tea and coffee

Tea and coffee when consumed with sugar and milk are included under other beverages providing energy. A large proportion of tea and coffee has always been consumed with sugar. There is now a large proportion of high-calorie teas and coffee being consumed (300–600 kcal/225 mL), as reflected by individuals moving into the sweetened tea and coffee group [i.e., other beverages providing energy (33 kcal/d in 2005–2006)].

3.3. Life cycle of total beverage intake: 2005–2006

The most recent beverage consumption data available for the U.S. is from 2005 to 2006 (Table 2). These nationally representative data provide a snapshot of current age-specific consumption patterns. Intake decreased considerably among those aged 60 and above. Interestingly, those aged 60 and older consumed considerably less water but more unsweetened tea and coffee than do younger adults. Diet beverage intake is highest among adults aged 40 to 59.

Table 2 also presents the kcal/d intake for U.S. individuals. SSB intake is the major contributor, particularly among those aged 7 to 39. Only among adults aged 40 to 59 is alcohol consumed more than SSBs. Whole milk and juices represent important contributors to consumption across all age groups in terms of energy contribution.

4. Discussion

Beverage consumption patterns have shifted markedly in the United States during the 20th century and they continue to evolve. The longest term shift we can highlight is the changing role of milk consumption. From a peak at the end of WWII, it has steadily declined and the mix is shifting toward reduced fat milk and reduced whole milk. Among all beverages, coffee and tea intake have remained quite

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Table 2
U.S. patterns of daily beverage consumption by age, 2005–2006.

	2–6	7–12	13–18	19–39	40–59	60+
Panel A. Amount of beverages, mL by age groups, 2005–2006						
Unsweetened coffee and tea	5	7	22	133	320	382
Low fat milk	63	69	68	61	48	78
Diet drinks	27	44	48	151	290	175
Juices	153	79	107	89	76	92
Whole fat milk	268	203	180	100	88	87
Alcohol	0	0	31	296	267	93
Soda/fruit drinks	206	342	606	520	307	150
Other beverages providing energy	29	43	91	244	361	212
Water as a beverage	325	509	773	1147	1134	830
Total milliliters of beverages	1075	1296	1927	2741	2891	2099
Panel B. Energy from beverages in kcal per capita, by age groups, 2005–2006						
Unsweetened coffee and tea	0	0	0	2	6	6
Low fat milk	26	30	27	24	19	29
Diet drinks	1	1	1	3	6	4
Juices	75	37	48	39	33	39
Whole fat milk	160	121	106	59	51	49
Alcohol	0	0	15	139	130	62
Soda/fruit drinks	87	140	242	207	122	60
Other beverages providing energy	17	18	27	58	61	33
Total energy from beverages	367	348	466	533	428	283

Note: Weighted to be nationally representative.

stable, while SSBs and bottled water have shown marked increases. From the perspective of individual intake, the most noted changes are in both SSB and alcohol, the latter increasing considerably for adults and SSB increasing among all age groups.

For children one potentially promising trend is the slight decrease in SSB intake and overall decrease in kcal/d. Children have also had a marked reduction in total milk intake as the total daily intake has gone from 249.1 mL/d to 157.8, a reduction of over 90 mL/d.

For adults, as noted the 70.3 kcal/d increase in alcohol mirrored the increase in kcal/d of 77.3 from SSBs over the 1977–2006 period. Other trends were not major. The other issue to be raised is the very low total beverage intake for adults aged 60 and older. This is a considerable drop from younger adults and potentially a health concern.

Interpretation of these results is tempered by the shifts in methods for collecting dietary intake between 1977 and 2006 by the individual dietary intake surveys. Most notable is the adoption of the four-step multiple-pass method (MPM) for collecting 24-hour dietary recall in the 1990 s and the five-step MPM implemented in NHANES and later surveys. Neither the USDA nor the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC), who were responsible for conducting the NHANES studies, conducted bridging studies to determine if systematic changes in reporting occurred as a result of these methodological changes. Therefore possible confounding of time and methodological effects remains. On one hand, it is possible that more accurate reporting of beverages as a result of changes to intake methods would artificially inflate intake estimates and upward trend. However bridging studies between the 1970 s and 1980 s found that shifts in total energy and food composition resulting from changes in methodologies did not significantly impact results [19,20].

There were differences in these results from those using the NHANES surveys with one day of intake (1988–1994, 1999–2002) where energy intake was much greater on the first day of measurement. This analysis was for comparative purposes and utilized only surveys with two days of dietary intake. The NHANES survey utilized the USDA methodology as part of the fully merged NMN system [21]. The decrease in SSBs is more marked if you use only the NHANES surveys from 1988 to 1994 and then 1999 to 2002.

An additional limitation is the potential for systematic underreporting in general and more specifically by body mass index (BMI) category. Specifically, it has been demonstrated that overweight individuals tend to underreport dietary intake [22–25] which may result in an underestimation of beverage consumption. With obesity increasing particularly in the past two decades the magnitude of underreporting may have also increased, resulting in an underestimation of the upward trends in beverage consumption. Finally, because of recent changes in the availability of certain drinks, specifically caffeinated waters and vitamin waters and other new beverages, we cannot adequately address the effects of these changes in the American diet.

The other measurement concern relates to water intake [18]. The Donald study in Germany is the only study that truly attempted to measure accurately water intake by using 24-hour urine measurements to help validate total quantity of beverage intake [26,27]. We have not conducted validation work for the methods of measurement used in large national surveys such as NHANES and the UK Dietary Assessment surveys. Validation studies on water intake and total beverage intake comparing the 24-hour recall results with urine collection would be most useful and needed as we begin to understand the value of water intake as a replacement for intake of beverages providing energy.

Overall results among food availability surveys are fairly consistent in reporting the large decrease in milk intake and an equally important increase in SSB consumption. Beverages providing energy remain a most important component of our total energy intake and one deserving further study and possible program and policy consideration. A growing number of scholars perceive reducing SSB consumption as a major target for cancer prevention [28], the prevention of obesity [29], and a reduction of the risk of diabetes and heart disease [29,30]. Already a number of countries and scientific panels have recommended the need to make important changes in what we drink [31,32]. A recent American Heart Association statement advised that women should consume no more than 100 kcal from all sugary products including SSBs and men no more than 150 kcal/d. This paper shows that today all ages consume far more sugar from SSBs and related beverages than any other time [33].

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