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The high carbonated and sugar-sweetened beverages (SSB) consumption and associated factors in the West of Iran: a cross-sectional study

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Abstract

Background The consumption of soft carbonated drinks and other sugar-sweetened beverages (SSB) has been identified as a risk factor for several chronic diseases. We aimed to ascertain the proportion of carbonated beverage and SSB consumption, as well as the associated factors, in Hamadan, a city in the west of Iran.

Methods This cross-sectional study was conducted on adults over 18 years old. To estimate the information related to the consumption of SSB, the standardized Iranian version of the FFQ questionnaire was used. The weekly consumption of four or more cups was considered to be high consumption. Multiple logistic regression was used for the identification of related factors of SSB. The results were reported at the 95% confidence level.

Results A total of 628 individuals were included in the study. The mean age of the participants was 38.05 (SD = 12.54), and 42.36% of the sample was male. The frequency (%) of high total SSB consumption was 321 (51.11%), with 95% CI: 47.20, 55.02. The high consumption was higher among males than females, 162 (60.90%) versus 159 (43.92%); $p < 0.001$, and among unmarried and married individuals was 54.88% and 50.55% respectively but the difference was not significant ($p = 0.465$). The odds of high SSB consumption were significantly lower for individuals of advanced age and female gender. In terms of socioeconomic status, the second, third, and fourth quartiles exhibited higher odds of high SSB consumption compared to the first quartile, with ORs of 1.64 (95% CI: 1.04, 2.60), 1.61 (95% CI: 1.01, 2.57), and 1.77 (95% CI: 1.09, 2.88), respectively.

Conclusion Based on the results of this study the high sugar-sweetened beverage consumption was significant. The consumption among females and younger was lower than males and older people. It seems, that there is a significant negative association between female gender and age with SSB consumption, suggesting that males and older individuals tend to consume more sugar-sweetened beverages. On the other hand, socio-economic status was positively associated with SSB consumption, indicating that individuals with higher socio-economic status may have a higher intake of these beverages.

Keywords Sugar-Sweetened beverages, Carbonated beverages, Frequency, Risk factors, Hamadan

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Introduction

In recent years, there have been significant shifts in the lifestyles of societies around the globe, particularly in dietary habits. The consumption of carbonated beverages and ready-made meals has emerged as one of the most notable changes in people's diets. There has been a marked increase in the intake of soft carbonated drinks and other sugar-sweetened beverages (SSB) compared to previous trends [1]. Prior research has demonstrated a direct correlation between the high consumption of SSB and an increased risk of developing certain diseases, including obesity, chronic heart disease, renal failure, and diabetes [2–4]. The excessive consumption of SSB has been linked to an increased risk of developing several health issues, including metabolic syndrome, non-alcoholic fatty liver disease (NAFLD), and hypertension. Furthermore, research indicates that high consumption of SSB among adolescents is associated with an increased risk of dental caries, premature maturation, and aggressive behavior [5–7].

A review of studies conducted in low and middle-income countries indicates that approximately 52% of teenagers consume carbonated soft drinks at least once per week [8]. As indicated in the WHO report, despite the observed increase in SSB consumption across various societies, preventive measures have also been implemented. For instance, approximately 50 countries, including France, Brunei Darussalam, Chile, Hungary, India, and Ireland, have introduced a tax on sugary soft drinks [9].

In Iran, as in other societies, the consumption of foods and beverages with added sugar such as SSB and increased concurrently with the phenomenon of nutrition transition [10, 11]. Studies have demonstrated a correlation between high consumption of SSB and the prevalence of metabolic syndrome and obesity among Iranian individuals [12, 13]. Accordingly, the objective of this study was to ascertain the proportion of high SSB consumption and the associated factors influencing SSB consumption in the western region of Iran.

Methods and material

This analytic cross-sectional study was conducted in Hamadan, the capital of Hamadan province in the west of Iran, in 2022. The proposal for this study was approved by the ethics committee of Hamadan University of Medical Sciences (IR.UMSHA.REC.1398.522).

The study population consisted of adults residing in Hamadan City. In order to participate in the study, individuals had to meet the following eligibility criteria: they had to be between the ages of 18 and 65, be literate, and reside in Hamadan city. The sampling frame was the population covered by comprehensive health service centers. We selected five areas covered by the mentioned centers

in different city areas, including the center, north, south, east, and west of the city. In each region, simple random sampling was used, whereby the samples were selected from various times and parts of areas such as clients attending comprehensive health centers, banks, parks, drug stores, mosques, and stores. The number of samples assigned to each comprehensive health center was based on the population it served. Trained interviewers were responsible for conducting interviews with participants and completing the questionnaires.

The questionnaire was comprised of three sections. The initial section pertained to the participants' demographic and basic information, as well as their history of non-communicable diseases, including hypertension, cancer, diabetes, osteoporosis, and cardiovascular diseases (CVDs). This information was obtained through self-report. The second section pertained to the requisite data concerning the consumption of carbonated beverages and sugar-sweetened beverages. Accordingly, the standardized Iranian version of the food frequency questionnaire (FFQ) [14] was utilized. The questionnaire inquired about the frequency of consumption of seven beverage types, including carbonated drinks (soda), energy drinks, non-alcoholic drinks, industrial juice, homemade fruit juice, industrial syrup, and homemade syrup, on a daily, weekly, monthly, or yearly basis. The subsequent inquiry pertained to the quantity of beverages consumed (in cups).

Due to the disparate responses regarding the frequency of consumption (daily, weekly, monthly, yearly), the amount of consumption was converted into a weekly unit. This was done by multiplying the daily consumers by seven, dividing the monthly consumers by four, and dividing the annual consumers by 52. The lower than four cups per week and the upper than or equal four cups per week were considered low and high total SSB consumption, only carbonated drinks, and sweet drinks respectively [15].

The third section of the questionnaire was designed to assess the socio-economic status (SES) of participants. This was achieved through the utilization of a method that examined the assets held by individuals. The list of common assets included the following: personal car (not used for income generation), personal computer, smartphone, internet access, refrigerator, dishwasher, washing machine, vacuum cleaner, microwave oven, and LCD/LED TV.

The Wealth Index was constructed through the application of principal component analysis (PCA) to the aforementioned assets. Principal component analysis (PCA) is a technique for reducing the number of variables in a dataset while retaining the majority of the information contained within them [16]. The initial component accounts for the greatest proportion of the total variance

among the model variables and is therefore deemed the wealth index. In accordance with the results of the principal component analysis (PCA), the participant was assigned to one of four groups, ranging from the lowest socioeconomic status (SES) quartile (1st) to the highest (4th), based on their classification.

In order to calculate the requisite sample size, the findings of Dehdari et al. [17] were utilized. In the aforementioned study, the prevalence of daily carbonated beverage consumption was reported to be 81%. The maximum acceptable error was deemed to be 0.065 at the 95% confidence level. The design effect of 1.5 was employed for estimating the sample size, resulting in a final sample size of 700.

The categorical variables were presented as frequencies and percentages, while the continuous variables were reported as means and standard deviations (SD). The chi-squared test and t-test were employed to ascertain whether there were any statistically significant differences between the categorical and continuous variables within the groups of participants who were categorized according to their consumption of SSB. Furthermore, a logistic regression model was employed to examine the

association between variables with high SSB consumption. The results were reported at the 95% confidence level. The data were analyzed using Stata 14.2 (StataCorp, TX, US).

Results

In this population-based cross-sectional study, 628 adults aged 18 years and above participated. The response rate was 89%. The mean age of participants was 38.05 years (standard deviation = 12.55), and 42.36% of participants were male. The majority of participants (57.48%) had completed an academic level of education (Table 1).

The frequency (%) of people with high total SSB consumption was 321 (51.11%), with 95% CI: 47.20, 55.02. The frequency (%) in male was 162 (60.90%) versus 159 (43.92%) in female; $p < 0.001$, and among unmarried and married individuals was 54.88% and 50.55% respectively but the difference was not significant ($p = 0.465$). Furthermore, the high consumption was lower in overweight and obese individuals than in those with a normal weight. The frequency of the high consumption in patients with a history of chronic disease was notably elevated. The proportion of total high consumption of only carbonated drinks and only sweet drinks was 24.68% (95% CI: 21.46, 28.21) and 30.73% (95% CI: 27.24, 34.46), respectively (Table 2). The mean age of participants with high total SSB consumption was significantly lower than that of participants with low total SSB consumption (36.88 versus 39.27 years old; $P = 0.008$).

The univariate logistic regression model revealed an inverse association between increasing age (OR = 0.98; 95% CI: 0.97, 0.99), female gender (OR = 0.50; 95% CI: 0.36, 0.69), and increasing BMI (OR = 0.98; 95% CI: 0.94, 1.02) with high consumption of SSB. Furthermore, a direct association was observed between socio-economic status and high consumption of SSB. Individuals with a higher level of SES exhibited a greater likelihood of high SSB consumption compared to those with a lower SES (Table 3).

The results of the multiple logistic regression model indicated that age and gender were significantly associated with lower odds of high SSB consumption. Furthermore, a negative association was observed between the level of education and high SSB consumption. The odds ratio for diploma and academic levels versus illiterate were 0.56 (95% CI: 0.16, 1.99) and 0.40 (95% CI: 0.12, 1.41) respectively, these associations were not statistically significant. Regarding socio-economic status, the second (OR = 1.64; 95% CI: 1.04, 2.60), third (OR = 1.61; 95% CI: 1.01, 2.57), and fourth (OR = 1.77; 95% CI: 1.09, 2.88) quartiles of socio-economic status were associated high SSB consumption in comparison to the first quartile (Table 3). The stratified univariate and multiple logistic regression results by gender are shown in the

Table 1 The demographic and baseline characteristics of the study population

Variables	Frequency (n = 628)	Percent
Male gender	266	42.36
Marriage status		
Unmarried	82	13.06
Married	546	86.94
Education		
Academic	361	57.48
Diploma	142	22.61
Elementary	113	17.99
Illiterate	12	1.91
Job		
Employer	364	59.19
Housekeeper	140	22.76
Student	73	11.87
Retired	25	4.07
Jobless	13	2.11
Socio-economic Status		
1st quartile	165	26.27
2nd quartile	154	24.52
3rd quartile	158	25.16
4th quartile	151	24.04
History of diseases based on self-report of participants		
None	550	88.00
CVDS	19	3.04
Diabetes	17	2.72
Hypertension	17	2.72
Other	13	2.08
Cancer	6	0.96
Osteoporosis	3	0.48

Table 2 The frequency and proportion of total SSBs, only carbonated drinks, only sweet drinks consumption based on the baseline characteristics of participants

Variables	Total SSBs			Only carbonated drinks*			Only sweet drinks**		
	Freq (%)	95% CI	p-value	Freq (%)	95% CI	p-value	Freq (%)	95% CI	p-value
Total	321 (51.11)	47.20, 55.02	-	155 (24.68)	21.46, 28.21	-	193 (30.73)	27.24, 34.46	-
Gender									
Male	162 (60.90)	54.90, 66.60	< 0.001	89 (33.46)	28.04, 39.36	< 0.001	93 (34.96)	29.46, 40.90	0.049
Female	159 (43.92)	38.88, 49.09		66 (18.23)	14.58, 22.56		100 (27.62)	23.25, 32.47	
Marriage status									
Unmarried	45 (54.88)	44.03, 65.28	0.465	25 (30.49)	21.50, 41.26	0.191	28 (34.15)	24.71, 45.03	0.472
Married	276 (50.55)	46.35, 54.74		130 (23.81)	20.42, 27.57		165 (30.22)	26.51, 34.21	
Education									
Illiterate	7 (58.33)	30.72, 81.55	0.808	5 (41.67)	18.45, 69.28	0.172	5 (41.67)	18.45, 69.28	0.195
Elementary	59 (52.21)	43.01, 62.25		21 (18.58)	12.43, 26.85		32 (28.32)	20.77, 37.32	
Diploma	76 (53.52)	45.28, 61.57		33 (23.24)	17.01, 30.90		53 (37.32)	29.75, 45.57	
Academic	179 (49.58)	44.44, 54.74		96 (26.59)	22.28, 31.40		103 (28.53)	24.10, 33.42	
Job									
Housekeeper	69 (49.29)	41.08, 57.53	0.464	29 (20.71)	14.78, 28.24	0.130	43 (30.71)	23.63, 38.85	0.871
Employer	191 (52.47)	47.32, 57.57		100 (27.47)	23.12, 32.30		116 (31.87)	27.27, 36.84	
Student	37 (50.68)	39.36, 61.94		19 (26.03)	17.24, 37.27		21 (28.77)	19.55, 40.16	
Retired	10 (40.00)	23.02, 59.78		2 (8.00)	2.00, 27.00		6 (24.00)	11.18, 44.20	
Jobless	5 (38.46)	16.94, 65.69		2 (15.38)	3.86, 45.14		3 (23.08)	7.61, 52.22	
Socio-economic Status quartiles									
First quartile (worst)	70 (42.42)	35.10, 50.10	0.071	37 (22.42)	16.69, 29.43	0.719	40 (24.24)	18.30, 31.37	0.131
Second quartile	86 (55.84)	47.91, 63.49		37 (24.03)	17.92, 31.41		48 (31.17)	24.34, 38.92	
Third quartile	84 (53.16)	45.36, 60.82		44 (27.85)	21.41, 35.35		50 (31.65)	24.86, 39.31	
Fourth quartile (Best)	81 (53.64)	45.65, 61.45		37 (24.50)	18.29, 32.00		55 (36.42)	29.13, 44.40	
Body mass index									
Normal	164 (53.77)	53.77 (48.14, 59.31)	0.364	78 (25.57)	20.98, 30.78	0.797	103 (33.77)	28.67, 39.27	0.279
Overweight	110 (47.83)	47.83 (41.43, 54.29)		56 (24.35)	19.23, 30.32		64 (27.83)	22.41, 33.98	
Obese	42 (48.84)	48.84 (38.46, 59.32)		19 (22.09)	14.55, 32.09		24 (27.91)	19.45, 38.30	

* including: Carbonated soft drink, Energy drink, Diet carbonated drinks, Beer, Carbonated dough, and Sparkling water

** including: Industrial juice, Homemade fruit juice, Homemade syrup, and Industrial syrup

[supplementary table](#). Among male participants age, BMI, and socio-economic status were significantly associated with high SSB consumption. In females based on the results of multiple logistic regression, there was no statistically significant association between age, BMI, education level, marriage, and socioeconomic status with high SSB consumption.

Discussion

Based on the result of our study the frequency of SSB consumption was high. The percent of total SSB consumption was found to be 51.11%. The high SSB consumption was significantly higher among males than among females. Furthermore, the high SSB consumption was found to be lower among individuals with obesity and overweight than among those with normal weight. The high consumption of only carbonated drinks and only sweet drinks was 24.68% and 30.73%, respectively. Based on the results of the adjusted model, increasing age and female gender were significantly associated with a lower high SSB consumption. Additionally, the frequency

of high consumption was higher in younger people than in older individuals. One potential reason for the low frequency in females compared to males may be due to the fact that women tend to have healthier lifestyles and dietary habits [18].

The consumption of fast food is more prevalent among younger individuals, and consequently, the consumption of carbonated beverages is also more prevalent among this age group [19]. A positive correlation was observed between the level of socioeconomic status (SES) and the consumption of SSB. The elevated cost of carbonated beverages in the household food basket limits access to such drinks for individuals with lower socioeconomic status. In patients with a history of chronic disease, the proportion of high consumption was high; however, due to the low number of patients with chronic disease, this finding may be unreliable.

A recent Brazilian study [20] revealed that 20% of adults consume non-diet soft drinks on a daily basis. Similarly, the Framingham Study [21] in the United States reported that 12% of adults consume these beverages at

Table 3 The association between high consumption of SSBs and demographic variables and socio-economic status using univariate and multiple logistic regression

Variables	Univariate analysis			Adjusted analysis		
	OR	95%CI	P-value	OR	95%CI	P-value
Age (per one year)	0.98	0.97, 0.99	0.018	0.97	0.96, 0.99	0.001
Gender						
Male	1.00			1.00		
Female	0.50	0.36, 0.69	< 0.001	0.45	0.32, 0.63	< 0.001
BMI (kg/m ²)	0.98	0.94, 1.02	0.353	0.99	0.95, 1.03	0.473
Education						
Illiterate	1.00			1.00		
Elementary	0.78	0.23, 2.61	0.687	0.56	0.16, 1.99	0.371
Diploma	0.82	0.25, 2.71	0.748	0.56	0.16, 1.99	0.370
Academic	0.70	0.22, 2.25	0.553	0.40	0.12, 1.41	0.154
Marriage status						
Married	1.00			1.00		
Unmarried	0.84	0.53, 1.34	0.465	1.35	0.77, 2.38	0.299
Socio-economic status						
First quartile (worst)	1.00			1.00		
Second quartile	1.72	1.10, 2.67	0.017	1.64	1.04, 2.60	0.035
Third quartile	1.54	0.99, 2.39	0.054	1.61	1.01, 2.57	0.044
Fourth quartile (Best)	1.57	1.01, 2.45	0.047	1.77	1.09, 2.88	0.022

least once a day. Additionally, a population-based study conducted by Khosravi et al. [12] during the initial phase of the Isfahan Cardiovascular Study revealed that 19.72% of individuals consumed more than three cups of SSB.

The elevated consumption of SSB observed in this study when compared to the aforementioned studies may be attributed to discrepancies in the nutritional diet patterns of the community under investigation and other contributing factors. The aforementioned studies [22, 23] have demonstrated that the consumption of SSB, as well as carbonated beverages, is considerably higher among young individuals. The present study revealed that the average age of heavy drinkers was lower than that of low drinkers. Additionally, the multivariate logistic regression model revealed an inverse relationship between age and high SSB consumption.

The present study revealed that men reported a higher consumption of SSB than women. Furthermore, this relationship was also established in the multivariate regression model. This finding was also observed in several other studies [22, 24, 25]. Additionally, the present study revealed an inverse relationship between the increase in education and the consumption of SSB; however, the observed difference was not statistically significant. Those with higher levels of education tend to have more accurate sources of information and are more likely to adopt a healthier diet and lifestyle [12, 26].

Although the current study revealed a lower frequency of high SSB consumption among obese and overweight individuals compared to those with normal weight, the observed difference was not statistically significant. The

reason for this relationship may be due to the fact that obese individuals have reduced their consumption of beverages in accordance with medical recommendations.

Although there was no significant statistical association between BMI and high SSB consumption, in the stratified analysis, by gender, among male participants BMI was significantly associated with lower consumption of SSB. At the same time, the association between BMI and high SSB consumption in women was not significant. Based on the results of published studies SSB consumption is positively associated with obesity in both males and females [27]. Obese people may consume less SSB according to doctor's advice. In our study, male obese people tend to lower consumption of SSB significantly, although in obese female adjusted odds ratio was protective (0.96), but the association was not statistically significant. We must pay attention to this point that our study design was cross-sectional, so we could not assess the temporality between obesity and high SSB consumption. These association should be assessed in cohort studies. The higher socioeconomic status in male was significantly associated with high SSB consumption, but among female, the people with higher socioeconomic status have lower odds for high SSB consumption, but the associations were not statistically significant. Results of another study showed that regardless of gender higher socioeconomic status was associated with high SSB consumption [28]. Overall, based on our results, it seems there is a gender difference in the association of BMI and socioeconomic status with high SSB consumption.

The present study revealed a statistically significant association between the proportion of high SSB consumption and levels of SES. The adjusted regression model indicated that individuals with higher SES exhibited a greater likelihood of consuming high amounts of SSB compared to those with lower SES. Recent studies [22, 29, 30] have demonstrated that individuals with low financial productivity tend to adhere to a healthier diet than those with a favorable socioeconomic status. Additionally, they exhibit a greater proclivity for consuming fast food and carbonated soft drinks, which are the most consumed beverages alongside fast foods.

The consumption of sweetened and other carbonated beverages, as well as beverages sweetened with sugar, has been linked to an increased intake of energy and an elevated risk of obesity. Obesity represents the most significant independent risk factor for the development of type 2 diabetes [31]. The findings of the studies indicate that the consumption of SSB is associated with long-term weight gain. However, when the glycemic load of the beverages is increased independently, it results in the exacerbation of inflammation and insulin resistance. Conversely, fructose may exert an independent effect on blood pressure. Insulin resistance has been linked to an increased accumulation of visceral fat, dyslipidemia, and fat deposition, as well as the development of a fatty liver. Furthermore, dyslipidemia accelerates the process of atherosclerosis, which ultimately.

This study employed a population-based approach to estimate the proportion of consumption of various SSB in Hamedan city. The participation rate in this study was 89.0% which is favorable. One of the limitations of the study was related to the questionnaire. Despite the use of a standard FFQ tool to estimate the frequency of consumption, there is a possibility of recall bias (for consumption of SSB). Furthermore, the cross-sectional design of the study precludes the assessment of determinant factors of high SSB consumption due to the inability to specify the temporality of exposure and outcome.

Conclusion Based on the results of our study the proportion of high consumption of SSB was significant. The consumption among males was significantly more than that of females. There was a negative association between age and female gender with high consumption of SSB. Furthermore, there was a positive association between high consumption of SSB and socio-economic status. That means the consumption was higher among people with higher levels of socio-economic status.

Abbreviations

CURHCs	Comprehensive urban health service centers
SSB	Sugar-Sweetened Beverages
PCA	Principal component analysis

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-22198-1>.

Supplementary Material 1

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Author contributions

ZCh and ADI, Funding acquisition: ZCh, ADI, NSh, PCh. Methodology: ZCh. Project administration: ZCh, ADI, NSh, and PCh. Writing—original draft: ZCh, ADI, NSh, PCh & editing: ZCh.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The ethics committee of Hamadan University of Medical Sciences approved the proposal of this study (IR.UMSHA.REC.1398.522). All participants gave written informed consent.

Competing interests

The authors declare no competing interests.

Consent for publication

Not applicable.

Competing interests

The Authors declare that there is no conflict of interest.

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