Evaluating attitudes toward soft drink consumption among adults in Saudi Arabia: Five years after selective taxation implementation

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ABSTRACT

Objective: Saudi Arabia (SA) ranked first in soft drink consumption in the Middle East. A decrease in consumption was recorded after a selective 50% increased taxation policy in 2018. This study aimed to assess soft drinks consumption patterns among Saudi Arabian adults and examine the association between different attitudes and patterns post-taxation.
Methods: This cross-sectional study was conducted from October 2022 to March 2023, involving 1,935 Saudi adults aged 20–60 residing in Saudi Arabia. Participants completed online surveys using a validated questionnaire assessing sociodemographic characteristics, soft drink consumption patterns, and attitudes toward soft drinks. Chi-square and odds ratio (OR) tests were used to assess associations between sociodemographic characteristics, soft drink consumption frequency/quantity, and change in consumption patterns owing to selective taxation. Additionally, t-tests, Spearman's coefficient, and hierarchical multiple linear regression were used to measure differences in attitudes and linear relationships.
Results: Overall, 7.5% of the participants reported daily soft drink consumption, with 51.8% of these consuming less than one can per day and 41.2% consuming one can per day. Most (66.2%) reported no change in consumption post-taxation. Attitudes toward soft drink consumption varied significantly, with most agreeing on its health risks but also enjoying the drinks. Multiple regression analysis identified age, education, income, consumption frequency/quantity, and impact of taxation as significant predictors of overall attitudes toward soft drinks.
Conclusions: After taxation, 20% of participants reduced soft drink consumption, underscoring the importance of addressing taxation and intrinsic motivations to foster lasting changes in attitudes and behaviors towards soft drinks.

1. Introduction

Saudi Arabia (SA) has one of the highest obesity rates in the world (Salem et al., 2022). The overall prevalence has risen remarkably over the past three decades (Salem et al., 2022). By 2021, more than one-third (35.6 %) of the adult population had been affected (Salem et al., 2022). The prevalence varies across the country's 13 regions, with urban areas and the Eastern Region experiencing higher rates (Althumiri et al., 2021). Factors such as age, gender, and marital status significantly influence obesity rates, with older adults and women particularly affected (Benajiba et al., 2020). Several factors contribute to the obesogenic environment in SA, including poor dietary habits, over-consumption of sweetened soft drinks, fast food, and fried items, and high physical inactivity (Al-Hazzaa et al., 2012; Benajiba and Mahboub, 2019; Kamel

and Al-Otaibi, 2017; Khabaz et al., 2017; Syed et al., 2020). From a nutritional perspective, soft drinks (sweetened carbonated beverages) are considered unhealthy because of their poor nutritious value and high energy density. Consequently, the over consumption of soft drinks has been shown to be associated with serious health problems, including an increased risk of type 2 diabetes and obesity due to insulin resistance and inflammation (Ferretti and Mariani, 2019; Rivera-Paredez et al., 2020; Tseng, 2021; Vartanian et al., 2007). Similarly, non-alcoholic fatty liver disease has been associated with soft drink consumption, as it is a major source of high fructose corn syrup (Nseir et al., 2010). Moreover, the regular consumption of soft drinks has been positively associated with an increased risk of cancer (Chazelas, 2019). A multi-national analysis of 75 countries, including Middle Eastern countries, deduced that a 1 % rise in the consumption of soft drinks correlated with a 4.8 % increase in the prevalence of being overweight and a 2.3 % increase in obesity rates among adults (Basu et al., 2013). Additionally, the relative risk of obesity increased by 69 % with daily soft drink consumption (Martin-Calvo et al., 2014). Among Middle Eastern countries, SA ranked first with the highest soft drink consumption rates (Euromonitor International, 2019), with an annual per capita consumption of 113.8 L per person in 2020 (Statista, 2020).

Addressing the obesity challenge, the Saudi government embarked on a multifaceted approach, encompassing regulatory measures, policy initiatives, and commitments to promote healthier dietary strategies (Alsukait et al., 2020a; Bin Sunaid et al., 2021). In 2018, a selective taxation policy was implemented, leading to a 50 % price hike in soft drinks. Consequently, Saudi consumers began to perceive soft drinks as expensive and unhealthy (Euromonitor International, 2019). Accordingly, the quantity of soft drinks sold declined by 57.64 % between 2010 and 2017 (Megally and Al-Jawaldeh, 2020). This decrease was particularly evident in SA compared to other Arab Gulf States, as noted by Alsukait et al. (2020b). However, soft drink manufacturers have adopted compensation strategies, including reducing prices for multipacks of single-serve pack sizes, increasing the accessibility of large pack sizes, and releasing highly impactful marketing initiatives (Euromonitor International, 2019), to guarantee the same consumption level by Saudi consumers. Consequently, these strategies have posed challenges to the government's initiatives aimed at reducing soft drink consumption.

The choices of food selection and consumption are complex personal decisions that result from the interplay of numerous factors such as cultural influences, socioeconomic status, health value perceptions, and personal attitudes (Asp, 1999; Mattes and Foster, 2014). Any initiative aimed at modifying eating habits and food preferences on a larger scale should be founded on a thorough comprehension of the related elements. Swinburn et al. (2013) emphasized that creating effective interventions necessitates an in-depth knowledge of the relative significance of influential factors. This enables the prioritization of elements that hold the greatest potential for enhancing results. Aspects impacting food choices span sensory appeal, established habits and familiarity, social interactions, cost, accessibility, time limitations, personal attitudes, media and advertising influence, and health awareness (Asp, 1999; Fitzgerald et al., 2010; Pollard et al., 2002). The sociocultural factors that affect food choices can vary between nations (Pettigrew et al., 2015). Thus, the context for making a given food choice should be investigated in depth. This study aimed to assess the soft drinks consumption patterns among Saudi adults and examine the association between different consumption attitudes and patterns following the five-year implementation of selective taxation on these food items. We hypothesized that the five years of selective taxation would not significantly change attitudes toward soft drink consumption among adults in SA.

2. Materials and methods

This cross-sectional study was conducted between October 2022 and March 2023 in SA. The sample included 1,935 Saudi Arabian adults aged 20–60 years living in SA. Individuals with chronic conditions such as diabetes mellitus, or osteopenia/osteoporosis, and individuals following a specific diet for weight loss were excluded. Ethical approval was obtained from Princess Nourah bint Abdulrahman University Institutional Review Board (no. 20–0417; dated September 06, 2022). Participants gave their consent before taking part in the study by clicking on the "I agree" button, as the questionnaire was shared online. Data were collected through an online snowball survey, which included the following sections: Section 1 included sociodemographic characteristics such as age, sex, marital status, monthly income, and education level were measured as categorical variables. Age was categorized into four groups (20–29, 30–39, 40–49, 50–59); sex, into two (male and female); marital status into four (single, married, divorced, widowed); education level, into four (elementary [1st to 6th grade], high school [1st to 6th grade], college [university graduates], graduate school [postgraduate studies including Masters and PhD]); and monthly income, into four (<5000 SAR, 5000–10000 SAR, 11000–20000 SAR, >20000 SAR). Section 2 involved patterns of carbonated soft drink consumption, including the frequency, quantity, and consumption patterns after the implementation of the 50 % tax increase (Appendix 1). The frequency ranged from 1 to 5, with 1 representing "never," 2 representing "rarely (1–3 times a month)," 3 representing "sometimes (1–2 times a week)," 4 representing "usually (3–6 times a week)," and 5 representing "daily." The number of soft drinks consumed was based on the number of cans (330 ml): less than half a can, one can, two cans, or more than two cans. Section 3 included questions developed by Pettigrew et al. (2015) for evaluating attitudes toward soft drink consumption, which were adjusted to fit the aims and population of this study. It covered the attitudes of how participants perceived soft drinks and the participants were asked to rate their agreement or disagreement with each attitude using a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). (Likert, 1932). The sum of the scores for each attitude was calculated, and a total attitude measure toward soft drink consumption was generated. Overall scores ranged in the study participants from 6 to 26.

Prior to use, the questionnaire underwent pretesting with 15 Saudi women across two focus groups to establish face validity. A panel of 6 experts reviewed the relevance of each question based on a 4-point Likert scale (1 = not relevant, 2 = somewhat relevant, 3 = relevant and 4 = very relevant) to assess the content validity index for individual items (I-CVI) and the content validity index for scale (S-CVI). S-CVI/ Average and S-CVI/Universal agreement was then calculated as reported by Rodrigues et al. (Rodrigues et al., 2017). The values obtained were greater than 0.83 for I-CVI and equal to 0.91 and 0.83 for CVI/Average and S-CVI/ Universal agreement, respectively. Following feedback from the focus groups, modifications were made to the questionnaire. A Cronbach's coefficient ($\alpha = 0.72$) with a 95 % confidence interval [0.69, 0.75] was obtained indicating the questionnaire demonstrated acceptable internal consistency (Nunnally, 1978).

2.1. Statistical analysis

The required sample size was estimated using a standard statistical method designed for large populations and adjusted to account for potential missing data. The final sample size estimate was a minimum of 423 participants (Naing et al., 2006). There were two main outcome measures in this study: one was the change in after the five years of selective taxation (qualitative), and the other was attitudes (quantitative). Normality testing using the Kolmogorov test revealed that the quantitative outcome variable is normally distributed. The normally distributed continuous data (attitudes toward soft drinks consumption) were presented descriptively using as mean ± standard deviation and analytically using Student *t*-test. The Student's *t*-test was used to measure the difference in attitudes related to soft drink consumption among the two study groups included (group 1: participants that changed their consumption patterns because of selective taxation; group 2:

participants that did not change their consumption patterns because of selective taxation). The independent variables sociodemographic, frequency, and quantity of soft drinks consumed were included as categorical variables and presented as numbers and percentages. The Chi square test was used to measure the relationship between sociodemographic characteristics, frequency, quantity of soft drinks consumed and the changes in the patterns of soft drink consumption because of selective taxation. An odds ratio (OR) and 95 % confidence interval (CI) were used to measure the strength of the associations. Spearman's rho (r_s) coefficient was used to measure the strength of the linear relationship between attitude and all the study variables and categorized as weak (0.1–0.3), moderate (0.4–0.6), or strong (0.6–0.9) (Dancey and Reidy, 2004). Hierarchical multiple linear regression identified predictors of attitudes toward soft drink consumption, presented using unstandardized beta (β) and 95 % CI, with R^2 measuring model fit. Sociodemographic variables were in the first model, soft drink frequency and quantity in the second, and changes due to taxation in the final model. Dummy variables were created for categorical predictors, with significance set at p-value < 0.05. Data were analyzed using the IBM SPSS software package (version 20.0; Armonk, NY, IBM Corp).

3. Results

3.1. Sociodemographic profile

Table 1 shows the sociodemographic characteristics of 1,935 participants: 39.2 % were ≤ 30 years old, 80.4 % were female, 55.4 % were married, and 86.6 % had a university degree or higher. After the 2018 tax, 56.1 % did not change their soft drink consumption, while 43.9 % did. Statistically significant associations were found between age and changes in soft drink consumption due to taxation (X^2 (3) = 7.95, p = 0.047). Higher education levels (65.9 %) did not significantly change consumption (X^2 (3) = 18.05, p < 0.001, OR: 0.65, 95 % CI: 0.17–2.45). Similarly, high-income participants (>20,000) were less likely to change consumption (X^2 (3) = 18.59, p < 0.001, OR: 0.55, 95 % CI: 0.41–0.73).

However, most widowed women (71.4 %) significantly changed their consumption patterns and were 3 times more likely to do so (X^2 (3) = 12.6, p = 0.006, OR: 2.9, 95 % CI: 1.26–6.67). Significant associations were also found with residence; 56.6 % of participants in the western

region changed their patterns and were 1.5 times more likely to change (X^2 (4) = 14.91, p = 0.005, OR: 1.67, 95 % CI: 1.22–2.3).

3.2. Patterns of soft drinks consumption

Table 2 outlines the consumption patterns of soft drinks. A notable 17.1 % of participants reported never consuming them, whereas 38.3 % rarely consumed them (1–3 times per month). Only 7.5 % reported daily consumption. Regarding the quantity consumed in each instance, 51.8 % of participants consumed less than one can at a time, whereas 41.4 % consumed exactly one can at a time.

A higher frequency and quantity of soft drink consumption were associated with changes in the patterns of soft drink consumption because of selective taxation: Of the daily consumers, 66.2 % were less likely to change their consumption pattern (X^2 (4) = 65.8, p < 0.001, OR: 0.3, 95 %CI: 0.2–0.46). Of the participants consuming more than two cans, 55.6 % changed their consumption pattern significantly and were approximately 1.5 times more susceptible to changing their consumption patterns (X^2 (3) = 42.95, and p = 0.014, OR: 1.53, 95 %CI: 0.73–2.79).

3.3. Attitudes toward soft drink consumption

Fig. 1 displays the participants' attitudes toward soft drink consumption. Most of the participants (n = 1,227, 63.4 %) concurred with the notion that soft drinks are unhealthy. In terms of enjoyment, a substantial number of participants found soft drinks enjoyable (n = 828, 42.8 %) or very enjoyable (n = 174, 9.0 %). A total of 1182 participants (61 %) held the perception that spending money on soft drinks was wasteful. The indispensability of soft drinks at the time of eating was largely disagreed with (40.6 %, n = 785). About 41 % believed that soft drinks should not be permitted for children. Finally, about 41 % strongly agreed with the perspective that soft drinks were essential during social gatherings; thus, nuanced attitudes were evident across the various statements.

The overall mean attitude score toward soft drink consumption was 15.86 ± 3.67. On comparing the difference in attitudes related to soft drink consumption according to changing the consumption patterns as a result of selective taxation of the participants, student's *t*-test revealed

Table 1
Relationship between sociodemographic characteristics and changes in soft drink consumption patterns due to selective taxation among adults in SA, 2022–2023.

Characteristic	Responses	Overall N (%)	Study Group According to change in consumption		Test	P Value	OR (95 %CI)
			No change N (%)	Change N (%)			
Age groups (years)	≤ 30	759(39.2)	411(54.2)	348(45.8)	7.95	0.047*	1
	30–39	607(31.4)	362(59.6)	245(40.4)			0.8(0.64–0.99)
	40 – 49	316(16.3)	184(58.2)	132(41.8)			0.85(0.65–1.1)
	≥50	253(13.1)	128(50.6)	125(49.4)			1.15(0.87–1.53)
Gender	Male	380(19.6)	222(58.4)	158(41.6)	1.06	0.30	1
	Female	1555(80.4)	863(55.5)	692(44.5)			1.13(0.9–1.41)
Marital status	Never married	750(38.8)	403(53.7)	347(46.3)	12.6	0.006*	1
	Married	1072(55.4)	623(58.1)	449(41.9)			0.84(0.69–1.01)
	Divorced	85(4.4)	51(60.0)	34(40.0)			0.77(0.49–1.22)
	Widowed	28(1.4)	8(28.6)	20(71.4)			2.9(1.26–6.67)
Educational level	Primary school	9(0.5)	5(55.6)	4(44.4)	18.05	0<.001*	1
	Secondary school	250(12.9)	123(49.2)	127(50.8)			1.29(0.34–4.92)
	University	1356(70.1)	746(55.0)	610(45.0)			1.02(0.27–3.82)
	Higher studies	320(16.5)	211(65.9)	109(34.1)			0.65(0.17–2.45)
Monthly income (SAR)	<5000	820(42.4)	424(51.7)	396(48.3)	18.59	0<.001*	1
	5000–10000	424(21.9)	237(55.9)	187(44.1)			0.84(0.67–1.07)
	11000–20000	413(21.3)	240(58.1)	173(41.9)			0.77(0.61–0.98)
	> 20,000	278(14.4)	184(66.2)	94(33.8)			0.55(0.41–0.73)
Place of residence in KSA (region)	Central	853(49.4)	480(56.3)	373(43.7)	14.91	0.005*	1
	Northern	370(21.4)	206(55.7)	164(44.3)			1.02(0.8–1.31)
	Southern	236(13.7)	145(61.4)	91(38.6)			0.81(0.6–1.08)
	Eastern	75(4.3)	40(53.3)	35(46.7)			1.13(0.7–1.81)
	Western	191(11.1)	83(43.5)	108(56.5)			1.67(1.22–2.3)
Total		1935(100.0)	1085(56.1)	850(43.9)			

*P-value is statically significant < 0.05, OR: Odds Ratio, CI: Confidence Interval, SAR: Saudi Riyals, KSA: Kingdom of Saudi Arabia.

Table 2

Relationship between frequency, quantity of soft drinks consumed and changes in consumption patterns due to selective taxation among adults in SA, 2022–2023.

Characteristic	Responses	Overall N (%)	Study Group According to change in consumption pattern**		Test	P value	OR (95 %CI)
			No change N (%)	Change N (%)			
Frequency	Never	330(17.1)	123(37.3)	207(62.7)	65.8	0<.001*	1
	Rarely	742(38.3)	454(61.2)	288(38.8)			0.38(0.29–0-49)
	Sometimes	458(23.7)	251(54.8)	207(45.2)			0.49(0.37–0.65)
	Usually	260(13.4)	161(61.9)	99(38.1)			0.39(0.28–0.55)
	Daily	145(7.5)	96(66.2)	49(33.8)			0.3(0.2–0.46)
Quantity of soft drink intake	<1 can	1003(51.8)	535(53.3)	468(46.7)	42.95	0.014*	1
	1 can	801(41.4)	482(60.2)	319(39.8)			0.76(0.63–0.91)
	2 cans	95(4.9)	52(54.7)	43(45.3)			0.95(0.62–1.44)
	> 2 cans	36(1.9)	16(44.4)	20(55.6)			1.53(0.73–2.79)
Total		1935(100.0)	1085(56.1)	850(43.9)			

*P-value is statically significant < 0.05, ** Study Group: participants changed their consumption patterns because of selective taxation or not. OR: Odds Ratio, CI: Confidence Interval.

'Frequency of soft drink intake: rarely (1–3 times/month), Sometimes (1–2 times a week), Usually (3–6 times a week).

1 Can = 330 ml.

	Perceived healthiness	Enjoyment	Value for money	Indispensability during meals	Appropriateness for children	Indispensability during social gatherings
■ Strongly disagree	63.4	16.8	30.5	40.6	18	2.8
■ Disagree	30.2	18.9	30.5	31.1	26.7	14.3
▨ Neutral	10.5	12.5	20.4	6.7	9.4	7.8
■ Agree	0.3	42.8	16.7	16	34.6	34.2
■ Strongly Agree	0.2	9	1.8	5.6	11.4	40.9

Fig. 1. Distribution of attitudes towards soft drink consumption among adults in SA, 2022–2023.

that the overall mean attitude scores were significantly higher among those who did not change their pattern of soft drinks consumption (16.44 ± 3.63 vs. 15.13 ± 3.60, p= 0<.001). Moreover, those who changed the pattern of consumption had significantly lower mean scores and considered soft drinks as unhealthy compared with those who did not change their consumption pattern (1.46 ± 0.63 vs. 1.40 ± 0.65, p = 0.047) (Table 3).

Whereas, those who did not change the consumption pattern had a significantly higher mean score and considered soft drinks as enjoyable (3.04 ± 1.31 vs. 3.2 ± 1.19, p = 0.006), had a significantly higher mean score regarding whether soft drinks should not be allowed without restriction to children (3.03 ± 1.31 vs. 2.84 ± 1.35, p = 0.002), and had a significantly higher mean score considering that soft drinks have good value for money (2.39 ± 1.14 vs. 1.95 ± 1.01, p < 0.001) and considered soft drinks as non-indispensable during meals (4.01 ± 1.12 vs. 3.82 ± 1.23, p = 0.007) (Table 3).

3.4. Correlation between the study variables

The correlations matrix of the study variables is illustrated in Table 4. It shows that the overall attitude toward soft drink consumption was significantly negatively correlated with age, gender, and marital status (r^s = -0.23, −0.14, and −0.17 respectively, $p < 0.001$). Similarly, the overall attitude was negatively correlated with changing the pattern of consumption as result of selective taxation (r^s = -0.18, p < 0.001). However, a significant positive correlation was shown between overall attitude and frequency and amount of consumption of soft drinks (r^s = 0.62 and 0.14, respectively, $p < 0.001$).

3.5. Factors potentially predicting attitude towards soft drink consumption

Multiple regression analysis was used to explore factors potentially

Table 3

Differences in attitude scores on soft drink consumption by changing consumption patterns due to selective taxation among adults in SA, 2022–2023.

Variables	Overall M +/- SD	Study Group According to change in consumption**		p-value
		No change M +/- SD	**Change M +/- SD**	
Perceived healthiness	1.43 ± 0.64	1.46 ± 0.63	1.40 ± 0.65	0.047*
Enjoyment	3.08 ± 1.28	3.04 ± 1.31	3.20 ± 1.19	0.006*
Value for money	2.29 ± 1.12	2.43 ± 1.14	2.10 ± 1.09	0<.001*
Indispensability during meals	2.14 ± 1.26	2.25 ± 1.30	2.01 ± 1.20	0<.001*
Appropriateness for children	3.96 ± 1.15	3.03 ± 1.31	2.84 ± 1.35	0.002*
Indispensability during social gatherings	2.95 ± 1.34	3.96 ± 1.11	3.96 ± 1.19	0.96
Overall attitude	15.86 ± 3.67	16.44 ± 3.63	15.13 ± 3.60	0<.001*

* P-value is statically significant < 0.05; ** Study Group: participants changed their consumption patterns because of selective taxation or not; M: mean; SD: standard deviation; means ± SD refer to attitude scores.

predicting attitudes towards soft drink consumption after conducting a univariate analysis, the significant variables of which were included in the corresponding block of the multiple regression analysis as revealed in Table 5. Sociodemographic variables entered into the first block of the regression analysis model, including age, gender, marital status, income, and region of residence. Then, both frequency and amount of consumption were entered in the second block. Whereas, in the third block, we included changes in the pattern of consumption. The multiple regression model revealed that the third block was the one with the greatest predictive capacity of attitudes toward soft drinks and significantly predicted 44 % of the outcome variance ($R^2 = 0.44$, $p < 0.01$), which is considered large according to Cohen's guidelines. Independent factors that significantly predicted overall attitude towards soft drink consumption included age (ß=-0.15, $t = -6.18$, $p < 0.001$), educational level (ß=-0.05, $p = 0.02$), income (ß=0.06, $p = 0.02$) frequency of consumption (ß=0.49, $p < 0.001$), amount of consumption (ß=0.13, $p < 0.001$) and changing the pattern of consumption according to selective taxation (ß=-0.07, $p < 0.001$) (Table 5).

4. Discussion

The results supported our hypothesis as a significant majority of the sample did not report changes in their dietary habits related to soft drink consumption during the 5-year initial taxation period; one in five participants reduced soft drink consumption, while one in 20 reported an increase. This outcome is consistent with that of a 2022 study that observed a 19 % decrease in soft drink consumption in Medina, SA (Jalloun and Qurban, 2022); although the most significant effects were likely observed one year after the tax increase (Alsukait et al., 2019). This finding may be due to the strong correlation between favorable attitudes toward soft drink consumption and the frequency of consumption. In this study, widowed participants reported a significant change in dietary patterns within the sample population; region of residence (western region) was also associated with behavior change. How soft drinks are marketed, sold, and regarded by consumers may be

Table 4

Spearman's Rank Correlation matrix of attitudes towards soft drink consumption and sociodemographics factors among study participants in SA, 2022–2023.

	Attitude	Age	Gender	Marital status	Education	Income	Residence	Frequency	Amount Used	Change pattern
Attitude	1									
Age	−0.23**	1								
Gender	−0.14**	−0.06**	1							
Marital status	−0.17**	0.58**	0.11**	1						
Education	0.03**	0.09**	−0.03	0.07**	1					
Income	−0.01**	0.49**	−0.18**	0.33**	0.35**	1				
Residence	0.05**	−0.24**	−0.07**	−0.16**	−0.07**	−0.21**	1			
Frequency	0.62**	−0.18**	−0.18**	−0.13**	−0.08**	−0.07**	0.10**	1		
Amount Used	0.50**	−0.14**	−0.12**	−0.11**	−0.09**	−0.09**	0.09**	0.69**	1	
Change pattern	−0.18**	−0.004	−0.04	−0.01	−0.09**	−0.09**	0.07**	0.10**	0.17**	1

* Correlation is significant at 0.05 level; ** Correlation is significant at 0.01; Spearman's rank coefficient (rho) is shown.

Table 5

Regression analysis of sociodemographic characteristics, soft drink intake vs. attitude score among adults in SA, 2022–2023.

	Univariate analysis		Multivariable analysis					
			Model 1[b]		**Model 2[c]**		**Model 3[d]**	
	β (95 % CI)	Sig.	β (95 % CI)	Sig.	β (95 % CI)	Sig.	β (95 % CI)	Sig.
Constant			18.49	21.14	12.051	0<.001*	12.400	0<.001*
Age	−0.81(−0.97 to −0.7)	0<.001*	−0.28(−1.2 to 0.76)	0<.001*	−0.16(−0.71 to −0.37)	0<.001*	−0.15(−0.7 to-.36)	0<.001*
Gender	−1.3(−1.7 to −0.92)	0<.001*	−0.15(−1.8 to-.89)	0<.001*	−0.04(−0.67 to 0.02)	0.065	−0.04(−0.7 to.027)	0.07
Marital	−1.01(−1.26 to-.75)	0.04*	−0.02(−0.44 to.23)	0.53	−0.02 (−0.39 to-.14)	0.346	−0.02(−0.39 to.13)	0.33
Education	0.204(−0.09 to −0.49)	0.03*	0.01(−0.28 to.35)	0.83	0.05(0.08 to.58)	0.01*	0.05(0.05 to.56)	0.02*
Income	−0.048(−0.19 to −0.10)	0.05	0.07(0.05 to 0.44)	0.02*	0.06(0.05 to −0.35)	0.01*	0.06(0.04 to.34)	0.02*
Residence	0.126(−0.03 to-.26)	0.05	−0.02(−0.18 to 0.08)	0.43	−0.05(−0.22 to −0.02)	0.02*	−0.04(−0.2 to-.01)	0.03*
Frequency	2.0(1.9 to 2.1)	0<.001*			0.49(1.43 to1.75)	0<.001*	0.49(1.4 to 1.73)	0<.001*
Amount	2.09(1.9 to 2.26)	0<.001*			0.15(0.41 to 0.83)	0<.001*	0.13(0.36 to 0.78)	0<.001*
Pattern change	−0.14(−0.53 to-.25)	0<.001*					−0.07(−0.25 to-07)	0<.001*
Model statistics			$R^2 = 0.086$, adj $R^2 = 0.086$, $P < 0.001$		$R^2 = 0.43$, adj $R^2 = 0.35$, $P < 0.001$		$R^2 = 0.44$, adj $R^2 = 0.008$, $P < 0.001$	

* P <.05 is significance; adjustments were made for confounding factors, β: standardized beta

a. Dependent Variable: overall attitude score

b. Model 1: Predictors: (Constant): Age, Gender, Marital status, Education, Income, Residence

c. Model 2: Predictors: (Constant): Age, Gender, Marital status, Education, Income, Residence, Amount, Frequency

d. Model 3: Predictors: (Constant): Age, Gender, Marital status, Education, Income, Residence, Amount, Frequency, Consumption after the implementation of 50% taxes

influenced by region of residence, this finding is not yet accounted for within the scope of this study. Widowed status presents as a curious outcome and further investigation into a causal relationship between this variable and reduced consumption may be warranted. The mediating factors of higher education level and higher income did not significantly affect these outcomes.

We observed a modest yet notable decline in soft drink consumption following the 50 % tax increase; however, this deterrent does not appear to be stronger than favorable attitudes toward soft drink consumption (e.g., soft drinks are enjoyable during meals and social gatherings) (Benajiba et al., 2020). Our analyses did not specifically quantify the percentage of these minority groups, accounting for 45 % of those who consume soft drinks weekly or daily. Further research targeting regular soft drink consumers is warranted. Understanding the sociodemographic characteristics of Saudi Arabians who consume soft drinks weekly or daily could lead to a better understanding of their motivations, and strategic campaigns designed to educate and reduce consumption can be employed.

Following taxation changes by the Saudi Government in 2018, soft drink companies developed targeted responses. The selected pricing schemes and promotional efforts likely counteracted some of the anticipated decreases in soft drink consumption. The decision-making process surrounding food choices and dietary adjustments is intricate and influenced by an array of factors, including sensory appeal, familiarity and habit, social interactions, and personal attitude. The cost of the product is just one of many factors (Asp, 1999; Fitzgerald et al., 2010; Pollard et al., 2002). While raising costs as a deterrent can be a valuable part of the solution, consumers are unlikely to alter their established patterns, habits, or attitudes based on a single adjustment. Our linear regression model demonstrated that taxation in concert with measurable, intrinsic (age) and extrinsic (income, consumption behaviors) factors can be effective in reducing soft drink consumption; we caution against considering how education affects this relationship given the ubiquity of this variable in our study sample. However, the circumstances become more complex when beverage companies counter-taxation through price reductions, as evidenced by industry trends (Euromonitor International, 2019).

Our study highlights the importance of intrinsic attitudes toward unhealthy dietary habits compared to extrinsic deterrents (e.g., taxation). The idea that soft drinks are "healthy" or "enjoyable" are important indicators of consumption, outweighing awareness of their adverse health effects and the financial implications. Our study, characterized by educated Saudi Arabian adults with moderate incomes, underscores the prevalence of habits and attitudes, potentially intertwined with social expectations (e.g., social gatherings, soft drinks with food). This dynamic might exert a more potent influence than costs and health concerns, particularly among women (Benajiba et al., 2020). While we do not discount the impact of taxation on soft drink consumption, we propose integrating it into a multifaceted, stratified framework. It appears that within certain strata, the influence of cost on behavior might not be decisive. Our study underscores the necessity of delving beyond surface-level interventions like taxation and addressing the complex amalgamation of attitudes, habits, and societal norms that steer dietary preferences.

4.1. Strength and Limitations

The study has several strengths. First, it stands out as one of the few studies that have delved into attitudes toward soft drink consumption post-implementation of a 5-year taxation period. Second, it encompasses a sizable sample drawn from all regions within SA. Third, the questionnaire used was previously tested for its validity and reliability.

However, it also had certain limitations. First, the cross-sectional design that we used makes it hard to determine a direct cause-and-effect relationship. Second, although we employed a validated questionnaire, relying on questionnaires to measure soft drink consumption

could lead to errors when interpreting the findings due to recall bias, reporting bias, and social desirability. Third, the sample population was largely female (80.4 %) and educated (86.6 %), holding conventional higher institution degrees. Moreover, Saudi women consume soft drinks at higher rates than the general adult population of SA. These demographic and behavioral factors limit the generalization of our results to the broader target population. Second, our respondents recounted their soft drink consumption habits approximately five years after the 50 % tax hike. Such self-reported experiences are contingent on accurate memory and are inherently subjective. Consequently, our attempt to objectively report consumption rates was inevitably influenced by this limitation.

5. Conclusion

The study examined the impact of a 50 % tax increase on soft drinks implemented by the Saudi Arabian government in 2018, aimed at curbing overweight and obesity. Over a 5-year period, approximately 20 % of participants showed a decrease in soft drink consumption. Significant factors influencing attitudes towards soft drink consumption were identified, particularly related to mealtimes and social contexts. Despite modest overall effects, taxation appeared to be more effective among certain age and income groups. The findings underscore the importance of addressing both extrinsic factors like taxation and intrinsic motivations to foster lasting changes in attitudes and behaviors towards soft drink consumption.

Author contributions

All authors have contributed equally to this work including writing the manuscript. All authors approved the final version for publication.

CRediT authorship contribution statement

Shahd Alabdulkader: Writing – original draft, Validation, Supervision, Project administration, Methodology, Funding acquisition. **Abeer S Alzaben:** Writing – review & editing, Methodology, Data curation. **Fatmah Almoayad:** Writing – review & editing, Methodology, Data curation. **Eman M Mortada:** Writing – review & editing, Formal analysis, Data curation. **Nada Benajiba:** Writing – review & editing, Methodology, Conceptualization. **Basil H. Aboul-Enein:** Writing – original draft. **Elizabeth Dodge:** Writing – original draft. **Joshua Bernstein:** Writing – original draft. **Nahla Bawazeer:** Writing – review & editing, Methodology, Data curation.

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.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.

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