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The Socio-Economic Determinants of Energy Drink Consumption and Related Health Outcomes in Riyadh, Saudi Arabia

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Abstract

Objective: To estimate the prevalence and socio-economic determinants of energy drink (ED) consumption and related health outcomes in Riyadh, Saudi Arabia.

Methods: A self-report survey was used to collect data from 2,024 students (aged 13-20 years). Logistic regression was used to determine the relationship between ED consumption, diet and health-related outcomes.

Results: In total, 54% of young people reported ED consumption at least once and 25.5% at least weekly. The most common (38.65%) reason for ED consumption was the enjoyable flavour. Male students reported higher ED consumption compared to females (OR = 1.26, 95% CI 1.08 to 1.46). ED consumption was associated with an unhealthy diet (OR = 1.69, 95% CI 1.53 to 1.87), tobacco use (OR = 5.91, 95% CI 3.47 to 10.07), poor quality sleep (OR = 0.73, 95% CI 0.47 to 0.99). Those who regularly ate breakfast were less likely to report ED consumption (OR = 0.89, 95% CI 0.83 to 0.95).

Conclusion: More than 1 in 2 young people reported ED consumption among a sample of Riyadh-based students. Consumption was found to be associated with a poor-quality diet and negative health outcomes. Findings suggest that there is a public health need to reduce the consumption of EDs among this population.

Keywords: ED, consumption, health outcomes, young people, socio-economic

1. Introduction

An energy drink (ED) is a non-alcoholic beverage that contains caffeine and sugar, served in combination with brand-specific ingredients that can include herbal extracts. These drinks are advertised as energy boosters, improving mental alertness and physical performance. (Seifert et al., 2011). The consumption of ED has increased significantly, becoming a global health problem in the past few years. The global EDs market is estimated to reach $61 billion by 2021 worldwide (Piccioni et al., 2020; Saku et al., 2020).

The continuous increase in consumption and sales has drawn the attention of policymakers and health consultants worldwide (WHO, 2014). The sale of EDs has now been restricted for children <16 years in some European countries, such as Sweden (2008) and Germany (2008), and legislation has been introduced in several Nordic countries and Canada (Seifert et al., 2011). The United Kingdom is also reviewing to ban the sale of EDs for under 16 (Global and Public Health Group 2018). While other countries have implemented changes to labelling laws that include a requirement for clear health warnings; an approach adopted universally across the European Union (Seifert et al., 2011). ED manufacturers have been aggressively marketing EDs in Saudi Arabia over the past two decades. According to the Global EDs Report (2012), Saudi Arabia was one of the top ten nations by per capita ED consumption. The more recent Global ED report (2019) stated an 8.9% increase in growth in the global EDs market, but the Middle East and North Africa reported a considerable decline in consumption. This was due to the implementation of a 50% tax on energy drinks in Saudi Arabia. As a result, energy drink consumption decreased by 9.5% during 2018 in Saudi Arabia.

There are not many studies that report the prevalence of ED consumption among young people from the Middle East, particularly in Saudi Arabia. Al-Hazzaa et al. (2011) reported that 16.3% of males in Saudi Arabia aged 14 to 19 years consumed EDs more than three times a week (Al-Hazzaa et al., 2011). More recently, higher prevalence rates have been recorded across different districts in Saudi Arabia. In the city of Damman, 45.6% of students reported ED consumption (Alsunni & Badar, 2011) while 59.9% of students in Jeddah city reported consumption at least once can a week (Alrasheedi, 2016). In Madinah, 52.2% of female students reported ED consumption (Aluqmany et al., 2013) and Epuru et al., (2015) stated 60% of male students from two education level; secondary and elementary school, in Hail city, were current ED consumers, with a higher percentage from the secondary school (Epuru et al., 2015). A common occurrence among all these studies was the higher prevalence of reported consumption among males compared to females.

Adolescents (aged 12-19 years) represent 20% of the population in Saudi Arabia (AlBuhairan & Olsson, 2014). In 2012, Saudi's Council of Ministers banned the sale of EDs at all government, education and health facilities, and abolished advertising and sponsorship by ED manufacturers. Moreover, the Saudi government now requires ED companies to include a health warning on ED labels together with advice that consumption should not exceed two servings each day, written both in Arabic and English (Alrasheedi, 2016). In 2017, the Saudi government further imposed a tax on unhealthy products that included a 100% tax on EDs. Despite all the precautions, EDs are still readily available and accessible to adolescents in Saudi Arabia, and there are no age restrictions put on sales (Alrasheedi, 2016). Although there are earlier reports on consumption rates among different provinces in Saudi Arabia (Alabbad et al., 2019), research on the prevalence of EDs consumption among Saudi youth remains limited. Many studies (Alabbad et al., 2019; Subaiea et al., 2019; Aljaloud, 2016) have focused on the prevalence of consumption rates and have not attempted to identify any determinants of ED consumption. Moreover, no study has considered the association between ED consumption and health outcomes among young people in Saudi Arabia. An understanding of current consumption rates is needed to develop strategies to increase awareness and inform future prevention measures.

According to findings of our recent review (Alhumud et al., 2020), the consumption of EDs is associated with a multitude of serious adverse effects on young people's health (Physical, mental, and behavioural health) and as such underpins the hypothesis of this study. This study determines the prevalence of self-reported ED consumption among a representative sample of Saudi's aged 13-20 years in Riyadh. It assesses the association between socio-demographic characteristics and ED consumption and also the association between ED consumption and health behaviours and health outcomes.

2. Method

2.1 Study Sample

Male and female students, aged between 13 and 20 years and enrolled in an intermediate or high school in Riyadh, Saudi Arabia were eligible for the study. A random sampling technique was used to recruit the study sample. The minimum sample size was determined to be ±0.05 of the total Riyadh population belonging to the age group of 13 to 20 years (N = 1,522 schools and N = 424,434 students).

A random selection of 25 schools (including private and public) was identified using the official school list. The sample was recruited from intermediate schools (students aged 13 to 15 years) and secondary schools (students aged 16 to 20 years). For each randomly sampled school, an email was sent to the headteacher describing the study aims and objectives along with the approval letter from the Ministry of Education. Nine of the schools declined to participate in the study giving no reason; two classes were randomly selected from each year from the remaining 16 schools that agreed to participate (96 classes in total). The prospective sample size of 1,522 was increased to 1,000 males and 1,000 females to account for possible attrition.

2.2 Procedure

All participants were informed about the objectives and type of the study. Written informed consent was gathered from parents before the study survey was issued to the participants. Before data collection, the students were informed that participation was entirely voluntary. Data were collected from February 2018 to April 2018. Approval for the study was obtained from the Ethical Committee of the Ministry of Education in Saudi Arabia.

2.3 Study Tools

The survey developed was based on an existing model implemented by the School Health Research Network (SHRN) in the United Kingdom (SHRN, 2018). The format of the survey was revised, and some questions relevant to ED consumption in Saudi Arabia were added. (Attached in Supplementary section). The survey was initially developed in English and subsequently translated into the Arabic language. Once the data collection using the

Arabic survey was completed, the data was translated from Arabic back into English, and the forward-backwards-forward translation technique (Apolone & Mosconi., 1998) was applied to check the accuracy.

A pilot study was carried out before the full implementation of the research study. It involved the distribution of the study questionnaire to a group of 15 students aged between 13 and 18 based in Saudi Arabia. The pilot group comprised of seven male and eight female students chosen randomly from different schools that fulfilled the inclusion criteria. The researcher was present to address any queries from the students regarding the study survey. Following a period of 14 days, the survey was redistributed to the same 15 students. This step was included in determining whether a difference was observed in either the survey results or difficulties in completing the survey when students completed the survey twice. No change was made to the survey following the piloting. The survey data collected at both points reported the same results, and there was no variation observed across the data for each of the 15 participants. The 15 participants that took part in the pilot study and the survey used for the pilot study were excluded from the final analysis.

The survey was divided into three sections. The first section collected data concerning participants' demographics, including gender, age, education level, nationality and family monthly income. The second section included multiple-choice questions on ED consumption and reasons for consumption, with response options of 'it is a famous brand', 'Good taste', 'Advised to drink ED', 'It is available', 'Helps me to wake up', 'Other', 'Do not know'. The third section covered participants' physical and mental health, and behavioural outcomes such as (smoking, eating breakfast, healthy diet, sleep times).

2.4 Data Analysis

Data analysis was done using STATA (v.14, Stata Corp LLC) (STATACORP, 2018). Descriptive statistics were used to calculate frequencies for categorical data such as gender, age group, nationality, type of school, family income and, student pocket money. Data reduction techniques were used for data from the dietary questions that dealt with the frequency of consumption fruits, vegetables, sweets, coke or other soft drinks, skimmed or semi-skimmed milk, full-fat milk, other milk products (yoghurt, milkshakes), chips, white bread, cereals, fish. Responses resolved to two indices: healthy and unhealthy. However, low-fat milk, full-fat milk, cornflakes, and fish consumption had low factor loadings and thus, were excluded from indices (Table 1).

Table 1. The factor loadings for each of the variables as well as the unique variances estimated per variable

Variable	Healthy	Unhealthy
Fruit	0.52	-0.03
Vegetables	0.95	-0.12
Sweets	0.15	0.53
Soft drinks	-0.00	0.55
Low fat milk	0.23	0.04
Full fat milk	0.25	0.20
Milk products	0.42	0.23
Potato chips	0.11	0.50
White bread	0.29	0.67
Cornflakes	0.14	0.26
fish	0.23	0.03

Possible side effects of ED consumption among the young people was evaluated by asking how often had they suffered from a headache, stomach ache, nervousness, dizziness, irritability, low mood, insomnia, feeling dizzy, and depression in the last six months. Factor analysis was used as a data reduction technique on health data, which resolved to one index, which was termed 'wobbles' (including 'headache', 'stomach ache', 'irritation', 'insomnia', 'feeling dizzy', with 'depression',' nervousness', 'dizziness' being dropped due to a low factor loading). Logit and general linear models examined the associations between ED consumption, and socio-economic determinants, adverse effects and other factors affecting ED consumption (Table 2). The Quantity of ED consumed referred to how many EDs would one usually drink in one go. ED frequency referred to how many times a week does one

usually drink EDs. In addition, a new variable was created, ED intensity which was defined as a composite of two existing variables; ED frequency and ED quantity.

Table 2. The factor loadings for each of the health related outcomes variables as well as the unique variances estimated per variable

Variable	Factor 1(Wobbles)
Headache	0.85
Stomach aches	0.49
Irritation	0.77
Feeling low	0.36
Insomnia	0.45
Feeling dizzy	0.52
Depression	0.46

The analysis was conducted on the amount of ED consumed by students to establish an impact on their physical health and sleep patterns. Ordered logistic regressions were used with factors predicting student's eating behaviours (consumption of breakfast), and to assess whether the quantity of ED consumed also impacted student's sleeping patterns. Lastly, logistic regression was generated to determine whether the amount of ED consumed had an impact on the student's oral health.

3. Results

3.1 Socio-Demographic Characteristics of the Participants

Twenty-four students (18 male and 6 female) opted out of the study giving viable data for the 2000 surveys, a response rate of 98% was noted. The ratio of females and males was 1:1. Most of the participants were Saudi nationals (84.73%), and 45.65% were from public school. Table 3 provides an overview of participant's demographic characteristics.

Table 3. Demographic characteristic of study participants

Characteristic		n (%) *
Gender		
	Male	1,000 (50.00)
	Female	1,000 (50.00)
Age Group (year)		
	13	368 (18.40)
	14	473 (23.65)
	15	371 (18.55)
	16	312 (15.60)
	17	240 (12.00)
	18	99 (4.95)
	19	54 (2.70)
	20	83 (4.15)
Nationality	Saudi	1,692 (84.73)
	Non-Saudi	305 (15.27)
Type of education	Public	913 (45.65)
	Private	1,087 (54.35)

Family monthly income*	Low	312 (15.60)
	Middle	1,532 (76.60)
	High	155 (7.75)
Student pocket money (£, monthly)	≤60	1,210 (60.50)
	>60	790 (39.50)

* 0.5% of the participants did not respond to this question.

3.2 EDs Consumption

Of the total sample, 52.5% reported ED consumption, of which, 25% reported consumption of one can per week, 11.20% reported two to four cans per week, and 1.60% (n = 32) drank more than one can per day. When providing reasons for consumption, 39% of students reported that they enjoyed the flavour and 57% reported other reasons such as for driving, for trying something new, and using as substitute social drink. It was also found that 32 % of the students started to consume EDs between the age of 11-15 years, with 22% consuming EDs at home (Table 4).

Table 4. Consumption of energy drinks among participants

Variable	**n (%)**
Consumption of EDs	
Yes	1,051 (52.55)
No	949 (47.45)
ED Consumption	
Once a week	511 (25.55)
2-4 at Week	224 (11.20)
5-6 at Week	43 (2.15)
More than once a day	32 (1.60)
Do not know	241 (12.05)
Never	949 (47.45)
Reason for drinking EDs (only drinkers)	
It is a famous brand	87 (4.35)
Good taste	773 (38.65)
Advised to drink ED	48 (2.40)
It is available	29 (1.45)
Helps me to wake up	57 (2.85)
Other	57 (2.85)
Do not know	949 (47.45)
At what age did you have your first ED? (only drinkers)	
Less than 5 years of age	26 (1.30)
6-10 years of age	170 (8.50)
11-15 years of age	635 (31.75)
16 years of age	164 (8.20)
Do not know	56 (2.80)
Do not want to answer	949 (47.45)

3.3 Frequency of EDs Consumed

Table 5 shows that males were 1.23 times (95% CI, 1.07 to 1.41 P<0.05) more likely to consume ED more frequently, compared to females. Participants with secondary school education were also 1.55 times (95% CI, 1.12 to 2.16 P<0.05) more likely to consume ED frequently than younger students (elementary school); in addition to those with unhealthy diets (odds ratio = 1.67; 95% CI, 1.52 to 1.83 P<0.05) and those who smoke (odds ratio = 5.67; 95% CI, 3.41 to 9.44 P<0.05). Students who ate breakfast were 0.88 times (95% CI, 0.83 to 0.94 P<0.05) less likely to consume ED.

Table 5. Ordered logistic regression analysis between the frequency of ED consumption and consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people

ED consumed (frequency)	Coef.	Std. Err.	z	p>z	95% Conf.	Interval
Male	0.21	0.07	2.95	0.003	0.07	0.34
Secondary school	0.44	0.16	2.65	0.008	0.11	0.77
State school	-0.04	0.08	-0.48	0.633	-0.21	0.12
Saudi nationality	0.24	0.18	1.34	0.180	-0.11	0.60
Father education	0.12	0.13	0.92	0.359	-0.14	0.38
Family income - medium	0.05	0.17	0.28	0.778	-0.29	0.38
Family income high	0.02	0.19	0.09	0.925	-0.36	0.40
Healthy diet	-0.07	0.06	-1.2	0.229	-0.19	0.04
Unhealthy diet	0.51	0.04	10.79	<0.001	0.42	0.60
Age	-0.03	0.03	-1.07	0.284	-0.09	0.02
Nicotine use	1.73	0.26	6.67	<0.001	1.22	2.24
Eat breakfast	-0.12	0.03	-4.02	<0.001	-0.18	-0.06

3.4 Quantity of EDs Consumed

It can be seen in Table 6 that males were 1.23 times (95% CI, 1.07 to 1.43 P<0.05) more likely to consume higher quantities of ED compared to females. Students with secondary education were also 1.52 times (95% CI, 1.14 to 2.01 P<0.05) more likely to consume higher quantities of ED. Students with unhealthy diets were 1.68 times (95% CI, 1.53 to 1.85 P<0.05) more likely to consume higher quantities of ED, and also those who used nicotine were 5.53 times (95% CI, 3.69 to 8.28 P<0.05) more likely to consume higher quantities of ED. Students who ate breakfast were 0.89 less likely to consume higher quantities of ED (95% CI, 0.83 to 0.96 P<0.05). In terms of socio-economic status, the young people with high family income were 1.08 more likely to consume high quantities of ED, but it was not statistically significant (p > 0.05).

Table 6. Ordered logistic regression analysis between the quantity of ED consumption and consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia, young people

ED (quantity)	Coef.	Std. Err.	z	p>z	95% Conf.	Interval
Male	0.21	0.074	2.83	0.005	0.06	0.36
Secondary school	0.42	0.14	2.87	0.004	0.13	0.70
State school	-0.03	0.10	-0.33	0.743	-0.24	0.17
Saudi nationality	0.12	0.20	0.63	0.531	-0.27	0.52
Father education	0.15	0.12	1.23	0.220	-0.09	0.38
Family income - medium	0.04	0.15	0.28	0.777	-0.26	0.35
Family income high	0.08	0.15	0.56	0.577	-0.21	0.38

Healthy diet	-0.07	0.03	-2.03	0.042	-0.14	-0.00
Unhealthy diet	0.52	0.04	10.91	<0.001	0.42	0.61
Age	-0.03	0.03	-0.99	0.32	-0.09	0.03
Nicotine use	1.71	0.20	8.31	<0.001	1.30	2.11
Eat breakfast	-0.11	0.03	-3.03	0.002	-0.19	-0.04

3.5 Intensity of EDs Consumed

It was found that males were 1.26 times (95% CI, 1.08 to 1.46 P<0.05) more likely to consume ED of higher intensity compared to females. Students who had secondary education were also 1.57 times (95% CI, 1.14 to 2.15 P <0.05) more likely to consume ED of higher intensity as compared to high schoolers. It was also observed that unhealthy diets lead to 1.69 times (95% CI, 1.53 to 1.86 P<0.05) higher consumption of ED of higher intensity. Those who used nicotine were 5.91 times (95% CI, 3.47 to 10.07 P<0.05) more likely to consume ED of higher intensity. However, students who ate breakfast were 0.89 times (95% CI, 0.83 to 0.95 P<0.05) less likely to consume ED of higher intensity (Table 7).

Table 7. Ordered logistic regression analysis between Intensity of ED consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people

ED consume (intensity)	**Coef.**	**Std. Err.**	**z**	**p>z**	**95% Conf.**	**Interval**
Male	0.23	0.08	3.01	0.003	0.08	0.38
Secondary school	0.45	0.16	2.76	0.006	0.13	0.76
State school	-0.05	0.08	-0.65	0.518	-0.22	0.11
Saudi nationality	0.21	0.19	1.09	0.278	-0.17	0.60
Father education	0.12	0.13	0.89	0.374	-0.14	0.38
Family income - medium	0.04	0.16	0.23	0.821	-0.28	0.35
Family income high	0.00	0.17	0.02	0.982	-0.34	0.34
Healthy diet	-0.07	0.04	-1.47	0.143	-0.16	0.02
Unhealthy diet	0.52	0.05	10.47	<0.001	0.43	0.62
Age	-0.02	0.03	-0.78	0.433	-0.08	0.03
Nicotine use	1.78	0.27	6.54	<0.001	1.24	2.31
Eat breakfast	-0.12	0.03	-3.41	0.001	-0.19	-0.05

3.6 Amount of EDs Consumed and Its Association on the Physical Health and Eating Behaviours of Students

It was observed that participants who consumed higher quantities of ED were more likely to experience poor health outcomes that include headache, irritation, and dizziness (Table 8). The results indicated that young people who consumed higher quantities of ED were 0.74 times (95% CI, 0.64 to 0.84 P < 0.05) less likely to eat breakfast. Students who used nicotine were also 0.57 times (95% CI, 0.41 to 0.79 P < 0.05) less likely to eat breakfast. However, students with healthy diets were 1.44 times (95% CI, 1.33 to 1.55 P < 0.05) more likely to eat breakfast. Thus, an increase in the quantity of ED consumed is significantly associated with an increase in the odds of students eating breakfast, as can be seen in Table 9.

Table 8. Linear regression analysis between health outcomes and the quantity of ED consumption, consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people

Health outcomes	Coef.	Std. Err.	z	p>z	95% Conf.	Interval
ED (quantity)	0.36	0.03	10.17	<0.001	0.28	0.42
Male	-0.01	0.04	-0.38	0.71	-0.11	0.08
Secondary school	0.06	0.07	0.85	0.403	-0.09	0.21
State school	-0.02	0.04	-0.52	0.606	-0.12	0.07
Saudi nationality	-0.01	0.07	-0.13	0.895	-0.15	0.14
Father education	-0.02	0.05	-0.4	0.691	-0.12	0.08
Family income - medium	-0.05	0.12	-0.45	0.659	-0.31	0.20
Family income high	-0.09	0.11	-0.83	0.416	-0.34	0.14
Healthy diet	-0.08	0.03	-2.92	0.008	-0.14	-0.02
Unhealthy diet	0.05	0.02	2.3	0.032	0.00	0.09
Age	0.03	0.02	1.23	0.235	-0.02	0.06
Nicotine use	0.39	0.07	5.52	<0.001	0.24	0.53
Eat breakfast	-0.06	0.01	-3.97	0.001	-0.09	-0.03

Table 9. Ordered logistic regression analysis between eating breakfast and the quantity of ED consumption and consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people

Eat breakfast	Coef.	Std. Err.	z	p>z	95% Conf.	Interval
ED (quantity)	-0.31	0.07	-4.47	<0.001	-0.44	-0.17
Male	-0.01	0.13	-0.07	0.945	-0.25	0.23
Secondary school	-0.13	0.12	-1.07	0.283	-0.36	0.10
State school	0.01	0.07	0.08	0.935	-0.14	0.15
Saudi nationality	0.04	0.11	0.37	0.711	-0.18	0.26
Father education	0.10	0.13	0.76	0.449	-0.16	0.36
Family income - medium	-0.12	0.15	-0.78	0.433	-0.43	0.18
Family income high	-0.02	0.21	-0.11	0.91	-0.43	0.38
Healthy diet	0.36	0.039	9.37	<0.001	0.29	0.44
Unhealthy diet	0.04	0.037	1	0.317	-0.03	0.11
Age	-0.02	0.038	-0.59	0.554	-0.09	0.05
Nicotine use	-0.55	0.16	-3.39	0.001	-0.88	-0.23

Students who consumed higher quantities of ED were 0.73 times (95% CI, 0.47 to 0.99 P<0.05) less likely to sleep at later times. Students who were Saudi nationals were also 0.65 times (95% CI, 0.22 to 1.09 P<0.05) more likely to sleep at later times; inclusive of students with an unhealthy diet (OR= 0.22; 95% CI, 0.09 to 0.35 P<0.05) and students who used nicotine (OR= 0.61; 95% CI, 0.19 to 1.02 P<0.05). Students with healthy diets were 0.23 times (95% CI, 0.35 to 0.12 P<0.05) less likely to sleep at later times, along with students who ate breakfast (OR= 0.26; 95% CI, 0.37 to 0.16 P<0.05). Thus, a significant association with an increase in the quantity of ED consumed with an increase in the odds of students sleeping at later times can be seen in Table 10.

Table 10. Linear regression analysis between sleep late and the quantity of ED consumption, consumption and gender, grade, ethnicity, school type, nationality, Father education, family income, smoking, and breakfast in Saudi Arabia young people

Sleep late	Coef.	Std. Err.	z	p>z	95% Conf.	Interval
ED (quantity)	0.73	0.12	5.86	<0.001	0.47	0.99
Male	-0.18	0.12	-1.5	0.15	-0.43	0.07
Secondary school	0.41	0.26	1.55	0.136	-0.14	0.96
State school	-0.16	0.18	-0.9	0.378	-0.54	0.21
Saudi nationality	0.65	0.21	3.14	0.005	0.22	1.085
Father education	0.05	0.14	0.36	0.722	-0.23	0.33
Family income - medium	-0.05	0.35	-0.13	0.898	-0.78	0.69
Family income high	0.45	0.34	1.32	0.203	-0.26	1.17
Healthy diet	-0.23	0.06	-3.92	0.001	-0.35	-0.10
Unhealthy diet	0.22	0.06	3.52	0.002	0.09	0.35
Age	0.019	0.05	0.34	0.735	-0.09	0.13
Nicotine use	0.61	0.19	3.07	0.006	0.194	1.02
Eat breakfast	-0.26	0.05	-5.38	<0.001	-0.35	-0.15

It is seen in Table 9, that students who consumed higher quantities of ED were 1.40 times (95% CI, 1.19 to 1.64 P<0.05) more likely to be in the higher categories of poor oral health, students with fathers who had degrees were also 1.32 times (95% CI, 0.99 to 1.17 P ≤ 0.05) more likely to be in the higher categories of poor oral health. Lastly, students who used nicotine were 2.06 times (95% CI, 1.46 to 2.92 P<0.05) more likely to be in the higher categories of poor oral health. Thus, an increase in the quantity of ED consumed is significantly associated with an increase in the odds of students being in the higher categories of poor oral health (Table 11).

Table 11. Linear regression analysis between oral health and the quantity of ED consumption, gender, grade, ethnicity, FAS, smoking, and breakfast (reporting odds ratios and 95% confidence intervals)

Oral health	Coef.	Std. Err.	z	p>z	[95% Conf.	Interval]
ED (quantity)	0.33	0.08	4.11	<0.001	0.17	0.49
Male	-0.21	0.20	-1.05	0.293	-0.61	0.18
Secondary school	0.12	0.22	0.53	0.599	-0.32	0.56
State school	-0.13	0.09	-1.44	0.151	-0.31	0.048
Saudi nationality	-0.06	0.29	-0.21	0.834	-0.64	0.51
Father education	0.27	0.14	1.95	0.052	-0.01	0.55
Family income high	0.04	0.19	0.19	0.846	-0.34	0.41
Healthy diet	-0.05	0.07	-0.71	0.478	-0.18	0.08
Unhealthy diet	0.04	0.07	0.56	0.575	-0.10	0.19
Age	-0.00	0.05	-0.08	0.934	-0.09	0.09
Nicotine use	0.72	0.18	4.09	<0.001	0.38	1.07
Eat breakfast	-0.02	0.05	-0.43	0.664	-0.11	0.07

4. Discussion

4.1 The Prevalence of ED Consumption

Saudi Arabia is the fifth-largest consumer of sugar-sweetened beverages, including energy drinks globally, which

is likely to increase further since more than two-thirds of the population is under 29 years of age (Murphy, 2011). In response to the increase in sugar-sweetened drink consumption, Saudi Arabia applied the highest tax worldwide on these drinks, raising the price of soft drinks by 50% and energy drinks by 100% (Alsukait et al., 2020). Almost all the studies from Saudi Arabia are from before the implementation of the taxes. Our study explores the prevalence of EDs consumption along with predictors of use and health outcomes after-tax implementation.

High consumption of EDs was seen in male students studying in secondary schools, who consumed nicotine and had an unhealthy diet in general, suggesting ED consumption is associated with poor health-related behaviours. This is consistent with similar studies (Richards and Smith, 2016, Visram et al., 2016, Mann et al., 2016). The main reason for ED consumption was reported to be the flavour of the drink, which was similarly reported by Musaiger and Zagzoog (2013), in a similar population. However, many participants gave no reason for consuming ED, suggesting factors such as social and marketing influence for ED consumption.

Higher consumption of EDs in males compared to females has been reported in many studies (Azagba and Sharaf, 2014, Flotta et al., 2014). Interestingly, Aluqmany et al. (2013) investigated the motives to consume ED in female Saudi secondary school students and found that a large proportion of students did not recommend the consumption of ED, yet a significant proportion still used them. The main reasons were linked to social factors, degree of satisfaction, body changes, and increased concentration and alertness. In contrast to this, the reasons given by males include energy, experimenting, and as a replacement for soft drinks (Alsunni and Badar, 2011, Costa et al., 2014, Mann et al., 2016). The results seen in our study were similar to Al-Hazzaa et al. (2011), who reported that 16.3% of males and 8.5% of females consumed ED more than three days per week. An increase in the consumption frequency during the time of examinations, assessments, and projects was reported by Bawazeer and AlSobahi (2013), which may also be contributing reason among the current study population. Another possible explanation for routine ED consumption among the young in Saudi Arabia is because of social acceptance and less awareness about the potential harm on health.

The prevalence of ED consumption may be reliant on several factors, including social influences, marketing, and individual needs. Further exploration of reasons among the Saudi population is needed, given the evident cultural differences among worldwide populations. The current findings, however, add to the growing literature which identifies males in secondary schools as the primary consumers of ED in Saudi Arabia. The high consumption in males is related to the strategic marketing campaigns reported to be concentrated explicitly on them (Alrasheedi, 2016).

Socio-economic status can have a significant influence on the choices one makes. The participants in this study were from different socio-economic backgrounds, yet no significant association was seen between family income and ED consumption in our study. This may be due to almost similar lifestyle even among different socio-economic backgrounds. Richards and Smith (2016) found that children from higher socio-economic sectors were similar to middle-income sectors where consumption of ED led to lower consumption of breakfast.

Even though this study recruited both Saudi and non-Saudi participants, there was no difference between the two group's reporting. This may be because all the participants in our study were residing in Saudi Arabia and were exposed to similar lifestyles. There was also a smaller number of non-Saudi participants, compared to Saudi participants (85%). Having a more significant representation from other nationalities may provide greater insight into the differences between ethnicities.

The use of ED has commonly been found to be associated with various socio-demographic variables. Similarly to the results reported by Cameron et al. (2012), our study found that the education of the mother only had a strong correlation with ED consumption in girls and the father's education was found to have a strong correlation with boys. It was also observed that students whose fathers held a degree were more likely to report higher consumption of ED. Ratnayake and Ekanayake (2012) also reported males attending private schools were associated with the consumption of sugar-sweetened soft drinks while factors relating to the mother's education level and father's occupation were found to be significant predictors of consumption. The parent's education and occupation are suggested to have a significant influence on the consumption as well as the frequency of consumption of ED in young Saudi children. In the Saudi families, the father is considered as the primary breadwinner, and his education and job status have direct influences, especially on the male children. The daughters are usually closer to their mothers; therefore, the mother's education, job status and lifestyle influence are seen on the daughters.

4.2 EDs Consumption and the Predictors of Use

Breakfast is an essential meal of the day, and it is known for those who miss a healthy breakfast have more unhealthy food choices in school and later in the day (Laska et al., 2015). This study observed that those who did

not consume breakfast had a higher intake of ED on a daily and weekly basis which further led to behavioural changes. Several studies have reported the possible behavioural associations of adolescents who consume ED (Harris & Munsell, 2015). Jackson et al. (2013) reported behavioural effects such as the increased risk of "being in trouble" either in school or at home as well as various physiological effects such as caffeine toxicity (Oddy & O'Sullivan, 2009; Wolk et al., 2012; Oddy & Sullivan, 2015). Individuals who had a healthy diet were more likely to consume breakfast regularly and were less likely to have regular consumption of ED. Several studies have investigated the various lifestyle factors which can lead to being overweight or obese with several studies suggesting this is partially due to ED consumption. For example, Al-Hazzaa et al. (2012) reported ED to be one of the critical factors in weight gain in both male and female Saudi students alongside factors such as an unhealthy diet and sedentary behaviours. Alrasheedi (2016) suggested that a primary reason for the frequent consumption may be related to the lack of knowledge and understanding in regards to the ED contents and health implications.

This study also identified an increase in late-night sleep pattern in young people who regularly consumed ED. Interestingly, the current study observed that late-night sleep pattern was more prevalent in Saudi nationals compared to non-Saudi nationals. Many studies similarly reported a strong association between ED consumption and sleep pattern. Calamaro et al. (2009) reported students who had consumed more ED were more likely to fall asleep during school hours and have difficulty falling asleep at night.

Higher consumption of ED leads to an increase in risky behaviours in adolescents which can have many adverse health effects. The consumption of ED was linked to higher consumption of nicotine and reduced breakfast consumption in this study. Similar reports have been reiterated within the literature, for example; Terry-McElrath et al. (2014) reported the correlation of ED consumption with 30-day alcohol, cigarette, and illicit drug use in secondary school students in the US. The association between ED consumption and smoking is a common finding within the literature, with Larson et al. (2014) reiterating the finding in both middle and high school students in the US.

Nicotine consumption is also known to be a useful predictor of oral hygiene status. The regular consumers are at an increased risk of various dental conditions including periodontal disease (Genco & Borgnakke, 2013; Lappin et al., 2013), edentulism (Nagaraj et al., 2014; Peltzer et al., 2014), and oral cancers (Krishna Rao et al., 2013; Lin et al., 2011). It was observed in this study that young people who consumed ED frequently scored higher on the oral health measure, suggesting that ED consumption leads to poorer oral health. The effects of ED can cause deterioration of dental hygiene and lead to an increase in caries due to the pH level (Skinner et al., 2015). A study by Jawale et al. (2012) found regular soft drinks to have higher pH as compared to ED, posing a significant challenge to the enamel, suggesting that a combination of both excessive soft drink and ED consumption would lead to the most significant declines in oral hygiene.

4.3 ED Consumption and Health Outcomes

The side effects of EDs on the health of young people due to a high amount of caffeine and sugar is well documented. An association between the consumption of ED and health outcomes such as headache, irritation, and dizziness were found in this study which is consistent with previous studies. Nowak and Jasionowski (2015), reported that polish students consuming ED experienced common side effects which included stomach-ache (about 50%), excitement, palpitation, or vomiting. Furthermore, Khan (2019) reported some severe health effects among university students who consume ED, which included insomnia (45%), headache (35.7%), and increased urination (30.8%).

5. Conclusion

In conclusion, the prevalence of ED consumption among Saudi youth is associated with socio-economic characteristics and behavioural outcomes. The consumption of ED was found to be significantly associated with nicotine use which demonstrates the possible gateway effect of ED consumption to other risky behaviours such as alcohol and illicit drug use. Easy availability and focused marketing are contributing to increasing sales. In order to reverse the trend and adverse health effects, some major policy changes are required. A recent paper by Alsukait et al. (2020) discussed the strategies implemented in Saudi Arabia regarding the sale of EDs. This included a warning label to be placed on EDs in large print and bright colours in both Arabic and English, along with the ban of advertisements and sales in government and educational institutions. A 100% tax has also been applied to the sale of EDs, resulting in a decrease in the sale. Given the concerns and responses from other countries to the growing consumption, further, recommendations for both policy and future research should be considered carefully by the Saudi government.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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Appendixes

Survey

Energy drink use and associated health behaviours and health outcomes among young people

This is a survey will be conducted by a PhD student in Cardiff university to determine the prevalence and the pattern of use of energy drinks by adolescents in Riyadh city and the physical, mental and behavioural outcomes associated with energy drink consumption

All information disclosed in this survey will be kept private and confidential

Section 1: ABOUT YOU

This questionnaire is completely anonymous; we do not collect any information that can be used to identify you.

Please answer the following questions as honestly as you can. If you do not want to answer a question, then leave it blank.

Q1 – Are you a boy or a girl?
Please tick one box

Boy o_1
Girl o_2

Q2 – In what year were you born?
Please tick one box

1998	1999	2000	2001	2002	2003	2004	2005	2006
o_1	o_2	o_3	o_4	o_5	o_6	o_7	o_8	o_9

Q3 – What level are you in at school?
Please tick one box

Intermediate school o_1
Secondary school o_2

Q4 – What type of school are you studying in?

Please tick one box

Public school	o_1
Private school	o_2

Q5 – What is your nationality?

Please tick one box

Saudi	o_1
Other	o_2

Q6 – Where do you live?

Please tick one box

Al-Bat' ha	o_1
Al-'Olayya & Sulaymaniyyah	o_2
Nemar	o_3
Irqah	o_4
Diplomatic Quarter	o_5
Al-Malaz	o_6
Al-Shifa	o_7
Al-Urayja	o_8
Al-Shemal	o_9
Al-Shemaysi	o_{10}
Al-Ma'athar	o_{11}
Al-Ha'ir	o_{12}
Al-'Aziziyyah	o_{13}
Al-Naseem	o_{14}
Al-Rawdhah	o_{15}
Al-Selayy	o_{16}
Al-Moroje	o_{17}
Al-Sahafa	o_{18}
Al-Nakeel	o_{19}
Al-Falah	o_{20}
Other	o_{21}

Q7 – 1- What is the highest level of education completed by your father?

Please tick one box

None	o_1
Primary school education	o_2

Intermediate and secondary school education	o3
Bachelor's Degree	o4
Master's degree	o5
Advanced Graduate work or PhD	o6
Do not know	o7

Q8 – 1- What is the highest level of education completed by your mother?

Please tick one box

None	o1
Primary school education	o2
Intermediate and secondary school education	o3
Bachelor's Degree	o4
Master's degree	o5
Advanced Graduate work or PhD	o6
Do not know	o7

Q9 – How many adults/grown ups live with you in your home (aged 18 years or more)?

Please tick all that apply

One	o1
Two	o2
Three	o3
Four	o4
More than four	o5

Q10 – How many other children (not counting you) live with you in your home (under 18 years)?

Please tick all that apply

None	o1
One	o
Two	o2
Three	o3
Four	o4
More than four	o5

Q10 – What type of accommodation do you live in?

Please tick one box

The house is owned	o1
The house is rented	o2
The flat is owned	o3

The flat is rented	o4
Other	o5
Do not know	o6

Q11 – When you have free time, do you mainly?

Please tick one box

Go somewhere with friends	o1
Go to a friend's house (or they come to my house)	o2
Spend time with your family	o3
Spend time by myself?	o4
None of these	o5

Q13-How much pocket money do your parents give you monthly?

Please tick one box

Less than 300 SAR	o1
300 SAR	o2
More than 300 SAR	o3

Q13 – how many times a week do you usually eat or drink …. ?

Please tick one box for each line

		Never	Less than once a week	Once a week	2-4 days a week	5-6 once a week	Once a day, every day	Every more than once days
Q14	**Fruits**	o1	o2	o3	o4	o5	o6	o7
Q15	**Vegetables**	o1	o2	o3	o4	o5	o6	o7
Q16	**Sweets (candy or chocolate)**	o1	o2	o3	o4	o5	o6	o7
Q17	**Coke or other soft drinks**	o1	o2	o3	o4	o5	o6	o7
Q18	**Skimmed or semi-skimmed milk**	o1	o2	o3	o4	o5	o6	o7
Q19	**Ordinary (full fat) milk**	o1	o2	o3	o4	o5	o6	o7
Q20	**Other milk products (like yoghurt, milkshakes)**	o1	o2	o3	o4	o5	o6	o7
Q21	**chips**	o1	o2	o3	o4	o5	o6	o7
Q22	**White bread**	o1	o2	o3	o4	o5	o6	o7
Q23	**Cereals (like cornflakes, coco pops)**	o1	o2	o3	o4	o5	o6	o7
Q24	**fish**	o1	o2	o3	o4	o5	o6	o7

Q25 – How often do you eat breakfast during a usual school week?

Please tick one box

Every day	o_1
Three or four times a week	o_2
One or two times a week	o_3
Less than once a week	o_4
Never	o_5

Section B: ENERGY DRINK CONSUMPTION AND USE

Q26- Have you ever consumed an energy drink like (Red Bull, Bison, Red code….)?

Please tick one box

Yes	o_1
No	o_2

Q27 – How many times a week do you usually drink an energy drink like (Red Bull, Bison, Red code….)?

Please tick one box

Never	o_1
Less than once a week	o_2
Once a week	o_3
2-4 days a week	o_4
5-6 days a week	o_5
Once a day, every day	o_6
More than once a day	o_7
Do not know	o_8

Q28 – Did you drink an energy drink at any of these places in the last seven days?

Please tick ALL that apply

I do not drink energy drinks	o_1
At home	o_2
At a friend's house	o_3
At a party	o_4
At a relation's home	o_5
In a restaurant	o_6
In a public place (e.g. park)	o_7
In school	o_8

Q29 – At what age did you first drink your first energy drink?

Please tick one box

0-5 years old	o_1
6-10 years old	o_2
11-15 years old	o_3

16 years old or older o3
Do not know o4

Q30 – How did you first find out about energy drinks?
Please tick one box

Advertisement o1
At the store o2
Socially o3
Recommendation from friends o4
Do not know o5
Other (please specify) o6
_____

Q31 – In your opinion, what is the main reason for drinking energy drinks?
Please tick ALL that apply

To play sport o1
To study o2
To stay awake o3
For mental enhancement o4
For an energy boost o5
Good taste o6
To quench thirst o7
Other o7

Q32 – What type of energy drinks do you usually drink?
Please tick one box

Red Bull o1
Power Horse o2
Red Code o3
Bison o4
Other o5

Q33 – Why do you choose these energy drinks?
Please rank the top 3 reasons

It is cheap o1
It is popular o2
It tastes nice o3

It was recommended to me	o_4
It has ingredients that are good for me	o_5
It is available	o_6
It wakes me up	o_7
Other	o_8

Q34 – How many energy drinks would you usually drink in one go?

Please tick one box

Not more than one	o_1
Two	o_2
Three or more	o_3

Q35 – How often do you friends drinks energy drinks?

Please tick one box

Never	o_1
Less than once a week	o_2
Once a week	o_3
2-4 days a week	o_4
5-6 days a week	o_5
Once a day, every day	o_6

Q36 – On a scale of one (not very acceptable) to seven (very acceptable), how acceptable is it for someone of your age and gender to drink energy drinks?

Please tick one box

1	**2**	**3**	**4**	**5**	**6**	**7**
o_1	o_2	o_3	o_4	o_5	o_6	o_7

Section C: PHYSICAL, MENTAL AND BEHAVIORAL OUTCOMES

Q37 – How would you say your health is?

Please tick one box

Excellent	o_1
Good	o_2
Fair	o_3
Poor	o_4

Q38–How often do you experience the following?

please tick one box on each row

		Every day	More than once a week	About every week	About every month	Rarely or never
Q39	**Headache**	o1	o2	o3	o4	o5
Q40	**Stomach ache**	o1	o2	o3	o4	o5
Q41	**Backache**	o1	o2	o3	o4	o5
Q42	**Feeling low**	o1	o2	o3	o4	o5
Q43	**Irritability**	o1	o2	o3	o4	o5
Q44	**Feeling nervous**	o1	o2	o3	o4	o5
Q45	**Difficulties in getting to sleep**	o1	o2	o3	o4	o5
Q46	**Feeling dizzy**	o1	o2	o3	o4	o5
Q47	**Depression**	o1	o2	o3	o4	o5

Q48 – Gum disease is a common problem with the mouth. People with gum disease might have swollen gums, receding gums, sore or infected gums, or loose teeth. Do you think you might have gum disease?

Please tick one box

Yes	o1
No	o2
Do not know	o3

Q49 – Do you have a long-term illness, disability or medical condition (like diabetes, arthritis, asthma, or allergies) that has been diagnosed by a doctor and lasted more than one month?

Please tick one box

Yes	o1
No	o2

Q50 –when do you usually go to bed if you have to go to school the next morning?

Please tick one box

No later than 9 pm	o1	11.30 pm	o6
9.30 pm	o2	Midnight	o7
10 pm	o3	12.30 am	o8
10.30 pm	o4	1:00 am	o9
11:00 pm	o5	1.30 am or later	o10

Q51 – have you ever participates in any of these activities?

Activities		Never	Yes 1 – 3 times a week	More than 3 times a week
Q52	**Violent/ aggressive behaviour**	o1	o2	o3
Q53	**Serious physical fight**	o1	o2	o3
Q54	**electronic cigarette use**	o1	o2	o3
Q55	**Smoke shisha**	o1	o2	o3

Q56 – How often do you smoke tobacco?

Please tick one box

I do not smoke o1
Every day o2
At least once a week, but not every day o3
Less than once a week o4

Q57 – At what age did you smoke your first cigarette?

Please tick one box

I do not smoke o1
11 years of age or younger o2
12 years of age o3
13 years of age o4
14 years of age o5
15 years of age o6
16 years of age o7
17 years of age or older o8

Q58 – Would you like to gain weight?

Please tick one box

Yes o1
No o2

Q59 – Would you like to lose weight?

Please tick one box

Yes o1
No o2

End

Thank you