

GRADUATION PROJECT

Degree in Dentistry

***Isotonic and Energetic drinks and their effect
on adolescence oral health***

Madrid, academic year 2022/2023

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GRADUATION PROJECT STATEMENT OF ORIGINALITY

I, **Eva Maria Weustink**, with student number **21706815** declare that I am the author of the Final Degree Project entitled **Isotonic and Energetic drinks and their effect on adolescence oral health** , which I am submitting in fulfilment of my studies for the Degree of Dentistry at the Faculty of Biomedical and Health Sciences of the European University of Madrid, and I declare the following (i) that the work I am presenting is original and unpublished, being the result of my own intellectual contribution; (ii) that the figures, tables and illustrations contained in the work are an accurate representation, without digital alteration, for which I undertake to respond to any inconsistencies or inaccuracies that may exist in them; (iii) I assure that I have correctly identified and referenced all the information contained in the text and bibliographical references of the work, which has been obtained from previously published sources, guaranteeing honesty and integrity in the preparation of this academic document.

For the record, this declaration of originality is signed in Madrid, at **16.04.23**, 2023.

Signature:



Abstract:

Introduction: The following research investigates isotonic (ID) and energetic drinks (ED) and their effect on adolescent oral health. An in-depth description of the oral and general adverse effects associated with ED and ID use is provided after thoroughly investigating their components. The direct oral adverse effects are caries, erosion, cervical hypersensitivity, gingivitis, and periodontitis. The indirect adverse effects relate to bruxism, temporomandibular disorder, onychophagia and xerostomia. To demonstrate the high amount of sugar and caffeine in the EDs Redbull and Monster were analyzed.

Objective: The first objective of this study is to analyze the consumption habits regarding Energy drinks in Spain. The second objective is to study the possible effect of Energy drinks on adolescent oral health.

Methodology: A questionnaire of 16 questions was published in English and Spanish. It was targeted and distributed to 18-28 years old by online survey platforms, at the campus of the University Europea de Madrid (UEM) and social media between October 2022 and January 2023.

Results: 704 people answered our study, where 374 corresponded to the criteria. 60% of the participants are women, whereas 40% are men. The majority come from Germany, France and Spain. Generally, 24% of the participants consume EDs 2-5 times a week. The most favorite ED brands are Redbull and Monster Energy. Mostly EDs are consumed for study purposes. 19% brush their teeth three or more times a day, while 74% brush twice daily.

Conclusion: Energy drinks in Spain also play a significant role for students during exercise and recreation. The research helped discover that EDs have great potential for creating the analyzed direct, indirect oral, and as well the general adverse effect.

Keywords: Dentistry, energy drinks, caries, erosion, prevention

Resumen:

Introducción: La siguiente investigación analiza las bebidas isotónicas (BI) y energéticas (BE) y su efecto en la salud bucodental de adolescentes. Tras investigar a fondo sus componentes, se ofrece una descripción detallada de los efectos adversos orales y generales asociados al consumo de BE y BI. Los efectos adversos orales directos son caries, erosión, hipersensibilidad cervical, gingivitis y periodontitis. Los efectos adversos indirectos están relacionados con bruxismo, trastorno temporomandibular, onicofagia y xerostomía. Para demostrar la elevada cantidad de azúcar y cafeína en los BE se analizó Redbull y Monster.

Objetivo: El primer objetivo analiza los hábitos de consumo de BE en España. El segundo objetivo estudia el posible efecto de las BE sobre la salud bucodental de los adolescentes.

Metodología: Se publicó un cuestionario de 16 preguntas en inglés y español. Se dirigió y distribuyó a jóvenes de 18 a 28 años mediante plataformas de encuesta online, en el campus de la Universidad Europea de Madrid y por las redes sociales, entre octubre de 2022 y enero de 2023.

Resultados: 704 personas respondieron a nuestro estudio, donde 374 correspondían a los criterios. 60% de los participantes son mujeres, mientras que 40% son hombres. La mayoría vienen de Alemania, Francia y España. 24% de los participantes consumen ED entre 2 y 5 veces por semana. Las marcas preferidas son Redbull y Monster. La mayoría se consume para los estudios. 19% se cepilla los dientes tres o más veces al día y 74% lo hace dos veces al día.

Conclusiones: Las BEs en España son importante para los estudiantes durante el ejercicio y el ocio. La investigación ayudó a descubrir que las BE tienen un gran potencial para crear el analizado directa, indirecta oral, y así como el efecto adverso general.

Palabras clave: Odontología, bebidas energéticas, caries, erosión, prevención

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1 Introduction

1.1 Brief Explanation of energy & isotonic drinks

Still, in the 21st Century is a need for knowledge related to our health. There are many ailments in the stores playing with our senses. Due to the provocative marketing, especially regarding food products for children/ adolescents, it's tough to distinguish the good from the bad. Therefore, isotonic & energy drinks are bought chiefly by the good intention of giving the body the minerals or energy it's needed (1). Energy drinks are already around 60 years on the market and retained their good reputation. They contain caffeine, herbal extracts, B vitamins, certain amino acids, and their by-product, and most importantly, sugar for the taste. People drink it either for the demanding tasks or to increase their efficiency during sports. Isotonic drinks comprise plain carbohydrates and small amounts of sodium and potassium, preferably used throughout the sport and right afterwards (2).

1.2 Vitamins and Minerals Supplementations

The body cells and tissues comprise a considerable number of minerals like Calcium, Kalium, Magnesium, Sodium, and phosphorus. In contrast, Iron, Manganese, Selenium, and zinc are utmost pivotal for the execution of the physical performance. Therefore, isotonic drinks must be composed of this nutritive substance for maintaining constant hydration during sports (3). The general population is aware that we need many vitamins. However, in a German study, they found out that a lot of people are overconsuming vitamins and minerals to prevent diseases, maintain health, or/ and to increase their energy. This underrating of this consumer behavior, without doctors' involvement, can lead to serious health problems (4). The illnesses that could evolve include Osteoporosis, Obesity, Anemia, type 2 diabetes, ischemic heart disease and hypertension (2).

Apart from the appearance of somatic consequences of an overconsumption of vitamins and minerals, psychological problems could also arise, which will be discussed later (5). Compared to certified supplements, which can only be bought in the pharmacy, there are many products on the market which could be bought in a supermarket, so the ingredients don't have to pass the standard guidelines of pharmacy products and could therefore include whichever ingredient and dose in their product. This misconception of supplements that they are not always and, in each quantity, good for the health, should be more supervised by the state (4). This paradigm of the people leads to an easier choice for using energy and/ or isotonic drinks since they are supposed to be great for the body.

1.3 Components of Energy Drinks (ED)

The five main elements of ED drinks are caffeine, sugar or other sweetener, Taurine or L- carnitine as an amino acid, vitamin B, and lastly, some plant sources (6).

1.3.1 Caffeine

The amount of caffeine in a Can of ED is the same or even more than one cup of coffee. Researchers found that there is a massive variety of the definite amount of caffeine for each type since some EDs are added by mate, guarana, and kola nuts that naturally contain caffeine. According to this unknown increase, unclarity for consumers arises, and therefore, it's hard to know the body's limit for the intake of caffeine. The symptoms of overconsumption are mainly bradycardia, nausea, hypertension, and increasing anxiety in the buying public body (6).

1.3.1.1 Psychological aspects

Regarding mental health, a study of adolescents stated an interrelationship between overconsumption of caffeine and attitude changes, including the general augmentation of aggressiveness. Furthermore, headache, sleep disorders, fatigue, and depression are assessed (7).

1.3.1.2 Alcohol

It is analyzed that a lot of adolescents are combining ED with alcohol which triggers overestimated and unhealthy behavior like smoking and drug consumption, and they are more likely to develop an alcohol addiction (7). Crucial in that context, is that the previously mentioned sleep disorder is also a risk factor for the accrument of addictions to drugs or alcohol (8).

1.3.1.3 Rhabdomyolysis

Many athletes consume energy drinks although they should use isotonic drinks instead. Energy drinks aren't a source to gain energy before, within, or after doing an exercise. The highly negative effect which could occur in an athlete's body whose consuming ED is presented in a Case Report. Rhabdomyolysis causes the death of the striated muscles, which causes the discharge of noxious intracellular components. It must be treated as soon as possible since it provokes severe hyperkalemia (9). In this context it's highly important to outline that ED shouldn't be consumed by athletes due to the high risk of evolving a serious health problem.

1.3.2 Plant-based sources in Energy Drinks

Caffeine-rich guarana is an herb that is the most used plant component of ED. Yerba mate is quite like guarana and possesses significant caffeine. Another plant found in a few energy beverages is the ginkgo biloba which could cause severe hemorrhage incidents (10). An overconsumption of especially guarana can provoke significant cardiovascular and neurological problems (2).

1.3.3 Sugar in ED and ID

Essential to mention is that sugar has no positive impact on health, instead its stimulating the occurrence of dental and general diseases (1). It is stated that regular sugar consumption could lead to obesity, cardiovascular diseases and diabetes (2). Recently the World health organization (WHO) labeled obesity as one of the leading health hazards regarding the population living in the 21 century (11). The combination of sugar and caffeine has a considerable effect on the metabolic system, and accordingly, this merger could be responsible for the volatile mood produced by the changes in the blood glucose levels (5). Additionally, it must be mentioned that there is a vast number of people, consume IDs without doing any sport and have a mainly sitting lifestyle where the contained sugar won't be used, and weight gain can occur (2).

1.3.4 L-Taurine

Taurine is an amino acid (aa) and has psychoactive effects, so that it can execute neurotransmitter performances. It's not deeply analyzed how this aa act in contact with alcohol and caffeine. In an animal study, they found out that Tauron itself is harmless, but the consumption of a mix with caffeine could end up lethal.

On the one hand, a study states that the drinking of alcohol together with ED raises the ethanol level in the blood. On the other hand, the beneficial effect of

Taurine is described when Alcohol and EDs are consumed together. Summing up, there should be further studies exerted by Taurine and its function with alcohol and caffeine (12).

1.3.5 B- Vitamins

The eight water soluble vitamins that make up the B vitamin group play a crucial role regarding cellular activity. This group consists of Cyanocobalamin, Pantothenic acid, Pyridoxine hydrochloride, Riboflavin, Niacin, Thiamine, Inositol, and Biotin. In the most ED a huge quantity of B-Vitamins is observed nonetheless through a normal diet the body gets enough of this vitamin group (10).

1.3.6 Example Redbull and Monster Energy

The quantity of caffeine in Redbull and Monster Energy ranges from 32mg to 34mg per 100mL. Therefore, in a tin with around 250ml, the amount of caffeine makes up 80mg. If a person chooses to drink 470 ml, their caffeine intake would be 160mg. Additionally, the amount of sugar in these EDs is very high, with 24g per 250ml and thus, 54g per 470ml. A study asserted that caffeine and sugar affect each other, which leads into high rise in insulin and blood sugar levels following its intake. Consuming these EDs for an extended period while they contain a lot of simple carbohydrates can cause overweight and insulin intolerance. The American Association of Toxicology affirmed deaths related to Energy drink consumption in the USA. The Food and drug administration (FDA) published that 400mg of caffeine is the acceptable maximum a day for young adults and below 2.5mg/kg for children over 14 years old (10). A Study from 2015 found out that the selection of the ED Brand depends mainly on the taste, then the Price and lastly on the effect (6).

1.4 Oral health and its pH variations

Nevertheless, the consumption of Energy and Isotonic Drinks doesn't only provoke general health problems, but also has a massive impact on the oral health of the customers. It's important to consider that a decline in oral health leads mainly to worsening general health (13). Though sugar plays an extraordinary role, the low pH of these popular drinks shouldn't be underrated either (1).

1.4.1 Dental Caries

The most frequently encountered oral disease is caries. It emerges out of bacteria which adhere on the tooth surface. The bacteria are fed by carbohydrates which are fragmented in the mouth into sugar. The main environmental factors of the creation of caries are smoking, stress, low socioeconomic status, reduced fluoride, a decrease in saliva, and poor oral hygiene (14). Therefore, the microorganisms that adhere to the tooth produce acid, removing the dental enamel and producing caries (15). A study stated that the sugar intake increased during the last 30 years by 300% due to the addition of artificial sugar in industrialized food, which is very common in people's diets. Furthermore, they found that the frequency of sugar consumption has more influence than quantity (14). Therefore, adolescents who consume Energy Drinks or Isotonic Drinks are more prone developing dental caries than if they didn't.

1.4.2 Dental Erosion

Dental erosion is a flat concavity with round borders, plain surface area, without plaque, and often correlated with abrasion and attrition (16). It is created by irreversibly removing the enamel and dentin of the teeth, which happens most likely at a pH of 5.5 (13). Energy drinks have a pH lower than 5.5 whereas the sport drinks pH around 2.5. Distilled water has a pH of around 8.2 (17).

Compared to dental caries, no bacteria are involved in that pathological process. Dental Erosion can occur because of intrinsic or extrinsic factors. Gastric reflux or induced vomiting over an extended period of time are damaging the dental tissue intrinsically. These types are causing dental erosion mainly on the lower posterior teeth.

The causes which correlate to the environment, medication, diet and lifestyle are extrinsic. The consumption of ED and ID is interrelated to extrinsic causes. Crucial to mention here is that regular intentional consumption by thinking that especially ID will help improve the health status is one of the main reasons adolescents are developing dental erosions (13). Its prevalence in children and adolescents worldwide isn't particular and is studied between 7.2%-95% (16)

Additional factors that effect in the evolution of dental erosion are the quality of its buffering, its sequestering feature, the kind of acid, and the quantity of sugar (17).

1.4.3 Cervical hypersensitivity

A study stated that Energy and Soft drinks can remove the smear layer of the tooth, which is supposed to protect the dentinal tubules and therefore avoid the diffusion of pain. This action happens due to the very low pH (lower than 5.5) of EDs and IDs. Consequently, by eliminating of it, hypersensitivity in the cervical area arises. Important to mention is that the severity of cervical hypersensitivity highly depends on the type of acid. Some EDs contain Citric acid, which is the most aggressive type. Furthermore, if there is the apparition of demineralized tooth Surface, the teeth are very sensible for toothbrushing (17). In another study, it is claimed that even composite, resin and ceramic obturations in the cervical area of the tooth are affected by the acidity of ED and ID drinks (18).

1.4.4 Gingivitis and Periodontitis

Periodontal disease compromises the stability of the bone and is associated to systemic diseases, bad oral hygiene, smoking and lifestyle habits. Since ED and ID have a high amount of sugar, consuming these drinks on a regular basis, could lead to the occurrence of gingivitis and periodontitis. Gingivitis is a state of gingival bleeding that could, without adequate treatment, develop into periodontitis. Periodontitis has effects on oral and general health. On the one hand, tooth loss could occur do to the diminish of the stability of the bone. That would lead to a decrease in the capacity of proper biting and consequently reduces the condition of living. Moreover, there will be an overall change in the appearance of the face. On the other hand, it's proven that it increases the risk of developing cardiac problems, rheumatoid arthritis and being overweight (19).

1.5 Indirect Side effect of Stress, Sleep disorders and obesity

1.5.1 Bruxism

An indirect side-effect of the consumption of ED is the increased feeling of anxiety. This state of worrying triggers a feeling of insecurity and could become chronic. Probably an accumulation of other vegetative reactions will occur. Furthermore, anxiety is in a lot of cases, correlated with clenching or grinding the teeth, by repetitive muscle activity, during the day (awake bruxism, AB) or night (sleep bruxism, SB). The prevalence of bruxism within worldwide adults is around 5.9-49% (8).

1.5.2 Temporomandibular Disorder (TMD)

Temporomandibular joint pain is corresponded to awake and sleep bruxism (20). The TMD leads to varying aches values in the masticatory and neck muscles. The fundamental conclusion of one article is that it's indispensable in reducing stress & anxiety for compromising the prevalence of Bruxism and TMD (21).

1.5.3 Onychophagia

The age range of biting its nails is widely spread. The habit is commonly associated with stress or/and anxiety as a distraction method. Unfortunately, that behavior could cause extensive dental, gingival and TMJ problems. Additionally, a study concluded a high correspondence between the nail-biting habit and smoking (22).

1.5.4 Xerostomia

Saliva is of utmost importance in our everyday life since it helps us prevent dental caries or other oral diseases as well as facilitate our nutrition. Anxiety provokes vegetative reactions, so a study reasoned the coherence between the diminished production of unstimulated saliva and the mental state. Thus, the increased altering of mental wellbeing by ingesting EDs or IDs could lead to a diminution of saliva in the mouth. Consequently, talking and mastication complications might occur. As well irritation of the mucosa, an accumulation of fungus like Candida and teeth are not protected anymore by acids and bacteria. This condition could increase the prevalence of especially Caries (23).

1.6 Prevention and Treatment

Fluoride works against microbes creating a highly potent action contra bacteria which are prone to cause caries. Epigallocatechin gallate (EGCG) presents, due to its chemical arrangement as a catechin a strong anti-caries effectiveness (24).

1.6.1 Methods

Fluoride in tap water and in toothpaste is an effective and cheap method to help the teeth remineralize and, therefore, to suppress the creation of Caries.

Is utterly important here to mention that the effect of fluoride would be shallow if a person has unhealthy habits, like not brushing in the right way and not the time the teeth are supposed to be brushed (25).

1.7 Justification

Due to the pursuit of accomplishment, individualism, and otherness in our society, it's essential to conduct research on the consumption behaviour of energy drinks and isotonic drinks related to adolescents. So, the author of this study wants to analyse and clarify the still underrated side effects concerning dental health and general health regarding Energy and Isotonic drinks. It's essential to study these drinks' psychological aspects and reason for choosing to drink them. Furthermore, the Writer of the study is interested to learn about the adolescent's beliefs in marketing and the occasions and frequency of the consumption of EDs and IDs. Consequently, it's crucial to know if and how society and a dentist can prevent the creation of long-term damage in adolescence especially related to their oral health. Consequently, this research aims to evaluate Energy drinks, their impact on oral health and the critical importance of dental care provided by a dentist.

2 Objectives

First Objective:

- Analyze the consumption habits regarding Energy drinks in Spain.

Second Objective:

- Study the effect of Energy drinks in the oral health.

3 Material and Methods

3.1 Keywords and research strategy

Online research was executed on Medline and PubMed from the year 2010 to 2023. The following keywords were merged:

Oral health, energy drinks, caries, erosion, prevention

A study in English and Spanish from the previous year about energy drinks targeting 18-28 years old was used and distributed to over 700 people.

3.2 Article selection

The author aims to create awareness of the consumption of energetic and isotonic drinks. Therefore, the obtained results were statistically analyzed.

The data was studied and compared with the differences and similarities found in the already available literature.

3.2.2 Inclusion and Exclusion Criteria

Articles which are qualified to create the questionnaire and the research question. Furthermore, they should be adequate to gain research knowledge.

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none">• Cross-sectional studies• Proposal for a World health organization• Study of ingredients of energy and isotonic drinks• Helena Study two nonconsecutive 24 h recalls• Quantitative Research• In vitro Study• Research Article• An epidemiological systematic review and Meta regression analysis• Complete articles	<ul style="list-style-type: none">• Complete article not available in English nor German nor Spanish• Articles with restricted access• Published before year 2010• Lack of citation of article

3.2.3 Research/ PICOS question

- **Patient:** 18-28
- **Intervention:** Diagnosis
- **Comparison:** Control with descriptive prospective data
- **Results:** Effect
- **Study type:** Questionnaire

P I C O	Topics
Patient	Patients [mesh], Energy drinks [mesh]
Intervention	Oral health [mesh]
Comparison	Behavior, age
Outcome	Effect

3.2.4 Bibliographic research

The research platform of choice to find adequate articles was Medline. For further investigation PubMed was used.

- At first, the research in Medline without any filter “Energy drink” releases 4,934 results. Obtaining 2,597 results by using the following filters: 2010 - 2023 and full text available. The research regarding the Mesh, “Energy Drink “AND “Oral health, found 133 articles.
- After searching in PubMed for “Energy drink” where 4, 918 results were found. Adding the filters “free full text“ AND publishing date “last 10 years “ receiving 1,414 results. By searching for the Mesh, “Energy Drink“ AND “ Oral health“ 46 results were obtained
- Doubled articles were subtracted so the total number of articles dropped to 4954. With applying the previously mentioned exclusion criteria there are 4874 Articles to rule out, receiving 100 articles.

- With these results obtained, 54 articles were selected by applying “full text accessibility”AND “published after 2010”.
- Exclusion of 27 articles and therefore keeping 27 articles for our research

3.2.5 Prisma

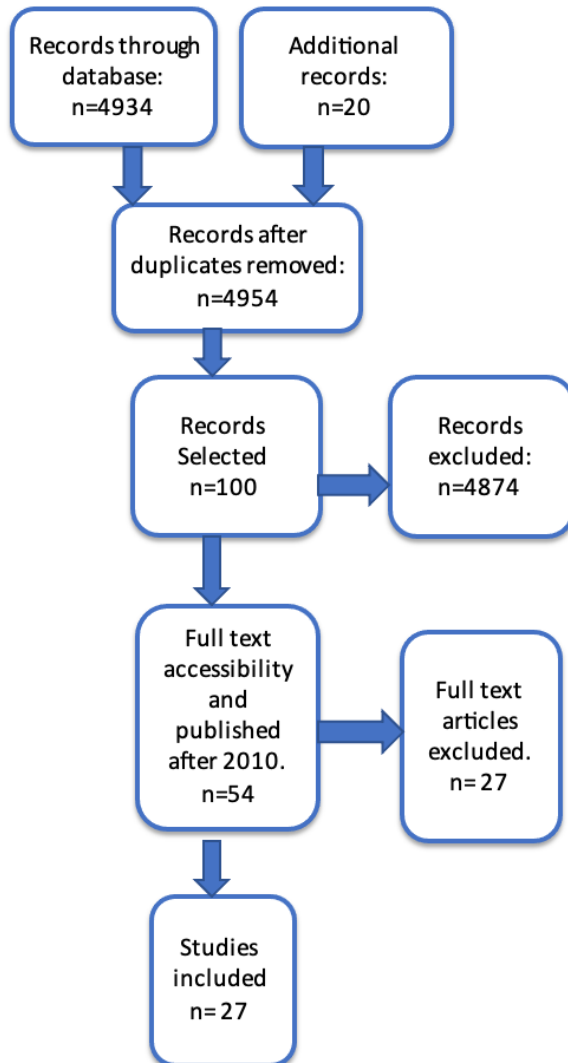


FIGURE 1: PRISMA

3.3 Survey

The survey with the Code CIPI/22.023 passed the Ethical Committee of the European University of Madrid. To obtain the most precise results of the requested data, the survey is done in English and Spanish and contains 16 questions. It was published in a licensed online platform called "Survey Circle" simultaneously distributed through social media and at the Campus of the Universidad Europea de Madrid between October 2022 and January 2023. The interrogates are asked about their age, their consumption behaviour of ED, their frequency, their preferably brand and during which activity they are ingesting these. Additionally, they have to say how often they brush their teeth and if they think EDs are bad for oral health.

4 Results

To answer the questionnaire, it was compulsory to be over 18 and respond “yes” to the question if they wanted to participate likewise, they must indicate their birth year. After 704 results were obtained, 330 answers were subtracted since a study of adolescences between the age range of 18-28 is wanted. Overlaying the two excel sheets which were received from the English and Spanish survey it was calculated that 374 answers were useful for our studies.

4.1 Gender

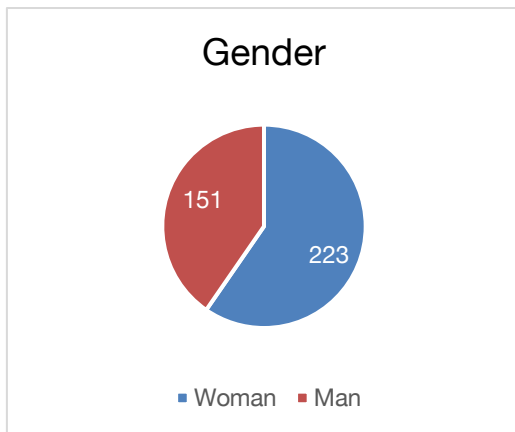


TABLE 1: GENDER DISTRIBUTION

Gender	Female	Male
Answers	223	151
%	59.6%	40.4%

FIGURE 2: GENDER DISTRIBUTION

223 out of the 374 answers were from female participants, which results in 59.6% and 151 out of 374 were male participants, which results in 40.4%.

4.2 Country of Origin of the participants

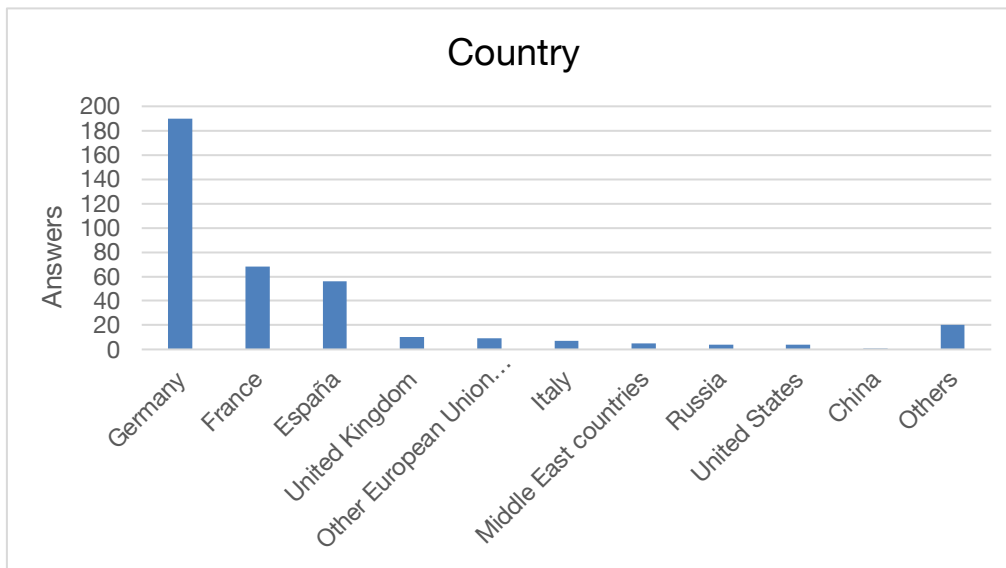


FIGURE 3: COUNTRY OF ORIGIN

TABLE 2: COUNTRY OF ORIGIN

Count	Spain	Italy	France	Germany	UK	OE	R	US	Ch	ME	Other
Answers	59	7	68	190	10	9	4	4	1	5	20
%	15.8%	2%	18.2%	50.8%	2.7%	2.4%	1%	1%	0.2%	1.3%	5.3%

59 out of the 374 were Spanish, which displays a percentage of 15.8%. 7 Italians answered the study, which means 2%. 68 French were responding to the questionnaire which results in 18.2%. The German participants were 190, which means 50.8%. 10 people came from the UK, which displays a percentage of 2.7%. Other European countries were represented by 9 persons, 2.4%. 4 Russians answered the study which results in 1%. US- Americans were represented by 4 people meaning 1%. One Chinese person replied, which results

in 0.2%. Middle Eastern countries were represented by 5 people, which results in 1.3%. Other countries were indicated by 20 people which results in 5.3%.

4.3 Smoking habits

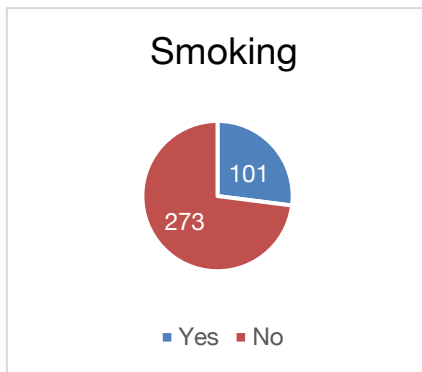


TABLE 3: SMOKING

Smoking	Yes	No
Answers	101	273
%	27%	73%

FIGURE 4: SMOKING

101 out of 374 people indicated to be a smoker. Therefore 273 don't smoke. Generally, 27% are smoker and 73% are non-smoker.

4.4 Age of first Energy drink

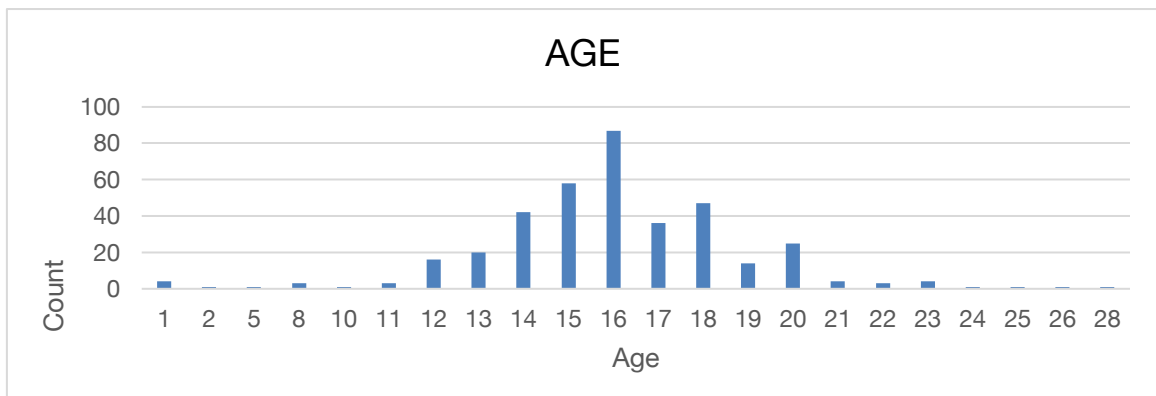


FIGURE 5: AGE

TABLE 4: AGE

Energy Drink	1-14 years	15-17 years	18 + years
Answers	88	181	101
%	23.8%	48.9%	27.3%

In this category only 370 answers were accepted since 4 answers weren't reasonable due to non-adequate dates. 88 out of 370 answers indicated that the participant's first drink was between 1-14 years of age, which is a percentage of 23.8%. 181 were between 15-17 years old, meaning 48.9%. 101 out of 370 reveals to be 18 or older, which results in 27.3%.

- Median age: 16,5 years old
- Mean value: 15,9 years old
- Mode age: 16 years old

4.5 Frequency of Energy Drink consumption

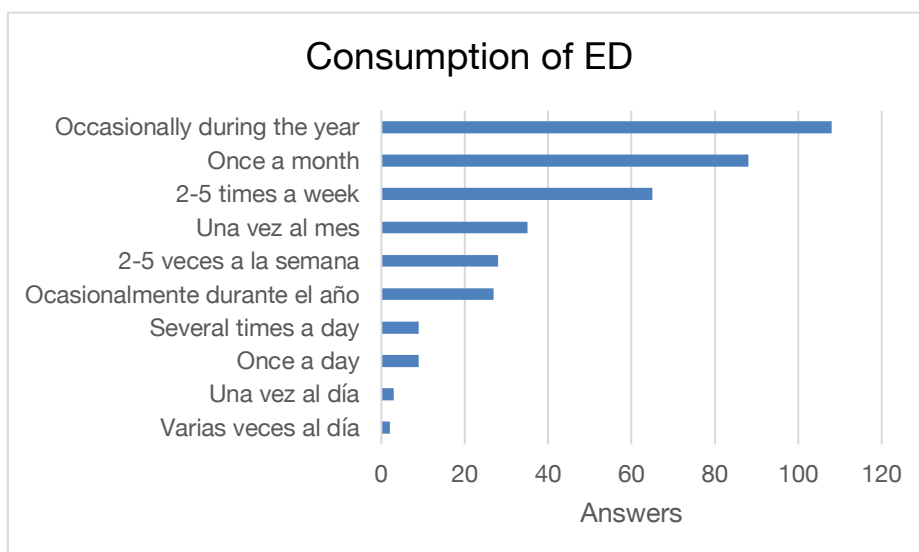


FIGURE 6: CONSUMPTION OF ED

TABLE 5: CONSUMPTION OF ED

Frequency of Consumption of ED	1x month	2-5 times the week	Sometimes during the year	1x day	Multiple times a day
Answers	123	93	135	12	11
%	33%	25%	36%	3%	3%

123 out of 374, 33%, indicated to drink ED's once a month. It is consumed 2-5 times a week by 93 persons, means 25%. 135 people responded to drink ED's sometimes during the year, which results in 36%. 12 persons revealed to drink ED's once a day. 11 persons drink it multiple times a day, both in total make a percentage of 6%.

4.6 Brand of ED

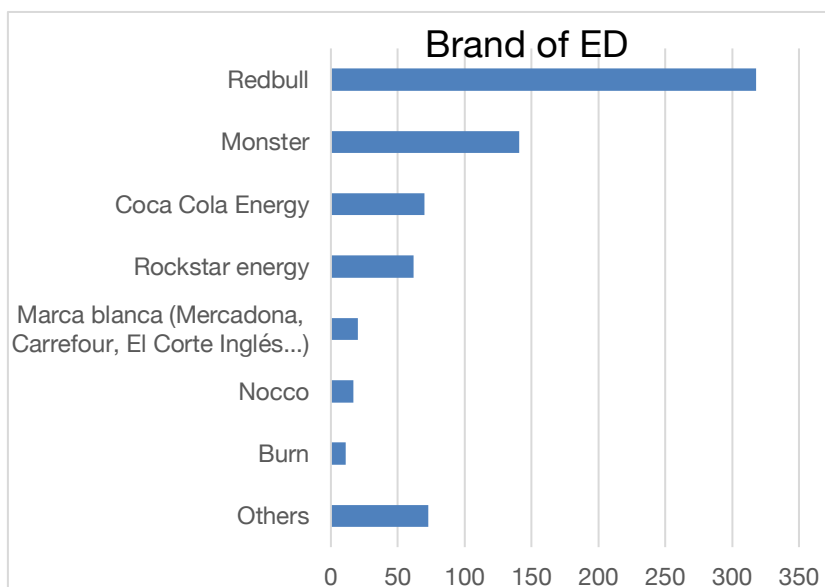


FIGURE 7: BRAND OF ED

TABLE 6: BRAND OF ED

Brand	Redbull	Monster	Coca Cola Energy	Rockstar	Marc blanc	Nocco	Burn	Others
Answers	318	141	70	62	20	17	11	73
%	44.6%	19.8%	9.8%	8.7%	2.8%	2.4%	1.5%	10.2%

In this rubric the participants were able to choose several answers. 318 out of 712 so 44.6% of the answers was Redbull. 141, so 19.8% were selecting Monster. 70 out of 712, so 9.8% indicated that they like to drink Coca Cola Energy. Rockstar is chosen 62 times, so 8.7%. Marca Blanca, Nocco, Burn and Others make up around 16% of all answers.

4.7 Choice of sugar free/ diet Energy drinks

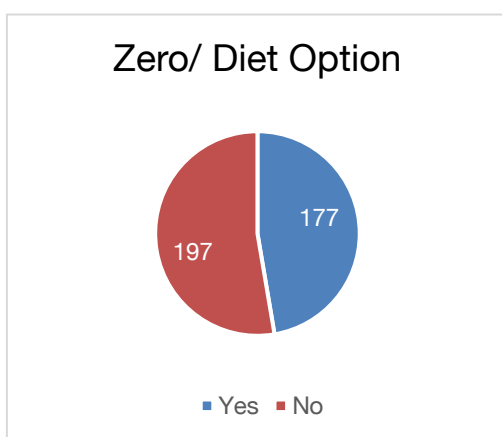


FIGURE 8: ZERO/DIET OPTION

TABLE 7: ZERO/DIET OPTION

Sugar free/ diet ED	Yes	No
Answers	177	197
%	47.3%	52.7%

117 out of 374 responds indicated to choose the sugar free or diet version of the Energy drink, results in 47.3%. 197 people didn't choose to drink the sugar free or diet version of the ED, that means 52.7%.

4.8 For which activities are EDs consumed

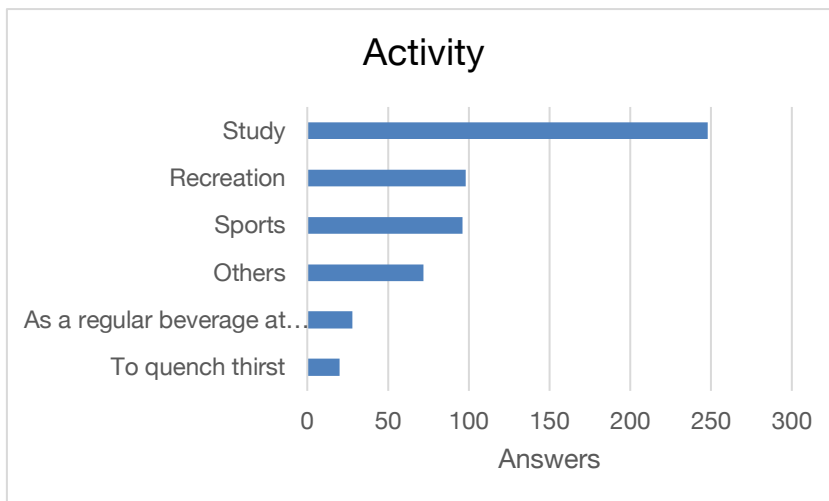


FIGURE 9: ACTIVITY

TABLE 8: ACTIVITY

Activities	Recreation	Sport	Study	As habit	Quitting thirst	others
Answers	98	96	248	28	20	72
%	17.5%	17%	44%	5%	3.5%	13%

Since in these rubric multiple answers were allowed, the total of responds was 562. 98 times, meaning 17.5% it was indicated to drink ED's for recreation. Sport is represented by 96 replies, which is 17%. 248 out of 562 answers are displayed in studying with a percentage of 44%. 28 replies, 5%, point out to drink ED's as a habit. 20 answers,3.5%, are corresponding to quit thirst with this type of drink. 72 times, 13%, the option others were selected.

4.9 Check the nutritional information of the ED before consuming

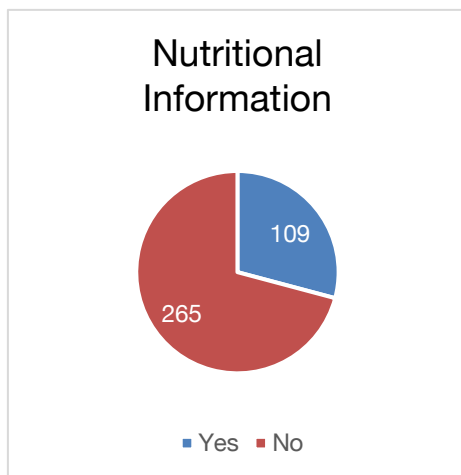


FIGURE 10: NUTRITIONAL INFORMATION

TABLE 9: NUTRITIONAL INFORMATION

Info about nutrition before consuming	Yes	No
Answers	109	265
%	29.1%	70.9%

109 out of 374 answered to read the nutritional information of the ED before the consumption, which means 29.1%. 70.9%, aren't checking the nutritional information before its consumption.

4.10 Quantity of toothbrushing per day

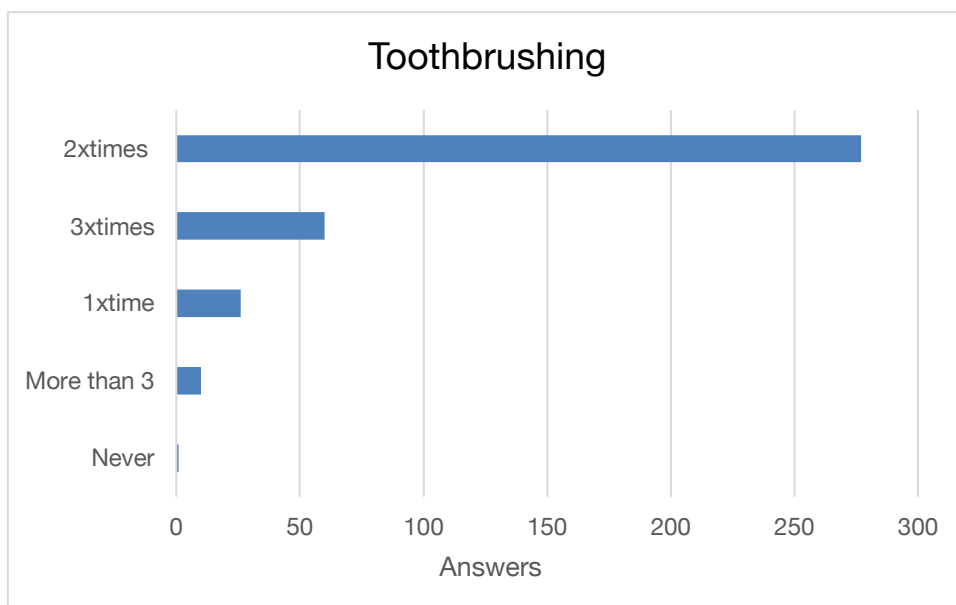


FIGURE 11: TOOTHBRUSHING

TABLE 10: TOOTHBRUSHING

Quantity of toothbrushing a day	More than 3 times	3 times	2 times	1 time	never
Answers	10	60	277	26	1
%	3%	16%	74%	7%	0%

10 participants', 3%, replied to brush their teeth more than 3 times a day. 60 people, 16%, answered to brush the teeth 3 times a day. The teeth are brushed two times by 277 participants, 74%. 26 replies are related to brushing the teeth once a day, which makes a percentage of 7%. One person indicated to brush the teeth never, which displays 0%.

4.11 Effects of sleep since ED consumption

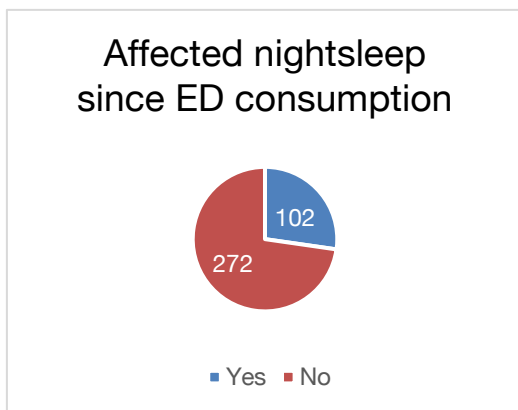


FIGURE 12: EFFECTS OF NIGHTSLEEP

TABLE 11: EFFECTS OF NIGHTSLEEP

Effects of sleep since ED consumption	Yes	No
Answers	102	272
%	27.3%	72.7%

102 persons out of 374, means 27.3%, indicated to notice effects of their sleep since they start drinking ED's. 272 participants, 72.7%, indicated to not have any effect of the sleep since the start of ED consumption.

4.12 Guessing if EDs have negative effects on oral health

Guessing ED negative effect on oral health

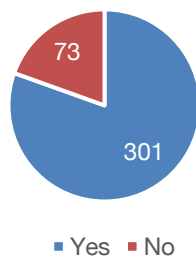


FIGURE 13: ED AND ORAL HEALTH

TABLE 12: ED AND ORAL HEALTH

ED negative for Oral health	Yes	No
Answers	301	73
%	80.5%	19.5%

301 out of 374, means 80.5%, were guessing that ED's have a negative effect on the oral health. 73 answers come from people who guessed that ED's don't have a negative effect on oral health.

5 Discussion

5.1 Description and analysing results

According to the obtained data from the questionnaire, it can be stated that the consumption of Energy drinks is still prevalent within all analysed countries.

Regarding the gender of the participants, 59.6% are female, whereas men display 40.4%. Therefore, more women than men are drinking EDs. Although a study executed in Slovakia with nearly 9000 participants with the age between 11-15 years old, found out that boys instead of girls consume more EDs (5).

Since the author's nationality is German, the main percentage of participants in the survey belongs to Germany, with 50.8%. The second highest nationality reflects the French with 18.2%. Spain reached a participant score of 15,8%. 5.3% are chosen by people whose country wasn't represented in the survey. The United Kingdom, Other European Countries, and Italy are incorporated by 2%. Russia, the USA, the Middle East, and China make 1% or less in the whole survey.

The study found that smoking is executed as a habit by 27% of the 374 people, and therefore the main percentage represents non-smokers with 73%. The previously mentioned Slovakia study asserts that ED consumers are more prone to start smoking (5).

Regarding the age, when the participants started to drink Energy drinks, the analysis was separated into three age groups. Already almost 24% have experience in the consumption of Energy drinks between 1 and 14 years. The primary age of gaining the first experience is around 15 to 17 years, which illustrates a percentage of 48.9%. From the executed study, we learn that 27.3% of the young adults had their first drink by the age of 18 or they were even older.

Examining the frequency of the consumption of Energy Drinks, the measuring is done in five different values. 3% are admitting drinking an ED once a day, and another 3% are indicating to drink it multiple times a day. 25% are consuming it two to five times a week. Once a month its consumed by 33%, and 36% stated to drink ED occasionally during the year. So, around 70% of all participants are either drinking EDs once a month or just occasionally during the year. In comparison only 6% have extreme consumption behaviour. Compared to a study executed in Poland between 2012-2013, where they found out that 20% of the 1756 students (12-20 years) drink ED once a month. 16% consume it daily, a few times a week or once a week. 2% drink EDs every day (6).

By giving the attendees eight options to choose from regarding their favorite drinks, it can be stated that Redbull, with 318 replies, makes 44.6% of the majority of the answers. Monster is displayed with the second most chosen answer with 141, so 19.8%. Coca-Cola Energy, with 70 answers (2.8%), and Rockstar, with 62 responses (2.4%), are in the middle field. The minority is Marca Blanca with 73 answers and Nocco with 11 (1.5%) answers. The option Others is selected 73 times (10.5%). The Polish questionnaire found out, that nearly 50% of the attendees choose Redbull as their favourite drink (6).

Evaluating the displayed answers 47.3% of all the participants would choose to drink a sugar-free or diet ED, whereas more than half, around 53%, wouldn't choose a sugar-free drink.

To know which for activities, the adolescents are consuming the ED, six categories were evolved. The survey illustrated that 17.5% are drinking it during their leisure time as a recreation tool. For doing Sports, 17% are drinking EDs. Most attendees stated to use it for study purposes, which is 44%. The minority of the people use EDs as a habit or for quitting thirst, which makes an overall 8.5%. The option "Others" were chosen by 13% of the people. The previously mentioned Polish study stated that even 27% consume it before doing sports to

improve the exercise performance (6). A Hungarian research from 2017 with around 650 adolescents claimed that men predispose to choose ED for amusement even though females drink it for recreation (7).

According to the interest in checking the nutritional information of the ED before its consumption, we could summarize that around 30% of the adolescents would check it.

Concerning the evaluation of the quantity of toothbrushing habits per day, 3% of the young adult brush more than three times a day. The teeth are brushed three times by 16% of the study participants. The most significant percentage arises for brushing two times a day with 74%. People who brush 1 time are displayed with 7%. Just one attendee chooses to select the option of never brushing the teeth.

The author of the study also wants to observe, if the participants note any effect towards their sleep since they are consuming ED's. Analysing the results reached, a value of 27% is answered by the people who indicate to have developed sleep disorders hence 73% are not having sleep issues since consuming EDs.

To find out if the attendees thought that EDs could have negative effects on oral health, this question was asked in the questionnaire. 80.5% are guessing that the consumption of EDs will create adverse effects on oral health. 19.5% think that it wouldn't cause anything wrong.

5.2 Direct Effect on the oral cavity

5.2.1 Erosions

Since a study claimed that most EDs have a pH under 5.5, the regular consumption of it led to the removal of the Enamel. Collaterally, EDs have a huge amount of non-reducing sugar, which increases the risk of developing an erosive appearance. A study described that a lot of EDs contain Citric acid, which is known for having the most erosive potential. On that account, manufacturers are adjoining sodium citrate, which can balance the pH and trigger the salivary flow. Nonetheless, sodium citrate has the same sequester capacity as citric acid. According to the study's results, we can claim that 6% percentage of the participants are bearing a high risk of developing erosion or might already have demineralized enamel (10).

5.3 Correlation between Smoking, ingestion of sugary drinks, and toothbrushing

A 2022 released scientific article is analyzing the interrelationship of smoking, sugary drinks, and tooth brushing in adolescents in China. After analyzing the 6084 young adults' habits, who are between 12-12 years old, it can be claimed that more boys than girls are smoking.

It's stated that 45% of the studied sample drink soft drinks two times or more a week and generally speaking, more boys are consuming them. It's appalling that the researchers discovered that more than 50% are brushing their less than twice a day. Even 20.3% aren't brushing daily, which can be linked to families with a lower level of education. A Japanese study found out that there is a direct connection between the oral hygiene habit of children and their parents.

The study asserted that smoking adolescents are prone to consume sugary drinks and have bad dental care practices, which would lead to gingival bleeding and dental caries. Since all behaviors are correlated with each other, the authors of the study insist on a unifying prevention strategy (26). Since in the authors study, around 30% attendees are smoking, they develop more likely the habit of skipping tooth brushing or even stop to brush their teeth.

5.4 Prevention of the state

According to the digitalization of the world within recent years, it has been more challenging to manage the information that teenagers and young adults may access. Therefore, it's not astonishing that social media and television are playing a massive role in the adolescent's daily life. This behavior is taken advantage of by the enormous sports drink and energy drink producer. In their advertisements, they are intended to create positive feelings related to these drinks. The consequence is that a lot of adolescents are choosing these drinks out of good intentions. Therefore, it is highly necessary that the state has more control of the media and advertisements and their target population.

The state could also restrict the sales to 18-year old's, they could make more signs on the cans, and lastly, they could increase the taxes on these products out of two reasons. At first, fewer people would buy it, and secondly, in low- or middle-income states, where there is not enough money to treat oral diseases, the tax money could directly go to health insurance (2). Another approach by the state to lower the incidences of oral diseases in a population is to fluoridate the tap water in each region equally (16). Since the previously mentioned Polish study stated that the average consumption age is 15.8 years and, in the authors, study its 15.9 years old, a lot of oral damages could be prevented (6).

5.5 Prevention by the Role of the Dentist

Consequently, to the tremendous popularity of EDs, a dentist's job is to educate patients about the potential long-term negative effects and help them prevent these (27).

5.5.1 In dental practice

To diminish the incidences of the new caries it's important for the patient to use toothpaste with a least 1400ppm of flour. Additional remineralization chemicals we should prescribe in high-risk patients, are toothpaste of 5000ppm and mouthwashes. To lower the creation of periodontal lesions, we should tell the

patient that proper oral hygiene is outrageously important, for instance the interproximal areas should always be cleaned.

In the event of dental erosion, the re-mineralizing chemical CCP- ACP can withstand the effects of the acids (27).

5.5.2 At home

5.5.2.1 Nutrition and Lifestyle

Before consuming an ED, it's essential to read the table of contents. While drinking it, sip through a straw to minimize mouth cavity contact. Drink water simultaneously with acidic and sugary beverages to decrease the unwanted effects. Never drink it before going to bed.

It's important to communicate that the consumption of dairy products like milk, yogurt and cheese that are high in calcium and phosphate will help the tooth to re -mineralize and lowers the change of developing dental caries.

It's best to stay away from soft drinks and candies. Preferably is the usage of clean water as hydration, and it's necessary to choose meals that are high in carbohydrates, such as fruits and whole grains. To protect the periodontium, it's very necessary to stop smoking (27).

5.5.2.2 Dental care:

According to the demineralizing effects of EDs, using, for instance, gums with Xylitol can decrease the adverse effect and help recreate the enamel and dentin. After ingesting of an ED it's vital to wait 45 minutes with toothbrushing since the teeth need that time to be repaired by the salivary buffering capacity. The patient should consult a dentist about preventive dental care and create an activity and good nutrition program (27).

5.6 Alternatives

A research article from 2013 investigates the most recent isotonic drinks. Since ID used to have a high amount of sugar and its usage is controversial, the newly IDs are created naturally by berries and the juice of lemons. They found out that the new introduced berries like maqui, acai, and blackthorn have a great biological activity and cell protection capability. The natural beverage lemon is an intriguing choice because it can regulate the body's Na/ K levels (3).

6. Conclusion

6.1 Analyse the consumption habits regarding Energy drinks in Spain:

It can be stated that 374 out of 704 attendees drink EDs and are between 18 and 28 years old. 27% of all the participants indicated that they smoke. Half of the adolescents indicated that they had their first ED between 15- 17 years. 25% drink it two to five times a week. Redbull and Monster are the most popular ED in the markets. 50% choose the sugar free/ diet version. 44% of the participants are using them for studying. More than 70% are not checking the nutritional values before consuming the EDs. 74% are brushing their teeth 2 times. 28% stated that since they started with the consumption of ED, their night sleep was affected. 80.5% think that ED could cause harmful effects on oral health.

6.2 Study the effect of Energy drinks in the oral health

It can be summed up that EDs not only have a negative effect on general health, but they are causing significant changes in the oral cavity. Related to the high amount of sugar, ED's consumers are very prone to develop caries. Sugar and the lack of a good oral hygiene is also the cause of the development of gingivitis or even periodontitis,. According to the very low pH of the EDs, which is lower than 5.5, the layers of the teeth are attacked. Therefore, the dental tissue is getting demineralized and could cause erosions. which are hard to treat if the habit is not suspended. EDs can remove the cervical part of the Enamel and Dentin so Cervical hypersensitivity can arise.

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Annexes

1. Ethics Committee approval document in English

Survey on consumption habits of energy drinks and oral health

This questionnaire is part of the Final Degree Project in Dentistry of the European University of Madrid entitled 'Isotonic and energy drinks and their impact on oral health' and directed by Professor Dr. Victor Díaz-Flores. The purpose of the present paper is to analyze the consumption of energy drinks and their possible influence on dental patient safety, and the information will be collected through a brief survey.

Your participation in this study is free and voluntary, and you may request to be excluded from it, without prior justification or prejudice to you. The information collected will be confidential and will not be used for any other purpose outside this research and derived from the research disclosure. The data collected will be completely anonymous. No personally identifiable information will be requested. The data collected in the survey will be treated in accordance with the provisions of the Organic Law 3/2018, of December 5, on the Protection of Personal Data and guarantee of digital rights.

For the purposes of the provisions of the regulations of the Organic Law 3/2018, of December 5, on the Protection of Personal Data and guarantee of digital rights, you are informed and expressly consent to the use of the data provided in the survey, for the purposes indicated above. This consent is granted without prejudice to all the rights you have in relation to the above mentioned regulations, with the possibility of accessing the information provided, rectification, cancellation and opposition at any time you wish. To do so, please write to Victor Díaz-Flores (victor.diaz-flores@universidadeuropea.es).

1.1 Questionnaire English

1. Are you at least 18 years old? *

Yes

No

2. Would you like to participate in this survey? *

Yes

No

3. Do you drink energy beverages? *

Yes

No

4. Indicate your birth year *

(Please specify only the year, without day and month)

Der Wert muss eine Zahl sein.

5. Please indicate gender: *

Woman

Man

6. Please indicate your country of origin *

España

Italy

- France
- Germany
- United Kingdom
- Other European Union Countries
- Eastern European countries (non UE)
- Russia
- United States
- China
- Middle East countries
- Others

7. Do you smoke? *

- Yes
- No

8. At what age did you start consuming energy drinks? *

Der Wert muss eine Zahl sein.

9. How often do you consume energy drinks? *

- Once a day
- Several times a day
- 2-5 times a week

- Once a month
- Occasionally during the year

10. What brand of energy drinks do you consume? *

You can mark more than one.

- Redbull
- Coca Cola Energy
- Reign
- Rockstar energy
- Burn
- Monster
- Raw
- V25
- Atlantic
- Crazy Tiger
- Nocco
- White label
- Others

11. Of the above brands, do you usually choose the Zero/Diet option if available? *

- Yes
- No

12. In what activities do you consume energy drinks? *

You can mark more than one.

- Recreation
- Sports
- Study
- As a regular beverage at lunch/dinner
- To quench thirst
- Others

13. Do you consult the nutritional information on the beverage before consuming it? *

- Yes
- No

14. How many times do you brush your teeth per day? *

- More than 3
- 3
- 2
- 1
- Never

15. Since consuming energy drinks, have your nighttime sleep hours been affected? *

- Yes
- No

16. Do you think that regular use of energy drinks can damage the health of your mouth? *

Yes

No

1.2 Ethics Committee approval document Spanish

Cuestionario sobre hábitos de consumo de bebidas energéticas y salud oral

El presente cuestionario forma parte del Trabajo de Fin de Grado en Odontología de la Universidad Europea de Madrid titulado 'Bebidas isotónicas y energéticas y su impacto en la salud bucodental' y dirigido por el Profesor Dr. Victor Díaz-Flores. El propósito del presente trabajo es analizar el consumo de bebidas energéticas y su posible influencia en la seguridad del paciente odontológico, y la información será recogida a través de una breve encuesta.

Su participación en este estudio es de carácter libre y voluntario, pudiendo solicitar ser excluido del mismo, sin justificación previa ni perjuicio para usted. La información recogida será confidencial y no se usará para ningún otro propósito fuera de esta investigación y derivados de la divulgación investigativa. Los datos recogidos serán completamente anónimos. No se solicitarán datos personales identificativos. Los datos que se recojan en la encuesta se tratarán de acuerdo con lo establecido en la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales.

A los efectos de lo dispuesto en el reglamento de la Ley Orgánica 3/2018, de 5 de diciembre, de Protección de Datos Personales y garantía de los derechos digitales, queda informado y es expresamente consiente de la utilización de los datos proporcionados en la encuesta, con los fines anteriormente indicados. El presente consentimiento se otorga sin perjuicio de todos los derechos que le asisten en relación con normativa anteriormente citada, existiendo la posibilidad de acceder a la información proporcionada, rectificación, cancelación y oposición en cualquier momento que lo desee. Para ello debe dirigirse por escrito al tutor Victor Díaz-Flores (victor.diaz-flores@universidadeuropea.es).

1.3 Questionnaire Spanish

1. ¿Es usted mayor de 18 años?

Si

No

2. ¿Desea participar en este cuestionario? *

Si

No

3. ¿Consume usted bebidas energéticas? *

Si

No

4. Indique su año de nacimiento *

(Indique solo el año, sin día ni mes)

Der Wert muss eine Zahl sein.

5. Indique su género: *

Masculino

Femenino

6. Indique su país de origen *

España

Italia

- Francia
- Alemania
- Reino Unido
- Otros Países de la Unión Europea
- Países de Europa del Este (no UE)
- Países de Oriente Medio
- Estados Unidos
- Rusia
- China
- Otros

7. ¿Es fumador/a? *

- Si
- No

8. ¿A qué edad comenzó a consumir bebidas energéticas? *

Der Wert muss eine Zahl sein.

9. ¿Con qué frecuencia consume bebidas energéticas? *

- Una vez al día
- Varias veces al día
- 2-5 veces a la semana

-
- Una vez al mes
- Ocasionalmente durante el año

10. ¿Qué marca de bebidas energéticas consume? *

Puede señalar más de una.

- Redbull
- Coca Cola Energy
- Reign
- Rockstar energy
- Burn
- Monster
- Raw
- V25
- Atlantic
- Crazy Tiger
- Nocco
- Marca blanca (Mercadona, Carrefour, El Corte Inglés...)
- Otras

11. De las marcas anteriores ¿suele elegir la opción Zero/Diet si está disponible? *

- Si
- No

12. ¿En qué actividades consume bebidas energéticas? *

Puede elegir más de una

- Ocio
- Deporte
- Estudio
- Como bebida habitual en las comidas/cenas
- Para saciar la sed
- Otras

13. ¿Consultas la información nutricional de la bebida antes de consumirla? *

- Sí
- No

14. ¿Cuántas veces se cepilla los dientes al día? *

- Más de 3
- 3
- 2
- 1
- Ninguna

15. Desde que consume bebidas energéticas ¿sus horas de sueño nocturno se han visto afectadas? *

- Sí
- No

16. ¿Cree que el consumo habitual de bebidas energéticas puede empeorar la salud de su boca? *

Si

No

2. Statistical Data

[Final Results Excel](#)

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