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ORIGINAL SCIENTIFIC ARTICLE

Impact of soft drinks to health and economy: a critical review

J. F. Tahmassebi[1] · **A. BaniHani**[1]

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Abstract

Aims To provide information regarding the different types of soft drinks and critically reviewing their risk on the dental and general health of children and adolescents, as well as the cost associated with such drinks.

Methods The literature was reviewed using electronic databases, Medline, Embase, Cochrane library, and was complemented by cross-referencing using published references list from reviewed articles. Search words; soft drinks, juices, carbonated drinks, sports and energy drinks, soft drink and dental diseases, soft drink and health, cost of soft drinks, soft drink advertising, sugar tax on soft drinks were used for this review. In total, 104 papers were reviewed by both authors; of these, 62 papers were found to have relevant information.

Results The consumption of soft drinks was found to have increased dramatically over the past several decades. The greatest increase in soft drink consumption has been among children and adolescents. Some commercial soft drinks are high in sugar content and acidity. In addition, they supply energy only and are of little nutritional benefit and lack micro-nutrients, vitamins and minerals. Soft drink consumption can contribute to detrimental oral and general health. Efforts have been made by manufacturers and government agencies to reduce the potential harmful effects of sugar-containing soft drinks on teeth and general health. These include banning the sale of soft drinks in schools, restricting soft drinks advertising, modifying the composition of soft drinks and introducing tax on sugar-containing soft drinks.

Conclusions The consumption of soft drinks with high sugar content and acidity can contribute to detrimental oral health and may also affect general health. Therefore, it is necessary to educate patients about the harmful effects of different types of soft drinks as it is not always easy for individuals to identify from drink labelling the ingredients which they contain.

Keywords Soft drink · Carbonated drink · Dental caries · Dental erosion · Obesity · Diabetes

Introduction

Soft drinks include carbonated drinks, still and juice drinks, dilutables, fruit juices, bottled waters, sports and energy drinks (British Soft Drinks Association Annual Report 2016). According to the British Soft Drinks Association Annual Report (2016), the overall consumption of soft drinks in the UK has increased slightly from 2010 to 2015 by 0.2%. In 2015; 13.3 billion litres of soft drinks were consumed compared with 13.2 in 2010 with more than half (58%) of the consumption was of no or low calorie types (0–20 kcal per 100 ml).

Commercial soft drinks first appeared in 1884 when a product called "Moxie" was made by a drugstore owner in Lisbon Falls in the USA (Tahmassebi et al. 2006). Soon afterwards, similar products appeared including Coca-Cola® and Pepsi-Cola®. Over the past century, soft drinks have changed dramatically from being a local pharmacy product to worldwide industry that earns $60 billion and produce 1 billion litres per year. These changes have been due to advances in manufacturing technology and marketing innovations (Shenkin et al. 2003).

Some soft drinks have been suggested to have a harmful effect on the dental and general health of people including children and adolescents (Al-Majed et al. 2002; Sayegh et al. 2002; Harding et al. 2003; Luo et al. 2005; Tahmassebi et al. 2006; Cheng et al. 2009; Vartanian et al. 2011; Malik et al. 2010; Chi and Scott 2019). The high content of sugar and

✉ J. F. Tahmassebi
J.Tahmassebi@leeds.ac.uk

A. BaniHani
A.BaniHani@leeds.ac.uk

[1] Leeds School of Dentistry/Faculty of Medicine and Health, University of Leeds, Level 6, Worsley Building, Clarendon Way, Leeds LS2 9LU, UK

acids, which have cariogenic and acidogenic potential, can contribute to dental caries, tooth erosion, as well as contributing to health effects such as overweight and obesity and may be associated with an increased risk of type 2 diabetes. Efforts have been made by manufacturers and government agencies to reduce the potential harmful effects of sugar-containing soft drinks on teeth and general health. These include banning the sale of soft drinks in schools, restricting soft drinks advertising, modifying the composition of soft drinks and introducing tax on sugar-containing soft drinks.

This paper aims to provide information regarding the different types of soft drinks and their risk on the dental and general health of children and adolescents and the use of artificial sweeteners in soft drinks and a discussion of the cost associated with such drinks.

Materials and methods

Research question

What are the different types of soft drinks and their risk on the dental and general health of children and adolescents including the use of artificial sweeteners as well as the cost associated with such drinks?

Search strategy

The literature was reviewed by both authors (AB and JT) using electronic databases, Ovid Medline, Embase, Cochrane library and was complemented by cross-referencing using published references list from reviewed articles. Search words included soft drinks, juices, carbonated drinks, sports and energy drinks, soft drink and dental diseases, soft drink and health, cost of soft drinks, soft drink advertising, and sugar tax on soft drinks were used for this review. For Ovid Medline, Embase, and Cochrane library, studies related to the MeSH heading of 'soft drinks' or the terms 'juices', 'carbonated drinks', or 'sports and energy drinks' together with the MeSH headings of 'soft drink and dental diseases', 'soft drink and health', 'cost of soft drink', 'soft drink advertising', or 'sugar tax on soft drinks' were combined. Papers were initially reviewed by assessing the title and abstract followed by the full paper. In total, 104 papers were reviewed; of these, 62 papers were found to have relevant information.

The search strategy is summarised in Fig. 1. The inclusion and exclusion criteria are summarised in Table 1.

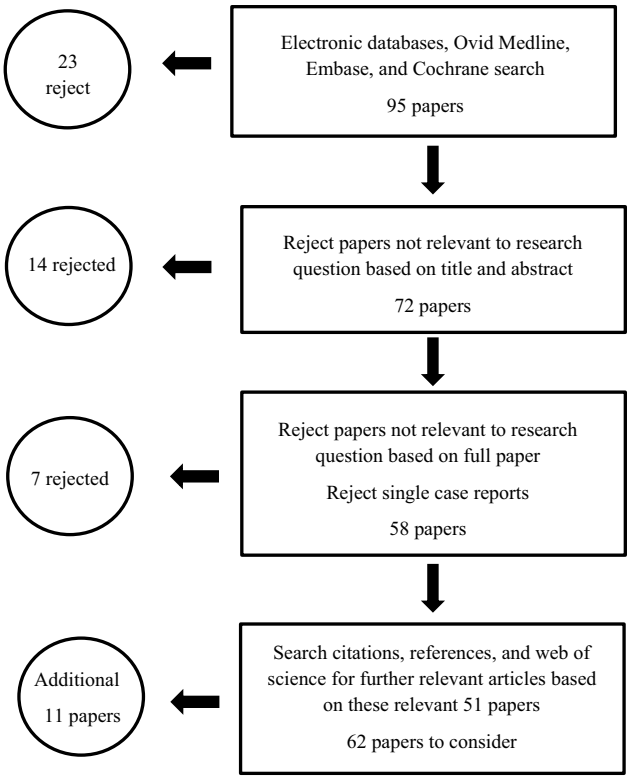

Fig. 1 Summary of search strategy with inclusions and exclusions

Table 1 Inclusion and exclusion criteria of the literature

Inclusion criteria
Primary studies
Contained relevant information to the aims of the paper
Types of soft drinks
Soft drinks risk on the dental and general health of children and adolescents
Use of artificial sweeteners in soft drinks
Cost associated with soft drinks
Published after 1983
Exclusion criteria
Single case reports

Different types of soft drinks

Modern drinks now contain carbon dioxide for carbonation. Carbonated soft drinks accounted for the largest category of these drinks in 2016, with a market share of 38% in the UK (British Soft Drinks Association Annual Report 2016). Carbon dioxide, a common factor to all carbonates, is added to make drinks fizzy. Other ingredients include water, sugar (sucrose, glucose, and fructose), intense sweeteners (discussed later), acid (citric acid, malic acid, and phosphoric acid), fruit juice, preservatives, flavourings, and colours. Currently, low- and no-calorie drinks make up 45% of the category, with a further 5% being mid-calorie (British Soft Drinks Association Annual Report 2016).

Some drinks are made with concentrates that require dilution to taste by consumers, such as squashes, and cordials, accounted for the second largest share (22%) of overall soft

drink consumption in 2016. There is a dominance of low- and no-calorie variants within this category (87%), providing lower calorie refreshment for adults and children alike (British Soft Drinks Association Annual Report 2016). Fruit juice is 100% pure juice which is made from the flesh of fresh fruit or from whole fruit, depending on the type used. No sugar, sweeteners, preservatives, flavourings or colourings are added to fruit juice. They contain cells or bits of fruit pulps and vitamin C (ascorbic acid). Fruit juice accounted for 7% of total soft drink consumption in UK (British Soft Drinks Association Annual Report 2016).

Sport drinks are another popular drinks especially amongst adolescents and young adults and they contain water, carbohydrate mainly glucose, maltodextrin as well as fructose, and electrolytes such as sodium, potassium and chloride (Coombes and Hamilton 2002; Coombes 2005; British Soft Drinks Association Annual Report 2016). The electrolytes are added to improve palatability and to help maintain fluid/electrolyte balance. Sport drinks aim to prevent dehydration, and enhance the athletic physical performance before, during or after sporting activity. They replace fluids and electrolytes/minerals lost by sweating and supply a boost of carbohydrates. The additional benefits of sport drinks over water alone in reducing the effect of dehydration resulting from exercise on cardiovascular dynamics, temperature regulation and exercise performance have been questioned (Coombes and Hamilton 2002; Coombes 2005; Seifert et al. 2011; Jean 2017). For most individuals engaged in physical activity, no clear evidence was found to support the additional performance benefits of soft drinks over water alone (Coombes and Hamilton 2002; Coombes 2005; Jean 2017). Although these drinks are designed to help athletes, they have become popular over recent years with the general population especially the younger generation and are being consumed socially (Coombes and Hamilton 2002; Coombes 2005).

Conversely, energy drinks are glucose based that supply a boost of energy from caffeine, guarana, taurine, and ginseng (British Soft Drinks Association Annual Report 2016). Energy drinks contain high amount of sugar and caffeine; therefore, they can enhance the mental and physical performance, improve alertness, concentration, endurance and mood (Bunting et al. 2013). The caffeine content and concentration vary widely between various brands and labelling of the amount of caffeine presents in these drinks is not mandated by the Food and Drug Administration of the USA (Rath 2012).

Currently, the sport and energy drinks sector in the UK market has a share of 6% and worth over £2 billion (Bunting et al. 2013; British Soft Drinks Association Annual Report 2016). Low- and no-calorie made up only 5% of the category with 62% of the energy drinks sold in the market are of the regular type.

It is encouraging to see that the consumption of bottled waters in UK has increased significantly from 2 billion litres (14.8%) in 2010 to nearly 3 billion litres (19.3%) in 2015. Likewise, in USA, total consumption of bottled water increased from 54 billion litres in 2015 to 58 billion litres in 2016, an increase of nearly 9%. The sales of bottled water surpassed carbonated soft drinks to become the largest beverage category by volume in the USA in 2016 (International Bottled Water Association 2017).

Effect of soft drinks on dental health

Dental caries is a multifactorial disease that is affected by several factors including salivary flow and composition, exposure to fluoride, consumption of dietary sugars, and by oral hygiene practices (González-Aragón Pineda et al. 2019).

Regular (non-diet)-soft drinks excluding bottled waters contain large amounts of sucrose or high-fructose corn syrup that have cariogenic potential; a typical 350-ml can of regular carbonated soft drink contains approximately 10 teaspoons (40 g) of these sugars (Table 2). Long-term and frequent consumption of regular-soft drinks with high sugar content may induce dental caries. Many studies have shown a positive relationship between caries and intake of soft drinks (Al-Majed et al. 2002; Sayegh et al. 2002; Harding et al. 2003; Luo et al. 2005; Cheng et al. 2009; Chi and Scott 2019). The greatest risk for caries development in children is associated with the consumption of soft drink between meals rather than with meals.

Unfortunately, dental caries is the most common reason for children aged 5–9 years to be admitted to hospital in UK when poor oral health is largely preventable (The Royal College of Surgeons of England 2015; BaniHani et al. 2019). In 2013–2014, nearly 46,500 children and young people under 19 years old in England were admitted to hospital for a primary diagnosis of dental caries from which over 55% of the cases were between 5 and 9 years old. This figure has increased by 14% from 2010 to 2011 and it continues to increase year on year. Dental rehabilitation under general anaesthesia (GA) is considered as a distressing experience for many children and their parents, and it carries risk of morbidity including postoperative pain, sleepiness, dizziness, nausea and vomiting, and mortality (Atan et al. 2004). This approach to dental care comes at a cost to health services as well. For example, in 2012–2013, the NHS spent £30 million on hospital-based tooth extractions for children aged 18 years and under with average cost of £837 for treatment under GA (The Royal College of Surgeons of England 2015; BaniHani et al. 2019).

The solubility of dental tissues is affected by a pH and titratable acidity of both the oral cavity and the soft drink. When oral pH drops below the pH of 5.5, enamel dissolution

Table 2 Description of the sugar and acid content in several soft drinks available in the global market

Soft drink type	Amount of sugar	pH of the drink
Burger king large chocolate milkshake	25.6 cubes ~ 102.4 g	6.7
Lucozade (500 ml)	15.5 cubes ~ 62 g	2.5
Coca Cola (500 ml)	13.5 cubes ~ 54 g	2.3
Diet Coca Cola (500 ml)	0 cubes ~ 0 g	2.61
Ribena (500 ml)	13.15 cubes ~ 52.6 g	3.19
Frijj chocolate milkshake (471 ml)	12.7 cubes ~ 50 g	6.7
Innocent pomegranates, blueberries and acai superfood smoothie (250 ml)	8.5 cubes ~ 34.3 g	3.59–3.73
Capri-Sun (330 ml)	8.25 cubes ~ 33 g	3.8
Tropicana orange juice (330 ml)	7.5 cubes ~ 30 g	3.8
Nesquik chocolate milk (240 ml)	7.25 cubes ~ 29 g	6.7
Red Bull (250 ml)	7.25 cubes ~ 29 g	3.3
Apple juice (240 ml)	6.5 cubes ~ 26 g	3.49
Orange juice (240 ml)	6 cubes ~ 24 g	3.84
Volvic flavoured water (500 ml)	5.75 cubes ~ 23 g	
Snapple Lemon Iced Tea (240 ml)	5.75 cubes ~ 23 g	–
Vitamin water, B-relaxed jackfruit and guava	3.25 cubes ~ 13 g	3.2
Flavour (240 ml)		–

occurs (Chowdhury et al. 2018). Most soft drinks excluding bottled waters have a pH that ranges from 2.5 to 3.5 with an average pH of 3.44 for the carbonated drinks and fruit juices (Table 2) (Chowdhury et al. 2018). In addition, they contain acids that have erosive potential mainly carbonic acid, phosphoric acid, malic acid, and citric acid (Shenkin et al. 2003; González-Aragón Pineda et al. 2019). Therefore, the consumption of soft drinks with high acidic content, both regular- and diet/zero-calories types, is significantly associated with dental erosion (Al-Majed et al. 2002; Sayegh et al. 2002; Harding et al. 2003; Luo et al. 2005; Cheng et al. 2009; Tahmassebi et al. 2014; Pachori et al. 2018). Dental erosion can contribute to significant tooth surface loss (TSL) not only in adults but also in children and adolescents resulting in teeth sensitivity, eating and drinking difficulties as well as dissatisfaction with appearance (Milosevic 2017).

The total acid level rather than the pH of the beverage, known as titratable acid, determines the actual hydrogen ion availability for interaction with the tooth surface, and is considered as an important factor in development of dental erosion (Tahmassebi et al. 2014). Other important factors include the type of acid and its calcium chelating properties, exposure time to the acidic drink, temperature, and the concentration of the modifying substances in the acidic beverage including the calcium, phosphate and fluoride (Zero 1996) (Table 3).

It has been shown that dental erosion is associated with the drinking methods. Frequent consumption of fruit drink, carbonated beverage and fruit juice as well as bedtime consumption increased the severity of dental erosion (Milosevic 2017). Holding the drink longer and swishing it around the mouth lead to a more pronounced pH drop (Eisenburger and

Table 3 Description of the prevalence of dental erosion among children and adolescents reported in the literature. Adopted from Taji and Seaw (2010) and Child Dental Health Survey (2015)

Study	Country	Age of children (years)	Prevalence of erosion
Child Dental Health Survey (2015)	UK	5–8 12–15	58% and 7% in their primary teeth 53% and 59% in their permanent teeth
Deery et al. (2000)	USA	11–13 13–19	41% in their permanent teeth 45.9% in their permanent teeth
Harding et al. (2003)	Ireland	5	50% dental erosion in their primary teeth 21% erosion into dentin
Ganss et al. (2001)	Germany	8–14	70.6% overall
Kazoullis et al. (2007)	Australia	5.5–14.6	25% overall
Ayers et al. (2002)	New Zealand	5–8	82% overall
Al-Majed et al. (2002)	Saudi Arabia	5–6	82% overall
Luo et al. (2005)	China	3–5	5.7% overall

Addy 2003). The latter can be enhanced by higher temperature of the acid; whereas, the use of a straw while drinking has been shown to reduce the risk of acid erosion (Tahmassebi and Duggal 1997).

In an attempt to reduce overweight, obesity and dental caries among populations, diet soft drinks were introduced. Diet (alternatively marketed as sugar-free, zero-calorie or low-calorie) drinks are sugar-free, artificially sweetened versions of carbonated soft drinks with virtually no calories. They are generally marketed toward health conscious people, diabetics, athletes, and other people who want to lose weight, improve physical fitness, or reduce their sugar intake (Weihrauch and Diehl 2004; Whitehouse et al. 2008; Tandel 2011; Gardner et al. 2012; Pearlman et al. 2017). Although diet soft drinks are non-cariogenic as they contain artificial sweeteners, they contain phosphoric and citric acid at a similar level as the regular beverages which contribute to the total acidic challenge potential on enamel (Roos and Donly 2002; Shenkin et al. 2003). Diet soft drinks often have a high erosive potential that can enhance enamel demineralisation and contribute to dental erosion as sugar-containing soft drinks (Tahmassebi et al. 2006). Ali and Tahmassebi (2014) reported in an in vitro study that diet-Coca cola® was acidic with an inherent pH value (pH 2.61) and low titratable acidity.

The management of dental erosion is an area of clinical practice that is undoubtedly expanding. Depending on the degree of tooth wear and symptoms, management can range from monitoring and fluoride treatment to tooth restoration including the placement of composite resin, glass ionomer fillings, and veneers (Milosevic 2017). The cost of placing and replacing a restorative material can be high.

Effect of soft drinks on general health

Soft drinks are often high in sugar content and acidity (Table 2). Each gram of sugar contains 4 calories. In addition, they supply energy only and are of little nutritional benefit (Bucher and Siegrist 2015; Chi and Scott 2019). Several studies have shown that soft drink with high sugar and acid content consumption can contribute to detrimental general and oral health effects on children and adolescents including an increasing risk of overweight, obesity, type 2 diabetes, dental caries and dental erosion (Scientific Advisory Committee on Nutrition 2015; Chi and Scott 2019).

Obesity has recently emerged as a major global health problem. The World Health Organisation (WHO) and Scientific Advisory Committee on Nutrition (SACN) recommend a diet where a maximum 5% of the energy comes from free sugars. The SACN (2015) reported that nearly a third of children aged 2–15 years living in the UK are overweight or obese, and that younger generations are becoming obese at earlier ages and staying so for longer. In the USA, two out of three adults and one out of three children are overweight or obese with over 18% of 6–19 year olds are above the 95th percentiles of body mass index (BMI), for age and gender (Ogden et al. 2014).

A rising consumption of sugar-containing soft drinks has been suggested as a major contributor to the obesity epidemic. The increase in intake of sugar-containing soft drink has coincided with rising body weights and energy intakes in several populations. In the USA, the per capita annual consumption of regular soft drink increased by 86% between 1970 and 1997 alone. During that period of time, the prevalence of obesity rose by 112% (Flegal et al. 2000).

Overweight and obesity can have major costs for individuals and their families as well as for the health care systems. It increases the risk of developing type 2 diabetes and heart disease as well as doubles the risk of dying prematurely (Pischon et al. 2008).

Type 2 diabetes has also emerged as a global public health concern, parallel to the global trends in the prevalence of obesity. Along with the increased consumption of soft drinks, there has been a rapid and large increase in the reported incidence of type 2 diabetes (Hu and Malik 2010; Greenwood et al. 2014).

In a systematic review by Vartanian et al. (2011), high consumption of soft drinks was related to low consumption of milk, calcium, fruit and dietary fibres contributing to an overall poorer diet. In addition, in two studies by Whiting et al. (2001) and McGartland et al. (2003), the high intake of carbonated soft drinks during adolescence was significantly associated with reduced bone mineral density among girls aged 12 and 15 years. Calcium is found mainly in dairy products and is an essential nutrient for the structural integrity of bone and for maintaining bone density throughout life (Shenkin et al. 2003); whereas, carbonated soft drinks contain mostly empty calories (Whiting et al. 2001).

Energy drinks are often high in caffeine to enhance the mental and physical performance, improve alertness, and concentration (Bunting et al. 2013). The amount of caffeine in most of the energy drinks is usually three times the concentration in cola drinks. They are available in the market of more than 140 countries and are the fastest growing soft drink sector not only in the USA and UK but also worldwide (Seifert et al. 2011).

Although moderate consumption of caffeine can be tolerated by most healthy people, studies showed that its high consumption (> 400 mg per day) has been associated with adverse effects on health including anxiety, restlessness, aggression, headaches, and depression. A prolonged exposure to high intakes of caffeine, levels greater than 500–600 mg a day, can result in chronic toxicity leading to nervousness, nausea, vomiting, seizures and cardiovascular

symptoms in severe cases (Seifert et al. 2011; Bunting et al. 2013; Jean 2017).

Artificial sweeteners in soft drinks and general health

Several artificial sweeteners are used to give diet soft drinks a sweet taste without sugar. They are called sugar substitutes because they provide the sweetness of sugars without the added calories, thus reducing the risk for obesity, and dental caries. However, their safety has been controversial (Whitehouse et al. 2008). The breakdown product of these sweeteners has controversial health and metabolic effects (Whitehouse et al. 2008). Some research has linked the consumption of artificial sweeteners with adverse health conditions including obesity, lymphomas, leukemias, cancers of the bladder, and brain, chronic fatigue syndrome, Parkinson`s disease, Alzheimer`s disease, multiple sclerosis, autism, and systemic lupus (Whitehouse et al. 2008). The carcinogenic potential of artificial sweeteners, mainly aspartame and saccharine, has been investigated. Exposure to these chemicals was associated with an increased risk of brain tumours and cancer of the bladder, in both male and female mice, respectively (Olney et al. 1996; Weihrauch and Diehl 2004). Another sweetener Saccharine® was prohibited in Canada and banned in the USA following the results of two-generation study published by Arnold et al. (1983). However, the ban on Saccharine® use in the USA was withdrawn in 1991; nevertheless, all food and soft drinks containing Saccharine® have to carry a warning label to indicate that "Saccharine® is a potential cancer causing agent". Conversely, future research has failed to conclude that there is a clear causal relationship between aspartame, saccharine and other approved artificial sweeteners consumption, with health risks in humans at normal doses (Chattopadhyay et al. 2014). Therefore, the FDA has concluded that these sweeteners are safe at current levels of consumption and, as a result, the decision of placing warning labels on all products that contain saccharine was overturned in 2000 (Tandel 2011).

Discussion

Some commercial soft drinks are high in sugar content and acidity and, therefore, their consumption can contribute to detrimental oral and general health. There is a clear association of soft drink intake with increased energy intake and body weight is evident in the literature (Malik et al. 2010; Vartanian et al. 2011; Basu et al. 2013; Powell et al. 2017). Soft drinks apart from the low- and zero-calories categories contain high sugar content. A daily addition of one 350-ml can of sugar-sweetened carbonated soft drink which contains 150 kcl and 40–50 g of sugar to a typical diet with no reduction in other caloric sources can lead to a weight gain of 6.75 kg within 1 year in adults (Apovian 2004). Moreover, soft drinks increase hunger, decrease satiety, and condition people to a high level of sweetness that produces a preference in other foods leading to excess energy intake. If normal dietary intake does not decrease by an equivalent amount of calories obtained from consuming soft drinks, then weight gain is very much to be expected (Malik et al. 2010; Vartanian et al. 2011).

Soft drinks can also contribute to type 2 diabetes through several mechanisms mainly by their ability to induce a weight gain, which is a risk factor for the development of the condition. In addition in the USA, some of these drinks contain high amounts of rapidly absorbable carbohydrates such as sucrose and high-fructose corn syrup (HFCS), a key ingredient in some of sugar-sweetened beverages. Though HFCS is not currently a key ingredient in sugar-sweetened beverages in the UK or EU, changes to the EU quota system on sugar policy since 2017 may influence addition of HFCS in the soft drinks in the future. These types of carbohydrates can lead to hepatic lipogenesis and high dietary glycaemic load resulting in inflammation, insulin resistance and impaired B cell function, thereby fuelling the development of type 2 diabetes (Hu and Malik 2010; Caprio 2012; Greenwood et al. 2014).

The economic costs of obesity and its related ill-health are great too. In 2014/2015, it was estimated that the National Health Service (NHS) in the UK spent nearly £5.1 billion on the treatment of obesity and its related ill-health. A higher figure was reported in the USA where healthcare expenditures on overweight and obesity were estimated to be between $150 billion and $190 billion, attributing to 20% of total healthcare costs per year (Scharf and DeBoer 2016).

Several artificial sweeteners are used to give diet soft drinks a sweet taste without sugar. The consumption of artificial sweeteners has been found to promote weight gain rather than weight loss in several studies (Hampton 2008; Swithers and Davidson 2008; Pearlman et al. 2017). These studies showed that these sweeteners induce insulin production into the blood and in the absence of blood sugar, hypoglycaemia and increased food intake occur resulting in overweight and obesity.

Actions have been taken by few countries across the globe to tackle the obesity and dental caries. These include banning the sale of soft drinks in schools, restricting soft drinks advertising, modifying the composition of soft drinks and introducing tax on sugar-containing soft drinks. Sugar-containing soft drinks are banned for sale in schools in many countries.

In the UK, strict rules on sales of high-sugar and -acid content soft drinks in school were instigated in 2007.

Beverages with added sugar including energy drinks are not permitted. Also, some schools have banned their students from bringing energy drinks into school from outside (British Soft Drinks Association Annual Report 2016).

Furthermore, governments in some countries such as the UK applied restrictions in marketing soft drinks to children online and on television (Al-Mazyad et al. 2017). Advertising is essential to the marketing of soft drinks with millions of dollars spent to promote their consumption. Food and beverage advertising increases the total demand and motivates brand switching (Powell et al. 2017). Children and youths are exposed to advertising from not only television, but also billboards, magazines, signs in stores and public places such as airports and subway stations, and now increasingly on technology such as iPad apps, and video games as well as social media (Scharf and DeBoer 2016). Social media are a relatively new medium through which soft drink manufacturers can uniquely target young people. The increased usage and importance of social media for young people make them vulnerable to highly personalised and targeted digital marketing campaigns by the food and beverage industry. Brownbill et al. (2018) explored how soft drinks are marketed to Australian young people, aged 13–25 years, through soft drink brand Facebook pages. The authors found that soft drink brands share highly engaging content on Facebook which seamlessly integrates their content into the lives of young people. Brands were found to align their products with common sociocultural values and practices such as masculinity, femininity, friendship, and leisure, which are regarded as important by young people today, thus portraying their products as having a normal place within their everyday lives. The results of the study suggested the need to monitor advertising via social media and the importance of understanding the exposure to, and impact on young people.

Australia, Sweden, and Belgium as well as UK are among the countries that have banned television advertisement of food high in sugar and fat during children's programmes (Story and French 2004).

A number of countries across the globe have introduced a tax on sugar-containing soft drinks in an effort to reduce childhood obesity and dental caries including France, Finland, Hungary and Mexico (World Cancer Research Fund International 2008). Colchero et al. (2016) reported a 10% decrease of sugar-based soft drinks consumption and a 4% increase in the purchase of healthier alternatives such as bottled plain water among the Mexican population following the introduction of a tax on soft drinks in 2014. In addition, 39 states in USA have applied a tax on sugar-containing soft drinks sold either in food premises and/or vending machines (Centre for Science in the Public Interest 2011).

A new sugar tax on soft drinks, known as the soft drinks industry levy, was introduced in April 2018 on soft drinks with added sugar in UK to help tackle childhood obesity by reducing the consumption of soft drinks with added sugars. The levy applies to soft drinks that contain 5 grams or more of added sugar per 100 ml. Revenue from the levy is planned to be used to develop programmes that aim to reduce obesity and encourage physical activity for school age children (HM Revenue & Customs 2016). This action is expected to reduce the consumption of sugar-containing soft drinks by 1.6%, and it is hoped that it will encourage soft drinks manufacturer to reduce the sugar content of their products.

Conclusions

The consumption of soft drinks was found to have increased dramatically over the past several decades with the greatest increase among children and adolescents. Excessive intake of soft drinks with high sugar and acid content both regular and diet could cause detrimental impacts on dental and general health including dental caries, dental erosion, overweight, obesity and increased risk of type 2 diabetes. The sugar tax has raised the level of awareness; however, it is necessary to educate patients about the harmful effects of different types of soft drink as it is not always easy for individuals to know from drink labelling what they actually contain.

Compliance with ethical standards

Conflict of interest The authors have no conflicts of interest to declare.

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