There is increasing community interest in the dental effects of soft drinks, sports drinks, energy drinks, and flavored waters due to the escalating consumption by children and adolescents over the last two decades. Immature teeth are porous and are more easily dissolved by acids. Parents need to understand the potential dental implications associated with consumption of sugary, acidic beverages in order to help their children minimize damage to their teeth.

**THE GROWING MARKET**

Soft drinks are big business in the United States. From 1990-2000 consumption increased by 56%, rising 2-3%/year. The U.S. market alone includes 450 different soft drinks, with total retail sales over $60 billion annually. Americans consume over 50 gallons per person per year, surpassing all other beverages including coffee, milk, alcohol, and bottled water. The largest increase in soft drink consumption has occurred among children and adolescents. Twenty two percent of one and two year old children consume soft drinks with an average of nearly one cup/day. Forty percent of pre-school children drink more than 8 ounces of soft drinks per day. Boys 12-19 years of age average 28 ounces/day and girls of the same age range average a rate of intake of 21 ounces/day.

Vending machines have contributed to the substantial increase in soft drinks consumption and are now the largest source of added sugars in the U.S. accounting for one third of total intake. In the past, vending machines dispensed 8-12 oz. bottles or 12 oz. cans. Now, many machines dispense 16-20 oz. bottles that can be resealed and consumed all day long. In addition, fast food restaurants and convenience stores promote and sell large volume containers of soft drinks in quantities of 32-64 ounces, resulting in greater frequency and volume of exposure to the teeth. In addition, soft drink purchases by schools have increased 1,100% over the past 20 years while dairy purchases have decreased by 30%.

Sports drink consumption has also dramatically increased with over $1.5 billion in sales/year. Over 90% of athletes are using these products on a regular basis. From 1998-2003, the sale of energy drinks increased in the U.S. by an estimated 465%. In addition, over the past several years, there has been rapid growth in bottled waters, which commanded 13% of the soft drinks market in 2002 compared with only 6% in 1992.
The primary nutrient displaced is calcium, which is found mainly in dairy products. Calcium is an essential nutrient for the structural integrity of bone and for maintaining bone density throughout life. The decline in consumption of dairy products is unfortunate not only because of their nutritional content but for their protective effects against tooth decay.

**Diet Drinks Are Not the Answer**

Because of concern with obesity and weight gain, diet soft drinks were developed. These drinks have been marketed as “sugar free” drinks. They use artificial sweeteners to reduce their caloric content. However, these drinks still have a low, acidic pH, and studies have shown their erosive potential to be nearly equal to their sugary counterparts. Also, with diet soda drinks, there appears to be a rebound phenomenon whereby having consumed a diet drink the body anticipates an intake of calories, which is not forthcoming. Accordingly, the satiety reflex is not induced and the individual then eats or drinks more.

**How the Various Beverages Rank**

From a review of current literature, it appears that non-cola drinks, especially those high in citric acid content (Mountain Dew, Sprite, 7-Up, Ginger Ale, etc…), commercial Lemonades, canned lemon-favored iced tea, and energy/sports drinks (Red Bull, Gatorade, etc…) have the most aggressive dissolution effect on dental enamel. These drinks are followed by the colas (Coke, Pepsi, Dr. Pepper, Mr. Pibb, etc…), and their diet counterparts, which still have strong erosive potential. According to one study, pure citrus juices are more erosive than carbonated beverages. The fruits regularly implicated in dental erosion, such as oranges and lemons, have high citric acid concentrations. Root Beer appears to be the safest soft drink alternative when considering tooth enamel risk. In general, the risk of enamel dissolution is 2-5 times higher for the non-colas than the colas. One study showed the dissolution from canned iced tea to be 30 times that produced by black tea or coffee. Tap water, root beer, brewed black tea, and black coffee all showed minimal enamel dissolution in one study.

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**The Link to Tooth Decay and Tooth Erosion**

Refined sugars play a pivotal role in the caries (tooth decay) process. The evidence linking sugar and tooth decay is overwhelming. An increase of 1 oz. in daily soda pop consumption increases a child’s risk of having extensive caries by 26%. Regular (non-diet) soft drinks contain large amounts of sucrose or high fructose corn syrup that are considered to be highly cariogenic (high decay potential). A typical 12 oz. can of sugared soda contains approximately 10 teaspoons of these sugars. A recent study in the U.S. showed a positive relationship between cumulative caries (tooth decay) scores and the frequency of mealtime and between-meal use of carbonated beverages. Daily between-meal consumption of soft drinks three or more times per day has been shown to increase the risk of dental decay by 179%. Research has shown that bedtime is the worst time to consume sugar-sweetened drinks.

Tooth erosion, or tooth wear, is the loss of tooth structure. Basically, tooth erosion refers to the wearing away of the hard part of your teeth, which is called enamel. The ideal (neutral) pH of the mouth ranges from 6.5-7.5. A pH of 5.5 is considered to be the threshold level for the development of dental decay. Both soft drinks and sports drinks have been shown to have a pH between 2.5 and 3.5. Demineralization of tooth enamel will occur more rapidly if the pH drops below the critical 5.5 level for long periods of time and if the pH is dropped below the critical level frequently. Also, research supports that a beverage’s composition and total acid content, rather than beverage pH, determine the actual aggression toward enamel. Citric acid is the most aggressive acid linked to tooth demineralization. A single acidic attack is of minor importance but if repeated the ability of the saliva to deal with the acid becomes less and less. Hence, the danger is the frequent use of soft drinks over time. Continuous sipping is more dangerous to tooth enamel than more rapid drinking.

**Other Health Effects**

In addition to potential tooth destruction, high soft drink consumption can lead to excessive caloric intake, which may contribute to childhood obesity, a growing problem in the U.S. Type 2 diabetes, cardiovascular diseases, and asthma are all conditions linked to obesity and nutritional imbalances. Also, the decrease in the consumption of dairy products has resulted in the displacement of many needed nutrients for both children and adolescents as well as for adult females.
WHY ARE SPORTS AND ENERGY DRINKS SO DESTRUCTIVE?
Results from research studies looking at sports and energy drinks have shown their destructive potential on tooth enamel to be even greater than cola-based carbonated beverages and some have simple sugar concentrations as high as 20% of the volume of the beverage. Also, research has indicated sports and high-energy drinks or beverages containing higher concentrations of citric acid are even more aggressive in this regard. In one study, Red Bull and Gatorade showed the greatest degree of enamel dissolution (over Coke and Diet Coke). The high concentrations of refined carbohydrates in energy and sports drinks make it harder for saliva to clear this product from the teeth and as such the pH remains more acidic for a longer period of time. This “buffering capacity” is generally more important than initial pH in terms of a beverage’s erosive potential. Also, dehydration from extended physical exertion can lead to low salivary flow. Thus dehydration can lead to even longer times to clear these drinks from your teeth putting the enamel at even greater risk. Athletes need to be reminded that water is still an important rehydrating fluid and is preferred over sports drinks that are high in carbohydrates (refined sugar) and low in pH. It is important to note that for most individuals engaged in physical activity, sports drinks have no performance benefit over water.

ARE FLAVORED WATERS SAFE?
There is a general perception amongst consumers that fruit-flavored water drinks are essentially water with subtle flavoring. As a consequence, they have been perceived as dentally safe. The flavoring of these drinks, however, frequently includes citric acid and other fruit-derived acids. In a recent study, the pH values recorded for the flavored water drinks ranged from 2.74 to 3.34, and those with the lowest pH were the lemon and lime, peach, and grapefruit flavors. Thus, in comparison with soft drinks, flavored water drinks should be considered as acidic drinks rather than water with flavoring. Therefore, flavored sparkling water drinks should be regarded as potentially erosive, and preventative advice on their consumption should recognize them as acidic drinks rather than water with flavoring.

ALTERNATIVES TO CONSIDER
Because of greater access to soft drinks, sports drinks, and flavored waters in vending machines and an increasingly wider availability of these products in schools, parents need to counsel their children to consume alternative beverages such as water or low-fat milk whenever possible. Parents of young children should also replace fruit drinks and soft drinks with low-fat milk or 100% fruit juice. Fruit juice consumption should be limited to 4-6 oz. per day for children age 1-6 and 8-12 oz. per day for children aged 7-18.

WHAT PARENTS CAN DO
Although parents may find it a challenge to control what their children drink and eat elsewhere, they can provide access to appropriate food and drink choices at home. Parents understand that their kids are going to want these drinks. Therefore, a realistic approach would be to get them to consume these beverages in a healthier way. Parents should focus on the following:

1) Be aware of how much their children are consuming in the first place (at school, games, practices) and make an effort to reduce their consumption by controlling their access whenever they can.

2) Try to eliminate between-meal consumption. Make sure these drinks are consumed with food. Do not allow any bedtime consumption.

3) Limit volume and exposure time by buying the smaller cans. Children should be encouraged to drink acidic drinks quickly and use a straw so that the liquid is pushed to the back of the mouth. Also, avoid buying re-sealable bottles and discourage sipping over a long period of time.

4) Encourage their children to rinse with water whenever possible following consumption of these beverages to neutralize the acids, and wait an hour before brushing their teeth.

5) Chew sugar-free gum to produce more saliva so as to promote quicker remineralization of enamel, and

6) Brush their teeth with a soft toothbrush two-times per day and be sure their toothpaste contains a high amount of fluoride. Also, children should be encouraged to use a fluoride brush-on gel and/or fluoride rinse daily just before bedtime.

Parents need to be more aware of the sugar and acid content in the beverages that their children consume and treat soft drinks and other related sugary or acidic beverages as an occasional treat (like you would sweet snacks or candy). The bottom line for all parents is that altering or reducing the intake of these beverages can decrease the degree of dental destruction in their children.

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