11 Sugar and health: a food-based dietary guideline for South Africa

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Keywords: food-based dietary guidelines, FBDGs, sugar consumption, sugar-sweetened beverages, dental caries, obesity

This article is an adaptation of a manuscript previously published by Steyn NP, Temple NJ. Evidence to support a food-based dietary guideline on sugar consumption in South Africa. BMC Public Health. 2012;12:502

Abstract

The intake of added sugar appears to be increasing steadily across the South African population. Children typically consume approximately 40-60 g/day, possibly rising to as much as 100 g/day in adolescents. This represents roughly 5-10% of dietary energy, but could be as much as 20% in many individuals. This paper briefly reviews current knowledge on the relationship between sugar intake and health. There is strong evidence that sugar makes a major contribution to the development of dental caries. The intake of sugar displaces foods that are rich in micronutrients. Therefore, diets that are rich in sugar may be poorer in micronutrients. Over the past decade, a considerable body of solid evidence has appeared, particularly from large prospective studies, that strongly indicates that dietary sugar increases the risk of the development of obesity and type 2 diabetes, and probably cardiovascular disease too. These findings point to an especially strong causal relationship for the consumption of sugar-sweetened beverages (SSBs). We propose that an intake of added sugar of 10% of dietary energy is an acceptable upper limit. However, an intake of < 6% energy is preferable, especially in those at risk of the harmful effects of sugar, e.g. people who are overweight, have prediabetes, or who do not habitually consume fluoride (from drinking fluoridated water or using fluoridated toothpaste). This translates to a maximum intake of one serving (approximately 355 ml) of SSBs per day, if no other foods with added sugar are eaten. Beverages with added sugar should not be given to infants or to young children, especially in a feeding bottle. The current food-based dietary guideline is: "Use foods and drinks containing sugar sparingly, and not between meals". This should remain unchanged. An excessive intake of sugar should be seen as a public health challenge that requires many approaches to be managed, including new policies and appropriate dietary advice.

Ⓟ Peer reviewed. (Submitted: 2013-04-12. Accepted: 2013-08-17.) © SAJCN **S Afr J Clin Nutr 2013;26(3)(Supplement):S100-S104**

Introduction

In 2003, the Department of Health in South Africa adopted a set of food-based dietary guidelines (FBDGs). The FBDG on sugar states: "Use food and drinks containing sugar sparingly, and not between meals".[1] Considerable new evidence has emerged over the past decade. In this paper, we evaluate present knowledge on the relationship between sugar and health. The most appropriate updated FBDG, with particular reference to South Africa, will then be proposed.

The health effects of added sugar have been debated at length for several decades. In the late 1960s and throughout the 1970s, Yudkin argued that sugar was implicated in several diseases, most notably coronary heart disease.[2-4] However, the supporting evidence was weak and, as a result, the hypothesis never gained widespread acceptance.

Sugar consumption in South Africa

The diet of South Africans has evolved rapidly in recent decades as the country advances down the road of the nutrition transition. One aspect of this is the increase in the consumption of added sugar by the black population, especially in the urban areas. The National Food Consumption Survey (NFCS), carried out in 1999, provided valuable information on this.[5] This study reported that the mean daily intake of sugar in children aged 6-9 years was 67 g (white children) and 47 g (black children); and 42 g in urban and 26 g in rural areas.[6] Sugar contributed 5.5% of overall energy intake (percentage of energy) in children aged 1-9 years.[7] This figure exceeded 10% energy in the urban areas. (Unless otherwise stated, "sugar" refers to added sugar. The term excludes sugar that is naturally present in foods such as fruit or milk).

The NFCS also reported that the most commonly consumed sources of added sugar in the diet came from (in decreasing order of frequency) table sugar, sweetened squash (sweetened concentrate to which water is added), jam, biscuits, carbonated sweetened soft drinks, sweets and breakfast cereals.

As children reach adolescence, they typically increase their consumption of sugar-rich foods, especially sugar-sweetened beverages (SSBs). This was clearly shown in

a longitudinal study of adolescents in Gauteng that was carried out from 2000-2003.[8] By 10 years of age, their mean intake of added sugar was 68 g/day (16% energy). This increased to 102 g/day by the age of 13 (20% energy).

Compared with what we know about the diets of children and adolescents, much less information is available on the role of sugar in the diets of adults. Valuable information came from the Cardiovascular Risk Study in Black South Africans (CRIBSA).[9] The dietary intake of sugar was estimated in 1 010 urban adults aged 18-60 years, living in four townships in Cape Town. Men consumed approximately 52 g/day of sugar (11% energy). Women consumed 51 g/day (15% energy) in the youngest group, falling to 38 g/day (11% energy) in the oldest.

It is informative to compare sugar intake in South Africa with that in the USA. The intake of added sugar rose at a rapid rate in the USA up until 2000. This was mainly because of the enormous increase in the consumption of SSBs that started in 1960.[10,11] However, between 1999 and 2000 and in 2007 and 2008, the intake of added sugar decreased by 23% from a mean of 100 g/day to 77 g/day.[12] This was mostly because of a reduction in the intake of SSBs. Sugar intake between 2007 and 2008 represented 15% of energy.

There is great variability in sugar intake in the USA and South Africa because of factors such as age, gender, socio-economic status and the desire to consume a healthy diet. Another important consideration is that estimations of food intake have a significant error. However, the above-reported data indicate that there is now a considerable overlap between sugar intake in the two countries.

Sugar and dental caries

Tooth decay is a widespread problem in South Africa and often goes untreated.[13-15] A large body of evidence has accumulated over recent decades that clearly reveals that there is a strong association between sugar intake and the risk of dental caries.[16-18] The mechanism by which sugar leads to tooth decay is as follows. Sugar and other fermentable carbohydrates are metabolised to acid by plaque bacteria.[18] The critical pH is 5.5. Demineralisation starts when acid production causes the pH to fall below that value. Fluoride, calcium and phosphates have a preventive action, as they raise the pH by approximately 0.5 pH units.

Sucrose is regarded as being the most cariogenic of all sugars, because of its ability to form glycan which increases adhesion to the teeth. However, two other important variables relate to sugar consumption. Firstly, the risk of caries increases when sugar is consumed more frequently. Secondly, when sugar is in a form that is retained in the mouth for relatively long periods (e.g. sucking sweets, rather than SSBs), the risk of caries increases.[19]

Some estimates have been made of a safe upper limit for sugar intake with respect to the prevention of dental caries. Sheiham[19] proposed an upper limit of 15 kg/person/year in the presence of adequate fluoride, and 10 kg in its absence. This translates to an intake of 41 g and 27 g per day, respectively. Sreebny[16] examined food balance sheets and caries prevalence in 47 countries. He proposed that 50 g/day should be regarded as the upper limit of safe sugar consumption. However, actual sugar intake may be appreciably lower than the values indicated by the food balance sheets. Therefore, the safe upper limit may be lower than 50 g/day.

Later in this paper, general guidelines on sugar consumption are proposed. Here, we focus specifically on the prevention of dental caries. Key recommendations include:

- Avoiding the frequent consumption of juice or sugar-containing beverages.
- Avoiding cariogenic snacks.
- Limiting cariogenic food to mealtimes.
- Restricting sugar-containing snacks that remain in the mouth for long periods or are eaten frequently, such as sweets.

An additional recommendation specific to preschool children is not to allow infants or children to sleep with feeding bottles.[20] Further recommendations include appropriate use of fluoride, good oral hygiene and regular preventive and restorative dental care.

Sugar and malnutrition

Sugar is devoid of all micronutrients. Therefore, it can be predicted that diets with a high sugar content tend to be depleted of micronutrients. However, a review explored this issue and found the evidence to be inconclusive. The investigators cited methodological issues as being an obstacle to reaching a firm conclusion.[21]

Nevertheless, several studies in Western countries have reported that people with a relatively high dietary intake of added sugar consume a smaller range of micronutrients.[22-24] South African studies have provided some supporting evidence.[1,25] On balance, the preponderance of evidence indicates that a relatively high intake of added sugar causes a reduced intake of micronutrients.

Socio-economic status appears to play a significant role in this question. Sugar is a low-cost source of food energy. In a study of food prices in South Africa, we showed that fruit and vegetables cost many times more than sugar when expressed as rands per 1 000 calories.[26,27] For that reason,

poor people are pressured to buy sugar, rather than fruit and vegetables. Of course, other factors play an important role in food selection, including taste preference and the motivation to eat a healthy diet.

Sugar and obesity

Much like many other countries across the world, South Africa has been experiencing a rapid expansion in the prevalence of overweight and obesity.[28] A recent survey reported a major increase in the level of overweight and obesity in adolescents.[29] The problem is especially acute in females and urban residents.

The possible role of sugar in the causation of excessive weight gain has focused mainly on SSBs. Impressive incriminating evidence on the consumption of SSBs in weight gain came from the recent findings of two large prospective investigations that were carried out in the USA. The investigators tracked 121 000 men and women for a period of 20 years.[30] The pooled results indicated that the intake of SSBs could explain almost one third of weight gain. (Subjects gained an average of 1.52 kg during each four-year period, of which 0.45 kg was linked to SSB). Other foods strongly associated with weight gain were French fries, potatoes, and red and processed meat (1.52 kg, 0.58 kg, 0.43 kg, and 0.42 kg, respectively).

The strongest evidence suggesting that SSBs play a causal role in the epidemic of obesity was from a systematic review and meta-analysis published in 2012.[31] This study combined the findings of 38 cohort studies and 30 randomised, controlled trials. The overall findings showed that the effects of sugar intake on weight resulted from SSBs, as well as the total intake of sugar. Increased sugar intake was associated with an increase of 0.75 kg in weight, whereas a decreased sugar intake was associated with 0.80 kg less weight. Findings from cohort studies indicated that after one year of follow-up, the odds ratio for being overweight or obese was 1.55, when comparing groups who had the highest and lowest intakes of SSBs. The study authors concluded that the intake of free sugar or SSBs was a determinant of body weight, and that this was the result of increased energy intake.

These findings are not surprising, as the consumption of sugar-rich foods results in poor satiety and therefore induces increased energy intake. Sugar-fat mixtures, like cakes and biscuits, are often tasty and appealing, and therefore encourage overeating. Of particular importance is that these foods have a high energy density, owed in no small part to the sugar. Considerable evidence indicates that food with a high energy density induces excessive energy intake and therefore overweight.[32,33] Feeding studies also strongly suggest that SSBs facilitate the consumption of an excessive quantity of calories.[34]

Another very pertinent finding was that the isoenergetic exchange of sugar with other carbohydrates did not cause weight change.[31] This suggests that sugar causes weight gain as a result of increased energy intake, rather than because sugar is somehow more harmful than other carbohydrates.

As sugar, especially that in SSBs, is strongly implicated in obesity, reducing its intake is a means of helping to prevent related conditions, including type 2 diabetes, cardiovascular diseases and cancer of the colon and breast.

Sugar and type 2 diabetes

Epidemiological evidence points to the role of SSBs in the aetiology of type 2 diabetes. The strongest evidence for this derives from a meta-analysis of prospective studies.[35] Results from eight studies on type 2 diabetes (311 000 subjects and 15 000 cases) indicate that the consumption of SSBs (1-2 servings per day versus < 1 serving per month) was associated with an elevated risk of type 2 diabetes [relative risk (RR) = 1.26]. The meta-analysis also examined the relationship between the consumption of SSBs and risk of developing metabolic syndrome, a strong predictor of type 2 diabetes. Three studies included 19 400 subjects and 5 800 cases. Again, subjects with a relatively high intake of SSBs (consuming the above quantities thereof) had an elevated risk (RR = 1.20).

A prospective study that appeared after the meta-analysis was carried out gave supporting results.[36] This study followed 40 400 men for 20 years, during which time 2 680 cases of type 2 diabetes were detected. The hazard risk for SSB intake (median intake of 6.5 servings per week versus never) and type 2 diabetes was 1.24. Interestingly, no significant association was found between the intake of artificially sweetened beverages and type 2 diabetes.

Sugar and cardiovascular disease

Some evidence implicates SSBs as a factor in cardiovascular disease. The strongest supporting evidence came from a report of a prospective study on 88 000 American women who were monitored for 24 years.[37] The risk of developing coronary heart disease was 35% greater risk in those who consumed two or more SSBs per day, compared with those consuming SSBs less than once a month.

Studies have also been carried out on the relationship between the intake of SSBs and risk factors for cardiovascular disease. Excessive consumption of SSBs may detrimentally affect blood lipids. A prospective study reported that frequent consumers of SSBs were at an elevated risk of both hypertriglyceridaemia and low high-density lipoprotein cholesterol levels.[38] People who consume above-average amounts of SSBs may also be

at elevated risk of hypertension. However, this relationship is uncertain. In one prospective study, the risk was similar for sugared caffeinated cola and diet caffeinated cola,[39] while in another, the association was not statistically significant.[38]

Sugar and disease: a summary

Some of the harmful effects of sugar have been well known for decades. Sugar is clearly a major factor in the development of dental caries. A high intake of added sugar may lead to a reduced intake of a variety of micronutrients. The role of sugar has been hotly debated for decades in the areas of obesity, type 2 diabetes and cardiovascular disease. However, research studies that have been published over the past decade have provided a solid body of valuable evidence that indicates that a relatively high intake of added sugar, especially SSBs, plays a significant role in obesity and type 2 diabetes, and probably cardiovascular disease too. In brief, the smoking gun has been found!

While the evidence of harm is strongest for SSBs, there is also strong evidence that sugar in itself is harmful. This has been most firmly established in connection with obesity. Additionally, sugar-rich solid foods have been linked to dental caries. Added sugar tends to reduce the dietary intake of micronutrients. For these reasons, foods that contain added sugar should be regarded as potentially harmful.

Dietary recommendations

The American Heart Association recently proposed an upper limit for added sugar in the diet of 100 calories (420 kJ, 25 g) per day for women, or 150 calories (630 kJ, 37.5 g) for men.[40] This is equivalent to approximately 5-6% of dietary energy. This can be viewed as an ideal upper limit, but is probably too low to be accepted by the majority of people. For that reason, an appropriate upper limit for the intake of added sugar is 10% of energy. However, for people who are at increased risk of the negative health consequences of sugar, an intake of < 6% of energy is advisable. This applies to people who are overweight or obese who have pre-diabetes or who live in areas where the drinking water is not fluoridated.

The above guidelines are appropriate for use by health professionals when designing or evaluating diets. However, the most widely used tool is the set of FBDGs for the general population. The current South African FBDG for sugar is: "Use food and drinks containing sugar sparingly, and not between meals". This should remain unchanged. Specific (quantitative) information can be added as follows. A 355-ml tin of an SSB (one serving) contains approximately 40 g of sugar (150 calories, 630 kJ). Drinking one tin per day translates to approximately 6-7% of energy. Therefore, ideally, both adults and children should limit the consumption of SSBs to one tin per day, or the equivalent amount of added sugar from other foods.

An additional recommendation is that infants and young children should not be given beverages with added sugar. Of particular importance is that, in order to avoid frequent or prolonged exposure to sugar, infants should not be allowed to lie down with a bottle. As children grow, they demand sweetened foods and drinks. In order to help to prevent dental caries, the frequency of intake thereof should be limited, and sugar-rich foods should be consumed only with meals, where possible.

What are the recommendations for fruit juice? The rich content of micronutrients and phytochemicals therein means that fruit juices are far more nutritious than SSBs. Although they are similar to SSBs in terms of carbohydrate concentration, they have a slightly lower glycaemic index (GI). Apple juice, orange juice and Coca-Cola® have GI values of 40, 50 and 58, respectively.[41] Therefore, fruit juices are preferable to SSBs, but their ease of consumption (low satiety) means they can contribute to excessive energy intake. The intake of fruit juices should not exceed 125-250 ml (1-2 servings) per day. Vegetable juices are preferable, as they have a lower carbohydrate content than fruit juice and, in general, a lower GI.[41] Whole fruit or vegetables are more valuable to the nutritional value of the eating plan as they provide fibre and satiety.

Public health intervention

Sugar should be seen as a public health challenge. Issuing FBDGs is a useful activity, but is unlikely to have a major impact on the dietary behaviour of the general population, especially young people. Many policy approaches have been tested in order to encourage healthier eating, such as fiscal measures and restrictions on advertising un-healthy foods and on the sale of unhealthy food to children in schools, as well as improved food labelling. Recently, Capacci[42] et al reviewed the use and level of success of these strategies in Europe.

Final note

An interesting development in recent years has been "vitamin water". It is displayed prominently in numerous supermarkets and corner stores across many countries, including South Africa. The beverage comes in several varieties and contains vitamins and herbs. While the sugar content is only approximately half that of regular cola drinks, it is still, in essence, nothing more than sugar water. It is perhaps one of the most brilliant examples of rebranding in corporate history. At a stroke, the manufacturing company transformed a beverage that was widely

regarded as being synonymous with "junk food" into one that gives the impression of being healthy, as long as one doesn't scrutinise the label.

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