Viewpoint
Sugar: is there a need for a dietary guideline in Australia?

Peter Williams

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Key words: sugar, dietary guidelines.

Introduction

When the first official dietary guidelines were established in Australia, three reasons were cited for avoiding too much sugar (dental caries, reduced intake of essential nutrients, and obesity) and this recommendation was placed fifth out of eight—ahead of recommendations about fibre, salt and alcohol. In the new 1999 Dietary Guidelines for Older Australians, dental caries is the only health condition still associated with sugar consumption and the advice to ‘Use added sugars in moderation’ is ranked as least important out of twelve guidelines. Table 1 sets out the evolution of this dietary guideline over the past twenty years (1–5).

Clearly there has been a change in thinking about dietary recommendations on sugar. Emphasis has shifted from advice about all sugars to added sugars, and the importance of this guideline (as reflected in its ranking) has declined progressively. Partly this has been due to better knowledge about the impact of sugar consumption on nutrient intakes and health and partly due to a change of focus, with growing interest in this country in the concept of the glycaemic index of carbohydrate-rich foods.

Many developed countries (including Canada and Japan) do not include sugar amongst their dietary guidelines (6) and Food and Agriculture Organization (FAO) is now promoting the development of food-based dietary guidelines that do not focus on individual nutrients (7). This paper reviews some of the new information about sugar that has been published since the establishment of the last set of dietary guidelines for the general Australian population nine years ago and suggests that it is time to reconsider whether a sugar guideline is still needed.

Australian sugar consumption

Australian apparent total sugar consumption has remained relatively static this century, declining slightly from 50.8 kg per head per year in 1938–39 to 48.4 kg in 1996–97 (8). Over the same time, there was an apparent trend for more of this sugar to be consumed in manufactured foods rather than as added table sugar (from 32% to 65%). Surveys of actual total sugar intake confirm that added sugar and refined sugar products are now a relatively small component of the total Australian diet. The 1995 National Nutrition Survey found that total sugars contributed 19.4% of adult energy intake (9), with the most highly refined sources (sugar, honey, syrups, jams and spreads, confectionery and soft drinks) contributing just under 8% (10). This is slightly less than the value of 9 to 10% reported by Baghurst et al. (11) when they summarised the data from three surveys conducted in the 1980s.

Table 2 indicates the major sources of sugars in the Australian adult diet.

While this analysis does not distinguish intrinsic food sugars and that added during manufacture, clearly over half of the sugar being consumed today comes from food categories that are generally being promoted as nutrient-dense foods (milk, fruit, vegetables and cereals).

Surveys by CSIRO in both Victoria and South Australia in the early 1990s found that the proportion of the population meeting the dietary target for sugar was greater than for other targets such as fat, fibre or sodium (12,13). Table 3 presents some of the 1993 South Australian results. They show that most Australians already consume only relatively modest amounts of sugar. If we were to prioritize public health messages and activities on the basis of the proportion of the population not meeting recommendations, advice about sugar would appear to be much less important than other components of the diet.

Sugar and health

Despite some ill-informed popular views to the contrary (14), all recent authoritative reviews have concluded that sugar intake is not related to diabetes, hypoglycaemia, cardiovascular disease, or hyperactivity (15–19). One case-control study suggested that diets high in sugar increased the risk of colon cancer (20), but even in that study the lowest odds ratio was not in the group with lowest sugar intake, and the conclusion has been disputed by other reviewers (21,22).

Only three health concerns have been cited as the reasons for earlier Australian dietary guidelines about sugar. In each case, more recent research has raised questions about the relevance of the current guideline.

Obesity

In the background papers to the 1992 guidelines, the increasing proportion of the population who were overweight or obese was noted. It was concluded that ‘for this group of people especially, sugar intake should be discouraged as it contributes to the excess in energy intake

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that is mainly responsible for obesity’ (3). In contrast, findings from a number of population studies over the past decade show an inverse association between the proportion of energy from total sugars and obesity (23–27).

Indeed, since dietary fat and sugar appear to be inversely related (26,28–30) some authors have suggested that advice to reduce fat and sugar simultaneously may be unattainable (31).

One Australian study, following dietary changes in adults over a four-year period, found that changes in the percentage of energy from sugar were strongly negatively correlated with changes in percentage of energy from fat in both men and women (32). Some authors do still argue that extrinsic sugar can be a vehicle for dietary fat (33). However, while it is possible to identify some foods rich in both fat and sugars, in the context of the whole diet foods that are the primary sources of sugars are only minor sources of fat and vice versa (28).

There is also no conclusive evidence that the sweetness of sugar contributes to increased appetite. In fact the opposite may be true; the body tends to have a much better appetite reduction response to carbohydrates and sugar than it does to dietary fat, and reducing sugar could actually undermine appetite regulation (34,35). Certainly weight reduction can occur as well on a high sugar diet (with 43% of energy from sucrose) as on a low sugar diet (with only 4%) (36), and a recent British dieting book written by a professor of dietetics promotes increased sugar intake to assist in weight management (37). The FAO/WHO (World Health Organization) report (18) concluded that ‘there is no indication that sugar is associated with excessive food intake’ and energy control with the primary emphasis on restriction of fat, rather than sugar, remains the cornerstone of recommended dietary treatment of obesity (38,39). Thus the best available evidence does not support any population dietary guideline for sugar intake on the grounds of obesity (40).

### Nutrient dilution

Table sugar has been labelled a food consisting only of ‘empty calories’ and it had been argued that a high consumption of sugar might displace micronutrient-rich foods from the diet and increase the risk of deficiency. In the US particular concern has been expressed about the quality of diets of people consuming large quantities of soft drinks (41,42). The new wording of the American dietary guideline (‘Choose beverages and foods to moderate your intake of sugars’) cautions consumers not to let soft drinks crowd out other foods needed to maintain health, such as low fat milk (43). However, national dietary guidelines need to reflect each country’s own nutritional priorities and there are significant differences between the US and Australia, with a lower level of soft drink consumption in this country (contributing only 2 to 3% of the energy intake of adults) (10) and higher milk intakes.

### Table 1. History of Australian dietary guidelines on sugar

<table>
<thead>
<tr>
<th>Date</th>
<th>Document</th>
<th>Wording of guideline</th>
<th>Ranking</th>
<th>Reasons cited</th>
</tr>
</thead>
<tbody>
<tr>
<td>1979</td>
<td>Australian Association of Dietitians dietary</td>
<td>Decrease consumption of sugars</td>
<td>3rd of 9</td>
<td>Dental caries, Obesity</td>
</tr>
<tr>
<td></td>
<td>guidelines for Australians (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1981</td>
<td>Dietary guidelines for Australians (2)</td>
<td>Decrease refined sugar consumption</td>
<td>5th of 8</td>
<td>Dental caries, Displacing nutritious foods</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>and reducing intake of essential</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>vitamin and minerals</td>
</tr>
<tr>
<td>1992</td>
<td>Dietary guidelines for Australians (3)</td>
<td>Eat only a moderate amount of sugars and foods containing added sugars</td>
<td>6th of 10</td>
<td>Dental caries, Obesity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>Dietary guidelines for children and adolescents (4)</td>
<td>Eat only a moderate amount of sugars and foods containing added sugars</td>
<td>7th of 10</td>
<td>Dental caries, May displace more nutrient</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>dense foods</td>
</tr>
<tr>
<td>1999</td>
<td>Dietary guidelines for older Australians (5)</td>
<td>Use added sugars in moderation</td>
<td>12th of 12</td>
<td>Dental caries</td>
</tr>
</tbody>
</table>

### Table 2. Main source of sugars in the Australian diet in the 1995 National Nutrition Survey (10)

<table>
<thead>
<tr>
<th>Food sources</th>
<th>Males aged 19 years or more (%)</th>
<th>Females aged 19 years or more (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk products</td>
<td>16.2</td>
<td>17.4</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>15.5</td>
<td>9.3</td>
</tr>
<tr>
<td>Sugar products</td>
<td>13.7</td>
<td>10.8</td>
</tr>
<tr>
<td>Fruit</td>
<td>12.5</td>
<td>17.1</td>
</tr>
<tr>
<td>Fruit and vegetable juices</td>
<td>10.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Cereal-based products</td>
<td>10.1</td>
<td>11.2</td>
</tr>
<tr>
<td>Cereals</td>
<td>6.3</td>
<td>6.1</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Confectionery</td>
<td>3.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Sauces</td>
<td>2.1</td>
<td>1.9</td>
</tr>
<tr>
<td>Meat</td>
<td>1.8</td>
<td>1.6</td>
</tr>
<tr>
<td>Alcoholic beverages</td>
<td>1.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

### Table 3. Percentage of the South Australian population conforming to dietary targets in 1993 (12)

<table>
<thead>
<tr>
<th>Target</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar ≤12% energy</td>
<td>68</td>
<td>77</td>
</tr>
<tr>
<td>Fibre 30 g per day</td>
<td>37</td>
<td>31</td>
</tr>
<tr>
<td>Sodium ≤2300 mg per day</td>
<td>23</td>
<td>52</td>
</tr>
<tr>
<td>Fat ≤30% energy</td>
<td>21</td>
<td>27</td>
</tr>
<tr>
<td>Sat fat ≤10% energy</td>
<td>12</td>
<td>18</td>
</tr>
</tbody>
</table>
Viewpoint: sugar

Moreover, many studies in the US and the UK have shown that in most cases energy and nutrient intakes are related positively to total sugar intake (24,29,30,44). The UK Committee on Medical Aspects of Food report (45) concluded: ‘on average people with high total energy intakes eat more of all nutrients including sugar’ and ‘sugar intake is a weaker predictor of absolute micronutrient intake than total energy consumption’.

A number of authors have examined the relationship between the proportion of energy from sugar and micronutrient intakes. Baghurst et al. (46) divided the intakes of 2800 Australian adults into tenths according to the percentage of dietary energy from added sugars, ranging from less than 4.7% to more than 19.3%. Intakes of vitamin B6, vitamin B12, carotene, folate, magnesium and zinc demonstrated an inverse trend with added sugar, but the decline was only significantly different from the median in the highest and lowest deciles. Across the broad range of 4 to 16% of energy from added sugars there was no significant variation in micronutrient intakes. Results from several other studies vary depending on the classification of different sugars used (29,47,48) but, in general, moderate sugar consumers appear to have the most adequate diets. Reviewers have concluded that added sugar intakes between 5% and 16% of energy do not appear to have any detrimental effect on micronutrient intakes (27), a range that spans the 20th to the 90th percentiles of the contribution of refined sugar to total energy intake in Australia (11).

In conclusion, there does not seem to be any compelling evidence that the current level of sugar consumption in Australia has any detrimental effect on diet quality. The mean intakes of most vitamins and minerals exceed the recommended dietary intakes (RDIs), with the notable exception of calcium (9), and the percentage of Australian adults with calcium intakes below 70% of the RDI is lowest in those in the highest decile of percentage of energy from added sugars (46).

Dental caries

While there is no doubt that dental caries continue to be a significant public health problem in Australia, there have been dramatic declines in average levels of dental decay, as defined by the number of decayed missing and filled teeth (DMFT) over the past three decades. In 12-year-old children DMFT scores fell from approximately 8 in 1965 to 1.01 in 1995. These improvements are obviously the starting point for future improvements in oral health in later life but, even in adults, the average number of missing teeth has fallen from 8.3 in 1973 to only 3.6 in 1995 (49).

Until recently, it has been usual to blame sugar as the chief factor in the cause of dental caries. In 1991 Sheiham (50) stated that ‘dental caries is a sugar induced disease’ and recommended a maximum intake of 15 kg per person per year (about one-third of the current Australian intake). On the other hand, caries prevalence has decreased markedly during the past 30 years in most developed countries although the consumption of sugars has remained relatively unchanged (51,52). The main reason for this improvement has been the introduction of fluoridated toothpastes and water supplies (53), rendering high sugar diets less of a caries risk than they used to be 20 years ago (51).

In Australia too, Sivaneswaran and Barnard (54) concluded that ‘the dramatic decline in dental caries bears no relationship to the apparent consumption of sugar, which has remained relatively high’. A study of annual sugar consumption and dental records in 29 industrialised countries found sugar explained less than 1% of the variation in scores of DMFT, despite a broad range of sugar consumption (from 80–195 g per day) (55).

The recent WHO/FAO expert consultation on carbohydrates confirmed that the incidence of dental caries is influenced by a number of factors. Foods containing sugars and starches that can be broken down easily by α-amylase and bacteria in the mouth can produce acid, which increases the risk of caries. Many starchy foods are as cariogenic as sugary foods, judged by the pH fall in dental plaque after consumption, and starchy foods with a high glycaemic index can be worse than sucrose solutions (56–58). Thus the impact of carbohydrates on caries is dependent on the type of food, frequency of consumption, degree of oral hygiene, availability of fluoride, salivary function and genetic factors (18). In UK children, for example, the levels of consumption of the main sugar-containing food groups do not vary significantly across social classes, but the percentage of children with decayed teeth varies enormously, being more than six times higher in the class V (lower socioeconomic) versus class I (higher socioeconomic) (59). It is thought that oral hygiene practices are the most significant factor in this variation. Analysis of the UK National Diet and Nutrition Survey of children found no relationship between caries and consumption of extrinsic sugars, chocolate, or soft drink, and an association between caries and sugar confectionery was present only among children whose teeth were brushed less than twice a day (60).

Nonetheless, in public health we often make policies in relation to risk factors that may not be the most significant variables. The important questions to ask are: would lowering the mean intake of sugar further reduce the caries incidence in Australia, and would this be a cost-effective method of caries prevention? There are few intervention studies to help answer these questions. The best evidence comes from examinations of the impact of sugar reductions at a population level. A review of data from 67 countries in the period 1982 to 1994 found no reliable relationship: of 43 countries where there had been a reduction in the per capita sugar supply, 18 had a decrease in DMFT and 25 had increases (27).

Even total removal of sugar from the diet would not necessarily eliminate caries in a population (61). Many other foods have cariogenic potential and some snacks such as plain crackers and potato crisps result in slower and more prolonged release of acid than some sugar-containing snacks (62). The WHO/FAO report finally rejected the terms ‘extrinsic’ and ‘intrinsic’ sugars in favour of a ‘more rational approach to the role of fermentable carbohydrates in dental caries’ and concluded that prevention programs to control and eliminate caries should focus on fluoridation and adequate oral hygiene rather than sucrose intake alone (18). This conclusion is supported by economic analyses that have found that advice about toothbrushing is likely to be a more cost-effective means of caries prevention than attempts at sustained dietary change (63).
Are there any risks from a dietary guideline on sugar?

It may be argued that the current recommendations to consume only ‘moderate’ amounts of sugar are conservative and unlikely to cause any harm. But many consumers will interpret such a message as a general warning against all sugar consumption. If there are serious questions about the evidence available to support a general population guideline that aims to limit sugar consumption, the question then arises: can a dietary guideline on sugar send any confusing or misleading messages to consumers or have any potential negative impacts on health? I believe that it can.

Confusion between sugar as a nutrient and a food

In all the research on the relationship between sugar and health, there is a constant difficulty in distinguishing sucrose used as table sugar or as ‘added sugar’ in manufactured foods from other naturally-occurring sugars. The Australian food tables do not identify the source of sugars in foods and neither do the nutrition information panels on food labels. This dietary guideline helps to perpetuate the myth that sucrose and ‘added sugars’ are in some way special: that added sucrose has different properties to the other sugars naturally present in many foods.

Consumers often rely on the nutrition information panel (NIP) on manufactured foods to make judgements about their nutritional value. How is the average shopper to evaluate the NIP on a food such as dried fruit or low fat flavoured milk, when they are being advised to eat only a moderate amount of sugars? Focus groups in the US found consumers were confused by this apparent contradiction (43) and recent Australia New Zealand Food Authority consultations with Australian health professionals about a new format for a NIP on all packaged food supported the removal of sugar from the mandatory list of nutrients to be declared. Diabetes educators in particular felt that many consumers were overly focused on the sugar figure to evaluate whether a food was suitable for inclusion in a diabetic diet.

Sugar-fat seesaw

The consistent inverse relationship between sugar and fat suggests that advice to moderate sugar intakes may lead to higher fat intakes, or at least make it much harder to keep them low. Even recommendations to eat more fruit and vegetables are probably going to increase the consumption of sugars if they are replacing fatty and salty snacks. We should recognise that the evidence for fat as a dietary risk factor is much stronger than that for sugar, and focus our communication efforts there.

Glycaemic index

The new Dietary Guidelines for Older Australians are perhaps the first in the world to include advice about eating more low glycaemic index (GI) foods, noting the FAO/WHO recommendations that the GI be used in conjunction with information on food composition to guide food choices (18). Increasingly it is being recognised that lower GI diets may be protective against diabetes and heart disease (64). There is little distinction between the glycaemic index of foods containing naturally-occurring sugars and those with added refined sugars (65). Foods containing sugar generally have low to intermediate GI values; by contrast, a low sugar intake has been associated with a higher dietary GI overall (66). Thus the old guideline helps to perpetuate outdated views about sugar and ignores the recent scientific developments in our understanding of carbohydrate digestion and metabolism.

Food restriction versus enjoyment and variety

The current sugar guideline promotes moderation in consumption, not unnecessary restriction of sugar-containing foods, except for those who are overweight. But we know that restrictive attitudes to food can begin at early ages and may have influence on the long-term development of disordered attitudes to eating (67,68). A negative focus on problem-based messages implying that sugar is bad may contribute to underlying fears about food and weight gain, which can precipitate eating problems. Child feeding practices that restrict children’s intakes of foods at the top of the dietary pyramid may actually promote their liking for and intake of those foods (69).

Humans are born with an genetic preference for sweet tastes (70) and have incorporated highly sweet foods such as honey in the diet for thousands of years (71). The Dietary Guidelines for Older Australians acknowledge that ‘inclusion of a moderate amount of added sugar...can increase variety and palatability without compromising nutrient intake’ (5). As we come to recognise the importance of food variety for good health, we should also acknowledge that the addition of sugars to products such as milk, yoghurts, fruit and cereals can significantly increase their appeal and therefore promote greater variety in the diet overall.

Conclusion

While the science on sugar has been changing, it also appears that consumers are now ready to accept a change in dietary advice on the role of sugar in the diet. A recent article in the Australian Consumers’ Association magazine Choice concluded: ‘if eating more sugar makes a healthy low-fat diet more palatable and easier to stick to, and you take good care of your teeth, there may be a case for relaxing your attitude to sugar’ (72). Perhaps in the next revision of the dietary guidelines, Australians would be better served by focusing attention on positive messages to increase intakes of desirable foods and communicating more about the concept of the glycaemic index, rather than maintaining a restrictive message about a single ingredient for which there is little evidence of need to change current consumption levels.

References


Sugar: why Australia should retain a dietary guideline

Rosemary Stanton

(Aust J Nutr Diet 2001;58;31–36)

Key words: dietary guidelines, sugar, soft drinks, conflict of interest.

Introduction

Dietary guidelines focus on prevention of chronic disease and are designed for use by health professionals (1) and as a stand-alone educational tool for the public (2). They serve the consumer by providing public education and direction for nutrition policy (3). Since the first Australian dietary guidelines were formulated (4), they have always included advice about sugar with the current guideline advising: 'Eat only a moderate amount of sugars and foods containing added sugars'. If the word 'only' is omitted, as has occurred in some publications (5,6), the intended message to avoid large quantities of sugar can be misinterpreted to suggest some added sugar is an essential part of the diet. Such a misinterpretation was reported by several school canteen managers attending a school canteen conference in Sydney in October 1998.

After an extensive review, the sugar guideline in the US has been reworded recently to be more specific and to assist compliance: ‘Choose beverages and foods that limit your intake of sugars’. It is listed under 'eat sensibly', after advice to: ‘Choose a diet that is low in saturated fat and cholesterol and moderate in total fat’ and before messages about salt and alcohol (7). The US rationale for retaining a guideline on sugar included concern over the high (and rising) incidence of overweight and obesity in adults, the high percentage of children at risk of excess weight and the fact that almost 90% of Americans need to improve their diets (7).

In Australia, similar problems exist. Excess weight is a major and increasing public health problem in adults (8) and children (9) and the Australian National Nutrition Survey shows evidence of some poor food choices (10). For example, 68% of males and 59% of females aged 19 to 24 years, 60% of males and 59% of females aged 16 to 18 years, and 50% of boys and 42% of girls aged 12 to 15 years had consumed no fruit on the day prior to the survey (10). The National Nutrition Survey also reported that nutrients such as folate, calcium, iron and zinc were low in some diets (11).

In the US, the number one source of added sugars is non-diet soft drinks (7,12). Sweets and candies, cakes and cookies, and fruit drinks and fruitades are also listed as major sources of added sugars (12). These foods provide kilojoules but little or no essential nutrients. Consumption of soft drinks is of particular concern in the US because...
children, adolescents, and women who consume these foods have lower consumption of milk (7,13).

The data collected by the National Nutrition Survey (10) do not separate added sugars from those occurring naturally in fruit and milk, so a direct comparison of major sources of added sugar with those in the US is not possible. However, from National Nutrition Survey data showing the proportion of sugars from selected food groups, the category ‘soft drinks, flavoured mineral waters and electrolyte drinks’ provided 21% of sugars for males and 16% for females (11) aged 12 to 18 years, making these foods the major source of added sugar among Australian youth, as in the US. Mean daily consumption of soft drinks among 2- to 18-year-olds in the US is 255 g (13) compared with 209 g in the same age group in Australia (10).

For the high (and growing) percentage of the population who are overweight or obese, the options to reduce body fat and prevent further increases are to decrease kilojoule intake, increase output, or both. Since those who are overweight or obese do not need lower amounts of nutrients, it is reasonable for dietary guidelines to advise limiting consumption of foods and beverages that contribute kilojoules but few nutrients. This includes products high in fat or added sugar or both. A dietary guideline to limit high fat foods, especially those high in saturated fat, generates little dispute. However, a guideline to limit sugar (or include the content on food labels) is not supported by Australia’s peak food industry organisation, the Australian Food and Grocery Council (14). Some academics also have argued against a sugar guideline in scientific presentations (15,16) and in newsletters available to the public (17). Copies of such presentations may be used by the sugar industry to influence others (Smith R, Dick Smith Foods Pty Ltd, Sydney, 2000, personal communication).

Removing a dietary guideline for sugar

The sugar industries in Australia and the United Kingdom have conducted long-term major public relations efforts to turn opinion leaders in favour of sugar (18,19). This may be appropriate to correct genuine misconceptions about sugar, such as those perpetuated by some authors of diet books who advise very low carbohydrate diets. But the sugar issue generates strong feelings as shown in a statement that ‘choosing to avoid sugar and eating unsweetened breakfast cereals, milk products, breads and low-joule soft drinks, jams and jellies may actually be doing more harm than good’ (15). The reasons given were that a diet restricting sugar ‘is more likely to be higher in fat, lower in satiety, higher in glycaemic index, and more likely to cause weight gain than the diet which caters for the natural desire for sweetness and includes a moderate amount of sugar’ (15). The final words in this message sit comfortably with the current dietary guideline on sugar, but there is no evidence to substantiate the claim that the current guideline may do harm.

Foods such as unsweetened breakfast cereals, plain milk products or bread have obvious nutritional benefits. Most cereals and breads are low in fat, and fat-reduced milk products are widely available. Popular unsweetened breakfast cereals such as wholewheat breakfast biscuits and rolled oats are valuable sources of nutrients and dietary fibre; milk products, including low fat varieties, are the major dietary source of calcium and riboflavin; and bread currently supplies 17% of dietary fibre, 20% of thiamin, 13% of folate and 11% of iron, but only 3% of fat intake (11). Wholegrains, including breakfast cereals and breads, are good sources of nutrients and have a high satiety rating (30). Many wholegrain products have a low glycaemic index, as do plain milk products (31). There is no evidence, theoretical or in practice, that these healthy foods are more likely to cause weight gain and it is difficult to see how consuming them could do ‘more harm than good’.

Low joule soft drinks and similar products are nutritionally useless and there is no evidence they lead to weight gain or loss. Their major ‘harm’ may come from maintaining a desire for sweet drinks and, like sugar-sweetened soft drinks, lead to lower consumption of milk and water (13) and subsequent reduction in some nutrients (32). Production of artificially-sweetened products also means energy resources are being used to produce foods with little or no energy, contrary to principals of environmental sustainability (33).

Health aspects of sugar

There are several extensive reviews of the health effects of sugar (34-37). The major US Food and Drug Administration review from the Sugars Task Force in 1986 concluded that: ‘Other than the contribution to dental caries, there is no conclusive evidence on sugars that demonstrates a hazard to the general public when sugars are consumed at the levels that are now current’ (34). A more recent monograph from the Institute of Life Sciences in 1995 based on papers presented at a workshop sponsored by the Institute of Life Sciences North Ameri-
can Subcommittee on Sugars and Health (36) draws similar conclusions, but plays down sugar’s role in caries, claiming ‘the most important factor is good oral hygiene with fluoride toothpaste’. The more recent comprehensive Food and Agricultural Organization and World Health Organization review of all carbohydrates, states that ‘high levels of carbohydrate, providing it is obtained from a variety of sources, is not associated with adverse health effects’ (37).

While accepting the extent and findings of these reviews, some more recent studies need acknowledgment. In a study conducted since the major reviews on sugar, three strictly controlled diets were each given for two weeks in randomised order to a group of 20 healthy women, aged 21 to 52 years (38). One diet was high in fat (46% of total energy) and saturated fat (21% of total energy), one was high in starchy carbohydrate (59% of total energy) with 2.5% of kilojoules as sucrose, and one had the same total carbohydrate but 23% of total energy as sucrose. Blood lipids, factor VII coagulant activity and fibrinogen were measured, fasting and in the post-absorptive state at the end of each diet period. Compared with the high sucrose diet, the diet with a higher amount of starch was associated with lower total cholesterol, low density lipoprotein (LDL) cholesterol, fasting and non-fasting triglycerides and non-fasting factor VII. The authors concluded that starchy foods with a natural content of dietary fibre should be recommended as substitutes for saturated fat in the dietary prevention of coronary heart disease but substitution with sucrose was not advisable. This was a small, short-term trial and the sucrose intake was relatively, but not unreasonably, high. However, its findings indicate a need for further investigations before removing the dietary guideline for added sugar. For those with insulin resistance, dyslipidaemia and obesity, who tend to have haemostatic problems such as raised plasma fibrinogen and factor VII coagulant activity levels, the optimal antithrombotic diet may be low in fat with a high content of foods rich in complex carbohydrates and dietary fibre (39). Foods high in added sugar rarely fit such criteria.

The inverse relationship between sucrose and high density lipoproteins (HDL) also may need reconsideration. In the Multiple Risk Factor Intervention Trial, the highest quintile of sucrose intake was associated with lower concentrations of HDL and higher ratios of LDL:HDL (40). This did not occur with higher intakes of fructose (from fruit) and lactose (from milk) which were associated with lower total and LDL cholesterol and higher HDL (40).

The Coronary Artery Risk Development in Young Adults cohort study of black and white men and women, aged 18 to 30 years at baseline, examined associations between energy from dietary sucrose and HDL-cholesterol (41). Cross-sectional data were available for the original cohort of 4734 and longitudinal data for 3335 participants who were available at baseline and year seven. Data on sucrose, energy and alcohol intake, physical activity level, body mass index (BMI), cigarette smoking and HDL-cholesterol were collected, and those with diabetes and extremes of reported energy intake were excluded. Sucrose intake ranged from 2.8% of total energy to 15.5% of total energy at baseline and from 4% to 12.1% of total energy at year seven. Using multivariate analyses, and adjusting for age, BMI, cigarette smoking, physical activity score and alcohol intake, energy intake from teritics of sucrose intake showed a consistent inverse association with HDL concentrations in different race and gender groups in cross-sectional data at baseline and year seven and in the longitudinal analyses over the seven-year period. The relationship was independent of triglyceride concentrations. LDL concentrations were not reported. The authors concluded that it may be advantageous to avoid high intakes of sucrose, especially in those with a predisposition to low HDL-cholesterol. A similar inverse correlation between HDL-cholesterol and simple carbohydrates has been reported in children with hyperlipidaemia (42), although the significance of low HDL in children is unclear.

The association between sucrose and triglyceride concentrations has been debated for some years. In animal studies, diets very high in fructose or sucrose induce hypertriglyceridaemia in some animals (43). Results in humans are conflicting (44) as triglycerides may rise initially and then fall. Continuing high concentrations may occur only when sugar intake is very high (34% of total energy or more), and when the dietary fat is predominantly saturated (45). A recent review from the UK concludes that certain people may be more sensitive to adverse effects on triglyceride concentrations from high intakes of sugars (46). The Institute of Life Sciences report also notes occasional hypersensitivity and hypertriglyceridaemia with high intake of sugars (36).

**Dental caries and sugar**

Major reviews (33–36) acknowledge that sugar makes a contribution to dental caries, but dismiss its importance because other factors are involved as well. The Food and Agricultural Organization and World Health Organization report (37) recognises that dietary sugar is a factor in the development of caries, but claims it is not the most important one. Some have argued that dental decay with high sucrose consumption is important in non-industrialised countries, but not in Australia. A review by Navia (47) which notes that additional factors are involved in caries incidence sometimes has been taken out of context. Navia also stresses the deleterious effects of sugars on teeth in all countries (47), The Director of the Dental Health Foundation, Australia, has pointed out that the few studies showing no relationship between dental caries and diet have not examined the main caries sites between the teeth (48). When these are taken into account, the effect of sugars is indeed valid.

Ruxton and colleagues from the UK Sugar Bureau claim that, where fluoride use is adequate, associations between sugar intake and caries rarely reach statistical significance. They conclude the available evidence does not justify a recommendation for sugar, but requires a more integrated approach that includes oral hygiene (49). In the US, 70% of the caries burden falls on 20 to 25% of children (50) and a major South Australian study rated only 27% of children in the category of low caries risk (51). Aboriginal children, who once had low incidence of caries, now have higher rates than other children in Australia (52). The British Nutrition Foundation has emphasised that dental caries is unacceptably high in some ‘at risk groups’ and recommends a two-pronged attack to increase access to fluoride and reduce frequency
of consumption of sugary foods (53). For Australia a similar approach would seem valid; removing the sugar guideline would not.

Soft drinks are a significant source of added sugar and, whether sweetened with sugar or artificial sweeteners, produce a high risk of dental erosion (54). Apparent consumption of soft drink in Australia is 11 L per head per year (55), although the 1995 National Nutrition Survey reported consumption at only 58% of this level (10). Soft drink consumption starts early, with average intake for all 2- to 3-year-olds being 58 g per day—considerably much less than the average daily intake of 388 g of milk. However, not all parents give 2- to 3-year-olds soft drinks and the 26% of this age group who do consume them have a median intake of 208 g per day (10). A recent study of 1675 preschool children in the UK showed higher consumption of soft drinks than milk (56), leading the authors to recommend that food policy guidelines should include information on sweetened drinks. The US dietary guideline on sugar has done so (7). In Australia, soft drink consumption currently peaks among 16- to 24-year-olds with a median intake of 522 g per day (10), contributing a higher percentage of added sugar than any other food (11).

There is little doubt that sugars and processed starches are both cariogenic, while fluoride is protective. However, if starch consumption is combined with a low sugar intake, and food is eaten only at main meals, starch does not seem to induce caries. If eaten with a higher level of sugar and eating frequency is three or more times a day, starch may increase caries activity significantly (57).

Dental caries is estimated as the most expensive diet-related health problem in Australia (58), so rather than playing down the role of sugars in caries, we should broaden the public health position to warn that refined starches also increase caries risk, especially in combination with sugars. The fact that other factors also are involved is no reason to remove the sugar guideline.

Sweet foods, obesity and a nutritious diet

It seems logical that when more foods of low nutritional worth are consumed, either less of the foods that supply essential nutrients will be consumed or total kilojoule intake will rise. This was shown in data reported from 15 611 subjects aged 20 years or over in the third US National Health and Nutrition Examination Survey where energy-dense, nutrient-poor foods were consumed at the expense of those that are nutrient dense (59). These foods included foods high in fat and/or sugar such as soft drinks, confectionery, biscuits, cakes, desserts, pastries and processed savoury snack foods.

Some studies show that micronutrient intake is affected adversely when the diet is high in added sugar. In a German study, the comparison between moderate and high sucrose consumers revealed a lower percentage of persons meeting nutrient intake recommendations in the high sucrose category (82 g/day) under the condition of a comparable energy intake (60). A study examining the effects of dietary adequacy in children with diabetes found that the control group of children, consuming 16% of total energy as sugar, had lower levels of essential nutrients (61). Others report that extremes of either high or low intake of extrinsic sugars may be associated with poor intake of fibre and micronutrients (62).

Excess intake of kilojoules relative to output is a major problem in Australia, leading to 63.7% of men and 47% of women being classified as overweight or obese (11). Using the new internationally-based cut-off points to define overweight and obesity in children and adolescents (63), Magarey and Daniels have shown that 19.5% of boys and 20.8% of girls aged between two and 18 years are overweight or obese (9). There is disagreement over the major cause of obesity. Fat generally is regarded as the most likely culprit (64,65), although others dispute this (66). However, there is general agreement that energy-dense diets result in overconsumption and the basic cause of excess weight is an excess of kilojoule intake over requirements (67). To prevent or treat obesity, it therefore makes sense to reduce consumption of foods that are energy dense and nutrient poor.

Those who wish to remove the guideline for sugar talk of a ‘sugar-fat seesaw’ (68–70). This may be correct in terms of percentage of total energy from sugar and fat. However, there is evidence that a diet high in sucrose may also be high in fat (71). In a study of 837 French adults, high consumption of added sucrose (in grams per day or grams per 1000 kcal per day) was associated with higher consumption of energy and fat and lower consumption of vegetables and fruit, although the high sugar consumers in this study were young and not overweight (72).

The ‘sugar-fat seesaw’ line of thought seems to assume that if you tell the public not to consume lollies, soft drinks and biscuits, they will eat more fatty foods such as chips, crisps and fried foods. That may occur in some people, but ascribing certainty to this principle reinforces the dietary errors that people make through ignorance and response to promotions for packaged snack foods high in sugar, fat, or both. Effective nutrition education—for which dietary guidelines are designed—would take the opportunity to promote consumption of fresh fruits; breads; high fibre, low sugar cereals; and low fat dairy products instead of foods high in either sugar or fat. Increased consumption of these foods would improve the total diet. This has been demonstrated in adolescents where a low fat, high fibre diet was accepted and provided better nutrient composition (73).

Possible conflict of interest

In discussing the sugar (or any other) guideline, it is important to consider potential conflicts of interest. For example, some researchers may be funded by the sugar industry (49,68,74–77) and organisations or companies marketing products high in sugar may quote extensively from their papers without disclosing the funding. Sources of funding and potential conflicts usually are included in the original publications in peer-reviewed journals, as occurs in the six studies listed above, and some authors make a statement to clarify any potential conflict (68), but when the paper is quoted or the abstract viewed on Medline, the potential conflict of interest will not necessarily appear. Problems of financial considerations and potential for bias have recently been addressed in two papers from the US (78,79). There is no direct connection with sugar or nutrition in these two papers, but the findings may be relevant to all research areas, including those connected with nutrition.
Conclusion

There is incontrovertible evidence that sugar is involved in dental caries causally, albeit not the only factor. There is also some evidence that a high sugar intake may have adverse effects on thrombotic factors and some blood fats—at least for some individuals. With reports of actual or potential adverse effects from added sugars, a guideline about sugar should remain.

There is no evidence that the current guideline to consume only moderate amounts of sugars is harmful, although the wording may need to be more specific so the public can more easily put its message into practice. A food-based guideline would be more relevant and could give guidance about healthy foods to substitute for high sugar, nutrient-poor items. There are valid reasons to encourage members of the public to make up their everyday diet with more of the wonderful variety of fresh fruits, low fat dairy products and wholegrain breads and cereals, and to keep foods and beverages that are high in sugar or saturated fat for occasional use. This should be the message of the dietary guidelines.

Changing eating habits is not difficult, as the food industry has proved with its successful promotions that have made soft drinks, fast foods, alcoholic beverages and a range of snack foods part of the daily diet. The fact that nutrition education has been less effective is not a reason to avoid giving appropriate advice about foods, but may signal the need for more public funds to be devoted to effective strategies.

References


