Sugars and Dental Caries: Evidence for Setting a Recommended Threshold for Intake[1–3]

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ABSTRACT

Dental caries affects ≤80% of the world's population with almost a quarter of US adults having untreated caries. Dental caries is costly to health care and negatively affects well-being. Dietary free sugars are the most important risk factor for dental caries. The WHO has issued guidelines that recommend intake of free sugars should provide ≤10% of energy intake and suggest further reductions to <5% of energy to protect dental health throughout life. These recommendations were informed by a systematic review of the evidence pertaining to amount of sugars and dental caries risk, which showed evidence of moderate quality from cohort studies that limiting free sugars to ≤10% of energy reduced, but did not eliminate, dental caries. Even low levels of dental caries in children are of concern because caries is a lifelong progressive and cumulative disease. The systematic review therefore explored if there were further benefits to dental health if the intake of free sugars was limited to <5% of energy. Available data were from ecologic studies and, although classified as being of low quality, showed lower dental caries when free sugar intake was <5% of energy compared with when it was >5% but ≤10% of energy. The WHO recommendations are intended for use by policy makers as a benchmark when assessing intake of sugars by populations and as a driving force for policy change. Multiple strategies encompassing both upstream and downstream preventive approaches are now required to translate the recommendations into policy and practice. *Adv Nutr* 2016;7:149–56.

Keywords: dental caries, sugars, dietary recommendations, dose response, food policy, oral health

Introduction

The prevalence of dental caries in industrialized countries remains high despite progress with fluoride protection and other preventive measures (1). Intake of dietary sugars is the most important risk factor for dental caries (2, 3). This review discusses the prevalence and impact of dental caries. It describes the guideline development process adopted by the WHO in the recent update of recommendations for sugars, including the systematic review of the dental evidence that informed the process (3). The recommendations for intake of sugars are discussed in terms of food sources, and consideration is given to potential strategies to reduce intake of sugars by populations. The overall aim is to provide the reader with an insight into the process adopted by the WHO in revising its recommendations for intake of free sugars and into the action required to realize these goals in practice.

[1] This article is a review from the Controversy Session: Sugars and Health: Are We Winning the Battle, but Losing the War? presented at the Advances & Controversies in Clinical Nutrition Conference, National Harbor, MD, 4–6 December 2014. The conference was jointly provided by the American Society for Nutrition (ASN) and Tufts University School of Medicine.

[2] The author reported no funding received for this study.

[3] Author disclosure: P Moynihan, no conflicts of interest.

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Current Status of Knowledge

Prevalence and impact of dental caries

Dental caries is the most prevalent noncommunicable chronic disease in the United States and worldwide and affects all age groups from infants to older adults. In the United States 15.7% of children (2007–2010 data) and 23.7% of adults (2005–2008 data) have untreated dental caries (4). Dental caries causes pain and anxiety in addition to causing time lost from work and school, and in young children untreated decay is a common cause of hospitalization. In addition to negative impacts on quality of life, dental caries is costly to health care systems, costing ≤10% of health care budgets in industrialized countries and is the fourth most expensive disease to treat (5–7). Even low levels of dental caries, especially when observed in the permanent dentition, are of concern because dental caries is a lifelong progressive and cumulative disease that tracks to adulthood, even with exposure to fluoride through water or mouth-care products (8, 9). Examples include data from the Dunedin Longitudinal Study that show that children with <3 decayed missing or filled tooth surfaces at age 12 y have developed 15 decayed missing or filled tooth surfaces by the age of 32 y (8), and data from the United States show that on

average 1 new carious surface develops per person per year in older adults (10). Bernabé and Sheiham (9) looked at age, period, and cohort trends in caries experience in the United States, England and Wales, Sweden, and Japan and found that, although a decline in dental caries experience occurred over recent decades, dental caries increases with age and that most dental caries now occur in adults. Therefore, it is incorrect to assume that few dental caries at age 12 y is indicative of good dental health in a population throughout the life course. Protecting oral health into old age is important because poor oral health in later life negatively affects quality of life and is associated with malnutrition and hospitalization (11–13).

Classification of sugars

Dietary sugars include all monosaccharides (glucose, galactose, fructose) and disaccharides (sucrose, maltose, lactose), and total sugars include monosaccharides and disaccharides both naturally present in foods and those added to foods. The term added sugars, in addition to added monosaccharides and disaccharides, sometimes includes honey, syrups (e.g., high-fructose corn syrups, maple syrup), and molasses within this classification. Natural sugars include sugars physically located in the cellular structure of grains, fruits, and vegetables plus those naturally present in milk and milk products. Evidence suggests that sugars naturally present in grains, whole fruits, and vegetables and also in milk (14–16) do not make an important contribution to the development of dental caries (or other noncommunicable diseases). This is because of the innate characteristics such as fiber content, water content, and other protective factors such as polyphenolic compounds or calcium or both. The impact of fruit, vegetables, and grains on mechanical stimulation of salivary flow helps mitigate the potential risk of the sugars. Sugars other than these intrinsic natural sugars are classified by WHO as free sugars which include all monosaccharides and disaccharides added to foods by manufacturer, cook, or consumer plus those sugars naturally present in honey, syrups, and fruit juices and concentrates (2). It is the intake of free sugars that should be restricted for health reasons (2).

WHO guideline for intake of sugars

In 2002 a WHO/FAO Expert Consultation on Diet, Nutrition and the Prevention of Chronic Diseases recommended that the intake of free sugars should provide ≤10% of energy intake (14). This consultation was based on a narrative review, and the numerical cap was based on data largely from population-based studies of the relation between intake of sugars and dental caries. Continued debate over whether the evidence related intake of free sugars and noncommunicable diseases warranted a review of the existing evidence in an updated robust and systematic manner. In March 2015, the WHO published a new guideline for intake of sugars for adults and children (2) and made a strong recommendation for a reduced intake of free sugars throughout the life course. A strong recommendation was also made for both children and adults that the intake of free sugars should be reduced to ≤10% of total energy intake. The WHO also made a conditional recommendation for a further reduction of the intake of free sugars to <5% of total energy intake. It was also stated that for countries with a low intake of free sugars that levels of intake should not be increased and that higher intakes of free sugars might jeopardize the quality of the diet by providing energy without nutrients (2). The WHO guideline stated that increasing or decreasing the intake of dietary free sugars was associated with parallel changes in body weight and that the relation exists irrespective of the quantity of sugar either as amount measured or percent contribution to energy intake. The quantitative recommendations were therefore based on evidence relating to the association of dental caries and free sugars.

The strength of the recommendation was informed by the Grading of Recommendations Assessment Development and Evaluation (GRADE)[4] process. Strong recommendations are issued when the "desirable effects of adherence to the recommendations outweigh the undesirable consequences," meaning "the recommendation can be adopted as policy in most situations." Conditional recommendations are issued when there is less certainty about the balance between the benefits and disadvantages of implementing a recommendation and when policy making will require substantial debate and involvement of stakeholders for translation into practice (17).

WHO guideline development process

The updating of the guideline for free sugars occurred according to the WHO guideline development process and is described in detail in the guideline (2). The process was undertaken by the WHO Department of Nutrition for Health and Development in collaboration with the WHO Secretariat and was guided by the WHO Steering Committee for Nutrition Guideline Development. A guideline development group, entitled the WHO Nutrition Guidance Expert Advisory Group (NUGAG) Subgroup on Diet and Health (NUGAG Subgroup), was convened to support the development of the guideline and included experts from all WHO regions with appropriate subject-matter expertise. External resource persons were also identified and included experts on dietary sugars, oral health, systematic review, and GRADE methodology. External experts attended NUGAG meetings as observers to provide technical input and to present systematic reviews. The role of the NUGAG Subgroup was to advise the WHO on outcomes important for decision making and on interpretation of the evidence for the development of recommendations. The WHO developed an initial set of questions to be addressed in the guideline with the use of the population, intervention, comparison, and outcome format. These questions were considered and reviewed by the WHO Secretariat and the WHO Steering Committee for Nutrition Guideline Development. A public consultation was held during the planning stages for comments on the scope of the guideline and on the research questions to be addressed in the systematic reviews. Comments received were review and

[4] Abbreviations used: GRADE, Grading of Recommendations Assessment Development and Evaluation; NUGAG, Nutrition Guidance Expert Advisory Group; NUGAG Subgroup, Nutrition Guidance Expert Advisory Group Subgroup on Dietary and Health; SSB, sugars-sweetened beverage.

assessed by the WHO Secretariat and passed to the NUGAG Subgroup for review. The NUGAG Subgroup considered both the scope of the guideline and prioritization of the questions. The WHO then commissioned systematic reviews and meta-analyses to address the population, intervention, comparison, and outcome questions.

The NUGAG Subgroup met to discuss the preliminary outputs of systematic reviews, and then the quality of the evidence was assessed with the use of the GRADE process (17). The classification was discussed among the NUGAG Subgroup, external resources persons, and the WHO Secretariat. When determining the strength of the various recommendations, the NUGAG Subgroup considered the overall quality of the evidence, the desirable and undesirable effects of the recommendation, values and preferences related to the recommendation in different settings, and the feasibility and cost of the options available to public health authorities in implementing the recommendations in different settings. The final wording of the draft recommendations and their strength were determined by consensus by the NUGAG Subgroup members and the WHO Secretariat.

The WHO Secretariat selected external peer reviewers who reviewed the draft guideline before finalization. A public consultation was also held to call for comments on the draft guideline before its finalization. These comments were also reviewed by the WHO Secretariat and assessed and considered when finalizing the guideline. A summary of the guideline development process is outlined in **Table 1**.

TABLE 1 Summary of WHO guideline development process[1]

Stage	Process
Planning	WHO develops initial questions in PICO format
	WHO Secretariat and WHO Steering Committee for Nutrition Guideline Development discuss and review questions
	Public consultation on scope of guideline and PICO questions; comments reviewed and assessed by the WHO Secretariat
	Comments from public consultation and assessment by the WHO Secretariat presented to the Guideline Development Group (the WHO NUGAG Subgroup on Diet and Health) for review
	Draft questions discussed and prioritized at meeting of NUGAG Subgroup on Diet and Health
Development	WHO commission systematic review of evidence by external experts
	NUGAG Subgroup on Diet and Health review and discuss the outcomes of systematic reviews and the GRADE assessment of the evidence which assessed the quality of evidence and the strength of the recommendation; GRADE classification discussed among NUGAG members, external resource persons, and the WHO Secretariat
	Finalization of the draft recommendations through consensus between NUGAG Subgroup on Diet and Health and the WHO Secretariat only
	Peer review of draft guideline to identify errors or missing information
	Public consultation for comments on the draft guideline
Publishing	WHO Secretariat assesses and considers response of peer review and public consultation process
	Guideline published

[1] Guideline was developed by WHO Department of Nutrition for Health and Development, guided and overseen by the WHO Steering Committee for Nutrition Guideline Development (2). GRADE, Grading of Recommendations Assessment Development and Evaluation; NUGAG, Nutrition Guidance Expert Advisory Group; PICO, population, intervention, comparison, and outcome.

GRADE process

In accordance with the WHO guideline development process, the GRADE working group methodology (17) was used to assess the quality of the evidence located through systematic review. The GRADE system provides a systematic and explicit method for judging the quality of evidence across a body of research studies. The process classifies the quality of evidence by taking into consideration study design, study limitations, consistency and directness of evidence, publication bias, size of effect, dose response, and effect of confounders. After consideration of these factors the body of evidence is rated high, moderate, low, or very low quality.

The quality of the evidence is one of several factors that the GRADE process takes into account when determining the strength of the recommendation. The other factors that affect this are the balance of desirable and undesirable effects on implementing the recommendation, values and preferences, and use of resources.

Systematic review on amount of sugars and risk of dental caries

The details of the systematic review relating to amount of sugars and the risk of dental caries were published elsewhere (3). In summary, the review was reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement (18) and asked the following questions for both children and adults. What is the effect on dental caries of a reduction in intake of free sugars? What is the effect on dental caries of an increase in intake of free sugars? What is the effect on dental caries of restricting intake of sugars to $\leq$10% of energy intake? The systematic review included human epidemiologic studies only, and all types of intervention and observational studies were sought. Studies were included if they reported absolute amount of intake of sugars and data on levels of dental caries or comparison of higher compared with lower caries groups. Sugars were defined as total sugars or free sugars or any component of free sugars measured by weight or by contribution to energy intake. The full protocol for the systematic review is available (19). The search included all age groups and all countries with no language restrictions and no date restrictions, and all available data sources were searched. After an initial screening to exclude studies outside the scope of the review, independent duplicate assessment of inclusion was conducted. The GRADE process was used to assess quality of the evidence as previously described.

After screening, assessment of qualification for inclusion and de-duplication 65 papers from 54 studies were included with most studies ($n = 50$) conducted in children with only 5 studies in adults. The data that were available came from

nonrandomized intervention studies (n = 3), longitudinal cohort studies (n = 8), cross-sectional observational studies (n = 24), and population-based surveys (n = 20). There was consistency in findings across studies with 42 (of 50) studies in children and 5 (of 5) studies in adults reported ≥1 positive association between amount of sugars and dental caries. Six studies reported both positive and null findings; 7 studies reported no association, and 2 studies reported ≥1 negative association between amount of sugars and dental caries. The positive associations covered all age groups; developing, transitional, and industrialized countries; and all decades of publication of results (1950s–present).

Much diversity was found in the format in which data were reported, for example, the length of study, date of study, the dental outcome (e.g., some measured caries prevalence, others severity), means of assessment, how exposure to sugars was reported (e.g., sucrose, total sugars, free sugars, added sugars), and the method of dietary assessment. Furthermore, data were not in a consistent format to provide sufficient data for pooling by study type; therefore, only crude meta-analysis was possible, but this did show that overall the data favored intake of sugars ≤10% of energy intake (3).

When looking at data systematically one should always consider the strongest study design first. In the case of sugars and dental caries no randomized controlled trials were found, so the best available data were from cohort studies (summarized in **Table 2**). The 8 identified cohort studies provided data that enable the impact of increasing and decreasing intake of free sugars to be determined (20–27); 7 of the 8 studies showed lower dental caries with lower intake of sugars, and evidence indicated a large size effect and a dose response. The GRADE process classified the quality of this evidence as moderate. Five of the 8 cohort studies identified had data that enabled comparisons of levels of dental caries when the intake of free sugars was >10% and ≤10% energy intake, and all of these studies showed lower levels of dental caries when consumption of free sugars was at a level equivalent to ≤10% of energy (20, 21, 24, 26, 27). The GRADE process classified the evidence from the cohort studies that enabled comparison of dental caries when intake of sugars was >10% and ≤10% of energy as moderate quality.

Despite the data from cohort studies indicating a lower risk of dental caries when intake of free sugars was ≤10% of energy intake, this level of intake of sugars did not eliminate dental caries. The information in **Table 3** indicates that, even when intake of free sugars is ≤10% of energy, dental caries is not totally eliminated. Moreover, many of

TABLE 2 Summary of cohort studies relating to amount of sugars and dental caries[1]

Study, year	Country	Age, y	Dentition	Findings
Rugg-Gunn et al. (20),[2] 1984	United Kingdom	12–14	Permanent	Highest consumers of added sugars (intake of sugars >10 E%) developed 0.9 more decayed tooth surfaces per year than the lowest consumers of added sugars (≤10 E%).
Stecksen-Blicks and Gustafsson (21),[2] 1986	Sweden	13	Permanent	Intake of sugars in group with low dental caries was ~9.8 E% compared with 14.5 E% in the high caries group.
Burt et al. (22), 1988	United States	10–15		Correlation found between percentage of energy from sugars and development of dental caries over a 3-y period. Each 5 g sugars was associated with a 1% increase in probability of developing caries. All had intakes >10 E%.
Batellino et al. (23), 1997	Argentina	4	Primary	Correlation between amount of sugars and number of decayed, missing, and filled teeth was found. A relation between lower socioeconomic class and high caries was found. All had intake of free sugars >10 E%.
Rodrigues et al. (24), 1999[2]	Brazil	3	Primary	Children with intake of added sugars at 16 E% were almost 3 times as likely to develop high dental caries as when intake of added sugars was ≤10 E%.
MacKeown et al. (25), 2000	South Africa	1–5	Primary	Change in caries incidence and prevalence between 1 and 5 y was not associated with intake of added sugars.
Karjalainen et al. (26),[2]	Finland	3	Primary	Intake of added sugars in children who developed caries over a period of 1 y was >10 E%, whereas it was ≤10 E% in children who remained free of cavities.
Ruottinen et al. (27), 2004[2]	Finland	10	Permanent	Finnish children with intake of sugars ≤10 E% had 0.5 decayed, missing, or filled teeth compared with 1.4 in children with intake of sugars >10 E%.

[1] E%, percentage of energy. Adapted from reference 3 with permission.
[2] Studies that enabled comparison of dental caries development in groups of children who consumed sugars at >10 E% and ≤10 E%.

the studies measured dental caries at the level of cavitation (i.e., once the surface of the tooth has collapsed and a cavity has developed). This is a late stage of the caries process because caries develops over time, and subsurface dental caries activity may not have been detected or included within the oral examination criteria.

The significance of even small reductions in risk of dental caries in childhood provided the rationale to explore the impact on dental caries risk of limiting free sugars further by considering the following question: What is the effect on dental caries of restricting intake of sugars to 5% of energy? To our knowledge, few epidemiologic data are available from populations who consume amounts of sugars equivalent to <5% energy. However, data from many countries show that dental caries in children was low before the introduction of free sugars to the diet (28, 29) or because of reductions in intake of sugars because of war-time rationing or sanctions (30–35). The only data available that enabled a comparison of levels of dental caries when the intake of sugars was <5% of energy with when it was >5% but ≤10% of energy were from population-based ecologic studies of Japanese children around the period of the Second World War (30–34). During this period the per capita sugars availability in Japan fell from a value before the war of 15 kg/person per year to levels as low as 0.2 kg/person per year. The studies related the per capita sugar availability to the annual caries incidence in the permanent teeth of children (obtained from national school-based detailed dental health examinations). In all the studies, lower dental caries development was seen when intake of sugars was equivalent to <5% of energy than when intake of sugars was >5% but ≤10% of energy. Log-linear dose response relations between sugars availability and caries development in the permanent molar teeth were observed between intake of sugars that ranged from 0.2 to 5–7.5 kg/person per year, with correlation coefficients that ranged from $r = 0.6$ to 0.8. The quality of these studies was classified according to the GRADE process which took into consideration the limitations of ecologic studies (such as lack of control for confounding and risk of bias); the quality of evidence was rated as very low quality. However, this outcome needs to be interpreted alongside the knowledge that, first, dental caries is still occurring in the permanent dentition of children at amounts of intake of free sugars equivalent to ≤10% of energy, and, second, prevention of dental caries throughout the life course and not just in childhood is important.

Frequency of sugars consumption compared with the amount consumed

Both the amount of sugars and the frequency with which they are consumed is a risk factor for development of dental caries. Pioneering animal studies have shown that frequency (35, 36) and amount (38–40) of intake of sugars is an important risk factor for dental caries. Some human epidemiologic studies show that frequency of intake of sugars is an important causative factor for caries development (41–43), but only studies that measure both variables simultaneously can conclude on the relative importance of amount and frequency. Few epidemiologic studies have measured the daily amount and frequency of free sugars from all sources and related this to dental caries. The studies that have found amount only (20, 22) or both (24) to be important. However, the relative importance of amount compared with the frequency of sugars is difficult to evaluate because the 2 variables are highly correlated, and an increase of either variable results in an increase in the other (20, 44). The WHO concluded that both amount and frequency of sugars consumed are important (14). Population nutrient goals, such as those set by the WHO, are set at an amount to enable the diets of populations and the impact of health promotion to be monitored against quantitative milestones. Moreover, when setting population nutrient goals the common risk factor approach must be considered. Evidence links intake of free sugars with obesity risk (2, 45, 46), and a higher contribution of added sugars to energy intake is associated with a substantially increased risk of cardiovascular disease mortality (47). Reducing frequency of sugars consumption alone will not reduce risk of noncommunicable diseases related to excess sugars. Advice to limit the frequency of intake of free sugars is, however, an important part of patient dental health education at the level of the individual. Goals set in terms of frequency are often more tangible for patients. Although population goals and upstream approaches to prevention should consider guidelines in terms of amount, downstream approaches to reducing sugars for caries prevention need to be mindful of the importance of limiting frequency and amount of intake of free sugars.

Translation and implementation of the WHO recommendations for free sugars

The WHO recommendations for the consumption of sugars are intended for use by policy makers as a benchmark against which to compare the intake of sugars of their populations and to assist policy makers in formulating

TABLE 3 Development of dental caries in children who consumed <10% energy as free sugars[1]

Study, year	Country	Dentition	Dental caries
Rodrigues et al. (24), 1999	Brazil	Primary	Average of 1 dmft in 1 y
Karjalainen et al. (26), 2001	Finland	Primary	No cavities developed
Routtinen et al. (27) 2004	Finland	Permanent	Average of 0.5 DMFT
Rugg-Gunn et al. (20) 1984	England	Permanent	Average of 3.2 DMFS over a 2-y period
Stecksen-Blicks et al. (21) 1986	Sweden	Permanent	0–2 DMFS over a 1-y period

[1] Decay was measured at the level at which cavitation of the tooth surface occurred, and precavitation lesions were excluded. DMFS/T, decayed, missing, or filled surfaces/teeth for permanent dentition; dmft, decayed, missing, or filled teeth for primary dentition.

country- and culture-specific nutrition policy and food-based dietary guidelines. Policy makers can work to introduce a range of measures, involving both upstream and downstream approaches to prevention, to help reduce intake of free sugars. These approaches might include fiscal pricing policies and regulation of marketing of products high in free sugars, legislation to underpin the reformulation of foods and drinks high in free sugars, improvements to nutrition labeling of foods and drinks for content of sugars, and improved education of both health professionals and consumers.

Taxing of sugars-sweetened beverages (SSBs) already exists in several countries, including France, Norway, and parts of the United States, although the impact of these initiatives is not fully evaluated. Recent research from Australia involving policy simulations has shown than an excise tax on SSBs would achieve the highest reduction in sugars ($\leq$8 g/d) consumption in high consumers of SSBs, despite that high consumers have less elastic demand for these drinks (i.e., change in price has less impact on consumption levels than it has for groups consuming lower amounts of SSBs) (48). In addition to any deterrent to consumption from any price increase imposed by tax, levying a tax on a product might also serve as a means of consumer education because it sends a message to the consumer that the product is not healthy.

Policy makers should consider imposing tighter controls that restrict the marketing of foods and drinks high in sugars as an important part of an overall strategy for reducing intake of sugars. In the United States the Federal Trade Commission and the Children's Advertising Review Unit impose little restriction on advertising of foods and drinks high in added sugars (49). Elsewhere in the world strategies, for example, the regulations imposed by Ofcom (an independent regulator and competition authority for the United Kingdom communications industries) and other regulatory bodies are limited to marketing and advertising aimed at children.

Reformulation of food and drinks, in particular processed foods that are high in free sugars, may also be considered as a key strategy for bringing a populations intake more in line with the recommendations for free sugars. Reformulation of products to lower the content of free sugars stands to benefit the health of the consumer without requiring any change in behavior. The success of reformulation of food products depends on consumer acceptance, and this requires a gradual decrease in sugars content over time, sometimes several years (50). Several food and drink manufacturers have already taken measures to reduce the sugars contents of their products. However, data on the level of consumption of reformulated products are needed so that any impact of this strategy on levels of intake of sugars by populations is realized. Moreover, reducing the sugars content of foods and drinks will have little impact on the frequency of intake of free sugars.

Health professionals and other professions such as teachers and those working in the fitness industry have an important role in disseminating health messages. In 2003 the WHO recommended that the training of all health professionals, including physicians, nurses, dentists, and nutritionists, should include diet and nutrition (14). The extent to which this occurs is likely to be highly variable within countries and between professions. Course accreditation of a defined core curricular is needed in the area of nutrition health education, including information on sugars and health, for all health professionals, educators, caregivers, and other relevant professions, so that there is consistency of accurate messages across professions.

Nutrition labeling of foods forms an important part of consumer education. In most countries, nutrition information on food and drink packaging contains information on total sugars only. This does not allow the consumer to ascertain how much free sugars or added sugars are in a product. Because many nutrition policies and food-based guidelines (e.g., Dietary Guidelines for Americans) recommend a reduction in added sugars only, it would be helpful if nutrition labels on foods contained information on the content of free sugars and how this compares with the recommended daily maximum. In the United States, the FDA is proposing to update the Nutrition Facts Label so that it is required to declare the added sugars and the content of total sugars (51). It would be desirable if other parts of the world adopted such a policy.

TABLE 4 Amounts of free sugars in selected foods and drinks

Food or drink	Free sugars, unit per portion	Free sugars, g/100 g[1]
Table sugar	5 g in 1 rounded teaspoon	100
Chocolate bar	12.5 g in a 20-g (0.7-ounceoz) fun-sized chocolate bar	65
Flapjack	21.3 g in a medium 60-g slice	35.5
Doughnut	11.6 g in a 75-g jam-filled doughnut	15.5
Plain fruit cake	25.2 g in average 90-g slice	28
Fruit cordial drink	12 g sugar in 1.7 fluid ounce (50 mL) of concentrate fruit cordial	24
Granola	11g in a medium 50-g (1.75-ounce) portion	22
Bran flake style breakfast cereal	5 g in a medium 30-g portion	16.7
Digestive biscuits	1.95 g per 15-g biscuit	13
Hot chocolate	25 g in 8 fluid ounce (240 mL)	10.4
Low fat flavored yogurt	14 g in a 5 ounce (140 g) yogurt	10
Unsweetened orange juice	20 g in small 6.75 fluid ounce (200 mL)	10
Lemonade	15 g in 10 fluid ounce (300 mL)	5

[1] Based on the methods of Kelly et al. (51). All values are approximate because sugars content may vary according to brand.

At a national level, translation of the recommendations for sugars into culturally relevant food-based dietary guidelines is important. Such guidelines should be targeted to different groups, including early years, schools, the workplace, care homes, doctors, and dental practices. Consuming ≤10% or even <5% of energy as free sugars does not imply consumption of a sugars-free diet. For an average adult, 10% of energy from free sugars equates to ~50 g or 10 teaspoons of sugars per day and 5% of energy to ~25 g or 5 teaspoons of sugars per day. The amounts of free sugars in some foods are provided in **Table 4**. Dietary advice in the dental practice serves to form an important part of preventive care for both general and dental health, and advice to eat less sugar and to reduce the frequency with which sugar foods and drinks are consumed, aiming toward a maximum of 1 a day, should help bring intakes in line with current guidelines. There is a dearth of research into the effectiveness of dietary intervention in the dental practice, but this should not be misinterpreted as dietary advice in dental practice being ineffective. What is required is more research into how to effectively intervene to modify dietary behavior in the dental practice and other settings. The WHO regularly updates recommendations to reflect most up-to-date evidence. For this high-quality cohort studies are needed with improved methods for assessing both dental caries and dietary intake (frequency and amount) of free sugars.

Conclusions

- The WHO adopted the systematic and explicit methods of the GRADE process to assist in revision of recommendations for thresholds for intake of free sugars, which included a comprehensive systematic review of the evidence pertaining to the amount of dietary sugars and risk of dental caries.
- The systematic review showed that an intake of free sugars of ≤10% of energy is associated with lower risk of dental caries, but this threshold did not eliminate dental caries. Because dental caries is a progressive cumulative lifelong disease, low levels of caries in childhood are of concern. The systematic review showed that there was some evidence albeit of a low quality to show a lower risk of dental caries when the intake of free sugars was equivalent to <5% of energy.
- On the basis of this systematic review, in a newly issued guideline, the WHO recommends a reduced intake of free sugars, and that in both children and adults the intake of free sugars should not exceed 10% of total energy intake. These are strong recommendations implying that these recommendations can be adopted as policy in most situations. The WHO suggested a further reduction in the intake of free sugars to <5% of energy. This was a conditional recommendation, implying that policy making will require debate and involvement of relevant stakeholders for this recommendation to be translated into action.
- Limiting the intake of free sugars to 10% or 5% of energy intake does not necessitate a sugar-free diet, and these limits allow for consumption of a limited amount of sugars-containing foods as part of a balanced diet.
- Issuing the new guideline on sugars is the first step toward reducing intake of free sugars. The WHO recommendations need to be followed by national nutrition-related policies, which could include fiscal policies, reformulation of foods, change in labeling regulations for sugars, improved education of professionals, and clear and updated consumer health education messages and food-based dietary guidelines. A concerted approach that is based on a broad range of strategies is required to successfully reduce the intake of free sugars and thereby safeguard both dental and general health.

Acknowledgments

The sole author had responsibility for all parts of the manuscript.

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