Added Sugars, Nutrient Intakes, and Grain-Based Foods

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Dietary guidance from authoritative bodies all over the world includes recommendations to reduce intake of added sugars. The most recent addition can be found in the report of the 2010 U.S. Dietary Guidelines Advisory Committee (DGAC) (21). This report reaffirms conclusions of the 2005 DGAC report (23) and strengthens the conclusions with specific recommendations and statements, including that consumers should a) “decrease consumption of energy-dense carbohydrates, especially refined, sugar-dense sources, to balance energy needs”; b) “reduce intake of foods containing added sugars and solid fats because these dietary components contribute excess calories and few, if any, nutrients”; and c) “lower intake of refined grains, especially refined grains that are coupled with added sugar, solid fat, and sodium.” There seems to be agreement among authoritative bodies as they all express similar concerns about added sugars as a potential source of excess calories. Other reasons given to limit or moderate sugars intake include the potential of added sugars to contribute to the development of dental caries and their assumed roles in obesity and chronic disease. There is also a concern that foods and drinks with added sugars displace foods delivering needed nutrients (11).

An analysis of effects of added sugars on nutrient adequacy was sponsored by the International Life Sciences Institute, North American Branch, and conducted by Marriott and colleagues (13). Using the U.S. National Health and Nutrition Examination Survey (NHANES) 2003–2006 Database, sugar intakes of 15,189 Americans over 4 years old were measured and compared with nutrient adequacy and health outcomes, including body mass index (BMI). Intake data were further classified by age and gender subgroups as well as by racial, ethnic, and socioeconomic categories. The NHANES Database is a representative sampling of the U.S. population. It is balanced to capture geographic, ethnic, racial, and age differences. The added sugars data were analyzed for all those who are over 4 years old, but excludes subjects who are fasting and pregnant and lactating women. The analysis also looked at the contribution of various food categories to added sugar intakes, including all categories of grain-based foods. These data are particularly relevant to grain-based food researchers, since the 2010 DGAC report includes statements about some grain-based foods. In the executive summary, the DGAC report stated: “High-energy, non-nutrient-dense carbohydrate sources that should be reduced to aid in calorie control include sugar-sweetened beverages; desserts, including grain-based desserts; and grain products and other carbohydrate foods and drinks that are low in nutrients.” Next we will look at the challenges and opportunities this dietary guidance presents for grain-based foods.

Added Sugars in the NHANES Database—Definition and Background

The discussion of added sugars requires an understanding of how each of the terms are defined, measured, and used. The term “added sugars” in the Marriott et al. paper was defined as follows: “Added sugars include all sugars used as ingredients in processed and prepared foods such as breads, cakes, soft drinks, jams, chocolates, and ice cream, and sugars eaten separately or added to foods at the table … Added sugars do not include naturally occurring sugars such as lactose in milk or fructose in fruit …” (13). Added sugar sources were defined as white sugar, brown sugar, raw sugar, corn syrup and corn syrup solids, high fructose corn syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey, molasses, dextrose, and dextrin. It is important to note that while the source list is fairly comprehensive, it fails to capture certain ingredients used to sweeten foods, such as concentrated juices or agave syrup. (The use of both of the latter has led to some product claims, such as “no sucrose” or “no refined sugar,” which can confuse and mislead the consumer.)

The determination of added sugars intake is always tricky, and a one-day assessment can often give a distorted picture. Some individuals may only have a calorically sweetened beverage or indulge in a sweetened grain occasionally, so if the recall is on that day, it artificially elevates added sugars intake. On the other hand, if a recall occurs on a day of nonconsumption for a person who frequently consumes these foods, then the one-day intake is underestimated. To address this issue, the added sugars measurement in the Marriott et al. analysis was derived from the intake of two days (4), which gives greater accuracy but still has some problems associated with it. Nutrient adequacy was evaluated by comparing the intake levels with either the estimated average requirement (EAR) or the adequate intake (AI). Acronyms, terms, and definitions associated with NHANES and nutrient adequacy as developed as part of the review on nutrient requirements by the Institute of Medicine (IOM) are found in Table I (22).

Added Sugars Intake in the Population

Despite recent concern about added sugars intake for the U.S. population, the intake has been relatively stable since the
1990s. A comparison of added sugars intake with Consumer Survey of Food Intakes of Individuals (CSFII) data from 1994 to 1996 shows that the mean g-eq added sugars intake was 83.1 g-eq/day compared with 82.2 g-eq/day (10). Furthermore, food sources of added sugars were also very comparable to those observed in the 1994–1996 CSFII data (10,11).

The analysis shows that three-fourths of the NHANES 2003–2006 population over 4 years old ingest under 20% of energy (E) as added sugars. Sixty-four percent of individuals has an estimated added sugars intake between 5 and 20% of E. However, for children and youth 4–18 years of age, over one-fourth ingest 15–20% of E as added sugars, while one-fifth to one-fourth of teens and young adults, ages 9–30 years old, ingest 20–25% of E as added sugars. While there is not unanimity, 20% of E as added sugars is considered as moderate intake in some dietary guidance; some recommendations, such as those from the Joint FAO/WHO, suggest that added sugars contribute no more than 10% of E (8).

Eighty-seven percent of the population ingests less than 25% of E as added sugars, a level the IOM Dietary Reference Intakes report (11) suggests as maximal, based on the decreased intake of certain micronutrients by some American sub-populations. What creates concern is the 13% of the U.S. population ingesting added sugars intakes at or above 25% of E. This added sugars intake group is subdivided into three subcategories with 7% of the population ingesting 25–30% of E as added sugars and 3% in both the 30–35% of E and the over 35% of E categories. These latter two categories represent high and extreme consumption of added sugars.

Added sugars intake also varies by socioeconomic, racial, and ethnic subgroups, with some of these subgroups having a higher proportion of individuals with high intakes of added sugars. Eighteen percent of persons living below the poverty level, compared with 9% with incomes three times the poverty level, ingest more than 25% of E as added sugars. More nonhispanic blacks compared with other racial and ethnic groups consume added sugars above 25% of E.

### Added Sugars Intake and BMI

Marriott et al. (13) found that individuals ingesting either the least added sugars (under 5% of E) or the most (above 35% of E) had the highest BMIs. Surprisingly, nearly 15% of those classified as obese ate less than 5% of E from added sugars. These data could reflect actual intake. In fact for some, low added sugars intake could reflect dietary modifications to deal with excess weight and related conditions, such as type 2 diabetes. Further, the data may reflect an important observation from the 2010 DGAC Report which stated that “A moderate body of evidence suggests that under isocaloric controlled conditions, added sugars, including sugar-sweetened beverages, are no more likely to cause weight gain than any other source of energy. All types of calories can lead to weight gain” (21). However, the findings could also be due in part to under reporting. Studies from a number of sources show that overweight and obese subjects—despite a number of techniques, including the five-step multiple pass method (4)—to improve the accuracy—under report their food intake and over report their physical activity (1,4,14,18).

Three-fourths of the population classified as overweight or obese by BMI consume added sugars between >5% and <25% of E. Thus, the added sugars intake of those who are overweight is not different than the population overall. This finding may also underscore the DGAC’s conclusion that any energy source can contribute to weight gain. However, under reporting may also be a factor.

### Added Sugars and Nutrient Adequacy

The most striking finding from the NHANES 2003–2006 data is that the overall micronutrient and dietary fiber intakes of the population are poor, irrespective of added sugars intake. However, for each 5% increase in added sugars, nutrient intakes of most nutrients decreased (13). These disconcerting statistics show shortfalls in nutrient adequacy in the U.S. population for nearly all age and gender categories. To make matters worse, the under consumption is occurring in the backdrop of national statistics that show that two-thirds of the U.S. population are overweight or obese (6). Thus, a large percentage of the population fails to meet the EAR for many vitamins, minerals, and dietary fiber (13). Since the EAR represents the mean requirement for a particular gender-age sub-class, much of the population could be at risk for suboptimal nutrition and, in some cases, overt nutrient inadequacy.

### Vitamins

Forty-four to 58% of the U.S. population over 14 years of age fails to meet the EAR for vitamin A. Thirty-seven to 47% of the U.S. population over 14 years of age

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### Table I. Glossary of nutrient terms established by the Institute of Medicine

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Meaning</th>
<th>Short Explanation</th>
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<tbody>
<tr>
<td>IOM</td>
<td>Institute of Medicine</td>
<td>Part of the National Academy of Sciences</td>
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<tr>
<td>LSG</td>
<td>Life stage group</td>
<td>An age-sex subgroup of the population</td>
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<tr>
<td>DRI</td>
<td>Dietary reference intake</td>
<td>A set of four reference values: estimated average requirement (EAR), recommended dietary allowance (RDA), adequate intake (AI), and tolerable upper intake level (UL).</td>
</tr>
<tr>
<td>EAR</td>
<td>Estimated average requirement</td>
<td>The EAR is expected to satisfy the needs of 50% of individuals in a particular age and sex category. (It is the average value from which the RDA is derived. It is used to assess nutritional adequacy of groups.)</td>
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<tr>
<td>RDA</td>
<td>Recommended dietary allowance</td>
<td>The RDA is used to estimate the nutrient requirement to assure that it has a margin of safety by considering the two standard deviations about the mean so that it meets the needs of 97–98% of healthy individuals in the population. (It is not used to assess nutrient adequacy of a population since it would assume that all in the population need the maximum intake of a nutrient.)</td>
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<tr>
<td>AI</td>
<td>Adequate intake</td>
<td>AI is used for all those dietary components for which there is no EAR because the data needed to establish an EAR are wanting. An AI can be used similarly to an EAR.</td>
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<tr>
<td>RDI</td>
<td>Reference daily intake (or recommended daily intake)</td>
<td>Daily dietary intake level of a nutrient which was considered (at the time they were defined) to be sufficient to meet the requirements of nearly all (97–98%) healthy individuals in each life-stage and sex group. The RDI is used to determine the daily value which is printed on food labels in the United States, Canada, and Australia. RDIs are based on the older recommended dietary allowances (RDAs).</td>
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fail to meet the EAR for vitamin C. Between 88 and 90% of the population fails to meet the EAR for vitamin E. The story for folate is better since 16–19% of the males over 14 years of age fail to meet the EAR. However, for females—the target of folate fortification programs—41–46% fail to meet the EAR.

Findings such as these were highlighted in the DGAC 2010 report, which found intakes of vitamins A, C, D, E, and K, and choline were well below recommended levels, making a number of these nutrients of concern (21). The Marriott et al. study (13) showed that the greater the percent of E as added sugars, the higher the percentage of the population who fails to meet the EAR. In fact, there was a graded decrement in vitamin intake for all the vitamins included in this analysis with each 5% increase of E as added sugars intake. The categories with the highest added sugars intake had from 41 to 63% lower mean intakes of vitamins A, C, E, K, folate, and choline than those with added sugars intake under 10% of E. Again, it must be emphasized that even for those in the category with the lowest intakes of added sugars, a substantial number still fails to meet the EAR or AI.

It is important to note that the DGAC report also found that specific health biomarkers indicating actual nutrient deficiency levels occurred in 7% or less of the population. Inadequate intake of nutrients on a regular basis may be a precursor to changes in biomarkers. Further, these biomarkers, such as low serum retinol for vitamin A and low blood alpha-tocopherol for vitamin E, while useful, may not capture the antioxidant and other potentially health-promoting functions that intakes nearer optimum levels might foster.

Minerals and Fiber

For minerals, the pattern is similar to that seen with the vitamins. Median intakes decreased the percent of E as added sugars increased. However, median calcium intake did not start to dramatically decrease until the levels of added sugars intake increased. Specifically, calcium intakes are very similar for consumers with 0–15% of E as added sugars. These data corroborate earlier findings that added sugars in calcium-containing foods, such as yogurts and flavored milks or breakfast cereals, may actually positively impact palatability and acceptance and increase milk and calcium intake, especially in children (2,15).

Mean intakes of iron, zinc, magnesium, calcium, and potassium by extreme consumers of added sugars (30–35% of E) were one-half to one-third lower than that observed in those with the lowest added sugars consumption (5–10% of E). The DGAC report listed calcium, magnesium, and potassium minerals as nutrients of concern for all age and gender classes. There is special concern that calcium is a shortfall nutrient for boys and girls aged 4 to 18 years, since this is a critical time for bone growth (3,24). There is also very great concern about the lack of potassium, since 97% of the population fails to meet the AI. The inadequate intake of potassium and other minerals (20) is associated with higher blood pressure, making this dietary inadequacy a concern for all ages. The inadequate intake of magnesium is associated with a number of chronic diseases, including diabetes and coronary disease (25). Thus, the intake of vitamins and minerals, regardless of sugars intake, fails miserably to approach adequate levels.

Dietary fiber is another nutrient of concern listed by the DGAC. Intakes of dietary fiber decreased by at least 1 g/day with each 5% increase in added sugars as a percent of E. Even in the lowest added sugars intake category, the intake of dietary fiber is only 16 g/day of the needed 25–38 g/day. Thus, regardless of added sugars intake for any age or gender category, no more than 5% of the population met the AI for dietary fiber.

Sources of Added Sugars

Analysis of the intake data by type of food showed that sugar-sweetened soft drinks provided 30.7% of the added sugars intake. When combined with added sugars from fruitades and fruit drinks, beverages were the largest contributor (41%) of the added sugars intake for those over 4 years of age. Sweets and candies provided 13.7% of the added sugars intake, and dairy-based desserts, such as ice cream, provided 6.4%.

Grain foods in total provided 20% of the added sugars intake with sweetened grains contributing 12.6% of the added sugars intake, breakfast cereals accounting for 4.3%, and “other grains” accounting for 5.1% of added sugars intake. Compared with the CSFII data collected from 1994 to 1996 on sources of added sugars, added sugars from grain foods, as was seen with other food categories, changed little over the 10-year period (10).

Within the grains category, the added sugars in breakfast cereals receive frequent media attention and capture the concern of many parents and some health professionals (16). For children 4–8 years old, breakfast cereals contribute 7.1% of the total added sugars intake and sweetened grains contribute 9.4%. These ratios change with increasing age. For teenage males aged 14–18 years, breakfast cereals contribute 5.4% of the added sugar intake, and 12.3% come from sweetened grains. For females 71+ years of age, breakfast cereals contribute 4.1%, while 20% is contributed by sweetened grains.

Some data indicate that added sugars in breakfast cereals could be viewed differently from those in sweetened grain foods. Studies on children and adolescents show that those who eat ready-to-eat (RTE) cereals have higher dietary fiber intakes and better nutritional adequacy for several micronutrients than either breakfast skippers and other breakfast consumers (5,7). Similar data are available on adults (9). In addition, RTE cereal consumers had lower measures of obesity than those eating no breakfast or other types of breakfast. There are probably several reasons for improved nutrient adequacy, including: a) RTE cereals are convenient, quick, and easy ways to get nutrients, b) many RTE cereals are fortified, and c) RTE cereals encourage milk consumption and calcium intake (2,17). Some added sugars may help increase the intake of under-consumed cereals, including whole grain and high-fiber (bran) cereals.

Foods in the sweetened grains category are specifically mentioned in the 2010 DGAC report because they are major contributors of solid fats and added sugars (SoFAS) in the diet. Sweetened grain-based foods include cookies, pies and pastries, doughnuts and sweet rolls, biscuits, muffins, scones, some specialty and quick breads, toaster pastries, and cakes. SoFAS contribute slightly more than one-third of the calories in the American diet, with the calories distributed approximately equally between solid fat and added sugars. Health professionals are concerned these foods often do not contribute needed nutrients but may provide excess calories. Since most sedentary consumers are allotted only 150–250 calories per day for all foods over and above those foods specified in food guidance systems (such as MyPyramid), the recommendation is that foods high in SoFAS be enjoyed as an occasional indulgence rather than part of the daily diet. On the other hand, foods in this category are used for snacking, and snacking is important in many diets. Thus, an aim for food formulators might be to have these foods deliver needed nutrients with reduced SoFAS.

Conclusions

Nutrient intakes in the U.S. population for all sex and gender categories fall far below recommended levels, irrespective of the added sugars content of the diet. However, for the 13% of the population with
high or very high added sugars intakes (≥25% of E), nutrient intakes are even lower and are associated with even lower levels of nutrient adequacy than the population as a whole. Nutrient adequacy for most micronutrients decreased with each 5% of E increase in added sugars. Calcium is one documented exception where up to 15% of E as added sugars intake did not markedly decrease calcium intake, although higher intakes of added sugars did.

The DGAC noted that added sugars, no matter the source, were of concern because of the potential contribution to extra calories. The analysis by Marriott et al. (13) showed that sugar-sweetened beverages were major contributors to added sugars intake. Grain-based foods only provided 20% of the added sugars intake. The DGAC noted that grain-based desserts was the food subcategory providing the most calories to the U.S. diet and is also a leading source of SoFAS. Intake of many of these foods may need to be reduced and many products may need to be reformulated to be closer in line with the recommendations. Some leniency may be warranted for use of judicious amounts of added sugars in breakfast cereals, and high fiber/whole grain products and snacks in order to improve palatability and promote their consumption. Data on RTE cereals suggest that they supply nutrients of concern, including dietary fiber. Further, data on breakfast cereal eaters show that they are more likely to have lower BMIs compared to those who don’t eat cereal.

A reduction of added sugars in grain-based foods provides a significant challenge to food formulators not only because of taste, but also because of the many functional roles of added sugars. Furthermore, the removal of added sugars from a solid food may not, as many believe, lower calories. Unless the sugar is replaced with water or a dietary fiber with a minimal calorie yield, the food with a sugar replacer will have at least the same number of calories per gram as the original food.

Grain-based products that promote nutrient-rich and calorie-controlled meal and snacking options are needed to help consumers address nutrient targets and control calories and SoFAS intakes. Despite a myriad of difficulties, formulators of grain-based foods strive to reduce added sugars and overall calories in their products while addressing nutrient deficits in the population, especially nutrients of concern, including calcium, magnesium, potassium, and dietary fiber. Use of whole grains, bran, and other high-fiber and nutrient-rich ingredients, such as nuts and fruits, can help address the dietary fiber gap and may add other nutrients. Such strategies are needed to deliver great tasting whole grain and bran- and fiber-containing products that easily move consumers to select such products over their refined counterparts.

Several strategies might be warranted to increase the micronutrients contributed by grain-based foods. Folate naturally present in whole grains should be brought to parity with that found in fortified products. Vitamins E and B6 naturally present in whole grains may need to be considered as part of the enrichment of refined grains. Calcium is allowed as part of flour enrichment. Its addition should be encouraged, and perhaps a change in regulations in order to increase the amount allowed is warranted. The addition of vitamin D to grain-based foods could also be explored. This would require both studies to predict how fortification would improve intake and to ensure that no population subgroup receives an excessive amount. Such additions would require changes in regulations regarding enrichment and fortification standards, food categories allowed for certain added nutrients and amounts, and products with a standard of identity. Such efforts could be especially timely as new recommendations for vitamin D and calcium are to be announced after deliberations of the IOM. Formulations that incorporate much needed fruit and vegetable servings will also help address nutrient shortfalls and food group deficiencies.

Dietary fiber has always belonged to the grain foods category. Formulators need creative ways to incorporate additional dietary fibers into products people enjoy. Ideally, higher levels of fiber and nutrients should be attained without adding calories, sugars, salt, or solid fats. While it is easy to say what we need from a nutritional point of view, making an enjoyable food product that delivers these attributes provides maximum challenges for the formulator. A close partnership for all in the supply chain is necessary to mount the effort to produce these needed grain products. The effort is worthwhile as the goal is to help improve nutrient intake and help the population meet DGAC recommendations to “limit calories, especially those from added sugar” (21).

Finally, guidance on dietary sugars is only one aspect of the DGAC report, which includes recommendations on the total diet; energy balance and weight maintenance; and translating the evidence, particularly with regard to the increasing incidence of obesity in the United States. Strategies to address these data on poor nutrient intake will undoubtedly be addressed in the upcoming translation of the DGAC report into the Dietary Guidelines for Americans (to be issued jointly by the DHHS and USDA at the end of 2010). Those in the cereal industry will need to be ready to meet the challenge.

References


