

Appendix E2.46: Evidence Portfolio

Part D. Chapter 6: Cross-Cutting Topics of Public Health Importance

What is the relationship between the intake of added sugars and dental caries?

Conclusion Statement: The DGAC concurs with the World Health Organization's commissioned systematic review that moderate consistent evidence supports a relationship between the amount of free sugars intake and the development of dental caries among children and adults. Moderate evidence also indicates that caries are lower when free-sugars intake is less than 10 percent of energy intake.

DGAC Grade: Moderate

Review of Evidence

These findings were extracted from a World Health Organization (WHO)-commissioned SR by Moynihan et al. published in 2014 examining the association between the amount of sugars intake and dental caries.¹ The search for SRs/MA published since completion of the WHO review did not yield any additional reviews that met the DGAC's inclusion criteria.

Moynihan et al. examined total sugars, free sugars,¹ added sugars, sucrose, and non-milk extrinsic (NME) sugars. In the review, eligible studies reported the absolute amount of sugars. Dental caries outcomes included caries prevalence, incidence and/or severity.

Several databases were searched from 1950 through 2011. From 5,990 papers identified, 55 studies (from 65 papers) were eligible, including 3 interventions, 8 cohort studies, 20 population studies, and 24 cross-sectional studies. No RCTs were included. Data variability limited the ability to conduct meta-analysis. Of the 55 studies included in the review, the majority were in children and only four studies were conducted in adults. The terminology used for reporting sugars varied, but most were described as pertaining to free sugars or added sugars.

The findings indicated consistent evidence of moderate quality supporting a relationship between the amount of sugars consumed and dental caries development across age groups. Of the studies, 42 out of 50 studies in children and five out of five in adults reported at least one result for an association between sugars intake with increased caries. Moderate evidence also showed that caries incidence is lower when free sugars intake is less than 10 percent of energy intake. When a less than 5 percent energy intake cutoff was used, a significant relationship between sugars and caries was observed, but the evidence was judged to be of very low

¹ Free sugar is defined by WHO as "all monosaccharides and disaccharides added to foods by the manufacturer, cook, or consumer, plus sugars naturally present in honey, syrups, and fruit juices." It is used to distinguish between the sugars that are naturally present in fully unrefined carbohydrates such as brown rice, whole wheat pasta, and fruit and those sugars (or carbohydrates) that have been, to some extent, refined (normally by humans but sometimes by animals, such as the free sugars present in honey). They are referred to as "sugars" since they cover multiple chemical forms, including sucrose, glucose, fructose, dextrose, and others.²

quality. Although meta-analysis was limited, analysis of existing data indicated a large effect size (e.g., Standardized Mean Difference for Decayed/Missing/Filled Teeth [DMFT] = 0.82 [CI = 0.67 to 0.97]) for the relationship of sugars intake and risk of dental caries. A strength of the in-depth SR was the consistency of data, despite methodological weaknesses in many studies, which included unclear definitions of endpoints, questions about outcomes ascertainment, and lack of clarity about the generalizability of individual study results given the study populations used.

Table 1. Summary of existing reports, systematic reviews, and meta-analyses examining the relationship between the intake of added sugars and risk of dental caries

Author, Year Publication Type AMSTAR Rating*	Added Sugars Definition Outcomes Considered	Date Range Searched Criteria Used	Included Studies (Number and Design)	Recommendations, Evidence/Conclusion Statements, and/or Main Results from Existing Report/ SR/ MA
Moynihan, 2013 Systematic Review (data variability limited meta-analysis) AMSTAR: 11/11	Total sugars, free sugars, added sugars, sucrose, non-milk extrinsic (NME) sugars, expressed as g or kg/d or /yr or as percentage energy Caries prevalence, incidence, and/or severity	1950 to November 2011 Healthy humans (no acute illness); developing, transitional, or industrialized countries; all ages; no language restrictions; studies had to report amount of added sugars, frequency only was excluded	65 papers (55 studies) 3 intervention, 8 cohort, 20 population, and 24 cross-sectional	This in-depth systematic review has identified largely consistent evidence supporting a relationship between the amount of sugars intake and the development of dental caries across age groups. Of the studies, 42 out of 50 of those in children and 5 out of 5 in adults reported at least one positive association between sugars and caries. The evidence has been classified as of moderate quality. There is also evidence of moderate quality showing that caries is lower when free-sugars intake is <10% energy. With the <5% energy cutoff, a significant relationship was observed, but the evidence was judged to be of very low quality.

* A measurement tool for the ‘assessment of multiple systematic reviews’ (AMSTAR)

References Included in Review

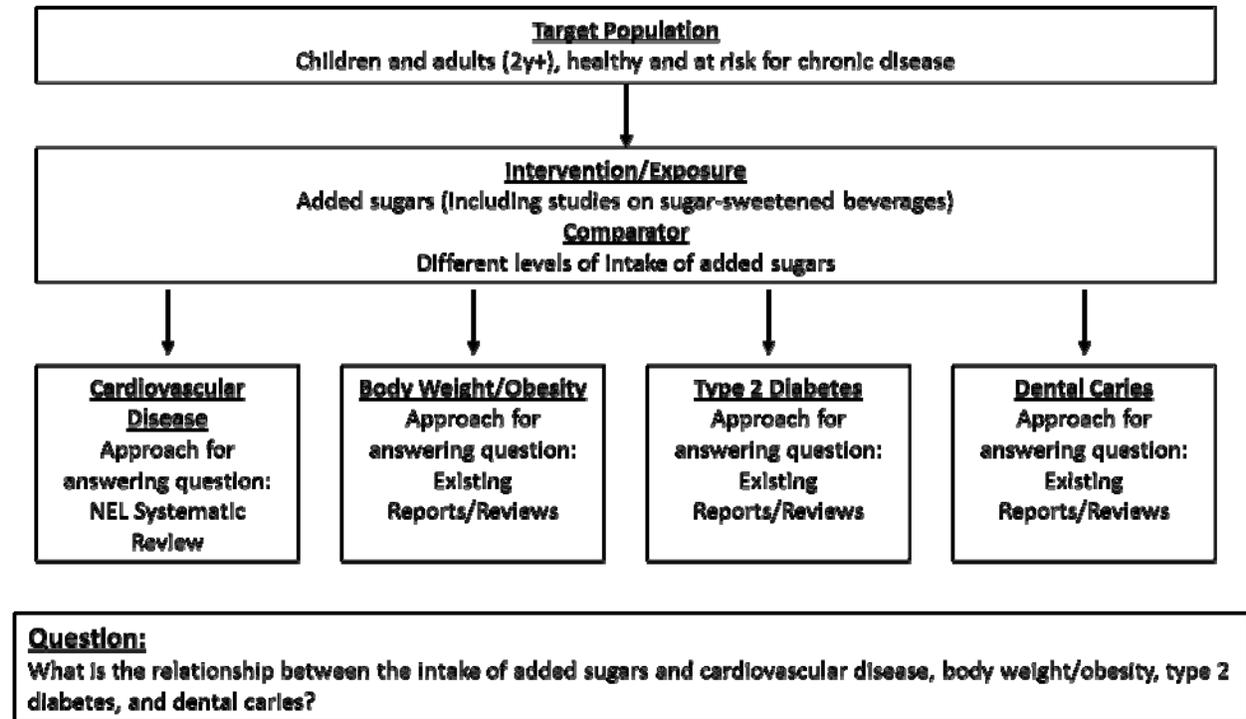
1. Moynihan PJ, Kelly SA. Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. *Journal of dental research*. 2014;93(1):8-18. PMID: 24323509. <http://www.ncbi.nlm.nih.gov/pubmed/24323509>

Additional Reference

2. The science behind the sweetness in our diets. *Bull World Health Organ*. 2014;92(11):780-1. PMID: 25378738. <http://www.ncbi.nlm.nih.gov/pubmed/25378738>.

Supplementary Information:

Analytical Framework



Methodology

To answer this question, the DGAC relied on a systematic review commissioned by the World Health Organization (WHO).¹ Additionally, to capture new research, the Committee searched for SRs and MA published since November 2011, the completion of the WHO review.

Search Strategy for Existing Systematic Reviews/Meta-Analyses

PubMed:

Added Sugar* OR brown sugar*[tiab] OR white sugar*[tiab] OR raw sugar* OR syrup*[tiab] OR dextrose OR fructose OR fruit juice concentrate* OR glucose OR honey[mh] OR honey[tiab] OR jam[tiab] OR invert sugar* OR malt sugar* OR maltose[tiab] OR maltodextrin OR molasses OR turbinado sugar* OR cane sugar*[tiab] OR cane juice*[tiab] OR "sugar cane"[tiab] OR sugar beet*[tiab] OR trehalose[tiab] OR sucrose[tiab] OR sweetene* OR table sugar*[tiab] OR "Monosaccharides"[Mesh] OR Monosaccharide*[tiab] OR disaccharide*[tiab] OR "Disaccharides"[Mesh] OR "Sweetening Agents"[Mesh:noexp] OR "Nutritive Sweeteners"[Mesh] OR "Dietary Sucrose"[tiab] OR sugar based* OR sugar-based* OR HFCS OR candy[tiab] OR "Candy"[Mesh] OR "Carbonated beverages"[mh] OR Soft drink* OR Liquid sugar* OR Soda pop* OR soda[tiab] OR Carbonated drink*[tiab] OR dessert*[tiab] OR pastries[tiab] OR ice cream*[tiab] OR cookies[tiab] OR cake*[tiab] OR pie[tiab] OR pies[tiab] OR gelatin*[tiab] OR

jello[tiab] OR fruit punch*[tiab] OR fruitade*[tiab] OR sugary[tiab] OR sweets[tiab] OR sugar-sweetene*[tiab] OR caramel OR "malt barley" OR "barley malt" OR "Sweetening Agents" [Pharmacological Action] (done; w/ food/diet terms 30; none selected; 8/7/2014) OR sugar-coated[tiab] OR sugar coated*[tiab] OR sugar*[ti] OR sugar sweeten*[tiab] OR dietary sugar*[tiab] OR confectioner*[tiab] OR fizzy drink*[tiab] OR chewing gum*[tiab]

AND

Dental caries*[tiab] OR "Tooth Demineralization"[Mesh] OR "Diet, Cariogenic"[Mesh] OR Cariogen*[tiab] OR "Cariogenic Agents"[Mesh] OR "oral health"[tiab] OR "oral hygiene"[tiab] OR ((dental[tiab] OR dentin*[tiab] OR tooth[tiab] OR teeth[tiab]) AND (cavit*[tiab] OR carious[tiab] OR caries[tiab] OR decay*[tiab] OR demineral*[tiab] OR plaque[tiab])) OR "Dental Plaque"[Mesh] OR "Dental Plaque"[tiab] OR "Dental Pulp"[Mesh] OR "Dental Caries Susceptibility"[Mesh]

Embase:

(added NEXT/1 sugar*):ti,ab OR (raw NEXT/1 sugar*):ti,ab OR (white NEXT/1 sugar*):ti,ab OR (brown NEXT/1 sugar*):ti,ab OR 'sugar intake'/exp OR 'sucrose'/exp OR 'sweetening agent'/de OR 'fructose'/exp OR 'monosaccharide'/exp OR 'sugarcane'/exp OR 'lactose'/exp OR (milk NEXT/2 sugar*):ti,ab OR 'sugar beet'/exp OR 'sugar'/exp/mj OR (sugar NEXT/1 beet*):ti,ab OR sugarcane:ti,ab OR (sugar NEXT/1 cane):ti,ab OR dextrose:ti,ab OR 'glucose'/exp OR (corn NEXT/1 syrup*):ti,ab OR (maple NEXT/1 syrup*):ti,ab OR 'honey'/exp OR 'invert sugar'/exp OR (invert NEXT/1 sugar*):ti,ab OR 'maltose'/exp OR (malt NEXT/1 sugar*):ti,ab OR 'maltodextrin'/exp OR 'molasses'/exp OR (turbinado NEXT/1 sugar*):ti,ab OR 'disaccharide'/exp OR disaccharide*:ti,ab OR trehalose*:ti,ab OR (sugar NEXT/1 based*):ti,ab OR HFCS*:ti,ab OR candy:ti,ab OR candies:ti,ab OR 'carbonated beverage'/exp OR (carbonated NEXT/1 beverage*):ti,ab OR (Soft NEXT/1 drink*):ti,ab OR (Liquid NEXT/1 sugar*):ti,ab OR (Soda NEXT/1 pop*):ti,ab OR popsicle*:ti,ab OR (soda NEAR/10 (drink* OR beverage*)) OR (Carbonated NEXT/1 drink*):ti,ab OR 'soft drink'/exp OR dessert*:ti,ab OR pastries:ti,ab OR (ice NEXT/1 cream*):ti,ab OR 'ice cream'/exp OR cookies:ti,ab OR cake*:ti OR pie:ti,ab OR pies:ti,ab OR gelatin*:ti,ab OR jello:ti,ab OR (fruit NEXT/1 punch*):ti,ab OR fruitade*:ti,ab OR (('fruit juice'/exp OR (fruit NEXT/1 juice*)) AND concentrate) OR sweets:ti,ab OR caramel:ti,ab OR (malt* NEAR/1 barley) OR ('syrup'/exp OR syrup*:ti,ab) OR sugary:ti,ab OR sugar*:ti OR (sugar NEAR/3 sweet*):ti,ab OR (sugar NEAR/3 coat*):ti,ab OR (dietary NEXT/1 sugar*):ti,ab OR confectioner*:ti,ab OR (fizzy NEXT/1 drink*):ti,ab OR chewing gum*:ti,ab OR 'chewing gum'/exp

AND

'dental caries'/exp OR 'tooth plaque'/exp OR 'cariogenic diet'/exp OR Cariogen*:ti,ab OR "oral health":ti,ab OR "oral hygiene":ti,ab OR ((dental:ti,ab OR dentin*:ti,ab OR tooth:ti,ab OR teeth:ti,ab) AND (carious:ti,ab OR caries:ti,ab OR decay*:ti,ab OR plaque:ti,ab OR demineral*:ti,ab OR cavit*:ti,ab)) OR 'tooth plaque'/exp OR "Dental Plaque":ti,ab OR 'cariogenic agent'/exp OR 'tooth pulp'/exp OR 'mouth hygiene'/exp

Cochrane:

(Added NEXT Sugar*) OR (brown NEXT sugar*) OR (white NEXT sugar*) OR (raw NEXT sugar*) OR syrup*:ti,kw OR dextrose:ti OR fructose:ti OR (fruit NEXT juice NEXT concentrate*) OR glucose:ti OR honey:ti OR jam:ti OR (invert NEXT sugar*) OR (malt NEXT sugar*) OR maltose:ti OR maltodextrin:ti OR molasses OR (turbinado NEXT sugar*) OR (cane NEXT sugar*) OR (cane NEXT juice*) OR "sugar cane":ti,ab OR (sugar NEXT beet*):ti,ab OR trehalose:ti OR sucrose:ti OR sweetene* OR (table NEXT sugar*) OR Monosaccharide*:ti OR disaccharide*:ti OR "Dietary Sucrose":ti,ab OR (sugar NEXT based*) OR sugar-based* OR HFCS OR candy:ti,ab OR candies:ti,ab OR (Carbonated NEAR beverage*) OR (Carbonated NEAR drink*) OR (Soft NEXT drink*) OR (Liquid NEXT sugar*) OR (Soda NEXT pop*) OR popsicle* OR soda:ti OR dessert*:ti,ab OR pastries:ti,ab OR (ice NEAR/1 cream*) OR cookies:ti,ab OR cake*:ti OR pie:ti OR pies:ti OR gelatin*:ti OR jello:ti OR "fruit punch":ti,ab OR fruitade*:ti,ab OR sugar*:ti OR sweets:ti OR (sugar-sweetene*:ti,kw,ab) OR caramel:ti,ab OR (malt* NEAR/1 barley) OR 'syrup':ti,ab,kw OR (dietary NEXT sugar*):ti,ab OR sugary:ti,ab OR sugar*:ti OR (sugar NEAR/3 sweet*):ti,ab OR (sugar NEAR/3 coat*):ti,ab OR (dietary NEXT/1 sugar*):ti,ab OR confectioner*:ti,ab OR (fizzy NEXT/1 drink*):ti,ab OR chewing gum*:ti,ab

Navigator:

((Added NEXT Sugar*) OR (brown NEAR/1 sugar*) OR (white NEAR/1 sugar*) OR (raw NEAR/1 sugar*) OR title:syrup* OR title:dextrose OR title:fructose OR (fruit NEAR/1 juice NEAR/1 concentrate*) OR title:glucose OR title:honey OR title:jam OR (invert NEAR/1 sugar*) OR (malt NEAR/1 sugar*) OR title:maltose OR title:maltodextrin OR title:molasses OR (turbinado NEAR/1 sugar*) OR (cane NEAR/1 sugar*) OR (cane NEAR/1 juice*) OR "sugar cane" OR (sugar NEAR/1 beet*) OR title:trehalose OR title:sucrose OR title:sweetene* OR (table NEAR/1 sugar*) OR title:Monosaccharide* OR title:disaccharide* OR "Dietary Sucrose" OR (sugar NEAR/1 based*) OR sugar-based* OR HFCS OR title:candy OR title:candie* OR (Carbonated NEAR beverage*) OR (Carbonated NEAR drink*) OR (Soft NEAR/1 drink*) OR (Liquid NEAR/1 sugar*) OR (Soda NEAR/1 pop*) OR popsicle* OR title:soda OR title:dessert* OR title:pastries OR (ice NEAR/1 cream*) OR title:cookies OR title:cake* OR title:pie OR pies:ti OR title:gelatin* OR title:jello OR "fruit punch" OR title:fruitade* OR title:sweets OR (sugar-sweetene*) OR title:caramel OR (malt* NEAR/1 barley) OR (dietary NEAR/1 sugar*) OR title:sugar* OR (sugar NEAR/3 sweet*) OR (sugar NEAR/3 coat*) OR (dietary NEAR/1/1 sugar*) OR title:confectioner* OR (fizzy NEAR/1 drink*) OR chewing NEAR/1 gum*)

Inclusion CriteriaDate Range:

- Published between December 2011 and August 2014 (in English in a peer-reviewed journal)

Study Design:

- Systematic review and/or meta-analysis that included randomized controlled trials and/or prospective cohort studies

Study Subjects:

- Reviews that included studies from high or very high human development (2012 Human Development Index)
- Healthy or at elevated chronic disease risk

Intervention/Exposure:

- Added sugars, including sugar-sweetened beverages
- Added sugars are sugars that are either added during the processing of foods, or are packaged as such, and include sugars (free, mono- and disaccharides), syrups, naturally occurring sugars that are isolated from a whole food and concentrated so that sugar is the primary component (e.g., fruit juice concentrates), and other caloric sweeteners.

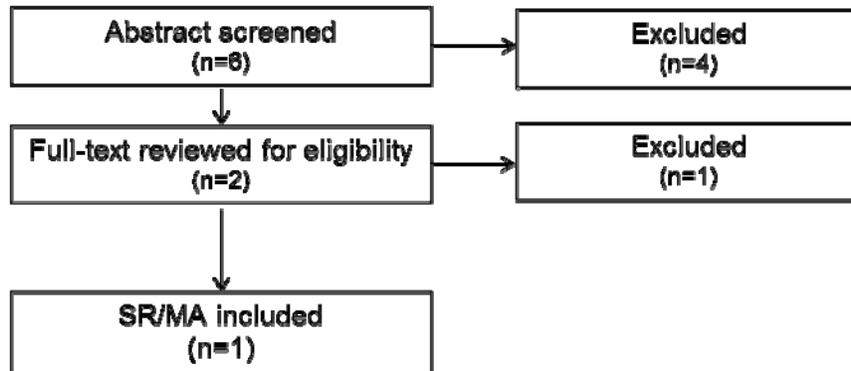
Outcome:

- Dental caries

Quality:

- Reviews rated 8-11 on AMSTAR (A measurement tool for the ‘assessment of multiple systematic reviews’)

Search Results



Excluded Articles with Reason for Exclusion

3. Chi DL. Reducing Alaska Native paediatric oral health disparities: a systematic review of oral health interventions and a case study on multilevel strategies to reduce sugar-sweetened beverage intake. International journal of circumpolar health. 2013;72:21066. PMID: 24377091. <http://www.ncbi.nlm.nih.gov/pubmed/24377091>. EXCLUDE: Did not examine relationship between added sugars and dental caries
4. Delpier T, Giordana S, Wedin BM. Decreasing sugar-sweetened beverage consumption in the rural adolescent population. Journal of pediatric health care: official publication of National Association of Pediatric Nurse Associates & Practitioners. 2013;27(6):470-8. PMID: 22932228. <http://www.ncbi.nlm.nih.gov/pubmed/22932228>. EXCLUDE: Original research article; did not examine relationship between added sugars and dental caries
5. Harris R, Gamboa A, Dailey Y, Ashcroft A. One-to-one dietary interventions undertaken in a dental setting to change dietary behaviour. The Cochrane database of systematic reviews. 2012;3:CD006540. PMID: 22419315. <http://www.ncbi.nlm.nih.gov/pubmed/22419315>.

EXCLUDE: Examined interventions in dental care setting, not relationship between added sugars and dental caries

6. Keukenmeester RS, Slot DE, Putt MS, Van der Weijden GA. The effect of sugar-free chewing gum on plaque and clinical parameters of gingival inflammation: a systematic review. *International journal of dental hygiene*. 2013;11(1):2-14. PMID: 22747775. <http://www.ncbi.nlm.nih.gov/pubmed/22747775>. EXCLUDE: Focused on sugar-free chewing gum, not added sugars
7. Ruxton CH, Gardner EJ, McNulty HM. Is sugar consumption detrimental to health? A review of the evidence 1995-2006. *Critical reviews in food science and nutrition*. 2010;50(1):1-19. PMID: 20047137. <http://www.ncbi.nlm.nih.gov/pubmed/20047137>. EXCLUDE: Working group focused on WHO review due to limited nature of the review