REVIEW

Review of 100% Fruit Juice and Chronic Health Conditions: Implications for Sugar-Sweetened Beverage Policy

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ABSTRACT

Whether or not drinking 100% fruit juice causes poor health is controversial. Although 100% fruit juice may contain as much sugar as regular soda, it provides needed nutrients to Americans' diets. We systematically reviewed the current evidence of the association of 100% fruit juice consumption and chronic health conditions in children and adults. We focused on data from systematic reviews and meta-analyses about cardiometabolic health outcomes, liver disease, and caries. Aside from increased risk of tooth decay in children and small amounts of weight gain in young children and adults, there is no conclusive evidence that consumption of 100% fruit juice has adverse health effects. Guidelines from groups like the American Academy of Pediatrics and Dietary Guidelines for Americans recommending that 100% fruit juice may be consumed in moderation are consistent with the available evidence and should be used to inform food policies. *Adv Nutr* 2018;9:78–85.

Keywords: 100% fruit juice, sugar-sweetened beverages, chronic diseases, systematic review, meta-analysis, nutritional epidemiology, policy

Introduction

The United States is in the midst of an epidemic of obesity, diabetes, and cardiovascular disease (1, 2), and reducing sugar-sweetened beverage (SSB) consumption may offer a population-level approach to addressing this epidemic (3). In meta-analyses comparing the highest with the lowest consumers of SSBs, high SSB consumers had a 12% increased risk of hypertension (4), 26% increased risk of type 2 diabetes (5), and 19% increased risk of cardiovascular disease (6). Consumers perceive 100% fruit juice as a healthier alternative to SSBs (7), but it is high in naturally occurring sugars and some studies have suggested that it has negative health effects similar to SSBs (8, 9). Few studies, to our knowledge, directly compare SSBs and 100% fruit juice, and experts disagree about where 100% fruit juice falls in the health spectrum of beverage options between water and SSBs.

Supported by the Ruth L Kirschstein National Research Service of the National Institutes of Health through the University of Washington grant T32HP10002 (to BJA).
Author disclosures: BJA, SD, PV-B, MK, and JK, no conflicts of interest.
Supplemental Table 1, Supplemental Appendix 1, and Supplemental Figures 1–7 are available from the "Supplementary data" link in the online posting of the article, and from the same link in the online table of contents at https://academic.oup.com/advances/.
Address correspondence to BJA (e-mail: brandon.auerbach@post.harvard.edu).
Abbreviations used: AAP, American Academy of Pediatrics; DGA, Dietary Guidelines for Americans; IRR, incidence rate ratio; RCT, randomized controlled trial; SSB, sugar-sweetened beverage.

The argument in favor of 100% fruit juice as a healthy beverage centers on the fact that Americans of all ages do not meet their daily fruit requirement, and 100% fruit juice offers most of the nutrients of whole fruit in a cheaper, more portable form (10). One-hundred percent fruit juice represents one-third of fruit intake among children aged 2–18 y, and contains nutrients that are of public health concern, such as calcium and vitamin D (in fortified juices) and potassium (11, 12) (**Supplemental Table 1**). US adults drink little 100% fruit juice, on average < 90 mL/d (13).

The argument against 100% fruit juice as a healthy beverage centers on the large amount of naturally occurring sugar it contains. Ounce for ounce, some 100% fruit juices have more sugar then regular soda (14). While 100% fruit juices contain most of the nutrients of whole fruit, they contain little or no fiber (15), which causes them to have moderately high glycemic indexes (16). Randomized controlled trials (RCTs) suggest that the body registers liquid sugar and solid sugar calories differently, and that liquid sugar calories lead to greater ad libitum energy intake than do solid sugar calories (17, 18). One-hundred percent fruit juice is a minor contributor (≤7%) of nutrients of public health concern to US children's diets (12), and contributes negligible amounts of nutrients of public health concern to the diets of most US adults. The Guidelines of the American Academy of Pediatrics

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(AAP) and the 2015–2020 Dietary Guidelines for Americans (DGA) recommend that 100% fruit juice in moderation may be part of a healthy diet for children aged >1 y and adults (12, 19).

To inform this debate, we reviewed the highest level of scientific evidence—from systematic reviews and meta-analyses—on the association of 100% fruit juice consumption in children and adults and the health outcomes of caries or tooth decay, glucose homeostasis, dyslipidemia, hypertension, liver disease, weight gain, diabetes, and cardiovascular disease. The evidence of possible links between 100% fruit juice and cancer risk, cognition, inflammation, oxidation, platelet function, and vascular reactivity was reviewed recently, so it was not included in this review (20). We concluded with recommendations for future research and for incorporating 100% fruit juice into SSB policies.

Methods

We searched PubMed and the Cochrane Central Register of Controlled Trials for peer-reviewed systematic review or meta-analysis articles available in English from each database's inception up to 6 February 2017. Our search methods were prespecified and documented in a protocol (PROSPERO registration number CRD42017056788) (21). The searches used combinations of keywords, including "juice", "beverages", "fruit", "caries", "diabetes", "glucose control", "dyslipidemia", "hypertension", "liver disease", "weight", and "cardiovascular disease". The inclusion and exclusion criteria are listed in **Supplemental Appendix 1**. One author (BA) reviewed titles and abstracts ($n = 1751$) and excluded obviously irrelevant manuscripts, then reviewed each potentially eligible study selected for further full-text review ($n = 33$). Ten studies were included. The software program Covidence (Melbourne, Victoria, Australia) was used to track searches and included and excluded articles.

It was necessary to reanalyze the data presented in 2 of the included meta-analyses (22, 23). These meta-analyses had compared 100% fruit juice consumption with a variety of beverage types, including water, isocaloric SSBs, and 100% fruit juice with low concentrations of polyphenols. The 2 studies combined all control beverages into a single category. To distinguish between the control beverages, we performed a fixed-effects meta-analysis (24) with new subgroups of *1*) isocaloric non-juice control beverages and *2*) water. Stata version 14 (Stata Corp, College Station, TX) was used to conduct the meta-analysis.

For the included disease outcomes where no systematic reviews or meta-analyses exist, individual studies identified through the same search strategy as above are briefly reviewed. The US Department of Agriculture Nutrition Evidence Library grading guidelines were used to grade the evidence for each outcome (25). Disagreements about study inclusion or grading were resolved by a consensus of 2 authors (BA, JK).

Evidence from Systematic Reviews and Meta-analyses on the Health Effects of 100% Fruit Juice

Changes in Glucose Homeostasis, Lipid Concentrations, and Blood Pressure

Two meta-analyses analyzed 19 short-term randomized trials and found no effect of consuming 100% fruit juice on fasting glucose, insulin, total cholesterol, HDL cholesterol, LDL cholesterol, or blood pressure level in adults (Table 1) (22, 23). In both meta-analyses, the authors calculated weighted mean differences between subjects who consumed ≥1 serving 100% fruit juice/d and subjects who consumed ≥1 serving/d of a range of other beverages, including isocaloric nonjuice control beverages (e.g., SSBs) and water. The randomized trials included in the meta-analyses had a range of 12–63 subjects, and their durations ranged from 1 to 3 mo. There was no significant difference between the effects of consumption of 100% fruit juice and the consumption of *1*) isocaloric non-juice control beverages or *2*) water on any of the 7 outcomes [changes in fasting glucose, insulin, total cholesterol, HDL cholesterol, and LDL cholesterol concentrations, as well as changes in systolic and diastolic blood pressure] (**Supplemental Figures 1–7**). Although the baseline health status of trial participants varied, heterogeneity was low for all comparisons ($I^2 < 50\%$), which strengthens these findings. Using oral glucose tolerance testing, which has a higher sensitivity for diagnosing impaired glucose tolerance, would strengthen future trials of the effect of 100% fruit juice on glucose homeostasis (26). Taken together, these meta-analyses suggest that 100% fruit juice has the same impact as water and SSBs on glucose homeostasis, blood lipid concentrations, and blood pressure.

Tooth Decay

In one meta-analysis published on the topic of 100% fruit juice and tooth decay, consumption of 100% fruit juice was associated with increased odds of tooth decay in children (Table 2) (27). Salas et al. (27) analyzed 7 studies examining the association between 100% fruit juice and tooth decay in children and adolescents aged 8–19 y. A total of 1919 children in 5 cross-sectional studies and 2 longitudinal studies were analyzed. The pooled OR of tooth decay in children who consumed ≥1 serving 100% fruit juice/d (≥240 mL/d) compared with children who consumed ≤1 serving/wk was 1.20 (95% CI: 1.02, 1.42). This meta-analysis was limited in that most of the included studies were cross-sectional and hence were vulnerable to confounding and reverse-causation (28). Studies from dissimilar countries were also included, which contributed to the high between-study heterogeneity ($I^2 = 75\%$). Nonetheless, Salas et al.'s (27) study is the only evidence synthesis study published on this topic, and it suggests that 100% fruit juice consumption is positively associated with tooth decay in children.

Change in Liver Enzymes

No systematic reviews or meta-analyses have been published on the effect of 100% fruit juice on liver function or liver

TABLE 1 Summary of effects of 100% fruit juice and health from meta-analyses conducted by the authors[1]

Outcome	Study	Population	Study type	Endpoint[2]	Subjects,[3] *n*	Comparison: ≥1 serving 100% fruit juice/d vs. ≥1 serving water or control bev/d	Outcome: difference in endpoint between 100% fruit juice group and control group (95% CI)	Conclusion	Evidence grade[4]
Change in glucose homeostasis	Wang et al. (22)	Adults	Meta-analysis: 12 RCTs	Fasting glucose	302	Isocaloric non-juice control bev	0.34 (–2.26, 2.94)	No effect in adults	Limited
					98	Water	2.74 (–2.50, 7.99)		
				Fasting insulin	151	Isocaloric non-juice control bev	–0.74 (–2.66, 1.17)		
					23	Water	–0.70 (–11.00, 9.60)		
Change in lipids	Liu et al. (23)	Adults	Meta-analysis: 19 RCTs	Total cholesterol	396	Isocaloric non-juice control bev	–1.51 (–7.95, 4.94)	No effect in adults	Limited
					240	Water	–7.54 (–15.78, 0.70)		
				HDL cholesterol	396	Isocaloric non-juice control bev	–0.30 (–2.21, 1.62)		
					178	Water	1.20 (–0.61, 3.01)		
				LDL cholesterol	396	Isocaloric non-juice control bev	–2.14 (–6.26, 1.98)		
					178	Water	–0.18 (–9.39, 9.03)		
Change in blood pressure	Liu et al. (23)	Adults	Meta-analysis: 8 RCTs	Systolic BP	157	Isocaloric non-juice control bev	–2.27 (–5.26, 0.73)	No effect in adults	Limited
					98	Water	–2.59 (–7.49, 2.31)		
				Diastolic BP	157	Isocaloric non-juice control bev	–0.43 (–2.71, 1.84)		
					98	Water	–1.80 (–4.95, 1.35)		

[1] One serving of 100% fruit juice is defined as 240 mL. For the meta-analyses performed by Wang et al. (22) and Liu et al. (23), it was necessary to perform new subgroup analyses based on the control beverage, the results of which are presented in this table. We categorized control beverages as isocaloric non-juice control beverages or water. Meta-analyses compared subjects who consumed ≥1 serving 100% fruit juice/d with ≥1 serving/d of either *1*) an isocaloric non-juice control beverage or *2*) water. Positive differences indicate an increase in the endpoint in the 100% fruit juice group compared with the control group; negative differences indicate a decrease in the endpoint. bev, beverage; BP, blood pressure; RCT, randomized controlled trial.

[2] Units for each endpoint were: fasting glucose, total cholesterol, HDL cholesterol, and LDL cholesterol: mg/dL; fasting insulin: μIU/mL; systolic and diastolic BP: mm Hg.

[3] The number of subjects refers to the total number of subjects in the comparison of both juice and the respective control beverage.

[4] The evidence grade is based on the USDA's Nutrition Evidence Library grading guidelines (25). Because some participants included in the RCTs were healthy whereas others had diseases that would impact the endpoints, such as diabetes, hypertension, coronary heart disease, and end-stage renal disease, the evidence grades were downgraded from moderate to limited.

TABLE 2 Summary of associations of 100% fruit juice and health from existing studies[1]

Outcome	Study	Population	Study type	Subjects, *n*	Comparison	Outcome (95% CI)	Conclusion	Evidence grade[2]
Tooth decay	Salas et al. (27)	Children	Meta-analysis: 2 PC, 5 X-Sect	1919	≥1 serving/d vs. ≤1 serving/wk	OR for tooth decay: 1.20 (1.02, 1.42)	Moderate adverse association in children	Limited
Liver enzyme change	Ravn-Haren et al. (29)	Adults	Single RCT	23	100% apple juice (500 mL/d) vs. whole apples (550 g/d)	No difference in change in ALT over 4 wk ($P > 0.05$)	No effect in adults	Not assignable
Weight gain	Hebden et al. (30)	Adults	Systematic review: 3 PC	108,708	Each additional serving/d	Pooled weight gain of 0.22 kg over 4 y (0.15 kg, 0.28 kg)	Small adverse association in adults; no clinically significant association in children	Moderate
	O'Neil and Nicklas (32)	Children	Systematic review: 11 PC, 1 RC	20,639	Consumption vs. no consumption	No association in 9 of 12 studies		
	Crowe-White et al. (33)	Children	Meta-analysis: 1 RC, 10 X-Sect	61,743	Highest vs. lowest consumers	RR for adiposity: 0.99 (0.95, 1.03)		
	Auerbach et al. (34)	Children	Meta-analysis: 8 PC	34,470	Each additional serving/d	BMI *z* score change of 0.09 U over 1 y (0.03, 0.17 U) in children 1–6 y and no change in children 7–18 y		
Diabetes	Xi et al. (37)	Adults	Meta-analysis: 3 PC	137,663	Highest vs. lowest consumers	RR for incident type 2 DM: 1.03 (0.91, 1.18)	Possible small adverse association in adults	Moderate
	Imamura et al. (38)	Adults	Meta-analysis: 14 PC	440,937	Each additional serving/d	RR for incident type 2 DM: 1.07 (1.01, 1.14), however significant risk of bias		
Cardiovascular disease	Joshipura et al. (39)	Adults	2 PC	114,279	Each additional serving/d of 100% citrus juice	Pooled RR for isch stroke 0.75 (0.61, 0.93)	Inconsistent results; possible protective association between citrus juice and isch stroke	Limited
	Hung et al. (40)			109,635		Pooled RR for incident cardiovascular disease: 0.97 (0.91, 1.014)		
	Hansen et al. (41)	Adults	Single PC	54,383	Highest vs. lowest consumers (quartiles)	RR for incident ACS: 1.03 (0.85, 1.24)		

[1] One serving of 100% fruit juice is defined as 240 mL. ACS, acute coronary syndrome; ALT, alanine aminotransferase; DM, diabetes mellitus; isch, ischemic; PC, prospective cohort; RC, retrospective cohort; RCT, randomized controlled trial; X-Sect, cross-sectional.

[2] The evidence grade is based on the USDA's Nutrition Evidence Library grading guidelines (25).

disease (Table 2). The single RCT on this topic analyzed 23 healthy adults in Denmark and compared the effect of consumption of 4 fresh apple products for 4 wk with a control diet in which participants consumed ≥2 servings whole fruit/d (1 serving defined as 1 medium apple or 240 mL of raw fruit) (29). The authors compared supplementation with whole apples (550 g/d), apple pomace (22 g/d), clear apple juice without fiber (500 mL/d), and cloudy apple juice with fiber (500 mL/d) with no supplement. Subjects followed the same diet that restricted other fruits or fruit juices. There was no significant difference in change in alanine aminotransferase between the 4 intervention groups and the control group ($P > 0.05$ for all interventions compared with the control diet). The evidence on 100% fruit juice consumption in relation to liver enzymes is very limited, but does not suggest any effect.

Weight Gain

Two systematic reviews and 2 meta-analyses examined the relation between 100% fruit juice and body weight and found that drinking 1 serving 100% fruit juice/d (240 mL/d) is associated with a small amount of weight gain in young children and adults that is likely not clinically significant (Table 2). A systematic review by Hebden et al. (30) considered the association between 100% fruit juice and weight change in adults and concluded, on the basis of a single observational study, that 100% fruit juice consumption was associated with long-term weight gain. This conclusion was based on an analysis by Pan et al. (31) of 108,708 participants in the Nurses' Health Study, Nurses' Health Study II, and Health Professionals Follow-up Study, which found an average 4-y weight gain of 0.22 kg (95% CI: 0.15, 0.28 kg) for each 240-mL serving 100% fruit juice/d consumed. An analysis of the same 3 cohorts by Mozaffarian et al. (9) showed similar results, and was excluded by Hebden and colleagues because it reported on the same cohort. Both analyses were not adjusted for total energy intake, as partially uncompensated extra calories in 100% fruit juice at least partly mediate any potential effect on weight gain.

One systematic review (32) and 2 meta-analyses (33, 34) have been published on 100% fruit juice consumption and weight status in children. The 2008 systematic review by O'Neil and Nicklas (32) identified 12 studies examining 100% fruit juice and weight status. Because only 3 of the 12 studies showed a significant association with weight gain, the authors concluded that "no systematic association" exists between 100% fruit juice consumption and weight in children.

A 2015 meta-analysis by Crowe-White et al. (33) used the pooled OR of increased weight or adiposity as its endpoint. Crowe-White and colleagues found a pooled OR of 0.99 (95% CI: 0.95, 1.03), and concluded that there is no association between 100% fruit juice consumption and adiposity in children. As a potential limitation, 10 of 11 studies included in this meta-analysis were cross-sectional.

A 2017 meta-analysis (34) pooled 8 prospective cohort studies, including 2 large prospective studies not included in the meta-analysis by Crowe-White et al. (33), and found no clinically significant association between each 1-serving increment/d (240 mL/d) of 100% fruit juice and change in BMI *z* score in children. In subgroup analyses, younger children (aged 1–6 y) had a statistically significant BMI *z* score increase of 0.09 U (95% CI: 0.01, 0.17 U) for each additional 1 serving 100% fruit juice/d, but this small BMI *z* score increase was below the level of BMI *z* score change in children that is associated with changes in cardiometabolic risk (0.25–0.50 U) (35).

Considered as a percentage of total body weight, the changes in weight observed in prospective cohort studies of young children (aged 1–6 y) and adults are small and are unlikely to be clinically significant in normal-weight individuals (35, 36). In these age groups, each 1-serving increment/d of 100% fruit juice consumption is associated with a <1% increase in total body weight over 1 y. Consuming 100% fruit juice was not associated with weight gain in older children, aged 7–18 y. In summary, although there is evidence that 100% fruit juice consumption is associated with weight gain in young children and adults, the small amount of weight gain is unlikely to be clinically significant.

Diabetes

Two meta-analyses do not suggest a strong link between 100% fruit juice consumption and type 2 diabetes risk in adults (Table 2) (37, 38). The first, by Xi et al. (37), compared the highest and lowest quantiles of 100% fruit juice consumption in 3 prospective cohorts studies ($n = 137,663$ individuals). They found a pooled RR of 1.03 (95% CI: 0.91, 1.18). In their meta-analysis published 2 y later, Imamura et al. (38) analyzed the RR of incident diabetes per additional 1 serving 100% fruit juice/d consumed in 14 prospective cohort studies ($n = 440,937$ individuals). In multivariable analyses, the pooled RR of incident diabetes was 1.07 (95% CI: 1.01, 1.14). Imamura et al. performed multiple sensitivity analyses, and found that for the outcome of objectively measured incident diabetes ($n = 11$ studies), the pooled RR was 0.98 (95% CI: 0.86, 1.11). Because the pooled RR of 100% fruit juice consumption and incident diabetes was sensitive to study design, the authors concluded that there is no strong evidence of an association between diabetes and incident diabetes in adults. Considered together, these 2 meta-analyses do not suggest a strong association between 100% fruit juice and diabetes risk.

Cardiovascular Disease

The evidence of whether 100% fruit juice consumption is associated with cardiovascular disease in adults is limited and inconsistent (Table 2). Three prospective cohort studies and no systematic reviews or meta-analyses have been published on this topic (39–41). One study found a protective association (39), and 2 studies found a null association between 100% fruit juice and incident cardiovascular disease (40, 41). Joshipura et al. (39) combined data from the Nurses' Health Study ($n = 75,596$ women; 14 y of follow-up) and Health Professionals Follow-up Study ($n = 38,683$ men; 8 y of follow-up) and analyzed the association of a 1-serving increment/d (240 mL/d) of 100% citrus juice and incident ischemic stroke.

This study found a multivariable adjusted RR of 0.75 (95% CI: 0.61–0.93) for incident ischemic stroke.

In a second study using the same cohorts, the same exposure, similar covariates, and the same follow-up duration, Hung and colleagues (40) found a pooled RR of 0.97 (95% CI: 0.91, 1.04) for incident cardiovascular disease per each additional 240-mL serving/d of 100% citrus juice consumption.

Hansen et al. (41) analyzed 54,383 women and men (mean follow-up 8 y) in the Danish Diet, Cancer, and Health cohort study for the association of 100% fruit juice and acute coronary syndrome. In multivariable adjusted analyses, 100% fruit juice intake was not associated with incident acute coronary syndrome, either in a model comparing highest to lowest quartiles of 100% fruit juice consumption [incidence rate ratio (IRR) in men: 1.03; 95% CI: 0.85, 1.24] or in a linear model comparing 25 g/d increments in 100% fruit juice (IRR in men: 1.01; 95% CI: 0.98, 1.04). The IRRs in women were similar.

Given that no association exists between 100% fruit juice and most risk factors for cardiovascular disease (changes in glucose homeostasis, lipid concentrations, or blood pressure), the limited current evidence does not suggest that 100% fruit juice consumption changes cardiovascular disease risk.

Limitations of Published Systematic Reviews and Meta-Analyses

Systematic reviews and meta-analyses on the health effects of 100% fruit juice share similar limitations. Aside from intermediate endpoints (changes in blood pressure, fasting lipids, and fasting glucose and insulin concentrations), RCT data do not exist on this topic. Most studies included in the systematic reviews and meta-analyses relied on self-reported dietary intake, which is susceptible to exposure misclassification (42). Because self-reported dietary intake tends to underestimate intake, associations may be biased towards the null. The included meta-analyses pooled individual studies that defined 1 serving 100% fruit juice differently, which could also lead to exposure misclassification. Other included meta-analyses compared the highest and the lowest groups of 100% fruit juice consumers, but as the difference in intake between the 2 groups was not large (the average daily consumption of 100% fruit juice by US adults is <90 mL/d), this reduced power to detect differences in health outcomes between the 2 groups. Most studies included in this review did not normalize 100% fruit juice intake to daily energy intake, which could also cause exposure misclassification and bias results towards the null. Only 2 included studies directly compared 100% fruit juice and SSBs (22, 23). Finally, different classes of 100% fruit juices (e.g., citrus compared with non-citrus juices) were not compared in any of the included systematic reviews or meta-analyses.

One strength of this analysis is that we carefully differentiated 100% fruit juice from non-100% fruit drinks. Although none of the included systematic reviews and meta-analyses cited the US FDA regulatory definition of 100% fruit juice (21 Code of Federal Regulations Section 101.30), all of the included studies presented 100% fruit juice as a stand-alone exposure category. If 100% fruit juice consumption were mixed in with non-100% fruit juice consumption, this would be expected to bias associations away from the null.

TABLE 3 Current recommended daily amounts of 100% fruit juice

Organization	Population	Policy statement
American Academy of Pediatrics (19)	Children	Infants: none Aged 1–3 y: ≤120 mL/d Aged 4–6 y: ≤180 mL/d Aged 7–18 y: ≤240 mL/d
US Dietary Guidelines for Americans 2015–2020 (12)	Adults	≤240 mL/d
Robert Wood Johnson Foundation Healthy Eating Research program, 2013 (43)	Children	Aged <2 y: none Aged 2–4 y: ≤120 mL/d Aged 5–10 y: ≤180 mL/d Aged 11–18 y: ≤240 mL/d
	Adults	≤240 mL/d

Current Policy Recommendations

The AAP (19), DGA (12), and Robert Wood Johnson Foundation Healthy Eating Research program (43) have published policy statements on how much daily 100% fruit juice is recommended for children and adults (**Table 3**). All 3 guidelines emphasize that consuming water and whole fruit is preferred to 100% fruit juice, since 100% fruit juice contains less dietary fiber than whole fruit, and when consumed in excess 100% fruit juice may contribute extra dietary calories. These guidelines have small differences in the amounts of 100% fruit juice that are recommended for children by age, and all recommend that 100% fruit juice intake should be limited to one 240-mL serving/d.

Conclusions

Evidence from systematic reviews and meta-analyses of the health effects of 100% fruit juice shows a mixed picture, but most studies show no associations with chronic health conditions. Consumption of 100% fruit juice is associated with an increased risk of caries in children, small increases in long-term weight gain in young children and adults that are likely not clinically significant in normal weight individuals, and a decreased risk of ischemic stroke in a single individual study. Although only 2 meta-analyses included in this review directly compared 100% fruit juice to SSBs (23, 24), the current body of evidence suggests that there are substantially lower health risks from 100% fruit juice consumption compared with SSBs.

Experimental studies with objective exposure measures are needed to better understand the health effects of 100% fruit juice. Randomized controlled trials or prospective cohort studies with outcomes of weight change (e.g., change in BMI *z* score) or changes in cardiometabolic intermediate endpoints are a priority in children aged 1–3 y, who showed a propensity for weight gain with 100% fruit juice consumption in 2 large prospective cohort studies (8, 44).

Although little evidence exists that 100% fruit juice is associated with major chronic diseases, the existing body of evidence is too limited to robustly support any expert opinion recommending changing the current guidelines on 100% fruit juice consumption. More RCTs are needed to confirm the health effects of consuming 100% fruit juice, and cohort analyses should report both energy-adjusted and energy-unadjusted associations. Until further research is available, current guidelines on 100% fruit juice by the AAP and DGA are prudent and should be followed. Because daily consumption of small amounts of 100% fruit juice may be part of a healthy diet, when governments consider taxing sugary beverages, we recommend that 100% fruit juice not be taxed. In "traffic light" food labeling systems, yellow (have "once-in-a-while") is the most appropriate label for 100% fruit juice.

Acknowledgments

We thank Dan Taber for his critical review and editing of this manuscript. All authors have read and approved the final manuscript.

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