

Recommendations for Upper Limits of Sugar Consumption: Findings from Recent Randomized Controlled Trials

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Abstract

Objectives: Agencies such as the American Heart Association (AHA), the World Health Organization (WHO) and draft guidance from the Scientific Advisory Committee on Nutrition (SACN) from England recommend an upper limit of sugar consumption of 10% of calories. The Dietary Guidelines for Americans 2010 (DGA 2010) and Institute of Medicine carbohydrate report (IOM) recommend less than 25% of added calories from sugar. There is a paucity of data from RCTs to demonstrate a dose-response effect upon which such recommendations should be made.

Methods: We conducted a series of blinded RCTs including a 10 week outpatient study (n= 355), a metabolic unit study (n=123), and a metabolic unit plus MRS/MRI study (n=68) to evaluate three different levels of added sugars from either high fructose corn syrup (HFCS) or sucrose --8% (roughly AHA, WHO and SACN), 18% (average US consumption), and 30% (roughly DGA 2010, IOM recommendations).

Results: There were no differences among the three different sugar levels pre to post intervention for cholesterol, triglycerides, HDL, LDL, glucose, insulin, insulin resistance, skeletal muscle fat, blood pressure, liver fat, or energy regulating hormones (insulin, leptin and ghrelin). (Interaction p > 0.05 for all parameters). The combined group of 355 participants gained 2.5 ± 5.1 lbs (p<0.001). The increase in the 30% group (3.7 ± 5.0 lbs) was greater than the increase in the 8% (2.1 ± 5.0 lbs) and 18% (1.9 ± 5.3 lbs) groups (p<0.01). There were no differences between HFCS and sucrose in any parameter (Interaction p>0.05).

Conclusions: These data suggest that over the short term (10 weeks), there are no significant differences when comparing recommended upper limits of sugar intake recommended by AHA, WHO, SACN, DGA 2010 and IOM. Thus, the scientific basis for recommendations for upper limit of sugar consumption is not settled yet.

Background

- Numerous agencies have stated general recommendations on the upper limit of sugar consumption
- 10% Calories - American Heart Association (AHA), the World Health Organization (WHO) and draft guidance from the Scientific Advisory Committee on Nutrition (SACN) of the United Kingdom
- 25% of calories from added sugar - Dietary Guidelines for Americans 2010 (DGA 2010) and Institute of Medicine carbohydrate report (IOM)
- The scientific basis for making such recommendations is questionable and may explain the difference in recommendations among the various agencies.

Methods

- We conducted a series of blinded RCTs in which participants consumed sugar sweetened milk as part of the usual diet in the following amounts:
 - 8% of the calories required for weight maintenance (roughly AHA, WHO and SACN)
 - 18% of the calories required for weight maintenance (average US consumption)
 - 30% of the calories required for weight maintenance (roughly DGA 2010, IOM recommendations)
- The entire study included 355 weight stable, apparently healthy individuals who completed the intervention and all outpatient, fasted stated testing. It also included
 - A metabolic unit study (n=123) to assess changes in elements of the neuroendocrine control of energy regulation in response to meals of different sugar content
 - An MRS/CT study (n=68) to measure to fat content of the thigh muscles and liver)
- Energy intake required for weight maintenance was estimated from the Mifflin St Joer prediction including an individualized activity factor based on responses to a physical activity questionnaire.
- Other than milk consumption participants followed no structured dietary program. They were counseled on how to account for the calories in the sweetened milk, but were told to continue to eat to the same level of fullness as prior to enrollment.

Results – Tables and Figures

Study 1 – Fasting Measures

		8%	18%	30%	All	Interaction
Weight (lbs)	Pre	171.8 ± 32.1	167.1 ± 30.3	168.2 ± 29.3	169.1 ± 30.6	0.018
	Post	173.9 ± 33.3***	169.0 ± 31.5***	172.0 ± 30.2***	171.6 ± 31.8***	
Cholesterol (mg/dl)	Pre	180.1 ± 37.8	187.1 ± 35.8	184.3 ± 39.5	183.8 ± 37.6	0.739
	Post	178.7 ± 37.8	188.0 ± 40.4	187.9 ± 44.4	184.7 ± 40.9	
Triglycerides (mg/dl)	Pre	105.2 ± 51.6	107.3 ± 63.3	105.1 ± 55.1	105.9 ± 56.8	0.136
	Post	118.5 ± 79.9	110.8 ± 59.7	123.4 ± 79.5	117.2 ± 73.3***	
HDL (mg/dl)	Pre	52.0 ± 14.4	52.5 ± 15.0	52.4 ± 12.7	52.3 ± 14.1	0.292
	Post	51.0 ± 13.1	52.6 ± 14.5	51.0 ± 13.1	51.5 ± 13.6*	
LDL (mg/dl)	Pre	107.1 ± 33.4	113.0 ± 29.2	110.9 ± 33.6	110.3 ± 32.0	0.370
	Post	104.5 ± 30.8	113.7 ± 33.9	112.4 ± 37.4	110.0 ± 34.1	
Systolic Blood Pressure (mmHg)	Pre	109.1 ± 11.1	107.9 ± 10.3	111.4 ± 11.1	109.4 ± 10.9	0.937
	Post	107.9 ± 10.8	107.0 ± 10.2	11.4 ± 11.7	108.3 ± 10.9	
Diastolic Blood Pressure (mmHg)	Pre	71.7 ± 7.3	71.4 ± 8.3	73.6 ± 8.2	71.2 ± 8.0	0.943
	Post	70.8 ± 8.3	70.4 ± 7.7	72.4 ± 7.9	71.2 ± 8.0	
Glucose (mg/dl)	Pre	89.9 ± 6.2	89.0 ± 6.4	89.2 ± 6.8	89.4 ± 6.4	0.116
	Post	89.5 ± 9.8	89.7 ± 7.7	90.9 ± 7.5	90.0 ± 8.5	
Insulin (µU/ml)	Pre	8.4 ± 5.4	7.6 ± 5.7	7.5 ± 4.8	7.9 ± 5.4	0.139
	Post	11.3 ± 15.3	8.0 ± 6.4	11.1 ± 14.9	10.1 ± 12.8**	
HOMA	Pre	1.9 ± 1.3	1.7 ± 1.3	1.7 ± 1.2	1.8 ± 1.3	0.189
	Post	2.6 ± 4.3	1.8 ± 1.4	2.5 ± 3.6	2.3 ± 3.6**	

Different within Group p<0.05 *, p<0.01 **, p<0.001 ***
Change greater than for 8% and 18% p<0.05 †

Study 2 – Imaging Study

		8%	18%	30%	All	Interaction
Liver (%fat)	Pre	15.6 ± 13.5	14.2 ± 10.3	11.6 ± 7.9	13.9 ± 10.8	0.854
	Post	14.0 ± 13.1	14.0 ± 11.6	11.9 ± 8.0	13.3 ± 11.0	
Vastus Lateralis (% fat)	Pre	3.0 ± 0.9	3.1 ± 0.7	3.1 ± 0.8	3.0 ± 0.8	0.280
	Post	3.0 ± 0.9	3.3 ± 1.0	3.1 ± 0.6	3.2 ± 0.9	
Gluteus Maximus (%fat)	Pre	3.8 ± 1.2	4.0 ± 1.7	4.4 ± 1.4	4.1 ± 1.5	0.295
	Post	4.0 ± 1.3	4.3 ± 1.7	4.3 ± 1.1	4.2 ± 1.4	

Study 3 – Metabolic Unit



Time effect Pre vs post for whole day AUC, p>0.05
Interaction effect p>0.05

Discussion

- These data show no differences in a variety of measures related to obesity and cardiac and metabolic diseases when sugar is consumed across a range of intake levels.
- As the upper level of intake exceeded even the most conservative of recommendation from the various stated agencies, the scientific basis of these recommendations is questionable, and seemingly not yet settled.

