

Effect of fructose-containing sugars on Metabolic Disease Risk Factors

A series of systematic reviews & meta-analyses of controlled trials

Fact sheet reviewed by: Laura Chiavaroli, PhD (Post-Doctoral Fellow, Department of Nutritional Sciences, University of Toronto) and Dr. John Sievenpiper, MD, PhD, FRCPC (Associate Professor, Department of Nutrition Sciences, University of Toronto)

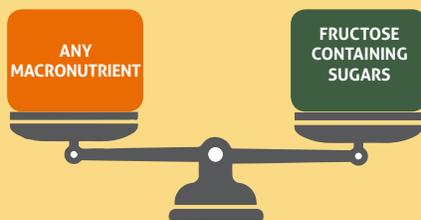
Key takeaways:

- Any adverse effect of fructose-containing sugars appears highly dependent on whether sugars are a source of excess energy.
- When fructose-containing sugars are consumed in energy-matched conditions there are no harmful effects on key risk factors of major chronic diseases.

Introduction

Dietary fructose and fructose-containing sugars are found both naturally in fruits and vegetables and are added to some packaged foods and beverages. Many health associations recommend limiting sugars consumption due to concerns that it may increase the risk of chronic diseases. To address these concerns, a series of systematic reviews and meta-analyses were conducted by researchers at the Clinical Nutrition and Risk Factor Modification Centre of St. Michael's Hospital in Canada to assess the totality of evidence from all available clinical studies in humans.

Studies were categorized as either substitution or addition studies in order to isolate the effect of fructose *per se* from studies where fructose was provided as a source of excess energy. This knowledge synthesis, representing a summary of the highest level of scientific evidence, strengthens the evidence-base for recommendations for the general public as well as those at risk of diabetes and cardiovascular disease, and may improve health outcomes through informing consumers and guiding future research.



Substitution Trials - Energy Matched

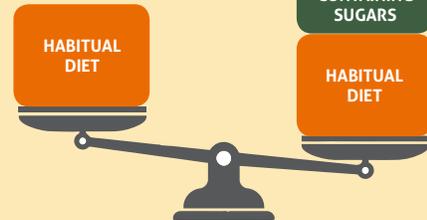
Energy from sugars is substituted for other sources of energy in the habitual diet. (**energy-matched** conditions where total energy intakes remain the same)

NO EFFECT on:

- Body weight¹
- Blood cholesterol (LDL-C, apolipoprotein B, non-HDL-C, HDL-C)²
- Triglycerides (fasting and postprandial)^{2,3}
- Fasting blood glucose⁴
- Insulin sensitivity (HOMA-IR) or fasting blood insulin⁴
- Systolic blood pressure⁵
- Uric acid⁶
- Markers of non-alcoholic fatty liver disease (liver fat, liver enzymes)⁷

DECREASE in:

- Glycated blood proteins, like HbA1c (improved blood glucose control)⁴
- Diastolic blood pressure, mean arterial pressure⁵



Addition Trials - Excess Energy

Energy from sugars is added to the diet (the effect of **excess energy** where the intervention is providing calories in addition to the habitual diet)

NO EFFECT on:

- Blood cholesterol (LDL-C, non-HDL-C, HDL-C)²
- Blood glucose control (glycated blood proteins, like HbA1c)⁴
- Fasting blood insulin⁴
- Mean arterial pressure⁵

INCREASE in:

- Body weight¹
- Fasting apolipoprotein B²
- Triglycerides (fasting, postprandial)^{2,3}
- Fasting blood glucose⁴
- Insulin sensitivity (HOMA-IR)⁴
- Uric acid⁶
- Markers of non-alcoholic fatty liver disease (liver fat, liver enzymes)⁷

Considerations

- Overall, there were over **50 trials** providing data on over **1,000 participants**, which included populations of various health status. No differences were found in effects between health status types. Follow-up duration of interventions ranged from **1-52 weeks**. Some analyses are limited by small sample sizes, short follow-up, and low-quality of included trials. Analyses on markers of blood glucose control were all conducted in individuals with Type 1 and Type 2 diabetes.
- **Substitution trials:** The majority of studies tested fructose-containing sugars at doses between **22-213 grams/day (equivalent to 5-53 tsp, 5-33% Energy)**.
- **Addition trials:** The majority of studies tested fructose-containing sugars as **excess energy** (predominantly using sugars-sweetened beverages as the source) at high doses, between **153-210 grams/day (equivalent to 38-55 tsp, 24-44% excess Energy)**, with some trials providing up to **300 grams/day (equivalent to 75 tsp, 55% excess Energy)**.

References and More Information

References:

1. Sievenpiper et al. Ann Intern Med 2012;156:291-304
2. Chiavaroli et al. JAMA 2015;4:e001700
3. Wang et al. Atherosclerosis 2014;232:125-133
4. Cozma et al. Diabetes Care 2012;35:1611-20
5. Ha et al. Hypertension 2012;59:787-95
6. Wang et al. J Nutr 2012;142:916-23
7. Chiu et al. Eur J Clin Nutr. 2014;68:416-423

For details of these studies and funding sources, see:
NIH U.S. National Library of Medicine ClinicalTrials.gov
Meta-analyses of Fructose and Cardiometabolic Risk
Study Identifier: [NCT01363791](https://clinicaltrials.gov/ct2/show/study/NCT01363791)

Infographic produced by the registered dietitians and nutrition researchers at the Canadian Sugar Institute.
FOR MORE INFORMATION, VISIT sugar.ca