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Effect of fructose on body weight in controlled feeding trials: a systematic review and meta-analysis

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CRD summary

This review concluded that fructose did not seem to increase body weight when substituted for other carbohydrates in diets that provided similar calories. Free fructose at high doses that provided excess calories moderately increased body weight; this effect may have been due to extra calories rather than fructose. The conclusions reflect the evidence presented and are likely to be reliable.

Authors' objectives

To assess the effects of fructose on body weight in humans.

Searching

MEDLINE, EMBASE, CINAHL and The Cochrane Library were searched up to November 2011. There were no language restrictions. Search terms were reported in a web appendix. Reference lists of included studies and relevant reviews were screened.

Study selection

Controlled feeding trials that evaluated the effect of free (unbound, monosaccharide) fructose compared with other sources of carbohydrate in diets supplemented with free fructose compared with the same diets alone on body weight in humans were eligible for inclusion. Trials needed at least seven days of diet duration. Eligible trials had to report body weight data. Trials were defined as isocaloric when fructose in the intervention group was compared with non-fructose carbohydrate that provided the same amount of energy in the control group and as hypercaloric when fructose in the intervention group was added to the usual or control diet in order for fructose to provide excess energy relative to the diet alone. Trials that evaluated high-fructose corn syrup (42% to 55% free fructose) were excluded except when used as a comparator. Trials that evaluated intravenous fructose were excluded.

The included studies involved participants who were diabetic (13 trials), overweight/obese (seven trials) and normal weight (21 trials). Most of the included trials (76%) were isocaloric trials. The controls in isocaloric trials were starch, sucrose, glucose, high-fructose corn syrup, dextromaltose and galactose. The control in all hypercaloric trials was diet alone. Median age of participants was 43.0 years in isocaloric trials and 24.7 years in hypercaloric trials. The median male-female ratio was 1.5:1 in isocaloric trials and 8:1 in hypercaloric trials. The median baseline body weight was 76.7kg in isocaloric trials and 72.6kg in hypercaloric trials. Included participants were generally healthy, but some normal-weight participants in isocaloric trials had comorbid conditions such as hypertriglyceridaemia and nondiabetic chronic kidney disease. Median follow-up was four weeks for isocaloric trials and 1.5 weeks for hypercaloric trials.

At least three reviewers assessed studies for inclusion.

Assessment of study quality

Study quality was assessed with the Heyland Methodological Quality Score of nine categories related to study design, sampling procedures and interventions (maximum possible score 13). Trials that scored 8 or more were judged to be of high quality.

It appeared that at least three reviewers performed quality assessment and any disagreements were resolved by consensus.

Data extraction

Data were extracted on mean body weight and standard deviation to enable calculation of mean differences and 95% confidence intervals (CIs). Any missing standard deviations were calculated from available statistics. Where these data were not reported, standard deviations were imputed using a pooled correlation coefficient derived from a meta-analysis of correlation coefficients from trials that reported sufficient data.

At least three reviewers independently performed data extraction. Disagreements were resolved by consensus.

Methods of synthesis

Weighted mean differences (WMDs) with 95% CIs were calculated using random-effects models. A separate analysis was performed for isocaloric and hypercaloric trials. Analyses were stratified by categories of diabetes, overweight/obese and normal weight. Sensitivity analyses were performed on four possible correlation coefficients (zero, 0.33, 0.66 and 0.99) to assess the effect of imputed correlation coefficients on analyses. Statistical heterogeneity was assessed using Cochran's Q and I^2. Potential sources of clinical and methodological heterogeneity were assessed with sensitivity analyses for different comparators and doses, fructose form (solid, liquid and mixed), follow-up (up to four weeks versus more than weeks), study quality (Heyland score less than 8 versus 8 or more), randomisation (yes versus no) and baseline body weight (up to 70kg versus more than 70kg). Meta-regression analyses were used to assess the significance of subgroup effects. Publication bias was assessed using funnel plots and Egger and Begg tests.

Results of the review

Forty-one trials were included in the review: 31 isocaloric trials (637 participants) and 10 hypercaloric trials (119 participants). Heyland scores ranged from 4 to 9 in the isocaloric trials and from 5 to 8 in the hypercaloric trials. Twelve isocaloric trials and four hypercaloric trials were judged as high quality.

There was no overall significant effect on body weight between the fructose and non-fructose carbohydrate groups in isocaloric trials. Significant weight loss was observed in the subgroup of overweight/obese participants (WMD -0.55kg, 95% CI -1.09 to -0.02; five trials). Significant heterogeneity was observed for both outcomes (p=0.02 and p=0.09).

Compare with diet alone, high dosages of fructose in hypercaloric trials (104 to 250g/day, 18% to 97% of total daily energy intake) were associated with a significant increase in body weight (WMD 0.53 kg, 95% CI 0.26 to 0.79; 10 trials). No significant heterogeneity was found in this outcome.

Subgroup and sensitivity analyses did not markedly alter the results. Meta-regression analyses did not show evidence of effect modification in most of the subgroup analyses. There was no evidence of publication bias.

Authors' conclusions

Fructose did not seem to increase body weight when it was substituted for other carbohydrates in diets that provided similar calories. Free fructose at high doses that provided excess calories

moderately increased body weight, an effect that may have been due to extra calories rather than fructose.

CRD commentary

The review question was clear and supported by appropriate inclusion criteria. Several relevant databases were searched. No attempts were made to find unpublished studies, which increased potential for publication bias. Risk of publication bias was formally assessed and little of evidence of it was found. No language restriction was applied to the search, which minimised the risk of language bias. Sufficient attempts were made to minimise reviewer errors and biases in the review process. Appropriate criteria were used to assess study quality. Statistical heterogeneity was assessed and appropriate methods were used to pool the results.

This review was generally well conducted. The authors' conclusions reflect the evidence presented and are likely to be reliable. The limited quality and short duration of most of the included studies should be borne in mind.

Implications of the review for practice and research

Practice: The authors did not state any implications for practice.

Research: The authors stated that further large high-quality and long-term (six months and more) feeding trials with fructose in the most commonly consumed forms at generalisable doses were required to clarify the role of fructose in obese people. Further high-quality feeding trials are required to investigate whether there were differences in effect on body weight between added fructose in sugar-sweetened beverages and naturally occurring fructose in fruits and vegetables.

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Bibliographic details

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This is a critical abstract of a systematic review that meets the criteria for inclusion on DARE. Each critical abstract contains a brief summary of the review methods, results and conclusions followed by a detailed critical assessment on the reliability of the review and the conclusions drawn.

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