Effects of low-carbohydrate diets versus low-fat diets on metabolic risk factors: a meta-analysis of randomized controlled clinical trials
Hu T, Mills KT, Yao L, Demanelis K, Elousta M, Yancy WS, Kelly TN, He J, Bazzano LA

CRD summary
This review concluded that low-carbohydrate diets were as effective as low-fat diets in reducing weight and improving metabolic risk factors. The authors' conclusions appear to reflect the results of the review, but they may not be reliable, due to unclear trial quality, clinical and statistical variation between trials, and possible publication bias.

Authors' objectives
To evaluate the long-term (six months or more) effect of a low-carbohydrate diet, compared with a low-fat diet.

Searching
MEDLINE (1966 to 2011), EMBASE, Web of Science, and Cochrane Database of Systematic Reviews were searched, with no language restriction. Search terms were reported. Reference lists of retrieved articles were handsearched.

Study selection
Randomised controlled trials (RCTs) that compared a low-carbohydrate diet (45% or less of energy from carbohydrates) with a low-fat diet (30% or less of energy from fat), in adults aged 18 years or older, were eligible for inclusion. The trials had to have interventions that lasted at least six months, and report metabolic risk factors as outcomes.

In most of the included trials, the participants were obese or overweight, without cardiovascular disease and diabetes mellitus. The mean age ranged from 27 to 60 years; approximately 40% of participants were male; and the mean weight ranged from 76kg to 198kg. The mean intervention duration ranged from six to 24 months. The goal dietary nutrition composition, and the starting body weight and metabolic risk factors, varied across the trials.

Two reviewers independently identified trials through searches. Any discrepancies were resolved with additional reviewers until consensus was reached.

Assessment of study quality
Blinding, loss to follow-up, and intention-to-treat analysis were assessed, by two reviewers independently.

Data extraction
The data were extracted to calculate the mean net changes and their 95% confidence intervals, for each metabolic risk factor. The mean net change was calculated by subtracting the mean change (from baseline to the end of trial) for the low-fat group from the mean change for the low-carbohydrate group.

Two reviewers independently extracted the data. Any disagreements were resolved through consensus with additional reviewers.

Methods of synthesis
The pooled mean net changes, and their 95% confidence intervals, were calculated using the DerSimonian and Laird, random-effects model. Heterogeneity was assessed using the Q test and I². Publication bias was assessed using Egger's and Begg's funnel plot tests, and the trim-and-fill method.

Sensitivity analyses were conducted by excluding each trial in turn, and by removing trials with less than a 70% completion rate, those with fewer than 20 participants per group, and those of patients after surgery or with severe diseases, such as cancer. Subgroup analyses were conducted for diabetic and non-diabetic participants; diets of very low carbohydrate (60g or less per day) and moderate carbohydrate (over 60g per day); longer (12 months or more) and shorter (less than 12 months) interventions; including males mainly and females mainly; and including older (mean age 50 years or older) and younger (mean age less than 50) participants. The Bonferroni and false discovery rate methods
were used to correct for multiple comparisons.

Results of the review
Twenty-three RCTs were included in the review, with 2,788 participants. Two trials were single blind, and one was double blind. Almost half the trials had a completion rate of less than 70%.

Compared with low-carbohydrate diets, low-fat diets increased total cholesterol (net change 2.7mg/dL, 95% CI 0.8 to 4.6; $I^2=0.2\%$; 15 trials) and low-density lipoprotein cholesterol (net change 3.7mg/dL, 95% CI 1.0 to 6.4; $I^2=50.0\%$; 19 trials). Low-carbohydrate diets significantly increased high-density lipoprotein cholesterol (net change 3.3mg/dL, 95% CI 1.9 to 4.7; $I^2=78.6\%$; 19 trials) and decreased triglycerides (net change -14.0mg/dL, 95% CI -19.4 to -8.7; $I^2=55.6\%$; 20 trials).

Statistically, there were no significant differences in body weight (22 trials), waist circumference (10 trials), ratio of total to high-density lipoprotein cholesterol (five trials), fasting blood glucose (14 trials), systolic blood pressure (18 trials), diastolic blood pressure (18 trials), and serum insulin (12 trials), between the two groups.

Publication bias was detected for triglycerides, body weight, total cholesterol, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, the ratio of total to high-density lipoprotein cholesterol, and serum insulin. After correcting for publication bias, the pooled net changes for total cholesterol, low-density lipoprotein cholesterol, and high-density lipoprotein cholesterol became non-significant, while the pooled mean net change in body weight became significant, favouring low-carbohydrate diets (net change -3.2kg, 95% CI -4.5 to -2.0).

The other subgroup and sensitivity analysis results were reported.

Authors’ conclusions
The findings suggested that low-carbohydrate diets were as effective as low-fat diets in reducing weight and improving metabolic risk factors. They could be recommended for weight loss in obese patients, with abnormal metabolic risk factors.

CRD commentary
The review question and inclusion criteria were clear. Relevant sources were searched, without language restriction, which minimised the risk of language bias. The authors did not search for unpublished trials, and the funnel plots showed potential publication bias for most of the outcomes. Appropriate methods to reduce reviewer error and bias were used in study selection and data extraction.

The minimum details of trial quality were reported; the methods of randomisation and allocation concealment were not assessed, which makes it difficult to determine the reliability of the included trials. Appropriate methods were used for pooling the data and for the subgroup and sensitivity analyses. Statistical heterogeneity was assessed, and significant heterogeneity was found for some of the outcomes.

The authors’ conclusions appear to reflect the results of the review, but they may not be reliable, due to unclear trial quality, clinical and statistical variation between trials, and possible publication bias.

Implications of the review for practice and research
Practice: The authors stated that low-carbohydrate diets could be recommended to reduce weight for obese patients, with abnormal metabolic risk factors.

Research: The authors stated that randomised trials were needed to demonstrate the long-term effects of low-carbohydrate diets, on cardiovascular events.

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