

Citation:

Halyburton AK, Brinkworth GD, Wilson CJ, Noakes M, Buckley JD, Keogh JB, Clifton PM. Low- and high-carbohydrate weight-loss diets have similar effects on mood but not cognitive performance. *Am J Clin Nutr.* 2007 Sep;86(3):580-7.

PubMed ID: [17823420](#)

Study Design:

Randomized Controlled Trial

Class:

A - [Click here](#) for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

The purpose of this study targeting overweight and obese subjects was to compare the effects on mood and cognitive function of a moderately energy-restricted low-carbohydrate, high fat (LCHF) diet with a isocaloric conventional high-carbohydrate, low fat (HCLF) diet.

Inclusion Criteria:

- Body mass index 26-34 kg/m²
- Age 24-64 years
- Abdominal obesity and > 1 metabolic risk factor as defined by the International Diabetes Foundation

Exclusion Criteria:

- History of liver, cardiovascular, peripheral vascular, respiratory, or gastrointestinal disease
- Diabetes
- Malignancy
- Psychological disorder

Description of Study Protocol:

Recruitment. Participants were recruited by public advertisement

Design Randomized controlled trial

Blinding used Not described

Intervention

- 8-week dietary intervention, diets designed to be isocaloric and have a moderate energy restriction of about 30%
- LCHF: 35% of total energy as protein, 61% as fat (20% saturated fat), 4% CHO
- HCLF: 24% of total energy as protein, 30% as fat (<8% saturated fat), 46% CHO
- Key foods for each diet representative of the diet's macronutrient profile were provided to aid compliance. The dietary plan was structured to ensure the correct macronutrient and energy requirements. Detailed dietary advice and information on meal planning and recipes were provided at baseline and every 2 weeks by a qualified dietitian.

Statistical Analysis.

- Between-group differences in baseline characteristics were compared by using independent t tests for continuous variables and Pearson chi-square test for categorical variables.
- The effect of the dietary intervention was assessed by using repeated measures ANOVA with time as the within-subject factor and diet and sex as the between subject factors.
- ANCOVA was used to adjust for differences in weight loss and age was used as a covariate in all analyses.
- Intention-to-treat analyses with the last observation carried forward was performed.
- Correlational analysis was used to determine relations between variables.

Data Collection Summary:

Timing of Measurements. Assessments were made at 2 week intervals during the 8-week intervention

Dependent Variables

- Mood assessment: 3 validated paper-based questionnaires including Profile of Mood States (POMS), Beck's Depression Inventory (BDI), and Spielberger State Anxiety Inventory (SAI). The POMS has a global score, total mood disturbance (TMD) and several sub-scores including tension-anxiety, depression-dejection, anger-hostility, vigor-activity, fatigue-inertia, and confusion-bewilderment.
- Cognitive function: Computer-based digit span backwards (DSB) to assess working memory and inspection time (IT) tests to assess speed of processing
- Body weight and height: using a stadiometer and calibrated electronic digital scales
- Biochemical tests including serum lipid and glucose concentrations and plasma ketones

Independent Variables

- 8-week dietary intervention, diets designed to be isocaloric and have a moderate energy restriction of about 30%
- LCHF: 35% of total energy as protein, 61% as fat (20% saturated fat), 4% CHO
- HCLF: 24% of total energy as protein, 30% as fat (<8% saturated fat), 46% CHO
- Dietary intake: scales for weighing food were provided.
- Three consecutive days (1 weekend day and 2 weekdays) from the semiquantitative food record of each 2-week period were analyzed using FOODWORKS while the participant was present to ensure accuracy.

Control Variables

- Gender
- Age

Description of Actual Data Sample:

Initial N: 120 participants enrolled

Attrition (final N): 93 participants (after 14 withdrew before commencement of the study, 12 withdrew during the intervention and 2 people in the LCHF were identified as outliers and excluded)

Age: LCHF = 50.6 (SD=1.1) years; HCLF = 49.8 (SD=1.3) years

Ethnicity: not reported

Body Mass Index: LCHF = 33.3 (SD=0.6); HCLF = 33.8 (SD=0.6)

Anthropometrics There were no significant differences between groups in baseline age, weight, body mass index, or cardiovascular disease risk factors

Mood measures and cognitive function measures: There were no significant differences between groups in baseline scores on the BDI, SAI, TMDS, or working memory or speed of processing

Location: Australia

Summary of Results:

Key Findings

- At week 8 there was a significant ($p=0.02$) time X diet interaction for weight loss; the LCHF diet group had a significantly ($p=0.0005$) greater weight loss ($8.0 \pm 0.3\%$) than the HCLF group ($6.6 \pm 0.4\%$). No significant effect of sex or age was observed. A comparable response was observed with intention-to-treat analysis.
- Dietary intakes were consistent with the prescribed dietary treatments. There was no significant difference in energy intake between the 2 groups ($p=0.25$). Plasma ketone concentrations indicated adherence to a very low CHO intake in the LCHF diet during the study.

Mood measures:

- For all three mood measures (Profile of Mood States, Beck's Depression Inventory, and Spielberger State Anxiety Inventory), there was no significant differential effect of diet composition for any of the mood scores ($p \geq 0.49$, time X diet interaction). Also, no significant effect of sex on these variables.
- The 6 subscales of POMS all showed significant improvements during the study ($P < 0.001$ for time). TMDS also showed same time course pattern improvements. No significant effect of diet was evident for any of these variables ($p \geq 0.23$), even after adjusting for weight loss.
- Intention-to-treat analysis showed patterns that did not differ significantly from completers.

Cognitive function measures:

- After the intervention, DSB test scores increased in both groups, and the difference between the groups were not significant ($p=0.67$).
- Speed of processing (IT scores) improved in both groups during the intervention, and the

HCLF diet promoted significantly greater improvements than did the LCHF diet (effect size 0.04, $P = 0.04$). This effect remained significant after controlling for weight loss. There was no significant effects of sex or age on the treatment effects. A comparable cognitive function response was observed with intention-to-treat analysis.

- Correlational analyses showed no significant associations between the changes in either DSB or IT scores with weight loss change or change in plasma ketone body concentrations.

Author Conclusion:

Under clinical supervision in an outpatient setting, consumption of a hypoenergetic LCHF diet has effects on mood and working memory similar to those of an isocaloric, conventional HCLF diet. Participants following either diet improved their speed of processing over 8 weeks, a significant interaction effect for speed of processing was observed which indicated that the improvements in the LCHF group were less than those seen in the HCLF control group.

Both dietary programs resulted in substantial reductions in body weight, with the LCHF diet producing greater weight loss than the HCLF.

Reviewer Comments:

Major strengths include isocaloric test diets, high dietary compliance, and use of valid and reliable outcome measures.

Unclear if the study was adequately powered to detect change in mood and other cognitive functions, power calculation not provided. Study only 8 weeks long.

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

- | | | |
|----|---|------------|
| 1. | Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies) | Yes |
| 2. | Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about? | Yes |
| 3. | Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice? | Yes |
| 4. | Is the intervention or procedure feasible? (NA for some epidemiological studies) | Yes |

Validity Questions

- | | | |
|----|--|------------|
| 1. | Was the research question clearly stated? | Yes |
|----|--|------------|

1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	Was the selection of study subjects/patients free from bias?	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	Yes
3.	Were study groups comparable?	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	N/A
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	N/A
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	Was method of handling withdrawals described?	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	Yes

4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	No
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	Was blinding used to prevent introduction of bias?	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	No
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	N/A
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were intervening factors described?	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	Yes
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	N/A
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	???
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	Yes
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	Were outcomes clearly defined and the measurements valid and reliable?	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes

7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	Yes
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	Was the statistical analysis appropriate for the study design and type of outcome indicators?	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	Yes
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	Are conclusions supported by results with biases and limitations taken into consideration?	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	Is bias due to study's funding or sponsorship unlikely?	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes

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