The Effects of a Low Glycemic Load Diet on Weight Loss and Key Health Risk Indicators

Patrick Holford, B.Sc. (Hons), DipION, FBant;
Kerry Torrens, B.Sc. (Hons), DipION, MBant; Deborah Colson, DipION, MBant

Abstract

Scientific literature reports consistent evidence that a low Glycemic Load (GL) diet has beneficial effects on weight loss, blood lipids, glucose regulation, cardiovascular and diabetes risk. This paper provides a review of such research and reports the results of a survey and open trial. A survey of 72 subjects following a low GL diet reported an average weight loss of 1.7 lbs per week among those with high-compliance, and 0.9 lbs with low-compliance. Those with high dietary compliance who took a multivitamin and any two or more of chromium, Hydroxycitric acid (HCA) and 5-hydroxytryptophan (5-HTP) reported a higher average weight loss (2.0 lbs/week) compared to those who didn't take supplements (1.3 lbs per week).

In a subsequent trial of 20 subjects on a low GL diet with multivitamin for 8 weeks, mean total weight loss was 10.25 lbs (1.3 lbs/week, $p < 0.0001$), drop in Body Mass Index was 1.6 ($p < 0.0001$). There was a decrease in blood pressure, (systole 135 vs 129, $p = .05$, diastole 86 vs 80, $p = .03$) and a decrease in pulse (73 vs 69 $p = .08$). No statistically significant changes were noted in mean HDL, cholesterol or homocysteine.

In conclusion, following a low GL diet is an effective means to lose weight and promote subjective and objective health parameters. There is a sound rationale to investigate the efficacy of low GL diets, with or without supplements, on sustained weight loss and health in more rigorously controlled and longer term studies.

1.Carters Yard, London SW 18 4JR
patrick@patrickholford.com
2.The Mapletons, Odiham Hampshire RG29 1DJ
Kerry.Torrens@foodlinkfirst.com
3. 13b Mayflower Road, London SW9 9JY
deborah@deborahcolson.com

Introduction

Conventional weight loss diets are devised on the basis that one's weight is the net result of calories consumed from food, less calories expended by exercise/activity and the body's basal metabolic rate. Since fat has more calories per gram (9 kcals) than protein or carbohydrate (3.75 kcals and 4 kcals respectively) conventional weight loss diets are typically low fat and therefore low calorie diets. Despite the emphasis on low fat, low calorie diets over the past two decades the percentage of people in the UK who are overweight and obese has steadily risen.[1]

Government surveys show that the amount of calories consumed, and the percentage of calories from fat, has steadily decreased over the last 15 years, while the percentage of obese people has steadily increased.[2] In addition, the 1998 Health Survey for England estimated that women increased their level of physical activity between 1994 and 1998, from 22 to 25 per cent. For men it seems there has been little change.[3] Conversely, carbohydrate, and more particularly sugar intake, has also risen in line with increasing obesity.

Increasing interest in excess carbohydrate intake as a cause of obesity arose from three findings. First, that low blood glucose levels are the primary trigger of hunger[4] and hence eating.[5] Secondly, that carbohydrate, compared to protein or fat, has the most significant effect on raising blood glucose levels.[6] Thirdly, that the incidence of overweight and obese people in the population has continued to rise despite decreasing calorie and fat intake and increasing exercise.

These observations support a different theoretical weight loss strategy involving high protein and low carbohydrate diets (examples of which are the Atkins Diet and the South Beach Diet). High protein diets have proven, in many cases, slightly more effective than low calorie low fat diets, largely due to reducing appetite by stabilising blood sugar.[7] However, their long-term results are not impressive, often due to poor compliance. Their long-term effect on health, specifically on kidney stone formation and bone health is also questionable.[8,9]

Increasing awareness that not all carbohydrates affect blood sugar in the same way led to the creation of the Glycemic Index (GI) of foods. The GI is a measure of how quickly the available carbohydrates within a food raise blood glucose, and for how long they remain elevated, compared to glucose. This led to diets based on eating more low GI foods and less high GI foods as a means to control appetite and weight. Diets based on eating low GI foods have been inconsistent and inconclusive in their effects on weight loss,[10] although there is a tendency for low GI diets to promote satiety and to improve glucose control, reduce glycosylated proteins and cardiovascular risk.[11]

Low-GI diets, however, are essentially unquantifiable since the GI of foods only tells you about the quality of the sugars in a food in respect of raising blood sugar levels. The GI score tells you nothing about the quantity of carbohydrate within a food. By knowing both the quantity of carbohydrates eaten and the GI of the food in question the total Glycemic Load (GL) of a diet can be determined. The GL value of a food relates to a serving size of that food in grams.

GL (per serving in grams) =
GI/100 X net carbohydrate (g)

Low GI diets are therefore only crude indicators of benefit for low GL diets since it is possible to eat low GI foods in abundant quantity, resulting in a high GL diet.

Review of Studies on Low GL Diets

Both animal and human studies show consistent weight loss, fat loss and health benefits on a low GL diet.

Animal studies demonstrate that a high GL diet leads to greater fat gain than a low GL diet of the same calories. Weight gain in rats was consistently greater in a group fed a high GL diet, compared with those fed a low-GL diet. Whereas the low-GL group remained weight-stable, the high-GL group gradually gained weight and were 16% heavier at the end of 32 weeks. Total fat mass, assessed by measurements of total body water, was significantly (40%) higher in the high-GL group ($P < 0.05$). The average weight of visceral fat in the high-GL group was twice that of the low-GL group and remained significantly higher when expressed as a proportion of total body fat ($P < 0.05$).[12] In another study, two groups of rats were given diets with identical nutrients, except for the type of starch - half were fed on high-GL starch and half on low GL-starch. The animals were fed in a controlled way to maintain the same average bodyweight in both groups for 18 weeks. Despite having similar average bodyweight (1.208 vs 1.211 lb), the rats on the high GL-diet had more body fat (0.194 vs 0.126 lb; $p=0.0152$) and less lean body mass (0.992 vs 1.084 lb; $p=0.0120$) than those given low-GL food. In addition, the high GL group also had greater increases over time in the areas under the curve for blood glucose and plasma insulin after oral glucose, lower plasma adiponectin concentrations, higher plasma triglyceride concentrations, and severe disruption of islet-cell (insulin-producing cell) architecture.[13]

A low-GL diet has improved both weight and serum insulin concentrations more than a conventional diet in hyperinsulinemic females during a 12-week crossover study (20.6 and 16.3 lb, respectively, $p<.05$).[14] High GL diets are associated with an increased risk of Type 2 diabetes and coronary artery disease. 120 patients who were advised to follow a low GL diet were evaluated and compared with 1,434 patients who were advised to follow the principles of Canada's Food Guide to Healthy Eating for People Four Years and Over. Patients on the low GL diet not only lost more weight at six months, they also had a greater improvement in high density lipoprotein cholesterol (0.14 vs 0.02 mmol/L, $P < 0.0001$), triglycerides (-0.44 vs -0.08 mmol/L, $P < 0.0001$) and glycemic control (fasting glucose -0.94 vs 0.91 mmol/L, $P = 0.0019$). After one year of follow-up, the low GL patients had maintained (weight gain 1.5 lb, triglycerides -0.07 mmol/L, fasting glucose -0.10 mmol/L and glycosylated hemoglobin A1c -0.18%; all not statistically significant) or augmented the initial results (waist circumference -1.3 cm, $P = 0.038$; HDL cholesterol 0.08 mmol/L, $P < 0.0001$). Implementation of a low GL diet was associated with substantial and sustained improvements in abdominal obesity, cholesterol and blood sugar control.[15]

A randomized controlled trial consisting of a 6-month intervention and a 6-month follow-up to compare the effects of an *ad libitum* low-GL diet with those of a conventional diet in obese adolescents. Fourteen obese adolescents aged 13 to 21 years completed the study (7 per group). The GL decreased significantly in the experimental group, and dietary fat decreased significantly in the conventional group ($P < .05$ for both). At 12 months, average BMI was reduced by 1.3 in the low-GL group compared to a gain of 0.7 in the conventional diet group ($P = .02$).[16]

An established problem with conventional diets is that the lower calorie intake leads to a lowering of the resting metabolic rate of the individual. A study investigated whether dietary composition affects the physiological adaptations to weight loss, as assessed by resting energy expenditure. The randomized parallel-design study followed 39 overweight or obese young adults aged 18 to 40 years who received an energy-restricted diet, either low GL or low-fat. Participants' resting energy expenditure was measured before and after 10% weight loss. Resting energy expenditure decreased less with the low-GL diet than with the low-fat diet, expressed in absolute terms (96 vs 176 kcal/d; $P=.04$) or as a proportion (5.9% vs 10.6%, $P=.05$). In addition, insulin resistance ($P=.01$), serum triglycerides ($P=.01$), C-reactive protein ($P=.03$), and blood pressure ($P=.07$ for both systolic and diastolic) improved more with the low-GL diet. The researchers concluded that a reduction in GL may aid in the prevention or treatment of obesity, cardiovascular disease, and diabetes mellitus.[17]

Researchers at the Harvard School of Public Health examined the relationship between diet and risk of non-insulin dependent diabetes mellitus (NIDDM) in a cohort of 42,759 men without NIDDM or cardiovascular disease, who were 40-75 years of age in 1986. Diet was assessed at the beginning via a food diary. During 6-years of follow-up, 523 incident cases of NIDDM were documented. The dietary glycemic load was positively associated with risk of NIDDM after adjustment for age, BMI, smoking, physical activity, family history of diabetes, alcohol consumption, cereal fiber, and total energy intake. Comparing the highest and lowest quintiles, the relative risk of diabetes was 1.37 times higher in the high GL group.[18]

In 1986, a total of 65,173 US women 40 to 65 years of age and free from diagnosed cardiovascular disease, cancer, and diabetes completed a detailed dietary questionnaire from which researchers from the Harvard School of Public Health calculated usual intake of total and specific sources of dietary fiber, dietary glycemic index, and glycemic load. During six years of follow-up, 915 incident cases of diabetes were documented. Those whose diet was high GL were 1.47 times more likely to develop diabetes.[19]

As well as losing more weight, and more fat on the same calories, people who eat a low-GL diet eat significantly less because they feel much more satisfied.[20]

The evidence validates that a low GL diet promotes weight loss and fat loss with positive changes to blood lipids, glucose and cardiovascular and diabetes risk.

GL Diet Survey

To initially investigate the efficacy of a specific low-GL diet, the Holford Low GL diet, 1,000 purchasers of the Holford Diet book were emailed and case history data was sought via testimonial primarily on the website www.holforddiet.com. In total 72 subjects provided complete data to conduct a survey. For the group as a whole, the average length reported on the diet was 17 weeks, ranging from 1 week to 118 weeks.

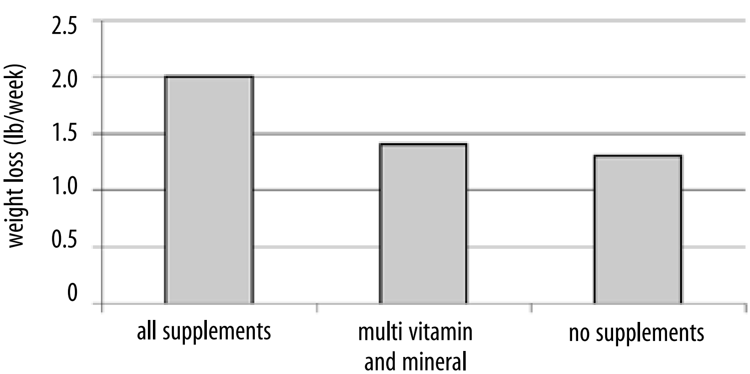
Results

For the whole group the average starting weight was 176 lbs and final weight 163 lbs. Twenty people reported low compliance with the diet and lost an average of 0.9 pounds per week. Fifty-four people reported high compliance (followed the diet 'fully' or 'pretty well') and lost an average of 2.1 pounds per week. On starting the diet 29 were obese (BMI>=30). On completing the survey 15 (52%) of these were no longer classified as obese (BMI <30). On starting the diet 26 were overweight (BMI>=25 and BMI <30). On completing the survey 10 (38%) of these were no longer classified as overweight (BMI<25).

Effects of exercise: Weight loss was compared between those who rated their level of exercise as 'high', 'moderate' or 'low'. No clear pattern of difference in weight loss was found between the groups.

Low GL diet plus supplements: The Holford Low GL Diet recommends supplementing with a high potency multivitamin and also extra chromium 200-400 mcg, hydroxycitric acid (HCA) 900 mg and

Figure 1. Supplementation in relation to weight loss.



the amino acid 5-hydroxytryptophan (5-HTP)100-200 mg. Dieters were split into three groups : those who didn't take any supplements; those who took a high strength multi-vitamin or equivalent; and those who also took any two of extra chromium, HCA and 5-HTP. Among those with high compliance on the diet those who took all the supplements, (AS) reported a higher average weight loss (2.0 lbs/week) compared to those who didn't take supplements (1.3 lbs per week). The multivitamin only group also reported a higher average weight loss compared to the non-supplemented group (1.4 lbs/week).

Of the 72 respondents, 27 reported having more energy, 20 better skin and 28 described the diet as easy. There were many other reported benefits including fewer cravings for sweets and stimulants, improved mood, less bloating and better sleep.

Low GL Diet Open Trial

To further test the effects of the Holford Low GL diet, 20 volunteers wishing to lose weight were enrolled in an open trial for eight weeks with weekly meetings to encourage compliance.

Design Subjects: The study comprised self-selected subjects who responded to a poster / leaflet promotion. A group of 20 volunteers (3 males, 17 females, aged 33 to 70, mean age of 46) with a mean weight of 173 lbs and a mean BMI of 28 were assessed over eight weeks to evaluate the results of the diet on weight loss and key health risk indicators. The group included 5 obese individuals (BMI>=30) and 7 over-weight individuals (BMI>=25<30). Some of the group (12%) had been medically diagnosed as suffering hypertension, hypercholesterolemia, or showing early stages of impaired glucose management. The remainder were in apparent good health, but had specific health goals relating to weight management. Fifteen of the group demonstrated high homocysteine levels (>8 mmol/L), 14 had sub-optimal HDL cholesterol (<30 mg/dL), 16 impaired glucose management (< 70 mg/dL or >99 mg/dL).

Method: The participants were required to follow the core principles of the Holford Low GL Diet, which recommends 45 GLs a day, with approximately 25% of calories derived from protein, 25% calories from fat, with an emphasis on high omega 3 and omega 6 foods, and 50% of calories from carbohydrate, were encouraged to exercise and were given a high potency multivitamin, 1 gram of vitamin C and an omega 3/6 supplement. Anthropometric and metabolic measures were performed to establish the baseline. Assessment methods included completion of a questionnaire and checklists of features and symptoms relevant to impaired blood sugar balance, weight gain and low energy. Blood pressure and pulse were recorded as well as weight and body fat percentage. In conjunction blood samples were taken to record levels of homocysteine, triglycerides, total cholesterol, HDL cholesterol and fasting blood glucose. A hand-held device incorporating a reflectance photometer was employed to test the whole blood samples for fasting glucose, cholesterol and triglycerides. In order to test for homocysteine a whole blood sample was taken and applied to a plasma separator and then submitted for laboratory testing. All participants were asked to fast for at least a six hour period prior to the conduct of the blood tests. Body composition was evaluated using electronic scales which applied Bioelectrical Impedance Analysis (BIA); studies purporting the accuracy of the appliance used indicate a tolerance factor of +/- 1%. Each participant was given a pedometer and asked to record activity levels and on a weekly basis participants were required to complete food diaries measuring estimated daily GLs and calorie intake. The baseline assessments were performed with each participant before he or she began following the diet and taking supplements. The participants attended weekly review meetings designed to both educate and motivate the group for compliance. Trial co-ordinators took weekly weight measurements and at week 3 and 8 of the trial, body-fat percentage and waist circumference were recorded. On completion of the eight week period baseline measurements were re-taken. The participants were supported throughout the eight week period with professional contact and a "club" style atmosphere to replicate similar weight loss forums. The Holford Low GL Diet also advocates supplementing the diet with extra chromium, HCA and the amino-acid 5-HTP. Eighteen participants added one or more of these supplements from week four.

Results

Compliance: Four of the 20 participants dropped out due to personal complications hindering their dietary and exercise regime. Out of the remaining 16 compliance with the diet and recommended supplement programme was high with some 86% of the sample population adopting and maintaining the supplementation protocol.

Weight loss: Of the participants that remained, four continued to be classified as obese and two of the sample remained over-weight. However, the group (16 subjects) had demonstrated a mean reduction in BMI of 1.6 ($p < 0.0001$) with a total group weight loss of 153 lb. This represented an average weekly weight loss of 1.3 lbs with a mean loss of 10.25 lbs per participant over eight weeks ($p <0.0001$). Sixty percent of the group (12 subjects) had lost at least 7 lbs. In addition, a mean change in body fat percentage of -2% was recorded over a 5 week period.

Physiological/biochemical parameters: Mean levels of blood pressure, cholesterol, triglycerides and homocysteine were within normal ranges by the end of the eight week period. Notably, there was an improvement in total cholesterol readings with an average increase in HDL cholesterol of 16% for the group. Insulin control improved with just 5 subjects demonstrating fasting glucose levels outside of the acceptable reference range. There was also a 2% reduction in the average homocysteine level for the group (11 subjects) over the eight week period. The subjects also recorded a decrease in both systole and diastole blood pressure, (systole 135 vs 129, $p = .05$, diastole 86 vs 80, $p = .03$) and a decrease in pulse (73 vs 69 $p = .08$).

Other effects: In addition to the improvement in reported health measures the sample population at the eight week review cited health benefits including greater energy (94%), greater concentration/memory/ alertness (67%), less indigestion / bloating (67%), clearer/less dry skin (67%), fewer feelings of depression (50%), more stable moods (50%) and symptomatic relief of conditions such as PMS (44%). There were no adverse effects reported and compliance with the programme was good with a low drop-out rate and a high compliance with the dietary regime and supplements.

Discussion

While the results of both the survey and diet trial are encouraging, this pilot study has a number of limitations: its size (20 subjects), duration (8 weeks) and, as with many weight loss trials, the control on the subjects' compliance. In addition, there are, at least, two other confounding factors. Most subjects took basic supplementation (vitamins minerals and EFAs) and most increased their supplementation from week four to include additional chromium, HCA and/or 5-HTP. In addition, subjects were encouraged to exercise but no significant control or measure of any changes in exercise was recorded. Overall, the results on weight loss were clearly positive, which provides a rationale to further research these factors in a more controlled design to identify which of these factors contributes to the overall weight loss.

The positive changes in blood pressure and pulse are encouraging however no significant changes in lipids and homocysteine were reported overall, even though some individuals with raised lipids and/or homocysteine had considerable reductions. Larger cohort studies have demonstrated the association of a low GL diet with an increase in HDL levels, improved insulin management and reduced homocysteine. The duration of this study may be a factor. Our intention is to follow up participants at six months to assess both long-term compliance and results on weight, lipids and homocysteine.

Conclusion

In summary, the compliance with the diet and adherence to the program was good. However, it should be noted that the findings from this study have been interpreted with caution given its short duration and small number of subjects. Nevertheless, based on the data achieved, it would appear that a low GL diet may be effective for short-term weight loss and improvement in key health factors. Further research is needed to demonstrate the benefits of such an approach for those looking to reduce their weight and alleviate the risk of cardiovascular disease, insulin resistance and diabetes. Further longer term studies are required to determine the efficacy of a low GL diet on long term weight loss and the sustained improvement in key health indicators. In conclusion there is a need to design a six month study comparing the Holford Low GL Diet approach (with or without supplementation) with a more conventional low calorie, low fat diet, or high protein, low carbohydrate diet, including the same level of exercise. This would provide a more accurate picture of the comparative effects of such a diet on weight loss and health indicators.

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