Position Statement on Very Low Carbohydrate Diets

The National Heart Foundation of Australia would like to thank members of the Nutrition and Metabolism Advisory Committee, and in particular Dr Manny Noakes, A/Prof Len Kritharides and Ms Margaret Miller who contributed to the development of this paper.

Summary of the Heart Foundation position

1. At present, there is insufficient evidence to support the adoption of very low carbohydrate (VLCARB) diets for long-term weight loss.
2. The Heart Foundation is concerned that
   a. the high and unrestricted saturated fat content of many VLCARB diets may contribute to cardiovascular risk, and
   b. many VLCARB diets do not provide adequate nutrition, particularly in dietary folate, calcium and dietary fibre.
3. In research studies over six months, subjects on VLCARB diets lost significantly more weight. However, studies over 12 months showed no significant difference between weight loss on VLCARB diets and other weight loss strategies.
4. It is uncertain whether VLCARB diets have cardiovascular benefits. While some cardiovascular disease risk factors (such as low density lipoprotein cholesterol) improve, they may not do so as effectively as with weight loss strategies based on a lower saturated fat intake.
5. A person attempting weight loss with a VLCARB diet should discuss it with their general practitioner so their cardiovascular disease risk factors can be monitored.
6. The Heart Foundation will continue to monitor the evidence in this area as it emerges.

Introduction

Increasing concern about rising obesity levels has resulted in a multitude of dietary patterns that promote weight loss. With few exceptions, these have not been scientifically studied or founded.

Very low carbohydrate (VLCARB) diets are among the most popular of these dietary approaches. The Heart Foundation’s major concern with many VLCARB diets is not their restriction of carbohydrate or increase in protein, but their high and unrestricted saturated fat content, which may contribute to cardiovascular risk.

The nutritional composition of many VLCARB diets contradicts conventional heart health recommendations. Given this, the Heart Foundation has examined the emerging scientific evidence exploring the efficacy and safety of these diets.

VLCARB diets have become a popular method of rapid weight loss. Advocates of VLCARB diets claim that severe restriction of carbohydrate intake with resulting ketosis and reduced circulating insulin levels, promotes lipid oxidation, satiety and negative energy balance.
The current literature, however, has no clear consensus on what constitutes a low carbohydrate diet\(^1\). Ketosis occurs at carbohydrate intakes around 50 g per day (7 to 10% energy intake). The recommended intake of carbohydrate to prevent ketosis is around 100 g per day (15 to 20% energy intake). Ad libitum average carbohydrate intake in Australia and other Western countries is 200 to 300 g per day (45% energy intake). Typically, recommended carbohydrate intake is 55% of energy and on an energy-restricted diet of 6000 kilojoules, carbohydrate intake is ~200 g/day.

VLCARB diets that focus on weight loss recommend elimination or severe restriction of carbohydrate in the early stages (less than 10 g per day), with maintenance at 40 to 50 g per day to maintain ketosis. For the purposes of this paper, VLCARB diets are defined as those containing less than 100 g carbohydrate per day. VLCARB diets may also be termed ‘high protein’ although not all high protein diets for weight loss are low enough in carbohydrate to be called VLCARB diets.

VLCARB diets derive a considerable proportion of energy from saturated fat and little from plant foods such as vegetables and wholegrain cereals that may have cardioprotective effects. Given this, there is concern that these diets are a higher cardiovascular risk.

Other research suggests that higher dietary protein loads may compromise renal function in susceptible people and accumulation of ketones may result in bone demineralisation and impaired liver and kidney function.

Table 1 highlights the key differences between VLCARB diets and Heart Foundation recommended eating patterns for weight management. In energy balance, high consumption of saturated fats results in increased plasma concentrations of low-density lipoprotein cholesterol (LDL-C), a key risk factor for cardiovascular disease. Reduced intake of carbohydrate restricts consumption of many fruit and vegetables potentially leading to reduced folate intake and increased plasma homocysteine levels. Some VLCARB diets have recently included lower levels of saturated fat, higher intakes of low starch fruits and vegetables and the use of nutrient supplements.

This paper aims to clarify:
- to what extent do people who follow VLCARB diets achieve weight loss, and
- what are the possible effects of VLCARB diets on cardiovascular and general health.

1. **Summary of key recent findings**

Studies to date have primarily evaluated whether VLCARB diets, with little dietary education, are effective in achieving weight loss and risk factor modification.

Samaha\(^2\) randomised obese adults to a VLCARB diet of less than 30 g/day (without restriction of fat intake and with a recommended vegetable and fruit intake containing a high ratio of fibre to carbohydrate) or a diet with less than 30% of calories as fat and caloric restriction\(^2\). At six months, VLCARB subjects lost more weight (5.8±8.6 kg versus 1.9±4.2 kg, p<0.005) and had greater mean reduction of plasma triglycerides (25±38% vs 8±35%, p<0.01) than fat-restricted subjects. The authors calculated that loss of 5% of baseline weight was required to achieve significant reduction in triglycerides (TG). Plasma LDL-C, high-density lipoprotein cholesterol (HDL-C) and total cholesterol did not change. VLCARB diets induced a greater reduction in mean fasting glucose in diabetic subjects, and, in non-diabetic subjects, insulin sensitivity improved on a VLCARB diet compared to a low fat diet.

Foster\(^3\) had similar findings, except that at three months, LDL-C was higher in the VLCARB group than in the low fat group and that there was a sustained elevation of HDL-C in the VLCARB group\(^3\). In this study, the VLCARB group (who had carbohydrate initially limited to 20 g/day and followed the ‘Atkin’s diet’ program) was compared to
a conventional calorie-restricted low fat diet group. Triglyceride-lowering and weight loss were greater in the VLCARB group at three and six months, but were no longer significantly different between groups by 12 months. Foster’s intensity of follow up and counselling was lower than in the Samaha study, and subjects received no advice on specific carbohydrate food groups.

Brehm et al placed 53 healthy obese women on an ad libitum VLCARB diet or on a calorie restricted diet with 30% of calories as fat. Over six months, the VLCARB diet achieved greater weight loss than the low fat diet (8.5±1.0 versus 3.9±1.0 kg, p<0.001), even though subjects showed a tendency to increase carbohydrate intake in the last three months of the study. Subjects on the VLCARB diet lost more body fat than the calorie restricted diet, and both groups had similar lipid profiles, despite elevated saturated fat intakes and cholesterol intakes in the VLCARB group. Calorie intakes were reported to be the same in the two groups, however, differences in activity, systematic differences in reporting, or diet-induced energy expenditure were possible.

Sondike compared the effects of a low-carbohydrate ad libitum VLCARB diet with those of an ad libitum low-fat (LF) diet for 12 weeks. The VLCARB group (n = 16) was instructed to consume less than 40 g/day of carbohydrate and the LF group (n = 14) was advised to consume less than 30% of energy from fat. The VLCARB group lost more weight (9.9 kg versus 4.1 kg, p<0.05) and had an improvement in non-HDL cholesterol levels. LDL-C fell in the LF group but not in the VLCARB group although these measures were taken during active energy restriction. In this study, the low fat diet group reported a lower total energy intake (1100 Calories versus 1830 Calories for the VLCARB group).

In a review of VLCARB diet studies which precedes recent studies by Brehm, Foster and Samaha, only five studies had followed subjects for greater than 90 days. Mean weight loss of >10 kg was predicted by lower calorie intake, longer duration of diet and pre-diet obesity. In randomised-controlled studies the severity of carbohydrate restriction was not a predictor of weight loss. Very few studies performed intention to treat analyses or monitored participants’ exercise.

Volek et al examined body composition by DEXA following a VLCARB diet for six weeks in 12 normal weight men and eight controls. Body mass decreased by 2.2 kg in the intervention group but remained unchanged in the control group. The intervention group showed a 3.3 kg fat mass decrease and 1.1 kg lean mass increase with no changes in the control group. Fasting insulin concentration fell by 34%. Carbohydrate intake decreased from 306 g to 46 g/day, fat intake increased from 91 g to 157 g and saturated fat increased from 31 g to 56 g.

Looking at lipid changes from this small trial, Sharman observed that although increases in LDL-C were apparent at week three, by week six LDL-C was not statistically different from baseline although it was 9% higher than the control group. There was a 33% decrease in fasting serum TG and LDL-C particle size increased in those with small particles. The subjects were not in energy balance at the time of lipid measurement.

2. Efficacy and mechanism of weight loss

Research shows that very low carbohydrate diets (VLCARB) diets appear to be at least as effective as (and possibly more effective than) low fat diets in achieving weight loss over a three-to-six month period.

The studies differ in important ways including age of patient populations, presence or absence of diabetes, the duration of follow up, and the precise nature of the diet prescribed. In these studies, the nature of the diet prescribed is a particularly important aspect because the effects of a specific diet can only be predicted if the active components, and the mechanism of action, are understood.
Calorie restriction clearly affects how much weight people on VLCARB diets lose – the more calories restricted, the more weight lost. In randomised controlled studies, VLCARB subjects usually lose more weight than fat-restricted subjects. This is surprising because estimated and prescribed calorie intake is usually less in fat-restricted subjects than in VLCARB subjects.

This may indicate systematic under-reporting of calorie intake when subjects are on low fat diets, or over-reporting when on VLCARB diets. If there is lower spontaneous calorie intake on VLCARB diets, this may arise from the dietary simplicity of VLCARB diets, or from greater satiety derived from increased protein and fat intake. Alternatively, there may be metabolic effects specific to VLCARB and high protein and fat intake that relate to ketogenesis and increased basal energy expenditure. Reduced serum insulin concentration, which has been observed after VLCARB diets, correlates closely with weight loss. This may be a consequence of, or contributor to, weight loss with VLCARB intake.

3. Effects on cardiovascular risk factors
VLCARB diets consistently reduce plasma TG, may increase HDL-C, can reduce insulin, and consistently reduce fat mass in obese subjects.

In some studies, VLCARB diets fail to decrease LDL-C as much as traditional low fat diets. Variations in the way VLCARB diets affect plasma LDL-C may be due to subjects’ variable intake of saturated fats in absolute terms, which may or may not increase during VLCARB diets. These variations may also depend on whether lipid measurements are taken during active weight loss, when energy restriction will reduce hepatic cholesterol synthesis, or in energy balance after weight loss.

There is no data evaluating how advice to avoid or substitute saturated fats with polyunsaturated or monounsaturated fats during VLCARB diets affects subjects. Variations in the extent to which HDL-C increases or TG and insulin decrease are likely to result from the degree of weight loss, the amount and type of carbohydrate in the diet (high or low in fibre) and the patient group studied (diabetic, insulin-resistant or non diabetic). Triglyceride lowering appears to occur even in subjects on lipid-lowering medication, but whether lipid-lowering medication prevents elevation of LDL-C in subjects on VLCARB diets is unknown.

Although there is a loss of body fat, there is no consistent effect on blood pressure associated with VLCARB diets, and effects on plasma homocysteine have not been reported.

4. Data quality
Most studies have very few subjects (all studies under 12 months had less than 100 subjects), and the large patient drop-out rate complicates studies with greater patient numbers. In many instances, analyses of patient withdrawals is unsatisfactory and show no intention to treat analyses.

Adherence to VLCARB diet diminishes with longer follow up (greater than three months), but adherence to conventional low fat dietary advice also drops markedly over this period. Thus, there is no clear evidence that compliance is worse with VLCARB diets than conventional diets.

5. What are the potential or known adverse effects of VLCARB diets?
Based on current nutrition knowledge relating to this dietary pattern in energy balance, most of the proposed adverse effects of VLCARB diets are speculative. The extent to which the weight loss achieved on VLCARB diets affects these speculated adverse effects is unclear.
It is possible that individuals sensitive to the effects of high saturated fat intake may have an increased risk of cardiovascular disease related to elevated LDL-C. Conversely, obese individuals with hyperinsulinemia and hypertriglyceridemia may demonstrate a decreased cardiovascular risk related to lower TG and lower serum insulin.

The high saturated fat content of VLCARB diets is another concern. Meals high in saturated fat can have acute effects on the impairment of endothelium-dependent vasodilation, which is an early marker of atherosclerosis. In cross sectional studies, the saturated fatty acid composition of serum lipids, partly reflecting the composition of dietary saturated fat consumed, is associated with endothelial dysfunction in apparently healthy subjects. Whether this is also true during energy restriction and after weight loss is not known.

There is a theoretical concern that a high protein intake may be associated with renal deterioration. A high protein intake has also been associated with increased proteinuria, especially in people with pre-existing, subclinical renal disease, diabetes and hypertension. However, these data are observational, not from randomised studies, and the prognostic significance of increased diet-dependent micro-albuminuria in patients without renal disease is unclear.

High protein intake is associated with hypercalciuria and potential loss of bone mass, and VLCARB diets are associated with low calcium intake. Given this finding, VLCARB diets may increase the long-term risk of osteoporosis and bone fracture. Certain patient populations who may be at risk for adverse effects of VLCARB diets are under-represented in studies published to date. These include the subjects with osteoporosis and with mild renal disease.

The VLCARB dietary pattern is also nutritionally variable and potentially incomplete. Folic acid, dietary fibre and calcium are some of the key nutrients in VLCARB diets that do not meet the Australian Recommended Dietary Intake levels. These diets low folate intake may exacerbate plasma homocysteine concentrations which, in turn, may impact adversely on the atherosclerotic process.

The long-term effects of strict carbohydrate restriction in VLCARB diets are not well described, and favourable or unfavourable effects of long-term carbohydrate restriction are unknown. This is because adherence of subjects to the restriction of carbohydrate intake has declined with longer studies. Importantly, no studies have evaluated the effects of VLCARB diets on cardiovascular outcomes. Lifestyle change incorporating low saturated fat diets and by so-called Mediterranean diets are found to improve cardiovascular outcomes.

**Heart Foundation statement**

Based on current available evidence, the Heart Foundation does not support the adoption of VLCARB diets for weight loss. We believe that this dietary pattern does not provide optimal cardiovascular risk reduction or nutritional adequacy.

The Heart Foundation found that subjects in research studies achieved more weight and fat loss on the VLCARB diets than on the conventional low fat diets, but this was only in the short term. Studies conducted for 12 months do not demonstrate superior efficacy.

The most plausible explanation for the short-term efficacy is that the limited variety of food (resulting from the VLCARB diet’s carbohydrate restrictions) facilitates energy restriction. VLCARB diets achieve loss of fat from all distributions including the abdomen. Original concerns that the diets achieved only loss of water (related to ketosis) are not supported in longer studies.
Weight loss on VLCARB diets is most likely because of a reduced range of food selections, a high satiety value of those foods and a simple educational or ‘exclusion’ strategy which involves limiting of carbohydrate. It is unclear if ketosis is essential to the efficacy of these diets.

If weight loss is achieved on VLCARB diets, many risk factors, particularly plasma TG, improve. However, LDL-C may not fall as effectively on VLCARB diets compared to weight loss strategies with more traditional low fat diets. For this reason it is uncertain whether VLCARB diets have cardiovascular benefit.

Given these findings, VLCARB diets high in saturated fat are not recommended for long-term weight loss or for cardiovascular risk reduction. If patients do chose a VLCARB diet, they should also consider lowering saturated fat intake.

The risks and benefits of VLCARB diets may vary between individuals. For example, in subjects with obesity, insulin resistance and high plasma TG, the short-term benefits of a VLCARB diet may outweigh the risks. However, in subjects with elevated LDL-C, renal disease and normal TG the risks may outweigh the benefits.

The Heart Foundation recommends that any person who undertakes a weight loss VLCARB diet should discuss it with their general practitioner to assess their risk factors and other potential adverse effects first, particularly if they plan to follow the diet for more than three months. Monitoring should include plasma LDL-C, plasma fasting TG, testing for microalbuminuria and calciuria. Long-term use of these diets may also require monitoring of bone mass.

Currently, studies are underway investigating the long-term effects of VLCARB diets on vascular outcomes. However, at this time, VLCARB diets high in saturated fat are not recommended as a long-term nutritional strategy for weight loss and cardiovascular health. The Heart Foundation will continue to monitor the evidence in this area as it emerges.

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Reference List


### TABLE 1: Differences between VLCARB diets and Heart Foundation recommendations

<table>
<thead>
<tr>
<th>Food Group</th>
<th>VLCARB</th>
<th>Heart Foundation</th>
<th>Comments</th>
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<tbody>
<tr>
<td><strong>Dairy</strong></td>
<td>Cheese only.</td>
<td>Recommend choosing low or reduced fat milk and yoghurt or 'added calcium' soy beverages. Try to limit cheese and ice-cream to twice a week.</td>
<td>Saturated fats from full fat dairy products increase plasma cholesterol and therefore heart disease risk.</td>
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<tr>
<td></td>
<td>All types of milk and milk products highly restricted as contain carbohydrate.</td>
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<tr>
<td><strong>Cereals and Bread</strong></td>
<td>All excluded in early phase and highly restricted in maintenance phase.</td>
<td>Grain based foods such as breakfast cereals, bread, pasta, noodles and rice, along with vegetables are encouraged to make up the major part of each meal. Wholegrain varieties encouraged in moderate amounts depending on energy needs.</td>
<td>Wholegrain intake is associated with lower risk of heart disease.</td>
</tr>
<tr>
<td><strong>Pasta and Rice</strong></td>
<td>All excluded in early phase and highly restricted in maintenance phase.</td>
<td>Grain based foods such as breakfast cereals, bread, pasta, noodles and rice, along with vegetables are encouraged to make up the major part of each meal. Wholegrain varieties encouraged in moderate amounts depending on energy needs.</td>
<td>May help keep saturated fat intake low and therefore control cholesterol levels.</td>
</tr>
<tr>
<td><strong>Meat/Chicken</strong></td>
<td>All types, including fatty types without restriction.</td>
<td>Select a moderate amount of lean meat (meat trimmed of fat and chicken without skin). Try to limit fatty meats including sausages and delicatessen meats such as salami.</td>
<td>Fatty meat and poultry is high in saturated fat and raises plasma cholesterol levels. Replacing with lean meat and skinless poultry will lower saturated fat intake.</td>
</tr>
<tr>
<td><strong>Fish</strong></td>
<td>No specific recommendation but all types included without restriction.</td>
<td>Fish recommended (any type of fresh or canned) at least twice a week.</td>
<td>Fish intake is associated with a lower risk of heart attack and omega 3 fats from fish help to maintain heart rhythm.</td>
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<tr>
<td>Food Group</td>
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<td>Heart Foundation</td>
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<tr>
<td>Vegetables</td>
<td>Restricted to only very low starch green vegetables.</td>
<td>Make vegetables and grain based foods such as breakfast cereals, bread, pasta, noodles and rice the major part of each meal. A wide variety of all types of vegetables actively encouraged.</td>
<td>Dietary patterns high in vegetables are associated with lower heart disease and contain cardioprotective components.</td>
</tr>
<tr>
<td>Fruit</td>
<td>Highly restricted.</td>
<td>Recommend snacking on a wide variety of all types of fruit.</td>
<td>Fruit contain cardioprotective components.</td>
</tr>
<tr>
<td>Fats, Margarines and Oils</td>
<td>All allowed including high saturated forms such as butter, cream, lard, dripping. Some VLCARB plans may restrict the latter and allow unrestricted oils/unsaturated margarines.</td>
<td>Limit saturated fat intake and replace with 25 g of added polyunsaturated and monounsaturated fats. Use margarine spreads instead of butter or dairy blends. Use a variety of oils for cooking – some suitable choices include canola, sunflower, soybean, olive and peanut oils. Use salad dressings and mayonnaise made from oils such as canola, sunflower, soybean and olive oils.</td>
<td>Fats high in saturated fat raise cholesterol levels whereas fats high in unsaturated fats may help lower cholesterol levels. Dietary patterns high in polyunsaturated fats and low in saturated fats lower heart disease risk.</td>
</tr>
<tr>
<td>Nuts, Seeds and Legumes</td>
<td>Moderate amounts allowed.</td>
<td>Nuts recommended as part of healthy eating, but can contribute to an excess kilojoule intake so watch quantity and frequency if weight a concern. Snack on plain, unsalted nuts and fresh fruit. Incorporate dried peas (e.g. split peas), dried beans (e.g. haricot beans, kidney beans), canned beans (e.g. baked beans, three bean mix) or lentils into two meals a week.</td>
<td>Nuts and seeds are high in unsaturated fat and may help lower cholesterol levels. Dietary patterns containing nuts are associated with lower heart disease.</td>
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<tr>
<td>Food Group</td>
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<tr>
<td>Cakes/ Biscuits/ Pastries/ Take-Aways/ Snacks</td>
<td>Excluded</td>
<td>Try to limit take-away foods to once a week. Take-away foods include pastries, pies, pizza, hamburgers and creamy pasta dishes. Try to limit snack foods such as potato crisps and corn crisps to once a week. Try to limit cakes, pastries and chocolate or creamy biscuits to once a week.</td>
<td>The majority of these foods contain saturated fats which raise cholesterol levels.</td>
</tr>
<tr>
<td>Soft Drinks</td>
<td>Excluded to only low kilojoule drinks and water.</td>
<td>Suggested to replace with low kilojoule drinks such as water, plain mineral water, soda water or diet soft drinks.</td>
<td>High sugar soft drinks are a source of excess kilojoules and are associated with obesity.</td>
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