



LOW CARBOHYDRATE DIETS: EFFECTS ON WEIGHT LOSS AND HEART DISEASE RISK FACTORS

Independent appraisal and summary of reliable research indicates similar weight loss and no additional protective effect on cardiovascular disease when compared to balanced diets

This summary is based on a systematic review

published in July 2014: Naude CE, Schoonees A, Young T, Senekal M, Garner P, Volmink J: Low carbohydrate versus isoenergetic balanced diets for reducing weight and cardiovascular risk: a systematic review and meta-analysis. PLoS ONE 2014;9(7): e100652.<http://dx.plos.org/10.1371/journal.pone.0100652>

Who is this summary for?

People making decisions about using low carbohydrate diets for weight loss in overweight and obese people with and without diabetes.

This summary includes:

Key findings from a systematic review of best available research and comments on the relevance of this research for South Africa and its interpretation. **Not included:** Recommendations and detailed descriptions of interventions or their implementation

What is a systematic review?

A summary of studies addressing a clearly formulated question that uses systematic and explicit methods to identify, select and critically appraise the relevant research, and to collect and analyse data from the included studies.

SUMMARY

This document summarises the key findings of a systematic review published in July 2014, which evaluated all relevant clinical trials comparing low carbohydrate and balanced diets [1]. The review shows that over 2 years, in overweight and obese people with and without diabetes, the two diets have similar effects on weight, and similar effects on risk factors for heart disease and markers of diabetes.

6 KEY MESSAGES

WEIGHT LOSS

1. Overweight and obese people with or without diabetes lose weight if they restrict their daily energy intake, irrespective of whether they follow a low carbohydrate or balanced diet.
2. Weight loss is the result of reduced energy (kilojoule) intake regardless of the proportions of carbohydrate, fat and protein that make up the total energy content of the diet.
3. Average weight loss varies with both diets, but there is no evidence from the pooled results that one diet type leads to more weight loss than the other when total energy in the diets is similar.
4. The longest follow-up in trials is 2 years, so any differences in long-term effects remain unknown.

HEART DISEASE RISK

5. Low carbohydrate diets and balanced diets probably have similar effects on the known risk factors for heart disease including blood pressure, cholesterol levels, and diabetes markers in overweight and obese people with or without diabetes.
6. The longest follow-up in trials is 2 years, so any differences in long-term effects remain unknown.



INTRODUCTION

DIET AND OBESITY

Many people's diets are high in energy-dense foods such as highly processed and refined foods, fats and oils, full fat dairy and fatty meats and added sugar. Coupled with increasingly sedentary lifestyles, this dietary pattern is one factor that contributes to the increasing levels of obesity, and contributes to rising levels of heart disease, diabetes and other chronic lifestyle conditions.

WHAT IS A HEALTHY BALANCED DIET?

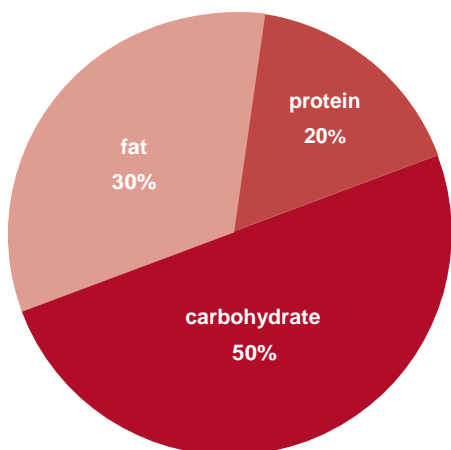
A healthy balanced diet meets the energy and nutrient requirements of an individual to maintain a healthy body weight, includes carbohydrate, fat and protein in the recommended ranges (Figure 1) and focuses on quality food choices, namely plenty of vegetables and fruit, inclusion of unrefined grains and cereals such as oats and barley, legumes such as beans and lentils, fish, lower fat dairy products, lean meats and vegetable oils. Salt, added sugar and highly processed foods are limited in a healthy diet. Long-term studies have found reduced risk of chronic lifestyle diseases with this dietary pattern [2-4]. For those trying to lose weight, standard nutritional advice is to limit overall energy intake by reducing energy-dense food choices and portion sizes, and to maintain carbohydrate, protein and fat intake within the recommended ranges.

WHAT IS A LOW CARBOHYDRATE DIET?

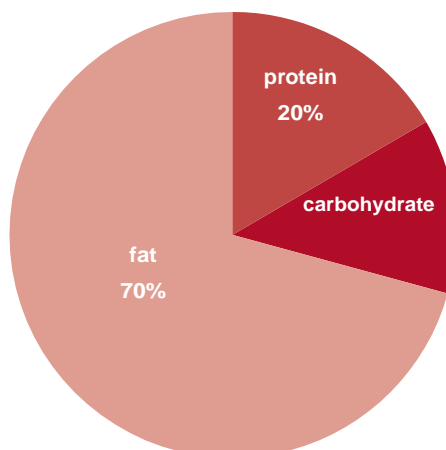
There is no universally accepted definition of low carbohydrate diets. Popular low carbohydrate diets vary in how stringent the carbohydrate restriction is, ranging from extreme e.g. 5% of total energy to 40% of total energy. Consequently, fat and protein proportions of these diets also vary and can range from being very high to moderate (Figure 1). This may result in the consumption of large amounts of fat from animal foods and plant sources of saturated fats; while avoiding all grains, cereals and legumes, with restriction of many types of vegetables and most fruits. Diets high in fat and protein are known to reduce hunger, leading to less food consumption and thus a lower energy intake. Reducing carbohydrates in the diet may also result in reduced total energy intake.

Figure 1: Typical carbohydrate, fat and protein proportions in balanced diets and in low carbohydrate high fat diets

Typical balanced diets



Typical low carbohydrate diets (with high fat)



Recommended Ranges (% of total energy):

Carbohydrate: 45 to 65%; Fat: 20 to 35%; Protein: 10 to 35%

SUMMARY OF THE SYSTEMATIC REVIEW

WHAT WAS THE AIM OF THE SYSTEMATIC REVIEW?

This systematic review [1] aimed to examine the effects of low carbohydrate diets compared to balanced diets on weight loss and the known risk factors for developing heart disease.

WHAT TYPES OF RESEARCH WERE CONSIDERED IN THE REVIEW?

The reviewers searched for randomised controlled trials directly comparing low carbohydrate diets and balanced weight loss diets (with equal energy content) in overweight and obese adults. To be included trials needed to have a minimum follow-up of 12 weeks. The review focused on the proportions (% contribution to total energy), as opposed to the type (quality) of carbohydrates, fat and protein in the diets.

HOW MANY TRIALS DID THEY FIND?

Nineteen trials with 3209 overweight and obese participants were included. The study size of included trials varied between 25 and 402 participants. Follow-up ranged from 12 weeks to 2 years. There were 14 trials in people without diabetes and five trials in people with type 2 diabetes mellitus. Two trials were only in men and the rest were mixed.

WHERE WERE THE TRIALS CONDUCTED?

Trials were conducted in high-income countries: Australia (7), United States of America (5), Spain (2), Germany (1), New Zealand (1), Norway (1), Sweden (1) and the United Kingdom (1).

WHAT DIETS WERE COMPARED?

The review included both extreme low carbohydrate diets high in both protein and fat (high fat variant), and less extreme low carbohydrate diets that are high in protein but with recommended intakes of fat (high protein variant). In this review, low carbohydrate diets were defined as those that contained less carbohydrate than the lower end of the recommended range (< 45% of total energy as carbohydrates). Statistical tests for heterogeneity showed that trials of the two low carbohydrate diet variants were similar enough; hence the results of all the trials with the same types of people could be analysed together.

GRADE: HOW MUCH CONFIDENCE CAN BE PLACED IN THE POOLED ANALYSES?

The GRADE tool is an internationally-accepted approach for grading the quality of evidence per outcome [5] and was applied in this review.²

² What do GRADE Working Group grades of evidence mean?

High quality: Further research is very unlikely to change our confidence in the estimate of effect.

Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low quality: We are very uncertain about the estimate.



What were the main findings of the review:

Question 1 Do low carbohydrate diets result in more weight loss compared to recommended balanced diets?

MAIN FINDINGS

- Overweight and obese people with or without diabetes lost weight if they restricted their daily energy intake, irrespective of whether they followed the low carbohydrate or balanced diet.
- Average weight loss in the trials varied with both diets, but there was no evidence from the pooled results that one diet type led to more weight loss than the other over 2 years.
- The longest follow-up in trials was 2 years, so any differences in long-term effects remain unknown.

SUMMARY OF FINDINGS FOR WEIGHT LOSS

Patient or population: Overweight and obese adults, some with diabetes

Setting: Primary care

Intervention: Low carbohydrate diets (energy restriction with low carbohydrate intake)

Comparison: Balanced diet plans (energy restriction with balanced macronutrient intake)

Outcomes	Balanced diets	Low carbohydrate diets	No. of participants (studies)	Quality of the evidence (GRADE) ^a
Weight loss at 3-6 months	Overweight or obese		1745 (14 studies)	⊕⊕⊕⊖ moderate ^{1,2}
	Average weight loss in people on balanced diets in randomised trials	Comparative average weight loss in people on low carbohydrate diets in randomised trials (95%CI)		
	Average weight loss ranged from 2.65 kg to 9.40 kg	0.74 kg extra weight lost on average (could be 1.49 kg extra to 0.01 kg less lost)		
	Overweight or obese and diabetic		599 (5 studies)	⊕⊕⊖⊖ low ^{3,4}
Average weight loss ranged from 3.08 kg to 5.4 kg	0.82 kg less weight lost on average (could be 1.25 kg extra to 2.9 kg less lost)			
Weight loss at 1-2 years	Overweight or obese		1025 (7 studies)	⊕⊕⊕⊖ moderate ⁵
	Average weight loss ranged from 3.5 kg to 10.9 kg	0.48 kg extra weight lost on average (could be 1.44 kg extra to 0.49 kg less lost)		
	Overweight or obese and diabetic		492 (4 studies)	⊕⊕⊕⊖ low ^{6,7}
	Average weight loss ranged from 2.1 kg to 6.0 kg	0.91 kg less weight lost on average (could be 2.08 kg extra to 3.89 kg less lost)		

CI: Confidence interval; ^aGRADE Working Group grades of evidence [5]

1 Downgraded by 1 for risk of bias: 8 of 14 studies did not report adequate sequence generation and 13 studies did not report adequate allocation concealment. 4 studies had high total attrition (>20%) and 2 other studies had differential attrition.

2 Not downgraded for inconsistency: no qualitative heterogeneity; some quantitative heterogeneity, to be expected.

3 Downgraded by 1 for risk of bias: 1 of 5 studies did not report adequate sequence generation and 3 of 5 studies did not report adequate allocation concealment. 1 study had high total attrition (>20%) and 2 studies had differential attrition.

4 Downgraded by 1 for imprecision: difference in mean weight loss ranges from a loss of 1.25 to a gain of 2.9 kilograms.

5 Downgraded by 1 for risk of bias: 5 of 7 studies did not report adequate sequence generation and only 1 reported adequate allocation concealment. 5 studies were judged to have a high or unclear risk of attrition bias.

6 Downgraded by 1 for risk of bias: 2 of 4 studies did not report adequate allocation concealment. 1 study had high total attrition (>20%) and 2 studies had differential attrition.

7 Downgraded by 1 for imprecision: The 95% confidence interval includes both a loss of 2.08 kg and a gain of 3.89 kg.

Question 2 Do low carbohydrate diets have additional benefits for heart disease and diabetes risk compared to recommended balanced diets?

MAIN FINDINGS

- Changes in average blood pressure, blood cholesterol and HbA1c were inconsistent with low carbohydrate and with balanced diets in overweight and obese people with or without diabetes.
- Low carbohydrate diets and balanced diets probably have similar effects on the known risk factors for heart disease including blood pressure, cholesterol levels, and diabetes markers in overweight and obese people with or without diabetes.
- The longest follow-up in trials was 2 years, so any differences in long-term effects remain unknown.

SUMMARY OF FINDINGS FOR MARKERS OF RISK OF HEART DISEASE AFTER 1-2 YEARS

Patient or population: Overweight and obese adults

Setting: Primary care

Intervention: Low carbohydrate diet plans (energy restriction with low carbohydrate intake)

Comparison: Balanced diet plans (energy restriction with balanced macronutrient intake)

Follow-up: 1-2 years after starting the diet

Outcomes	Balanced diets	Low carbohydrate diets	No. of participants (studies)	Quality of the evidence (GRADE) ^a
	Range of change in average values compared to pre-diet levels	Comparative average change in people on low carbohydrate diets (95%CI)		
Diastolic blood pressure	Average diastolic blood pressure after 1-2 years ranged from 1 mmHg lower to 11 mmHg lower	0.03 mmHg lower average diastolic blood pressure (could be 1.68 mmol/L lower to 1.62 mmol/L higher)	914 (6 studies)	⊕⊕⊕⊖ moderate ¹
Systolic blood pressure	Average systolic blood pressure after 1-2 years ranged from 10 mmHg lower to 8 mmHg higher	2 mmHg lower average systolic blood pressure (could be 5 mmHg lower to 1 mmHg higher)	914 (6 studies)	⊕⊕⊕⊖ moderate ¹
LDL cholesterol	Average LDL cholesterol after 1-2 years ranged from 0.79 mmol/L lower to 0.06 mmol/L higher	0.07 mmol/L higher average LDL cholesterol (could be 0.01 mmol/L lower to 0.16 mmol/L higher)	915 (6 studies)	⊕⊕⊕⊖ moderate ¹
HDL cholesterol	Average HDL cholesterol after 1-2 years ranged from 0.03 mmol/L lower to 0.15 mmol/L higher	0.04 mmol/L higher HDL cholesterol (could be 0.01 mmol/L to 0.08 mmol/L higher)	986 (7 studies)	⊕⊕⊕⊖ moderate ²
Total cholesterol	Average total cholesterol after 1-2 years ranged from 0.76 mmol/L lower 0.13 mmol/L higher	0.06 mmol/L higher average HDL cholesterol (could be 0.03 mmol/L lower to 0.16 mmol/L higher)	915 (6 studies)	⊕⊕⊕⊖ moderate ¹
Triglycerides	Average triglycerides after 1-2 years ranged from 0.44 mmol/L lower to 0.06 mmol/L higher	0.06 mmol/L lower triglycerides (could be 0.14 mmol/L lower to 0.03 mmol/L higher)	915 (6 studies)	⊕⊕⊕⊖ moderate ¹

CI: Confidence interval; ^a GRADE Working Group grades of evidence [5]

1 Downgraded by 1 for risk of bias: 4 of 6 studies did not report adequate sequence generation and 5 studies did not report adequate allocation concealment.

2 studies had high total attrition (>20%), 1 of which also had differential attrition.

2 Downgraded by 1 for risk of bias: 5 of 7 studies did not report adequate sequence generation and only 1 reported adequate allocation concealment.

5 studies were judged to have a high or unclear risk of attrition bias.



SUMMARY OF FINDINGS FOR HEART DISEASE RISK IN PEOPLE WITH DIABETES AFTER 1-2 YEARS

Patient or population: Overweight or obese adults with type 2 diabetes

Settings: Primary care

Intervention: Low carbohydrate diets (energy restriction with low carbohydrate intake)

Comparison: Balanced diets (energy restriction with balanced macronutrient intake)

Follow-up: 1-2 years after starting diet

Outcomes	Balanced diet	Low carbohydrate diets	No. of participants (studies)	Quality of the evidence (GRADE) ^a
	Range of change in average values compared to pre-diet levels	Comparative average change in people on low carbohydrate diet plans (95%CI)		
HbA1c	Average HbA1c after 1-2 years ranged from 0.28% lower to 0.4% higher	0.01 % higher average HbA1c (could be 0.28% lower to 0.3% higher)	492 (4 studies)	⊕⊕⊕⊖ moderate ¹
Diastolic blood pressure	Average diastolic blood pressure after 1-2 years ranged from 6 mmHg lower to 2.5 mmHg higher	0.09 mmHg higher average diastolic blood pressure (could be 1.95 mmHg lower to 2.13 mmHg higher)	492 (4 studies)	⊕⊕⊕⊖ moderate ²
Systolic blood pressure	Average systolic blood pressure after 1-2 years ranged from 11 mmHg lower to 3.7 mmHg higher	0.31 mmHg higher average systolic blood pressure (could be 3.1 mmHg lower to 3.72 mmHg higher)	492 (4 studies)	⊕⊕⊕⊖ moderate ²
LDL cholesterol	Average LDL cholesterol after 1-2 years ranged from 0.3 mmol/L lower to 0.04 mmol/L higher	0.10 mmol/L higher average LDL cholesterol (could be 0.06 mmol/L lower to 0.27 mmol/L higher)	492 (4 studies)	⊕⊕⊕⊖ moderate ¹
HDL cholesterol	Average HDL cholesterol after 1-2 years higher by 0.02 mmol/L to 0.19 mmol/L	No difference in average HDL cholesterol (could be 0.09 mmol/L lower to 0.08 mmol/L higher)	492 (4 studies)	⊕⊕⊕⊖ moderate ¹
Total cholesterol	Average total cholesterol after 1-2 years ranged from 0.3 mmol/L lower to 0.35 mmol/L higher	0.10 mmol/L higher average total cholesterol (could be 0.12 mmol/L lower to 0.31 mmol/L higher)	492 (4 studies)	⊕⊕⊕⊖ moderate ¹
Triglycerides	Average triglycerides after 1-2 years lower by 0.1 mmol/L to 0.3 mmol/L	0.08 mmol/L lower average triglycerides (could be 0.49 mmol/L lower to 0.26 mmol/L higher)	198 (3 studies)	⊕⊕⊖⊖ low ^{3,4}

CI: Confidence interval; ^aGRADE Working Group grades of evidence [5]

1 Downgraded by 1 for risk of bias: 2 of 4 studies did not report adequate allocation concealment, 2 studies had high total attrition (>20%) and 2 studies had differential attrition.

2 Downgraded by 1 for risk of bias: 2 of 4 studies did not report adequate allocation concealment. 1 study had high total attrition (>20%) and 2 studies had differential attrition.

3 Downgraded by 1 for risk of bias: 1 of 3 studies did not report adequate allocation concealment. 2 studies had high total attrition (>20%) and 2 studies had differential attrition.

4 Downgraded by 1 for imprecision: confidence interval range is about 0.7 mmol/L.



WHAT IS THE RELEVANCE OF THIS EVIDENCE FOR SOUTH AFRICA?

Being overweight and obese increases the risk of heart disease, type 2 diabetes, high blood pressure, stroke and other chronic lifestyle conditions. As people's weight increases, these risks also tend to increase. Overweight and obesity is a serious public health concern in South Africa and its impact and costs extend to individuals, families, communities, the health service, and society as a whole.

About 2 in 3 adult South Africans are either overweight or obese (BMI ≥ 25 kg/m²), and about 1 in 3 are obese (BMI ≥ 30 kg/m²), with more women (43%) than men (23%) being affected [6]. Heart disease and diabetes are also major problems in this country. In 2008, deaths from heart disease and diabetes in South African males were twice those of males in the United States (328 versus 190 per 100 000), and in South African females the rates were more than double those in their US counterparts (315 versus 122 per 100 000) [7].

Current diets of most South Africans are not healthy, with foods that are energy-dense, highly processed, high in salt, added sugar and unhealthy fats being common, and healthy foods such as fruit and vegetables, unrefined cereals and grains, legumes, fish and those with healthy fats being less common. Improving the diets of South Africans is an important step in preventing and managing obesity, heart disease, stroke and diabetes. Creating enabling environments that promote the intake of healthier foods will help achieve this. In South Africa, low carbohydrate high fat diets are currently widely promoted by advocates as a long-term lifestyle choice for weight loss, and heart and diabetes-related benefits. This has increased public awareness of the role of diet in overweight and obesity. The results of this review provide important insights into the potential value of different dietary approaches for preventing and managing these conditions. Significantly, this review indicates no clear advantages of low carbohydrate diets in terms of weight loss or prevention of heart disease and diabetes.

ADDITIONAL PERSPECTIVES ON THE EVIDENCE FROM THIS REVIEW

WEIGHT LOSS:

- Sustained energy deficit results in weight loss regardless of proportions of carbohydrates, fat and protein in the diet ("energy-in versus energy-out") [8].
- In this review, the similar reported average energy intakes in the low carbohydrate and balanced diet groups and the corresponding similar average weight loss in the diet groups, supports this fundamental physiologic principle of energy balance.

HEART DISEASE AND DIABETES:

- Weight loss alone improves markers of heart disease and diabetes risk, such as blood pressure and blood lipids [9-11]. Clinically meaningful changes in heart disease risk indicators are associated with a loss of at least 2.5 kg, or 2% of body weight [12].
- This review did not address the type (quality) of the carbohydrates, fat and protein in the diets, only their proportions (quantity). Quantity and type of carbohydrates and fat influence heart disease risk factors and diabetes markers [13-16].
- This review [1] found that changes in average blood pressure, blood lipids and diabetes markers over 2 years varied in participants in both diet groups. Variability can be attributed to the following:
 - not all participants had equally good adherence to carbohydrate, fat and protein goals of the two diets
 - not all low carbohydrate and balanced diets had precisely the same amounts and types of fat and carbohydrates
 - the degree of weight loss was not the same across the different trials.
- Diet is not the only risk factor for chronic lifestyle diseases like heart disease and diabetes. These conditions develop over many years of exposure to unhealthy diets and other risk factors, so it is a cumulative risk, based on many risk factors (family history, age physical activity, smoking, high blood pressure).
- The maximum period of follow-up in the trials included in this review was 2 years. This is too short a period to provide an adequate picture of heart disease and diabetes risk over the long-term.



THE UNANSWERED QUESTIONS

WHAT ARE THE EFFECTS OF LOW CARBOHYDRATE HIGH FAT DIETS OVER THE LONG-TERM?

- There is little data on the long-term benefits and harms associated with low carbohydrate high fat diets and the dietary pattern accompanying this approach.

ADHERENCE TO WEIGHT LOSS DIETS

- Adherence to dietary prescriptions and recommendations may be the single most important factor determining whether people are able to achieve the required energy deficit for weight loss [8].

- The problem of adherence was also seen in this systematic review, where strict adherence to reduced energy and the macronutrient goals was unsuccessful with both diets in most trials and generally declined over time [1]. Although the energy intake was not always in line with the energy prescription, the average reported energy intake did not differ between the diet groups being compared, and this similar energy intake translated into similar weight losses in the low carbohydrate and balanced diet groups [1].

SUGGESTED CITATION:

Naude CE, Schoonees A, Young T, Senekal M, Garner P, Volmink J. Low carbohydrate diets: effects on weight loss and heart disease risk factors - summary based on a systematic review of randomised controlled trials. July 2014

COMPETING INTERESTS AND FINANCIAL DISCLOSURE:

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