To carb or not to carb in diabetes management

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The following article aims to provide a brief summary of current dietary guidelines and research findings for the dietary management of type 2 diabetes and type 1 diabetes. Low-carbohydrate, high-fat diets have recently become popular, and have caught the attention of some members of the scientific community and the public. The author will consider the current research and present the evidence demonstrating why we should be cautious of the low-carbohydrate diet, citing international guidelines to instead promote an individualised, balanced diet.

The *Australian Dietary Guidelines* provide information for the general population on eating for health and wellbeing (National Health and Medical Research Council, 2013). The guidelines have a strong evidence-base and include the principles of achieving and maintaining a healthy weight, being physically active and choosing amounts of nutritious food and drinks to meet energy needs; enjoying a wide variety of nutritious foods from the five groups every day (*Figure 1*); and limiting intake of foods containing saturated fat, added salt, added sugars and alcohol.

Medical nutrition therapy in diabetes

Insulin responds directly to food ingested, so diet has always been an integral part of the management of diabetes and glycaemic control. People with diabetes are encouraged to follow the dietary guidelines and consume the recommended amounts of food from the five food groups (grains, vegetables, fruits, dairy and protein).

Over recent years, the term "diet therapy" has been replaced with medical nutrition therapy (MNT) and encompasses individualised nutritional recommendations based on assessment and treatment goals and outcomes, with consideration to usual eating habits and lifestyle factors (Escott-Stump, 2008). MNT is considered the first line of treatment in the prevention and management of type 2 diabetes and is an essential part in the management of type 1 diabetes (Marsh et al, 2011).

In this article, current dietary guidelines for adults and children with diabetes are discussed, as is the evidence demonstrating why we should be cautious of the low-carbohydrate diet – a diet that has gained in popularity over recent years.

MNT guidelines for adults with diabetes

The American Diabetes Association (ADA) standards of medical care (ADA, 2016) identifies MNT as an integral component of diabetes prevention, management and self-management education, indicating that all individuals with diabetes should receive individualised MNT provided by a registered dietitian with the appropriate knowledge and skills in diabetes. The goals of MNT for adults with diabetes are the following:

- Promote and support healthy eating patterns, acknowledging the inclusion of nutrient-dense foods in appropriate portion sizes.
- Acknowledge nutritional needs based on individual and cultural preferences, health literacy and numeracy skills, access to foods and behavioural changes, and barriers to change.

Citation: Date S (2016) To carb or not to carb in diabetes management. *Diabetes & Primary Care Australia* **1**: 101–5

Article points

1. Low-carbohydrate diet has gained in popularity over recent years for people with type 2 diabetes for weight loss and improved glycaemic control.
2. No diet exists that will work for everyone with diabetes and, hence, focus on one particular type of diet may not be helpful.
3. Consuming a wide range of nutritious foods in recommended portion sizes to achieve optimal health and diabetes management is vital and can be achieved by seeking individualised nutrition care from an accredited practising dietitian.

Key words

- Carbohydrate
- Fat
- Low-carb diet
- Macronutrients
- Protein

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Figure 1. Australian guide to healthy eating (National Health and Medical Research Council, 2013).

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1. International dietary guidelines for adults and children with diabetes recommend that individuals follow a balanced diet including elements from all food groups.
2. Carbohydrate has been considered the predominant macronutrient affecting postprandial glucose levels.
3. Choosing low glycaemic index foods or lowering the total carbohydrate content of the meal can decrease the glycaemic load of the meal and reduce postprandial glucose excursion.

- Provide non-judgmental messages about food so that individuals can continue to experience the pleasure of eating.
- Provide practical tools for healthy eating patterns rather than focusing on individual macro- and micro-nutrients.

MNT guidelines for children with diabetes

The 2014 International Society for Pediatric and Adolescent Diabetes (ISPAD) clinical practice consensus guidelines for the nutritional management of children and adolescents with diabetes identify similar recommendations. The recommendations are based on healthy eating principles suitable for children and families with aims to improve diabetes outcomes and reduce cardiovascular risk (Smart et al, 2014):

- Encourage appropriate eating behaviours.
- Incorporate a variety of nutritious foods from all food groups that will supply essential nutrients, maintain a healthy weight and prevent bingeing.
- Provide appropriate energy intake and nutrients for optimal growth, development and good health.
- Achieve and maintain an appropriate BMI and waist circumference.
- Achieve a balance between food intake, metabolic requirements, energy expenditure and insulin action to attain optimum glycaemic control.
- Prevent and treat acute complications of diabetes.
- Reduce the risk of micro and macro-vascular complications.
- Maintain and preserve quality of life.
- Develop a supportive relationship to facilitate behaviour change.

Effect of macronutrients on glycaemic control

National guidelines in Australia and Canada for adults and children with diabetes recommend that 40–60% of energy comes from carbohydrate intake, 30–35% of energy comes from fat, with less than 10% of energy from saturated fat, and 15–20% of energy from protein based on an individualised assessment (Smart et al, 2014).

Carbohydrate

Carbohydrate has been considered the predominant macronutrient affecting postprandial glucose levels; however, recent studies using continuous glucose monitoring systems have demonstrated the significant effect of fat, protein and glycaemic index (GI) on postprandial glucose excursion (Bell et al, 2015).

Glycaemic index and glycaemic load

The glycaemic index (GI) is a ranking of carbohydrates on a scale of 0 to 100 according to the extent to which the carbohydrate raises blood glucose levels after eating. High-GI foods are rapidly digested and absorbed, and so result in fluctuations and spikes in blood glucose level. Low-GI foods are digested and absorbed slowly and result in gradual rises in blood glucose level and insulin levels. Low-GI foods have proven benefits for health (Greenwood et al, 2013). The "glycaemic load" (GL) combines the quantity and quality of carbohydrate to estimate the overall effect of ingested carbohydrate on blood glucose and insulin levels. GL can be used

to compare different amounts of foods with different GIs and is calculated by multiplying the GI by the amount of carbohydrate per serving of food in grams. Choosing low GI foods or lowering the total carbohydrate content of the meal can decrease the GL of the meal and reduce postprandial glucose excursion.

The effect of GI and the GL in people with diabetes is complex. Lower GI diets may assist in the management of type 1 and type 2 diabetes but are not associated with weight loss (Greenwood et al 2013; National Health and Medical Research Council, 2013). Individuals with diabetes are encouraged to replace refined carbohydrates and added sugars with whole grains, legumes, vegetables and fruit and consider avoiding low-fat, non-fat products with high amounts of added sugars (ADA, 2016).

Fat

In a systematic review of the effect of fat on postprandial glycaemic control in type 1 diabetes, the evidence suggests that meals containing carbohydrates and that are high in dietary fat cause sustained late postprandial hyperglycaemia (Bell et al, 2015).

The studies investigated added varying amounts of fat (6.6 to 52 g) to a test meal. A meal with a high fat content was found to delay gastric emptying for up to 2 hours and increase the risk of hypoglycaemia followed by substantial hyperglycaemia for several hours postprandially, which has an effect on glycaemic control. This observation may be attributed to the increased free fatty acids, which induce insulin resistance, and increased hepatic glucose output (Roden et al, 1996).

The ADA (2016) identifies inconclusive data on the effect of total fat intake and gives no tolerable upper level for intake. The type of fat consumed is considered to be of more significance than the total amount of fat, with meals rich in monounsaturated fat compared to saturated fat found to have a beneficial effect on glycaemic control and blood lipids.

Protein

Meals rich in protein may result in delayed and sustained postprandial glucose excursions requiring increased insulin in people with type 1 diabetes (Paterson et al, 2016). It has been suggested that the addition of ≥28 g of protein to a mixed meal or consuming ≥75 g of protein alone is likely to result in significant and sustained postprandial hyperglycaemia commencing in the late postprandial period and continuing beyond 5 hours in people with type 1 diabetes (Paterson et al, 2015). It has been demonstrated that there is a continued rise in blood glucose levels over 5 hours for a 75 g to 100 g protein intake compared to 20 g glucose (Paterson et al, 2016; see *Figure 2*).

Dietary fat and protein have been found to impact postprandial glycaemic control in people with type 1 diabetes long after consuming food, and the effect of protein and fat is found to be additive on postprandial glucose concentrations (Paterson et al, 2015). Insulin dosing algorithms based on the total meal composition compared to carbohydrate content alone requires further investigation (Bell et al, 2015).

Page points

1. In a systematic review of the effect of fat on postprandial glycaemic control in type 1 diabetes, the evidence suggests that meals containing carbohydrates and are high in dietary fat cause sustained late postprandial hyperglycaemia.
2. Meals rich in protein may result in delayed and sustained postprandial glucose excursions requiring increased insulin in people with type 1 diabetes.
3. Dietary fat and protein have both been found to impact postprandial glycaemic control in people with type 1 diabetes long after consuming food, and the effect of protein and fat is found to be additive on postprandial glucose concentrations.

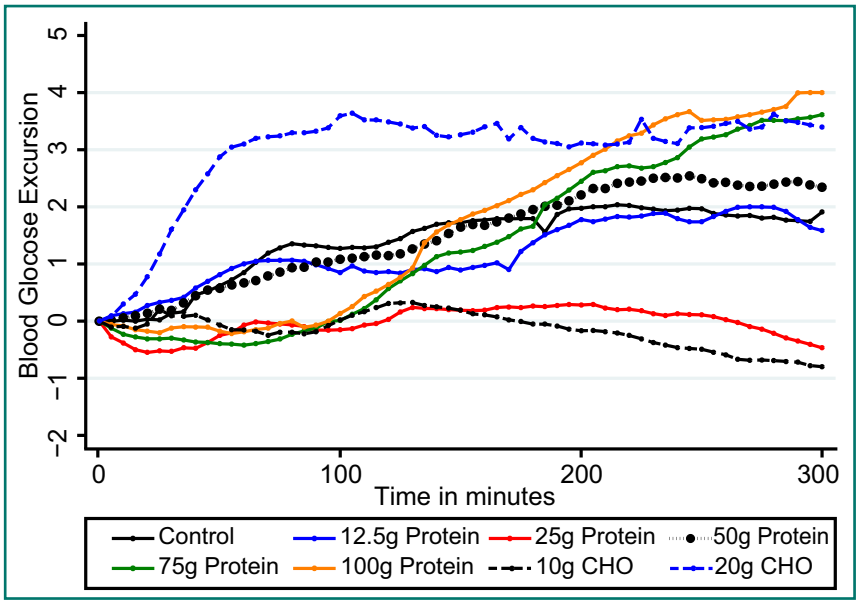

Figure 2. Mean postprandial glycaemic excursions (mmol/L) for 27 participants following consumption of 8 test drinks containing 0, 12.5, 25, 50, 75 and 100 g of protein; with two glucose (CHO) test drinks given for comparison, in amounts of 10 and 20 g without insulin. Compared with 0; protein loads of 75 g or 100 g produced significantly higher glycaemic excursions from 180–240 min (P=0.002) and 240–300 min (P<0.001). Glucose levels from 75 and 100 g protein were similar to that of 20 g CHO given without insulin, although the shape of the response was different. CHO=carbohydrate. (Republished with permission from Paterson et al [2016] and John Wiley and Sons.)

Page points

1. It can be difficult to measure the success of the low-carbohydrate diet in studies as the definition of low carbohydrate can vary from study to study.
2. Although some nutritional professionals may consider a low-carbohydrate, high-fat diet to achieve short-term health goals, the effectiveness and safety over an extended period of time have not been examined.
3. A diet high in total fat and saturated fat and low in carbohydrates can worsen diabetes control in individuals with type 1 diabetes.

For individuals with diabetes with normal kidney function, the ADA (2016) suggests that the evidence is inconclusive about recommending an ideal amount of protein for optimal glycaemic control. For those with diabetic kidney disease, dietary protein should be maintained at the recommended daily allowance of 0.8 g/kg body weight per day.

Low-carbohydrate, high-fat, high-protein diet

In recent times, there has been an increasing trend towards following a low-carbohydrate, high-fat, high-protein diet for diabetes management to promote glycaemic control and encourage weight loss. It can be difficult to measure the success of the low-carbohydrate diet in studies as the definition of low carbohydrate can vary from study to study. Feinman et al (2015) suggested the following carbohydrate amounts for low, medium or high-carbohydrate diets based on recommendations from the ADA and National Health and Nutrition Examination Survey.

- Low-carbohydrate diet: <130 g/day of carbohydrate.
- Moderate-carbohydrate diet: 130–230 g/day of carbohydrate.
- High-carbohydrate diet: >230 g/day of carbohydrate (Feinman et al, 2015).

Dietitians Association of Australia (2015) recently released a summary of key conclusions regarding the use of low-carbohydrate, high-fat, high-protein diets in diabetes management and identified that no diet exists that works for everyone with diabetes and, hence, focus on one particular type of diet may not be helpful.

Low-carbohydrate, high-fat, high-protein diet in type 2 diabetes

Tay et al (2015) recently conducted a randomised control trial in 115 obese individuals with type 2 diabetes comparing the effect of a very-low carbohydrate, high-unsaturated fat diet (VLCHF) to a high-carbohydrate, low-fat diet (HCLF) for 52 weeks. The energy distribution in the LCHF diet was 14% of energy as carbohydrate, 28% energy as protein and 58% energy as fat, with less than 10% saturated fat. The HCLF diet comprised of 53% energy from carbohydrate, 17% energy from protein and 30% of energy from fats, with less than 10% energy from saturated fat. Both study groups were involved in moderate-intensity aerobic and resistance exercises for diabetes management 3 days a week with regular reviews throughout the study period.

Results identified that both groups were able to achieve substantial weight loss and a reduction in HbA_{1c} and fasting glucose levels. The VLCHF diet, high in unsaturated fat and low in saturated fat, achieved greater improvements in lipid profile and blood glucose levels, and a reduction in anti-diabetes medication. The weight loss observed in both groups was attributed to the intense lifestyle intervention of the study, which included a detailed diet and exercise prescription with regular professional support.

The study had some limitations and excluded individuals with comorbidities commonly associated with diabetes, such as impaired renal function, cardiovascular disease and a history of smoking. Also, the long-term impacts of such diets on health parameters, as well as the potential impacts on overall nutritional intake in view of whole food groups being reduced, warrants further investigation prior to recommending this approach at a population level, such as a very-low carbohydrate ketogenic diet providing 20–50 g carbohydrate per day (Evert et al, 2014). Although some nutritional professionals may consider a low-carbohydrate, high-fat diet to achieve short-term health goals, the effectiveness and safety over an extended period of time have not been examined (Dietitians Association of Australia, 2015).

In order for similar results to those reported by Tay et al (2015) to be replicated in a community setting, it may be necessary for medical teams to consider a focused multidisciplinary lifestyle intervention prescription for the prevention and management of diabetes. Individuals with diabetes need support from an experienced, multidisciplinary healthcare team, and self-management advice needs to be tailored to individual needs to help them manage their diabetes.

Low-carbohydrate, high-fat, high-protein diet in type 1 diabetes

A diet high in total fat and saturated fat and low in carbohydrates can worsen diabetes control in individuals with type 1 diabetes (Dworatzek et al, 2013). High-fat, high-protein meals require more insulin to control late postprandial hyperglycaemia than low-fat and protein meals with similar carbohydrate content (Bell et al, 2015). It is anticipated that a low-carbohydrate, high-fat high-protein diet for individuals with type 1 diabetes will require insulin dose adjustments for excess protein to reduce the risk of unstable blood glucose levels (Paterson et al, 2015).

One of the challenging aspects of type 1 diabetes management is carbohydrate counting. With high-fat, high-protein diets warranting quantification to determine insulin dosing, this may further create additional burden that few can overcome (Bell et al, 2015).

Low-carbohydrate, high-fat, high-protein diet in children and adolescents

Bearing in mind the recent popularity of the low-carbohydrate, high-fat, high-protein diet in diabetes, there is international agreement that carbohydrates should not be restricted in children and adolescents with type 1 diabetes as it may result in deleterious effects on growth (Smart et al, 2014) High-protein diets comprising of >25% energy are also not advised in children for similar reasons. Meals rich in protein may result in delayed and sustained postprandial glucose excursions requiring increased insulin in people with type 1 diabetes (Paterson et al, 2016).

Conclusion

Diabetes is a serious and complex condition, and there is no standard eating plan that works universally for all people with diabetes. Effective nutrition therapy is based on individualised health goals, awareness of cultural and personal preferences, health literacy and numeracy, access to healthy choices and a readiness, willingness and ability to change (Evert et al, 2014).

The evidence-based *Australian Dietary Guidelines* released in 2013 provide the most appropriate guide to healthy eating for the entire population (National Health and Medical Research Council, 2013). Consuming a wide range of nutritious foods in recommended portion sizes to achieve optimal health and diabetes management is vital and can be achieved by seeking individualised nutrition care from an accredited practising dietitian. ■

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