CLINICAL USES FOR LOW CARBOHYDRATE DIETS

Maeve Hanan
Registered Dietitian (full time), City Hospitals Sunderland

The recommended daily intake of carbohydrates for the general public is around 50% of daily total dietary energy, which is roughly 313g of carbohydrates per day for the average man and 250g for the average woman.[1] Low carbohydrate diets (LCDs) involve eating less than 26% of your daily total calorie intake from carbohydrates.[1,2]

Maeve works as a Paediatric Dietitian in City Hospitals Sunderland. She also runs a blog called Dietetically Speaking.com which promotes evidence-based nutrition and dispels misleading nutrition claims and fad diets.

For full article references please email info@networkhealthgroup.co.uk

MECHANISM OF LCDs

There are many variations of low carbohydrate diets (see Table 1) which can either be viewed as a fad or a valid clinical diet depending on the context. Limiting carbohydrate intake reduces the rate of insulin released from the pancreas and promotes glucagon secretion which causes the following:[3]

- Glycogenolysis: the breakdown of carbohydrate stored in liver and muscle tissue so that glucose can be used as an energy source.
- Gluconeogenesis: creating new glucose (to be used as an energy source) using non carbohydrate sources such as certain amino acids, pyruvate, lactate and glycerol.
- Lipolysis: the breakdown of fat into glycerol and free fatty acids.

More extreme LCDs cause a type of fat burning called ketosis which is a compensatory mechanism usually occurring in starvation. When glycogen stores are depleted, fatty acid oxidation can occur in the liver which produces ketones (or ketone bodies) which can be converted and used as an energy source. However, roughly 10-20% of ketone bodies are thought to be excreted via the skin, urine and breath without being metabolised.[3] Although ketosis can result in acidosis in a person who has diabetes, this is not usually seen to occur in starvation or carbohydrate restriction in non-diabetic subjects.[3]

EPILEPSY AND METABOLIC DISORDERS

The 'ketogenic diet' (KD) is a low carbohydrate, high fat diet which was developed in the 1920s to treat epilepsy in children. This can still be used today under medical and dietetic guidance for children who don't tolerate or don't respond to epilepsy medication.[4-5] Although NICE supports this use of the KD, there is no official recommendation related to the treatment of adult epilepsy due to limited evidence.[6]

Table 1: Classification of LCDs[1-2]

Classification	Daily carbohydrate limit*	% of daily calorie intake from carbohydrates	Examples
Moderate carbohydrate diet	130 - 225g	26 - 45%	The Scarsdale Diet The Zone Diet
Low carbohydrate diet	Less than 130g	Less than 26%	The Paleo Diet The Drinking Man's Diet
Very-low carbohydrate diet	Less than 30g	Less than 6%	The Ketogenic Diet The Atkins Diet

*Based on a 2,000kcal daily intake (the recommended daily calorie intake for a moderate active woman who weighs about 60kg)

Table 2: Variations of ketogenic diets

Type of diet	Diet composition
The Classical ketogenic diet (KD)	A ratio of 3-4g of fat is given for every 1g of carbohydrate and protein.[7]
The Modified Atkins diet (MAD)	Restricts carbohydrates to 15-20g per day but doesn't restrict protein and encourages fat intake.[8]
The Low Glycaemic Index Treatment (LGIT)	40-60g of carbohydrates are allowed per day (portion sizes are used as a guide), low GI options are encouraged, fats are encouraged and protein is unrestricted.[4,9,10]
The medium chain triglyceride (MCT) ketogenic diet	60% of energy is derived from MCT fat, or a modified version to improve tolerance which has 30% MCT, plus 30% from long chain fatty acids.[7]

Table 3: Carbohydrate sources and cardiometabolic health associations (SACN 2015)[1]

Carbohydrate	Association
High intake of sugars-sweetened beverages	Increased risk of Type 2 diabetes.
Diet high in Glycaemic Index or glycaemic load	Increased risk of Type 2 diabetes.
High glycaemic load	Increased risk of cardiovascular disease.
High intake of white rice	Increased risk of Type 2 diabetes in certain Asian populations.
Consuming brown rice	Reduced risk of Type 2 diabetes.
High intake of potatoes	Increased risk of Type 2 diabetes - but it is not possible to establish a causal link due the confounding factors such as varied cooking methods (e.g. frying potatoes).
High intake of dietary fibre, cereal fibre and wholegrains	Reduced incidence of Type 2 diabetes, cardiovascular disease and coronary events.
High intake of bran and beta-glucan	Lower total cholesterol, LDL cholesterol and blood pressure.

The KD can also be used under medical and dietetic supervision with certain metabolic conditions such as: pyruvate dehydrogenase deficiency (PDH) and glucose transporter type 1 deficiency syndrome (GLUT1).[4] The main types of KDs used in clinical practice are outlined in Table 2.

WEIGHT MANAGEMENT

Although some meta-analyses identified that LCDs resulted in more weight loss than other dietary methods,[11-12] when SACN reviewed the overall evidence base in 2015 they concluded that energy-restricted high carbohydrate low fat diets were more beneficial in reducing BMI as compared to LCDs.[1] Some suggested reasons for the weight loss seen on LCDs include a loss of fluid as the process of breaking down glycogen stores can result in about 1kg weight loss as a result of fluid loss,[3,13] and a reduction in calories which may be partially due to the satiating effect of a high protein intake.[4,14-15] However, SACN (2015) found no significant difference in energy intake when diets with different proportions of carbohydrates, protein and fat were compared.[1] SACN also found that although sugar-sweetened drinks were associated with weight gain and a higher BMI in children and adolescents, when the total amount of carbohydrate in the diet was examined in this group, no association was found between carbohydrate intake and BMI or body fatness.[1]

Evidence is conflicting in terms of compliance when LCDs are compared with low fat diets.[15-16] However, for some individuals, restricting the intake of a specific food group may increase the risk of binge eating and subsequent weight gain.[17]

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CARDIOMETABOLIC HEALTH

Some studies have found an association between LCDs and improved glycaemic levels,[18-19] but SACN (2015) found that 'total carbohydrate intake appears to be neither detrimental nor beneficial to cardiometabolic health', which included glycaemia and incidence of Type 2 diabetes.[1] More recently, Diabetes UK released a position statement which concluded that for Type 2 diabetes, LCDs can be safe and effective. However, there is not enough evidence that this approach is better than others in terms of long-term weight management and glycaemic control and that 'there is no strong evidence to say that [LCDs are] safe or effective for people with Type 1 diabetes'.[20] However, there is ongoing research into carbohydrate intake and diabetes.

In terms of cardiovascular disease, some trials have identified an association between total carbohydrate intake and fasting blood lipids and systolic blood pressure.[1] However, due to confounding factors such as weight loss, it is not possible to establish a causal relationship and SACN (2015) found that total carbohydrate intake had a neutral effect on cardiovascular disease endpoints.[1] However, when different sources of carbohydrate are examined, the associated cardiometabolic health outcomes vary (see Table 3).[1]

CANCER

There is a hypothesis that KDs may be useful in combatting cancer which is based on 'The Warburg Effect'; an observation that cancer cells prefer producing energy via anaerobic glycolysis rather than oxidative phosphorylation.[21] Although there are some animal and in vitro studies which support the use of the KD with specific types of tumour cells,[22-24] there is also some contradictory research[25] and other studies have identified that ketones may actually fuel certain cancer cells.[26-27] Research is ongoing in this area, but currently, more evidence is needed before the use of the KD can be promoted as a routine treatment option for cancer, especially as this patient group are already at risk of malnutrition and cachexia.[21]

NUTRITIONAL CONSIDERATIONS

Although most people in the UK would benefit from reducing our intake of 'free sugars' (those added to foods by manufacturers, cooks or consumers, and the sugar found naturally in syrups, honey, syrups and unsweetened fruit juices), vilifying total carbohydrates intake can be harmful as it is recommend that 50% of dietary energy should come from carbohydrates.[1] Carbohydrates are the main source of fuel used by our body and are also found in many nutritious foods such as wholegrains, fruit, vegetables and dairy products.[1,26] There is strong evidence that fibre and wholegrains are associated with a lower risk of cardiovascular disease, diabetes and colorectal cancer.[1] Furthermore, an LCD may result in an increased intake of saturated fat and a high intake of saturated fat is associated with an increased risk of cardiovascular disease.[29-30] Considering that on average, UK adults already consume less fibre and more saturated fat than the recommended level,[31] an LCD could potentially have an adverse nutritional effect.

CONCLUSION

There are some well-established clinical uses for LCDs, such as using KDs with certain metabolic disorders, or for seizure control in children with epilepsy which is unresponsive to medication. However, the current evidence is more conflicting in terms of weight management and cardiometabolic health. Although in the UK we should be aiming to reduce our intake free sugars, carbohydrates are also found in many nutritious foods. Therefore, LCDs should only be encouraged in specific situations when there is a clinical indication for their use.