



NZSSD Position Statement on Ketogenic or Very-Low-Carbohydrate Diets and the Use of SGLT2-inhibitors in Adults with Type 2 Diabetes

Ketogenic or Very-Low-Carbohydrate Diets

The terms ‘ketogenic diet’ and ‘very-low-carbohydrate diet’ are often used interchangeably to describe a dietary pattern with the purpose of inducing ketosis^{1,2}. Ketogenic diets can be either isocaloric (same calorie) or low-calorie to induce weight loss via ketosis. This is achieved by heavily restricting total carbohydrate to less than 50 grams per day (or <10% total energy from carbohydrate) in order to induce dietary or nutritional ketosis. The following classification (Table 1) outlines the average carbohydrate (CHO) in grams per day derived from the mean estimated energy requirements and provides a practical tool for categorising carbohydrate restriction in adults.

Table 1: Classification of Dietary Carbohydrate Restriction

Diet description	Total Carbohydrate	% Total Energy*
Very-low-carbohydrate-ketogenic diet	<50 grams CHO per day	<10%
Low CHO diet	<130 grams CHO per day	<26%
Moderate CHO diet	130–225 grams CHO per day	26–45%

*Percentages are based on a mean 2000kcal (8.3MJ) total daily energy intake for adults

Sodium glucose co-transporter 2 (SGLT2) inhibitors

Sodium glucose co-transporter 2 (SGLT2) inhibitors have been available in Aotearoa New Zealand for a number of years (e.g. Dapagliflozin) and since February 2021 Empagliflozin (brand name: Jardiance or Jardiamet) has been approved for funding under the PHARMAC criteria. In addition to lowering blood glucose, Empagliflozin reduces risks associated with cardiovascular and kidney disease^{3,4}, co-morbidities often present in adults with Type 2 diabetes (T2D).

Empagliflozin reduces blood glucose levels and circulating volume by inhibiting the SGLT2 transporter in the proximal renal tubule, leading to increased urinary excretion of glucose and sodium, and decreased urinary excretion of ketones. Empagliflozin also enhances glucagon secretion. The combination of lowered circulating insulin and increased glucagon stimulates fat lipolysis and hepatic ketogenesis, raising ketone levels. Alongside a reduction in urinary ketone excretion, mild ketosis occurs.

Ketoacidosis associated with the use of SGLT2 inhibitors can occur even if the blood glucose level is not very high, with several case reports of euglycaemic DKA (euDKA) in those following ketogenic diets⁵⁻¹¹. This is caused by a decreased carbohydrate intake coupled with lower serum glucose resulting in further depression of insulin secretion leading to euDKA, and if suspected, the SGLT2 inhibitor should be discontinued and treatment instituted promptly^{9,11,12}.

Sodium glucose co-transporter 2 (SGLT2 inhibitors and dietary recommendations)

A very-low-carbohydrate or ketogenic diet is not recommended in combination with an SGLT2 inhibitor as these could further increase the production of ketones, particularly during times of intercurrent illness, dehydration, and/or metabolic stress, leading to diabetes ketoacidosis or DKA¹³⁻¹⁶; although there appears to be no increased risk of DKA with SGLT2 inhibitors when fasting for short periods without carbohydrate restriction, such as during Ramadan¹⁷.

When to refer to a diabetes dietitian

Anyone following a carbohydrate restrictive diet should not start Empagliflozin without a discussion with a dietitian. If an adult with T2D wishes to start Empagliflozin and is considering carbohydrate restriction <130 grams per day, referral to a diabetes dietitian should be made.

A dietitian will assess the quantity and quality of carbohydrate food choices, as well as give advice on carbohydrate distribution, which can impact on nutritional ketosis. They can also assess the overall nutritional adequacy of a person's eating pattern, advise if micronutrient requirements are not being met within their restricted carbohydrate intake, and offer strategies to optimise glycaemic control whilst eating a variety of nutritious foods.

Dietary recommendations in the NZSSD/Ministry of Health Type 2 Diabetes Management Guidance¹⁸, the American Diabetes Association^{19,20}, and Diabetes UK²¹ all promote safe, manageable and achievable nutrition advice for people living with T2D. Carbohydrate containing foods including wholegrains, starchy vegetables, fruit and milk products are very important sources of nutrients. When carbohydrate intake is restricted below 45% of total energy intake, the *quality* of carbohydrate needs to be considered in order to achieve an adequate intake of the micronutrients associated with it, particularly the B-vitamin group, vitamin C, calcium, and dietary fibre. If carbohydrate intake is severely restricted, adequate energy intake must be maintained by increasing fat and/or protein intake, and the impact that this change in macronutrient intake may have on other risk factors, such as lipid profile and/or renal function, requires careful monitoring.

Further evidence-based guidance for the management of type 2 diabetes in adults can be found at <https://t2dm.nzssd.org.nz/>

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