

Systematic Review

Unpacking ketogenic diet impact on diabetes: a systematic review

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ABSTRACT

This study used a literature review of various studies to examine the effects of VLC/KD on the level of glycated haemoglobin, body weight, blood sugar, lipid metabolism, and cardiovascular, renal, and neurological hazards in people with pre-diabetes or T2D. A thorough review of the literature was done with the assistance of expert librarians utilizing internet-based databases (Embase, PubMed, and the Cochrane Library). To provide a comprehensive overview of the study categories, methods, participants, the impact of the ketogenic diet on individuals with diabetes mellitus, and results, the gathered data were analyzed using descriptive statistics. According to review findings, the ketogenic diet considerably improves lipid profiles, glycaemic management, and weight loss when compared to controls. These results highlight the need to emphasise the significance of higher fibre, foods with a low glycaemic index, like legumes, vegetables and fruits, and entire grain cereals, as well as the replacement of monounsaturated fat sources for the consumption of saturated fat sources of information, in energy-balanced conditions, among individuals with diabetes.

Keywords: Non-communicable disease, Ketogenic diet, Diabetes-mellitus, Cardiovascular disease, Lipid metabolism, Neurological hazards

INTRODUCTION

One of the leading causes of illness and death in developed nations is type 2 diabetes. By 2025, it is predicted that more than 380 million people would have the illness, making it a serious public health concern with a rising prevalence.¹ 90% of instances of diabetes are associated with type 2 diabetes mellitus (T2DM), which is distinguished by insulin resistance (IR) and hyperglycaemia. According to international diabetes society standards, the treatment of type 2 diabetes mellitus (T2D) involves making lifestyle changes in addition to pharmacological interventions.² The undesirable effects and potential risks of pharmaceuticals still cause

individuals to keep a significant deal of attention to the efficacy of this therapy, despite the recent advancements in drug therapy. As a result, non-pharmacological therapeutic approaches, like the very low-carbohydrate ketogenic (VLCK) dietary regimen made up of foods high in fat, low in carbohydrates, and moderate in protein, are more often used.³ The diet called the ketogenic diet is noted for its high fat and low carbohydrate content. By ingesting more calories from fats and less from carbohydrates, a ketogenic diet aims to substitute glucose as the human body's main means of energy generation with ketone bodies created from fat breakdown. According to one participant, improved glycaemic control, weight loss, and satiety seemed to outweigh the diet's disadvantages,

including the absence of support from a doctor and reliable information sources.⁴ The ketogenic diet, which has been demonstrated to lower cholesterol levels, increase fasting glucose and insulin levels, and eliminate or lower the need for diabetic medication, can significantly help patients with diabetes.¹ The four distinct types of the ketogenic diet include the standard ketogenic diet, the cyclical ketogenic diet, the specially designed ketogenic diet, and the high-protein ketogenic diet.⁵ The traditional ketogenic diet, which typically contains fat in the amount of 70%, 20 per cent protein, and only 10% carbohydrates, is the most studied and recommended of them.

In addition to being used to treat paediatric epilepsy, the low in carbohydrates ketogenic diet (LCKD) is now gaining popularity as a dietary strategy to treat obese and type 2 diabetes. Also positively impacted by this diet include neurological disorders, glucose levels and glycosylated haemoglobin, and blood lipid profiles.⁶ The efficiency of various dietary methods for weight loss in obese adults has been examined in several literature reviews and meta-analyses. Despite the fact that there are numerous meta-analyses and systematic reviews of meals with low carbohydrate intake, no studies have focused on the effect of the low in calorie ketogenic eating plan on controlling glucose levels, weight, metabolism of lipids, neurological conditions, CVD risk results, or renal disorder risk outcomes in people with pre-diabetes or T2D and obesity.⁷⁻¹¹ The usefulness of VLC/KD for glycaemic management, lipid metabolism, CVD risk, and risk of renal disorders in these groups is therefore unclear. This study used a literature review of various studies to examine the effects of VLC/KD on the level of glycated haemoglobin, body weight, blood sugar, lipid metabolism, and cardiovascular, renal, and neurological hazards in people with pre-diabetes or T2D. This study is anticipated to offer fresh scientific support for DM non-drug therapy.

METHODS

In order to prepare this publication, we followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines.

Data sources

A systematic review of Embase, PubMed, and the Cochrane Library was performed to identify randomised controlled experiments (RCTs), reviews of the literature, meta-analysis, and descriptive research (originally released from 2016 to 2023) involving individuals with overweight or obesity in addition to or with no T2DM that evaluated the impact of a diet containing ketones on glycaemic management, loss of weight, and lipid levels as primary endpoints. The early database search methods were a combination of terms and Medical Topic Titles (ketogenic meal or high-fat meal) within the title/abstract AND (glucose or glycated haemoglobin, or HbA1c in the title/abstract.

Study selection and data collection

The databases were independently examined by B.G. and V.G., two reviewers, for pertinent studies. The studies located in the initial search were evaluated for eligibility using the following inclusion criteria RCTs (randomised controlled trials) looking at how ketogenic diets affect people who are overweight or obese metabolically; glycemic results related to the ketogenic diet, irrespective of patients' baseline T2DM status; plenty of raw data accessible from the initial study, and studies that were written in English. The selection of pertinent studies was done without regard to age. The initial author and year of release, country, trial design, duration of the intervention, a comparison of eating habits, individuals' gender and age, fasting glucose levels (FG), baseline body mass index (B and T2DM status, and particular eligibility requirements for years of age, BMI, and HbA1c (glycated haemoglobin) variables were all study attributes that the two critics independently extracted. Studies that were included assigned patients at random either to a ketogenic diet or a standard diet and included pre- and post-glycaemic indices, such as FG and HbA1c, in addition to other metabolic parameters related to weight and cholesterol management. Additionally, pre-post glycemic indicators such FG and HbA1c were reported. The last investigation period in each experiment, where there were additionally several treatment periods that were monitored in single research, was used to calculate the intervention duration in the current meta-analysis. On all controversial issues and disagreements, the authors came to an understanding.

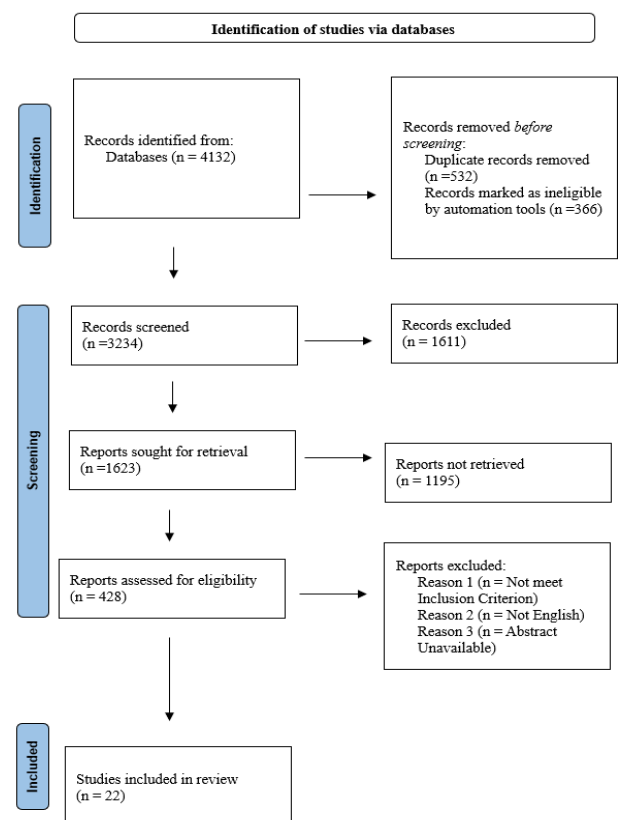


Figure 1: PRISMA flow diagram.

RESULTS

Review findings show that, as compared to controls, the ketogenic diet significantly affects weight loss, glycaemic control, and better lipid profiles. In terms of high-density lipoprotein (HDL) and glycated haemoglobin (HbA1c), the ketogenic diet worked far better than the control.¹

The results of this study are categorised into six broad categories including:

Body weight

The results of a study showed that from the first to the 56th week, both groups' LDL cholesterol, total cholesterol, and triglycerides significantly decreased. In individuals with high blood sugar levels (Group 1), after 56 weeks of LCKD administration, there was a 6.7% and a 12.5% drop in weight and glucose levels, respectively. Following 56 weeks, there was a 6.0 and 11.9 per cent reduction in weight and blood glucose levels, respectively. Both weight and glucose levels decreased in those with normal glucose levels. Both groups experienced statistically significant changes in their glucose levels. LDL cholesterol decreased while HDL cholesterol sharply increased.²

Blood glucose and HbA1c

Individuals who had elevated HbA1c and weight allocated to adhere to the LCK diet performed more effectively than people who were told to adhere to the MCCR diet during the course of a 12-month study in terms of reducing their weight, use of drugs, and HbA1c levels.²²

Lipid metabolism

The VLCK diet was linked to a significant reduction in triglycerides when compared to the untreated diet after 3, 6, and 12 months of therapy, according to a meta-analysis by Rafiullah et al. However, following 12 months of VLCK diet treatment, there was a risk of increased LDL levels.¹³

CVD risk

Overeating causes a rise in weight and carbohydrate intolerance, which triggers an endless cycle of insulin resistance as well as hyperinsulinemia that hinders the body from utilising fat for energy and encourages fat storage, leading to atherogenic dyslipidemia, which is represented by hypertriglyceridemia, minimal HDL, and small dense LDL. Overeating also causes weight gain as well as carbohydrate intolerance.³⁰

The carbohydrate-insulin model provides a more comprehensive explanation of the cause of obesity, MetS, and eventually diabetes type 2 (T2DM) and cardiovascular illness (CVD). Ketogenic diets decrease visceral adiposity as well as sensitivity to insulin, atherogenic dyslipidemia, and inflammatory markers of overeating. Recent research

shows that T2DM patients restored their metabolic, allergic, and dysglycemic indicators in addition to the anticipated 10-year atherosclerotic risk with very high compliance to a ketogenic diet for a maximum of two years. Over 50% of people had their diabetes reversed, and just about 8% had it completely cured.³⁰

Renal disorders risk

Given the important function of hyperglycaemia within the cause of the disease, it seems sense to suggest that an LCD method, which reduces blood glucose on its own, could be useful in reducing risk factors for DKD. This review suggests that for people with T2D and mild DKD or normal kidney function, this could potentially be the case.³¹

Our actual data, which show that an LCD approach was associated with significant drops in blood pressure, weight, cholesterol levels, urine ACR, creatinine levels, and eGFR along with to a 48% degree of T2D drug-free recovery for those who were recruited, seem to confirm this notion. Overall, this data refutes the hypothesis that LCDs, while regularly consuming more dietary fat and protein, may be harmful to kidney health.

However, applying the method to patients with medium to severe DKD is causing a lot of anxiety. This study provides some assurance to medical professionals adopting LCD interventions that this dietary strategy may improve various aspects of cardiovascular and metabolic health while presenting little harm to renal function for those with T2D, or even for those with regular kidney function or modest DKD.³¹

Neurological disorders risk

KD has been used for many years to treat a variety of neurological conditions, and recently, numerous studies have confirmed KD's function in neuroprotection. By lowering oxidative stress, controlling inflammation, regulating the utilisation of energy, and maybe affecting other processes, it may have neuroprotective benefits.³² As a result, the KD has drawn attention as a potential treatment for neurological disorders like dementia caused on by T2DM.³² Studies show that dementia is common in patients with diabetes type 2 mellitus (T2DM), and that dementia has an associated molecular process and underlying illness with T2DM. At the moment, T2DM-induced cognitive decline is characterised by altered cerebral glucose and insulin metabolism, shortening lifespan. More so than those in the MCCR group, individuals in the LCK group cut back on various diabetes-related drugs.²²

In another investigation, the mean weight loss in the fasting group ranged from 3.5 to 4.5 kg, while the mean weight loss in the control group was between 2.0 and 4.8 kg. The WHO-5 score for quality of life improved after a fast, and there was a substantial drop in blood pressure, glucose, and systolic and diastolic blood pressure.

Table 1: Characteristics of studies included.

Author	Type of study	Journal and year of publication	Country	Population and sample size	Findings and conclusion
Alarim et al¹	Review	Cureus 2021	Saudi Arabia	Priority was given to combining the information on a select few crucial variables, such as weight, glycaemic control, and lipid profile.	The analysis's findings show that, when compared to controls, the ketogenic diet significantly affects glycemic control, lipid profiles, and weight loss. High-density lipoprotein (HDL) and glycated haemoglobin (HbA1c) levels considerably increased on the ketogenic diet when compared to the control.
Li et al¹²	Case-control	BMC endocrine disorders 2022	China	Including 30 patients in each group, 60 overweight or obese individuals with T2DM were randomly assigned to the ketogenic diet group or the diabetes diet control group.	The two groups' weights, BMIs, waist measurements, TG, TC, LDL, HDL, FBG, FINS, and HbA1c all decreased significantly from the prior time frame. However, the ketogenic diet group's UA showed a growing tendency, but the group with diabetes control diet group's UA remained unchanged. The diabetic diet had better long-term compliance than the ketogenic diet.
Karolina et al²	Descriptive epidemiological analysis	Journal of Education, Health and Sport 2022	Poland	Two groups of 64 healthy obese people were created. Group I is made up of 31 participants with a body mass index (BMI) >30 and a level of blood glucose >6.1 mmol/L, while Group II is made up of 33 participants with normal blood sugar levels.	Patients with high glycemic levels (Group 1) had experienced a reduction in body weight and glycaemic level of 24.4 6.7% and 50.9 12.5%, respectively, after being put on a low-calorie ketogenic diet. In individuals with normal blood sugar levels, body weight and glycaemic levels fell; the corresponding percentage declines were 27.2 6.0 and 7.4 11.9 after 56 weeks, respectively.
Dashti et al⁶	Literature Review	Medical Principles and Practice.2020	Kuwait	N/A	There is evidence that people with type 2 diabetes who have LCKD require less insulin and oral medicines. The information provided in the article also demonstrates how LCKD can effectively and affordably manage type 2 diabetes.
Rafiullah et al¹³	Literature Review	Nutrition Reviews. 2022	Saudi Arabia	There were 8 RCTs with 648 participants.	For up to six months, the VLCK diet has been shown to reduce body weight and regulate glycemia in individuals with obesity and diabetes. The VLCK group experienced consistent drops in the requirement for diabetes medications as well as improvements in cholesterol levels and blood triglycerides over the course of a full year. The level of data that is now available prevents the recommendation of VLCK diets. The patients' poor compliance with the reduction in carbohydrates is the main disadvantage of the VLCK diet.
Lichtash et al¹⁴	Case Report	BMJ 2020	United States	A 57-year-old woman having type 2 diabetes who had been taking metformin and rigorously adhering to the diabetic diet had a haemoglobin A1c (HbA1c) level of 9.3%.	Following 4 months of shifting to KD combined with IF, the subject maintained glycaemic control without the need for medication and had an HbA1c of 6.4If workweeks began with twenty-four hours on three different days each week, they would subsequently increase to 42 hours on

Continued.

Author	Type of study	Journal and year of publication	Country	Population and sample size	Findings and conclusion
					three distinct occasions, 42 hours twice per week, and finally 16 hours once per week. After eight months, the maintenance phase began. Metformin was reinstated, and IF was decreased from 24 hours three times a month to 16 hours each day. At 14 months, the blood sugar level (HbA1c) was 5.8% and the body's mass index had barely altered.
Moore et al ¹⁵	Meta-analysis	Physician Assistant Scholarly Project Papers.2021	United States	Several high-quality studies were picked using PubMed, Dynamed Plus, Cochrane Library, CINAHL, and Clinical Key databases, with the use of keywords and MeSH terms to target search results.	According to numerous research, using the ketogenic diet as the initial treatment strategy does not improve health markers for T2DM patients more than conventional diets do. Due to the health benefits of several diet plans for type 2 diabetics, a dietary commitment was essential for success. The research is promising, but it will be crucial to take the patient's readiness and willingness to make lifestyle changes into account when developing a personalised treatment plan.
Schneider et al ¹⁶	Literature Review	Expert Review of Endocrinology & Metabolism, 2022	United Kingdom	Published data from MEDLINE, Embase, and PsycINFO were used by the author. Some of the search terms used were type 1 diabetes mellitus, insulin-dependent diabetes, T1D AND EDs, anorexia bulimia, or eating disorders AND low-carbohydrate diet, carbohydrate-restricted diet, low-carb diet, or ketogenic diet.	It makes sense that some of these people could profit from a lower-carb diet given the important role that hyperglycemia plays in the cause of CKD. The lack of agreement on isocaloric assessments that recommend a specific carbohydrate diet for T1D makes it difficult for doctors to provide risk assessments and guidance.
Zhou et al ¹⁷	Meta-analysis	Int. J. Environ. Res. Public Health 2022	China	For the purpose to conduct a meta-analysis, the author carefully reviewed papers in the Embase, a PubMed, the Web of Science, and the Cochrane Library databases.	The findings imply that an overweight T2DM patient's lipid profile, weight, and glycaemic control may be improved by a ketogenic diet, which may be a useful dietary therapy. Therefore, a ketogenic diet may be suggested for the appropriate management of overweight T2DM patients.
Goday et al ¹⁸	Multi-centric randomized clinical trial	Nutrition & diabetes. 2016	Spain	With T2DM and a body mass index between 30 and 35 kg/m ² , 89 men and women between the ages of 30 and 65 took part.	An interventional weight-loss strategy based on the VLCK diet is more successful for reducing body weight and increasing glycaemic control despite being well tolerated by T2DM patients than a normal hypocaloric diet.
Versha et al ¹⁹	Literature Review	International Journal of Pharmaceutical Quality Assurance. 2023	India	In this study, the impact of a low-carb or ketogenic diet was compared over the course of 56 weeks between obese patients with high blood glucose levels and those with moderate blood glucose levels.	The Keto diet is an effective diabetic treatment because it controls the body's insulin and glucose levels. It has been found that effective weight management and dietary changes, notably in carbohydrate content and glycaemic index, have positive effects on obese individuals with glucose intolerance. The low in carbohydrates ketogenic diet has shown promise in preliminary research for managing diabetes mellitus.

Continued.

Author	Type of study	Journal and year of publication	Country	Population and sample size	Findings and conclusion
Wong et al²⁰	Qualitative study	Canadian Journal of Diabetes. 2020	Canada	Adults with diabetes, either type 1 or type 2, who had been following the ketogenic diet for under three months, were recruited.	The diet's benefits, including better control of glycemic levels, weight loss, and satiety, were noted by the participants. These advantages appeared to outweigh the disadvantages, such as the scarcity of medical resources and knowledge.
Kumar et al⁴	Literature Review	Life Sciences. 2018	India	With the aid of keywords and MeSH phrases to focus search results, several high-quality studies were chosen using the PubMed, Dynamed Plus, Cochrane Library, CINAHL, and Clinical Key databases.	The best strategy to minimise the hazards to your health is to follow a ketogenic diet. KD can be viewed as an effective diabetic treatment because it regulates insulin and glucose levels. KD is thus also evidence of a treatment gap between diabetes and obesity.
Choi et al²¹	Meta-analysis	Nutrients. 2020	Korea	In Embase, PubMed, and the Cochrane Library, the author searched for randomised controlled studies that recruited people who were overweight or obese on a ketogenic diet for metabolic regulation.	The results of the study demonstrated that, when compared to low-fat diets, ketogenic diets were more successful at enhancing metabolic parameters related to glycaemic, weight, and lipid management in individuals who were overweight or obesity, particularly in those with pre-existing diabetes.
Saslow et al²²	Randomized control trial	Nutrition and Diabetes 2017	USA	Individuals (n=34) with an HbA1c level >6.0% and increased body weight (BMI>25) were randomly assigned to a moderate-carbohydrate, calorie-restricted, reduced-fat (MCCR) diet or a very low-carbohydrate ketone (LCK) diet (n = 16).	People who had elevated HbA1c and weight that were allocated to adhere to the LCK diet performed better than people who were told to adhere to the MCCR diet during the course of a 12-month study when it came to of weight loss, use of drugs, and HbA1c levels.
Myette-Côté et al²³	Randomized control trial	American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 2018	Canada	Respondents (n = 16; 8 men and 8 women) were randomly selected from the local populace in Kelowna, British Columbia, Canada. Participants were to be aged 48 to 72, not be exogenously insulin users, and have no known kidney, cardiovascular, or other complications from diabetes.	An LC diet improved 4-day glycaemic control and fasting proinsulin levels when compared to GL, and it had even more advantages for reducing blood sugar when combined with walking after meals.
Tay et al²⁴	Randomized control trial	Diabetes Obes Metab. 2018	Australia	A total of 115 persons with T2D were randomly assigned to 1 of 2 planned energy-matched, hypocaloric diets together with aerobic/resistance exercise	Similar amounts of weight were lost and HbA1c were lowered with both regimens. The LC continued to show higher gains in blood lipid levels and circadian blood glucose equilibrium, as well as no negative kidney impacts, all of which indicate better optimisation of T2D therapy.

Continued.

Author	Type of study	Journal and year of publication	Country	Population and sample size	Findings and conclusion
Lee et al²⁵	Randomized control trial	PLOS ONE 2016	Korea	T2D patients were randomised to follow either a vegan diet for 12 weeks (n = 46; avoiding all animal-based foods, including fish) or a traditional diet advised by the Korean Diabetes Association 2011 (n = 47).	HbA1c levels were reduced by both diets; however, the vegan diet provided better glycaemic management than the standard diet. Therefore, a vegan diet should be included in the dietary recommendations for T2D patients for better control and therapy.
Ren et al²⁶	Randomized control trial	Nutrients. 2020	China	45 T2DM patients finished each dietary programme for three months from December 2018 and December 2019 at a diabetes society and the Endocrinology Unit of the First and Second Associated Hospital of Soochow University, with 22 in the a-LCD category and 23 in the LFD group.	In T2DM patients, an A-LCD may benefit depression and glycometabolism. As to the writer, the impact of a-LCD in alleviating melancholy in T2DM patients may be connected to how it stimulates SCFA synthesis and GPR43 activation, further maintains GLP-1 secretion, and encourages the development of bacteria that create SCFAs.
Vitale et al²⁷	Randomized control trial	Nutrients. 2018	Italy	The study included 2568 individuals from 57 diabetic centres.	The results of the study support the notion that the diet known as the Mediterranean diet is an excellent choice for people with diabetes who have type 2 diabetes as well as that its beneficial effects on health are more due to the interaction of its various nutrients and foods than to any one of them alone.
Gardner et al²⁸	Randomized control trial	Am J Clin Nutr 2022	USA	A 12-week trial of the clearly defined ketogenic diet (WFKD) and the Mediterranean-plus diet (Med-Plus) was conducted on 40 individuals with prediabetes or type 2 diabetes who were above the age of 18.	After 12 weeks, there were no differences in HbA1c levels between diet phases, but both diets had improved from the beginning, most likely as a result of multiple shared dietary components. Although the WFKD lowered triglycerides more significantly, it was less sustainable, had a higher risk of side effects due to elevated LDL cholesterol, and reduced nutritional intakes because it excluded legumes, fruits, and whole grains.
Li et al²⁹	Randomized control trial	Exp Clin Endocrinol Diabetes 2017	Berlin	32 (n = 16 in each group) of the 46 recruited participants finished the experiment and were taken into account in the final analysis.	The findings of this research imply that extended fasting is doable and may have advantageous clinical benefits.

All other metabolic outcomes, comprising HbA1c, the hormone insulin, HOMA-index, and lipid levels in the blood, showed non-significant improvements in the fasting cohort in comparison to the control group, with the exception of mean total cholesterol levels, which declined non-significantly more in the control group. In neither cohort were there any significant negative side effects. Three participants in the fasting group had mild headaches on days 1-2, while one person in the later fasting phase reported mild vertigo. All people did not consider hunger to be acute.²⁹

DISCUSSION

In accordance to studies conducted by Alarim et al, the ketogenic diet is superior than placebos when it comes to of regulating blood glucose levels and lipid profile modifications. The results are convincing enough to recommend the diet for extra type 2 diabetes treatment.¹ Li et al, assert the fact that the phased-ketogenic diet may control blood sugar and blood lipid levels as well as to weight in people with overweight or obese T2DM. But maintaining tenacity over the long run is hard.¹² In accordance to studies conducted by Karolina et al, newly diagnosed overweight or obese people with type 2 diabetes may benefit from losing weight while attaining adequate control of blood sugar in the short term without medication. The ketogenic diet may control blood sugar and lipid levels in the blood in addition to weight in persons with overweight or obese T2DM. On this diet, diabetic patients should be regularly watched by a physician, who should also be able to adjust their medication as needed.³

LCKD reduces the requirement for oral antidiabetic drugs and insulin in persons with type 2 diabetes, claim Dashti et al.⁶ The VLCK diet appears to control glycemia while decreasing body weight in people having obesity and diabetes for a maximum of six months, according to the research of Rafiullah et al. For a full year, the VLCK group continued to benefit from lower levels of high-density lipoprotein cholesterol and blood triglycerides. They also used fewer diabetes medications.¹³

In their study, Lichtash et al discovered that she was able to attain glycemic control off of medication after 4 months of switching to KD paired with IF, with an HbA1c of 6.4. If workweeks started out with 24 hours on three separate occasions a week, they would then go to 42 hours thrice times a week, 42 hours two times per week, and lastly 16 hours once a week. After eight months, the continuation phase began. Metformin was reintroduced, and IF was reduced to 16 hours each day, with 24 hours occurring three times per month. The HbA1c level was 5.8% at 14 months, and the body mass index had hardly changed.¹⁴

According to Moore et al, the key to success with the various diet regimens that offered type 2 diabetes health benefits was diet adherence.¹⁵ According to Schneider et al, it makes sense that some of these people could profit

from a lower carbohydrate diet given the substantial role that hyperglycemia plays in the aetiology of CKD. It is challenging for clinicians to offer risk analyses and advice due to the lack of consensus regarding isocaloric comparisons that suggest a certain carbohydrate diet for people with type 1 diabetes (T1D).¹⁶

The results of research by Zhou et al suggest that a ketogenic diet may be an exciting nutritional approach for maintaining body weight and glycemic management, in addition to improved lipid levels, in overweight individuals who have T2DM. In order to treat T2DM in overweight patients, a ketogenic diet might be advised.¹⁷

In their study, Goday et al discovered that a VLCK diet-based interventional weight-loss programme is safer and more tolerable for T2DM patients than a typical hypocaloric diet to decrease body weight and improve glycaemic control.¹⁸

The low-carb ketogenic diet, according to Versha et al, has shown some early promise in the management of diabetes mellitus.¹⁹

According to Wong et al's research, participants reported diet advantages including better glycaemic control, weight loss, and satiety, which seemed to outweigh disadvantages like a lack of assistance from a healthcare provider and a lack of information sources.²⁰

In their study, Kumar et al discovered that the KD controls insulin and glucose levels, making it a viable diabetic treatment option. KD can therefore also serve as proof of a therapeutic gap between obesity and diabetes.⁴ According to the findings of the Choi et al study, ketogenic diets were superior to low-fat diets at improving metabolic parameters associated with glycaemic, weight, and lipid control in people who were overweight or obese, especially in those who already had diabetes.²¹

In a 12-month study conducted by Saslow et al., individuals with elevated levels of HbA1c and weight who were assigned to an LCK diet lost more weight, had greater HbA1c reductions, and stopped using more medicines.²²

In their study, Côté et al discovered that an LC diet enhanced fasting proinsulin levels and 4-day glycaemic management when compared to GL, with further benefits for decreasing blood sugar when LC was paired with post-meal walking.²³ Tay et al discovered in their experiment that the LC sustained greater decreases in the amount of diabetes medication required increases in the blood lipid levels and diurnal blood glucose equilibrium, and no negative renal impacts, suggesting better optimisation of T2D therapy.²⁴

Lee et al, discovered that both diets reduced HbA1c levels; however, the vegan diet had superior glycaemic management than the traditional diet. Therefore, a vegan

diet should be included in the dietary recommendations for T2D patients for better control and therapy.²⁵

A-LCD considerably reduced depression and HbA1c, according to Ren et al (p 0.01). Meanwhile, Roseburia, Ruminococcus, and Eubacterium, bacteria that produce short-chain fatty acids (SCFAs), greatly increased in response to a-LCD. The GLP-1 level was higher in the a-LCD category compared to the LFD arm. In T2DM patients, an A-LCD may benefit depression and glycometabolism. According to the author, the impact of a-LCD in alleviating depression in people with T2DM may be connected to how it stimulates SCFA synthesis and GPR43 activation, further maintains GLP-1 secretion, and encourages the development of bacteria that create SCFAs.²⁶ The results of a study by Vitale et al, support the idea that the synergy between different nutrients and foods in the Mediterranean diet-rather than on any one of its individual components-is what gives the diet its positive health effects and makes it a good model for type 2 diabetes.²⁷

Gardner et al found in their study that the WFKD had a greater decrease in triglycerides yet also had interest adverse consequences from higher levels of LDL cholesterol and reduced nutrient intakes from excluding legumes, fruits, and whole, intact grains in addition to being less maintainable.²⁸ Li et al's research indicates that prolonged fasting is feasible and may have positive clinical outcomes. The positive effects of fasting should be proven in larger validation trials that include intermittent fasting in follow-ups in order to produce greater and long-term benefits.²⁹

CONCLUSION

These results highlight the need to emphasise the significance of higher fibre, foods with a low glycemic index, like legumes, vegetables and fruits, and entire grain cereals, as well as the replacement of monounsaturated fat sources for the consumption of saturated fat sources of information, in energy-balanced conditions, among individuals with diabetes. This is in addition to the proof gathered from various observational and experimental research.

After being randomly assigned to an extremely low-carbohydrate ketogenic diet and lifestyle online programme instead of a traditional, low-fat diabetic diet online programme, people with type 2 diabetes maintained their glycaemic control and lost more weight. In order to have a larger reach in effective self-management of type 2 diabetes, online distribution of these extremely low-carbohydrate ketogenic diet and lifestyle advice may be necessary.

In people who have type 2 diabetes, intermittent calorie restriction is comparable to constant calorie restriction in terms of effectiveness in lowering HbA1c.

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