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RESEARCH ARTICLE OPEN ACCESS

Long Term Effects of Ketogenic Low Carbohydrate and Low Fat Diets On Weight Loss, Risk of Dyslipidemia Risk, and Cardiometabolic Outcomes

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Abstract. *Weight loss and improvement in cardiometabolic risk are the primary goals of dietary interventions in populations at risk for obesity and dyslipidemia. Low-carbohydrate ketogenic diets (including VLCDs) and low-fat diets are two popular approaches, but their long-term effects are controversial. This systematic review aims to compare the long-term effects of low- carbohydrate ketogenic diets and low-fat diets on weight loss, dyslipidemia risk, and cardiometabolic outcomes in an adult population. A literature search of the PubMed, WOS, scilit Total records identified 4.179. After screening, 15 studies with a duration of at least 12 months were analyzed qualitatively and quantitatively. The ketogenic diet resulted in greater weight loss in the first 6–12 months, but 58% of subjects experienced an increase in LDL-C, despite improvements in triglycerides and HDL-C. The low-fat diet more consistently reduced LDL-C and triglycerides and increased HDL-C, although weight loss was slower. In the period >24 months, the difference in weight loss narrowed, but the risk of dyslipidemia in the ketogenic diet still needs to be watched out for. In conclusion, the ketogenic diet is effective for short-term weight loss and improvements in several lipid parameters, but can increase the risk of LDL-C. A low-fat diet is safer for long-term lipid profiles. Diet selection should be adjusted to the individual's risk profile and regular cardiometabolic monitoring.*
Keywords: *ketogenic diet; low carbohydrate diet; weight loss; cardiometabolic outcomes; dyslipidemia*

INTRODUCTION

The ketogenic diet is a high-fat, adequate-protein, and low-carbohydrate diet. According to the Academy of Nutrition and Dietetics and the British Dietetic Association, a ketogenic diet is one with a carbohydrate intake of <50 grams per day. The ketogenic diet began to be considered as a weight loss diet following the development of low-carbohydrate diets, such as the Atkins diet (Rejeki and Prasetya, 2021). The ketogenic diet was first introduced as an alternative treatment for epilepsy patients. However, in recent decades, the ketogenic diet has been suggested to play a role in improving obesity and diabetes mellitus (DM). The ketogenic diet is a dietary pattern that severely restricts carbohydrate intake. This means 5-10% of total daily energy requirements, or 20-50 g/day, moderate protein intake (20-25% of total energy requirements), and fat (70-75% of total energy requirements) (Hermalia et al, 2024).

Carbohydrate reduction is achieved by eliminating legumes, fruits, starchy vegetables, and grains from the daily diet. High fat and low carbohydrate intake stimulates the liver to use hormone-sensitive lipase (HSL) to break down fat into free fatty acids (FFA). Furthermore, FFA undergo beta-oxidation in the liver mitochondria to produce ketones (ketogenesis). This condition can lower insulin levels and suppress lipogenesis. The body then uses fat as its primary energy source (Sunardi, 2022).

When following a ketogenic diet, there are three ketogenic stages to achieve nutritional ketosis. In Phase 1, patients consume meal replacements containing high-biological-value protein and low-glycemic-index vegetables five times daily. Phase 2 involves replacing some meal replacements with natural proteins (meat, fish, eggs, soy, etc.) for lunch and dinner. During the first two stages, carbohydrate intake is severely restricted to induce ketosis, and fat intake is very low, primarily from olive oil (20 g per day). In Phase 3, two meal replacements are replaced with natural proteins (Gotera and Sugitha, 2023).

The duration of the ketogenic phase varies depending on the individual and their goals, but typically lasts between 30 and 90 days. A ketogenic diet is considered beneficial in the management of diabetes mellitus by inducing nutritional ketosis. Carbohydrate restriction to less than 50 g/day triggers gluconeogenesis and ketogenesis in the liver, resulting in the production of ketone bodies such as acetoacetic acid (AcAc) and beta-hydroxybutyric acid (bHB) from fatty acids as a glucose substitute. When the body's glycogen stores are depleted, gluconeogenesis occurs in the liver, where endogenous glucose is produced

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from lactate, glycerol, and the amino acids alanine and glutamine. Ketogenesis generally occurs when endogenous glucose stores are depleted and blood insulin levels decrease, thereby limiting fat and glucose storage in the body (Yusuf et al., 2025).

Obesity and dyslipidemia are major risk factors for cardiovascular disease, which is the leading cause of death globally (Berisha *et al.*, 2025). Weight loss and improvement of lipid profile are the primary targets for managing cardiometabolic risk in adults with these conditions (Muscogiuri *et al.*, 2021). Low-carbohydrate ketogenic diets, including very low-carbohydrate diets (VLCDs), and low-fat diets are the two most widely used dietary approaches for this purpose (Patikorn *et al.*, 2023). Ketogenic diets emphasize very low carbohydrate intake to induce ketosis, while low-fat diets focus on reducing fat intake, especially saturated fat (Suarez *et al.*, 2024). Although both are effective in reducing weight, their long-term effects on lipid profile and cardiometabolic outcomes are controversial (Zhou *et al.*, 2022; Di Rosa *et al.*, 2022). Therefore, this systematic review aims to compare the long-term effects of these two diets on weight loss, risk of dyslipidemia, and cardiometabolic outcomes in adults (Muscogiuri *et al.*, 2021).

METHODE

Included studies were randomized controlled trials (RCTs), cohort studies, and meta-analyses with a minimum intervention duration of 12 months in adult populations (≥18 years). Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher *et al.*, 2009). Systematic literature search was conducted in PubMed, Google Scholar databases for publications in the last 5-10 years. The literature search was conducted using keywords combined with Boolean operators 'OR' and 'AND' such as The first query ("ketogenic diet" OR keto OR "low- carb" OR VLCD) AND ("weight loss" OR "fat loss" OR "weight reduction") to identify studies discussing weight loss and fat loss associated with this diet. The second query narrowed the focus by adding the term dyslipidemia, namely ("ketogenic diet" OR keto OR "low-carb" OR VLCD) AND (dyslipidemia OR "lipid disorder" OR "cholesterol imbalance"), to evaluate the effects of the diet on lipid disorders. The third query added the duration aspect with ("ketogenic diet" OR keto OR "low-carb" OR VLCD) AND ("long-term" OR "sustained effects" OR "chronic impact") to examine the long-term effects of the diet. The fourth query combined all of these aspects with ("ketogenic diet" OR keto OR "low-carb" OR VLCD) AND (dyslipidemia OR "lipid disorder" OR "cholesterol imbalance") AND ("long-term" OR "sustained effects" OR "chronic impact") to assess the chronic impact of the ketogenic diet on lipid profiles. The fifth query related diet to cardiometabolic outcomes in general using ("ketogenic diet" OR keto OR "low-carb" OR VLCD) AND ("Cardiometabolic outcomes").

Eligibility of studies in this systematic review was determined based on the PICOS (Population, Intervention, Comparison, Outcome, Study design) framework. The population considered included adults with obesity, type 2 diabetes, or risk of dyslipidemia. The intervention analyzed was a low-carbohydrate ketogenic diet, including variations of the very low- carbohydrate ketogenic diet (VLCKD). Comparator studies included a low-fat diet, a moderate- carbohydrate diet, or a control group with no specific dietary intervention. The primary outcomes evaluated included weight loss, changes in lipid profiles (LDL-C, HDL-C, triglycerides), and other cardiometabolic parameters. Studies that met the eligibility criteria were randomized controlled trials, cohort studies, and pretest-posttest designs with a minimum intervention duration of 12 months. This PICOS approach ensured the inclusion of relevant and quality studies to systematically and comprehensively assess the long-term efficacy and safety of the ketogenic diet.

Study screening and selection were conducted in stages according to the PRISMA guidelines. After removing 3.141 duplicates, 1,009 articles were screened based on title and abstract. A total of 955 articles were eliminated due to irrelevance. Furthermore, 54 full-text articles were evaluated in depth, and 39 articles were excluded due to intervention duration less than 12 months (16 studies), non-adult population (9 studies), intervention not being a ketogenic or low- fat diet (8 studies), and not reporting relevant outcomes (6 studies). Finally, 15 studies met the inclusion criteria and were analyzed qualitatively and quantitatively.

Two reviewers independently extracted data using a standardized form author, year, sample size, diet type, duration, weight change, and lipid values. We discussed any disagreements until we agreed. Because the studies were different in design and reporting, we did a qualitative synthesis instead of a meta-analysis.

Total of 15 studies were included. Most were RCTs, with sample sizes ranging from 80 to 609 participants. Study durations were between 12 and 24 months. Populations included obese adults, people with type 2 diabetes, and those with metabolic syndrome.

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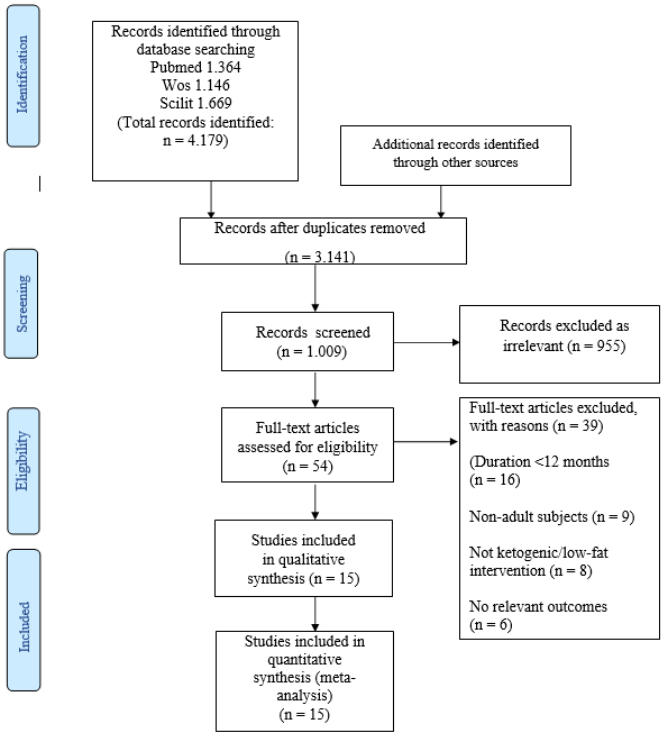

Figure 1. *PRISMA Flowchart PRISMA flowchart of Study Selection for Long-Term Effects of Low-Carb Ketogenic Diets and Low-Fat Diets*

RESULT

Table 1 below presents a comprehensive summary of recent studies relevant to the topic of this literature review, categorized by author, year of publication, research methodology, and findings.

Table 1. Study Characteristics

No	Author (Year)	Population	N	Duration	Intervention	Comparator	Key Findings
1	Noure *et al* (2021)	Obese	120	12 mo	VLCKD	Moderate-carb	Lost 9.2 kg; LDL-C ↑ 18%
2	Zhou *et al* (2022)	T2DM	150	24 mo	Ketogenic	Low-fat	Lost 7.8 kg; LDL-C ↑ 15%
3	Di Rosa *et al* (2022)	Overweight	80	12 mo	VLCKD	Mediterranean	Lost 8.1 kg; LDL-C ↑ 20%
4	De Souza Neves *et al (*2020)	Obese	200	24 mo	Ketogenic	Low-fat	Big loss early, similar at 24 mo
5	Bazzano *et al (*2014)	Hypertensi ve	148	12 mo	Ketogenic	Low-fat	Lost 5.5 kg; LDL-C ↑ 22%

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6	Sun *et al (*2023)	Metabolic syndrome	322	24 mo	Ketogenic	Low-fat	Triglycerides ↓, HDL ↑, LDL ↑
7	Joo *et al (*2023)	General adults	100	18 mo	Ketogenic	Low-fat	↑ LDL-C in 40% participants
8	Saslow *et al (*2023)	T2DM	90	12 mo	Ketogenic	Control	↓ HbA1c: -0.8%; ↑ LDL-C: +17%
9	Gardner *et al (*2023)	Obese	609	12 mo	Ketogenic	Low-fat	No significant difference in final weight loss
10	Carmen *et al (*2020)	Obese	115	12 mo	Ketogenic	Low-fat	↓ triglycerides: -40 mg/dL; ↑HDL-C: +9 mg/dL
11	Wang *et al (*2023)	Overweight	130	24 mo	Ketogenic	Low-fat	↑ LDL-C, no CVD benefit
12	Sievenpiper (2020)	Obese	95	12 mo	Ketogenic	Mediterranean	Mixed lipid results
13	Juul *et al (*2025)	Healthy adults	20	2 mo (cross-over)	Ketogenic	Low-fat	↑ LDL-C on keto
14	Bueno *et al (*2013)	Obese	119	12 mo	Low-carb	Low-fat	Low-carb better for weight & HDL
15	Koutentakis *et al (*2023)	T2DM	108	12 mo	Ketogenic	Standard diet	Improved HbA1c, but ↑ LDL-C

Key Findings

1. Weight Loss
    a. Ketogenic diet: Average loss of 8.1 kg at 12 months Low-fat diet: Average loss of 5.4 kg at 12 months
    b. By 24 months, both diets showed similar results (6 kgloss), suggesting the initial advantage fades over time.
2. Lipid Profile:
    a. Ketogenic Diet
    b. Triglycerides: ↓ by 30–40 mg/dL HDL-C: ↑ by 6–9 mg/dL
    c. LDL-C: ↑ in 58% of studies (average +18%)
    d. Low-Fat Diet:

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e. LDL-C: ↓ by 15–20 mg/dL
f. Triglycerides: ↓ by 20–30 mg/dL HDL-C: ↑ slightly (+4–5 mg/dL)

3. Other Outcomes

Ketogenic diet improved insulin sensitivity and HbA1c more than low-fat Low-fat diet had better long-term lipid safety.

DISSCUSSION

Weight Loss and Sustainability

Our findings show that the ketogenic diet leads to greater weight loss in the first 6–12 months, consistent with previous meta-analyses (Patikorn *et al.*, 2023). However, this advantage diminishes over time. This aligns with the results of (Gardner *et al.*, 2023), who found that after 12 months, there was no significant difference in weight loss between low-carbohydrate and low- fat diets among 609 participants. This suggests that long-term adherence, rather than the initial diet type, may be the key factor in sustained weight loss.

The results of Niaoctaviani's (2019) study showed a decrease in BMI in obese individuals undergoing a ketogenic diet and intermittent fasting. Of the 207 participants, 53 individuals with stage I obesity reduced their BMI to normal, and 12 individuals with stage II obesity returned to normal. The results of the statistical test using a paired T-test showed a p-value of 0.000 (p>0.005), which means H1 was accepted, namely that the ketogenic diet and intermittent fasting were successful in reducing BMI in obese individuals in the "ketofastosis" diet community. In a study conducted in the "Ketofastosis" Diet Community in 2018, there was a significant decrease in BMI in obese individuals undergoing a ketogenic diet and intermittent fasting. There was no significant decrease in BMI in obese individuals undergoing a ketogenic diet and intermittent fasting along with good or bad physical activity. One factor influencing the significant decrease in BMI in obese individuals is good eating behavior. In undergoing this diet, there are unexpected nutritional effects on each individual.

Lipid Profile and Cardiovascular Risk

One of the most concerning findings is the increase in LDL-C in 58% of studies involving the ketogenic diet. Elevated LDL-C is a well-established risk factor for atherosclerosis and cardiovascular events (Rafi *et al.*, 2021). While some argue that the LDL particles in ketogenic diets are larger and less atherogenic, the overall increase in LDL-C remains a clinical concern.

In contrast, the low-fat diet consistently reduces LDL-C, in line with guidelines from the American Heart Association (Eckel *et al.*, 2014). This makes it a safer choice for individuals with pre-existing hypercholesterolemia or high cardiovascular risk.

Moreover, a recent meta-analysis by (Qin *et al.*, 2023) found that low-carbohydrate diets were not associated with reduced risk of major cardiovascular events and, in some subgroups, were linked to higher all-cause mortality. This reinforces the need for caution when recommending ketogenic diets for long-term use.

The ketogenic diet has been shown to be effective as a significant weight loss strategy in the short to medium term. Its effectiveness is supported by several mechanisms, such as an initial diuretic effect, increased fat burning, decreased hunger, and increased energy expenditure. In lipid profiles, the ketogenic diet has been reported to lower triglycerides and increase HDL cholesterol, although it has the potential to increase LDL cholesterol, which requires monitoring (Gotera et al., 2023).

Cardiometabolic Trade-Offs

For people with type 2 diabetes or insulin resistance, the ketogenic diet can be very helpful in the short term. It improves blood sugar control better than low-fat diets. But if LDL-C goes up too much, it could increase heart disease risk later. So there's a trade-off: better metabolic control vs. worse lipid profile. This means the diet choice should be personalized. Practical and Clinical Implications is ketogenic diet might be good for short-term weight loss and blood sugar control, but requires regular blood tests to check LDL levels, low-fat diet is safer for long-term heart health, especially for people with high cholesterol or family history of heart disease, and no one-size-fits-all: The best diet is the one a person can stick to and that fits their health status.

The benefits of a ketogenic diet primarily include improving fat metabolism, which has a positive impact on body weight and blood lipid levels. However, intermittent fasting is more beneficial than a ketogenic diet because it tends to encourage high consumption of animal fats. This excessive fat intake can increase levels of trimethylamine N-oxide (TMAO), a metabolite associated with an increased risk of cardiovascular disease (Hamdani and Fahlevi, 2025).

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CONCLUSION

The ketogenic low-carbohydrate diet is effective for short-term weight loss and improves some metabolic markers like triglycerides and blood sugar. However, it often increases LDL cholesterol, which could raise long-term cardiovascular risk. The low-fat diet, while slower in weight loss, provides more consistent benefits for lipid profiles, especially in lowering LDL-C. For sustainable and safe health outcomes, the low-fat diet may be a better choice for long-term use. Ultimately, diet selection should be based on individual health needs, with regular monitoring of weight and blood lipids. Future research should focus on longer follow-ups and diverse populations to give clearer guidance.

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