

## The Impact of Ketogenic Diet on Lipid Metabolism

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**Abstract:**

**Background:** Many are interested in the possible consequences of the ketogenic diet on cardiovascular health and lipid metabolism because of its high-fat, low-carbohydrate, and moderate-protein composition. While some studies suggest improvements in lipid profiles, such as reductions in triglycerides and increases in HDL cholesterol, concerns remain about its impact on LDL cholesterol levels. The study expected to find out the effect of a ketogenic diet on lipid metabolism over a 4-month period in a sample of patients at Patna Medical College & Hospital, Patna Bihar.

**Aim:** To evaluate the impact of a ketogenic diet on lipid metabolism, focusing on changes in total cholesterol, HDL, LDL, triglycerides, and the HDL/LDL ratio.

**Method:** This was a prospective, observational study conducted from April 2024 to August 2024 at Patna Medical College & Hospital, Patna Bihar. A total of 100 patients, aged 18-60 years, were placed on a ketogenic diet (70% fat, 20% protein, 10% carbohydrates) for 4 months. Baseline lipid levels (total cholesterol, LDL, HDL, triglycerides) were measured, and follow-up measurements were taken at 2 months and 4 months. Paired t-tests and ANOVA were used to analyse lipid levels with time.

**Results:** At the end of the study, significant reductions were observed in total cholesterol (mean decrease: 12%), LDL cholesterol (mean decrease: 10%), and triglycerides (mean decrease: 20%). HDL cholesterol levels significantly increased (mean increase: 15%). The HDL/LDL ratio also improved, indicating a more favorable lipid profile. Statistical analysis revealed significant differences in lipid levels between baseline and follow-up points ( $p < 0.05$ ).

**Conclusion:** Lipid metabolism improved with the ketogenic diet, LDL cholesterol, lowering triglycerides, and increasing HDL cholesterol. These findings imply that a ketogenic diet may improve lipid profiles and reduce cardiovascular risk. Lipid levels must be monitored continuously because individual responses, especially for LDL cholesterol, differ. Longer, control group studies are needed to corroborate these findings.

**Keywords:** Ketogenic Diet, Lipid Metabolism, Triglycerides, LDL Cholesterol, HDL Cholesterol, Cardiovascular Risk, Dietary Intervention, Lipid Profile.

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**Introduction**

The ketogenic diet, or "keto," reduces carbohydrate consumption by switching the body's metabolic fuel source from glucose to fats [1]. The macronutrient distribution defines this diet. Most have 70–75% fat, 20% protein, and 5–10% carbohydrates [2,3]. Ketosis results from severe carbohydrate restriction. The liver converts lipids into ketone bodies, which the brain and other organs require for energy. The ketogenic diet was first prescribed to treat epilepsy, but it is now extensively used to lose weight, control diabetes, and enhance metabolic health, notably lipid metabolism [4,5].

Lipid metabolism—digesting, absorbing, synthesising, and breaking down lipids—is vital to health. Lipids like cholesterol, triglycerides, and

lipoproteins like HDL and LDL are necessary for cell structure, energy storage, and hormone production [6]. Lipid imbalances, especially high LDL and triglycerides and low HDL, are connected to heart disease, stroke, and atherosclerosis. Monitoring lipid profiles helps determine risk for certain diseases [7].

Lipid metabolism improvements from the ketogenic diet include higher HDL levels and lower triglycerides [8]. The effects on low-density lipoprotein (LDL) cholesterol are debated, however some study has revealed an increase in LDL, which may raise concerns for long-term cardiovascular health [9]. In varied patient populations with possibly variable baseline health concerns and

metabolic sensitivities, understanding how the ketogenic diet affects lipid metabolism is critical.

This study aims to determine how the ketogenic diet impacts lipid metabolism in Patna Medical College & Hospital, Patna Bihar patients. The growing popularity of ketogenic diets for metabolic illness treatment requires more regional and individual patient data, especially for Indian populations. This investigation may cover a knowledge vacuum left by Western cohort studies by examining Patna Medical College & Hospital, Patna Bihar patients' lipid responses over four months [10].

### Study Objective

This study will assess the effects of a ketogenic diet on total cholesterol, LDL, HDL, and triglycerides in 100 individuals from April to August 2024. The trial will provide crucial data on whether the ketogenic diet improves lipid profiles in this patient population and associated risks.

### Materials and Methods

**Study Design:** This four-month prospective observational ketogenic diet study evaluated lipid metabolism. Patna Medical College & Hospital, Patna Bihar researched from April to August 2024. A ketogenic diet and regular lipid screenings were followed.

### Sample Size and Inclusion Criteria

**Sample Size:** The study included 100 patients who met the eligibility criteria.

### Inclusion Criteria:

- Patients aged 18-60 years.
- Participants who committed to following the ketogenic diet for the full 4-month study duration.
- Patients free from any medications that could alter lipid metabolism (e.g., statins or other lipid-lowering agents).
- Patients who provided written informed consent to participate in the study.

### Exclusion Criteria:

- Patients with pre-existing liver disease, as it could affect lipid metabolism.
- Those with uncontrolled diabetes or any conditions that might interfere with the ketogenic diet or lipid measurements.
- Patients currently on lipid-altering medications such as statins or fibrates.
- Pregnant or lactating women.

**Dietary Intervention:** This study used a ketogenic diet with 70% fats, 20% protein, and 10% carbs. The study used this diet. This ultra-low-carb, high-fat diet aims to induce ketosis, a metabolic state in which fat is the predominant energy source.

Changes in metabolic pathways lead the liver to create ketone bodies, which fuel the brain and other organs. This eating regimen was tested for lipid metabolism throughout the experiment. To ensure ketogenic diet compliance, participants were required to keep detailed food diaries of their carb, protein, and fat intake. These self-reported records were crucial to dietary protocol monitoring. Participants kept a meal journal and met with the research team monthly to discuss their diet, any issues, and obtain treatment. Periodic blood or urine ketone level tests proved ketosis.

### Data Collection

The trial began in April 2024 with baseline data from each participant. Fasting lipid panels measured total cholesterol, HDL, LDL, and triglycerides. These baseline values could be used to assess trial-related lipid metabolism alterations. Anthropometric data, including BMI, were recorded alongside lipid profiles to assess body composition changes. Important follow-up measurements were taken at the study's start in June 2024 and end in August 2024. Each follow-up fasting lipid assay used the same settings to preserve homogeneity. This allows reliable comparison of lipid levels throughout time. Patients' negative effects, such as gastrointestinal distress or other ketogenic diet symptoms, were also recorded.

### Outcome Measures

The study's main objectives were ketogenic diet-induced lipid marker changes. Triglycerides, total, LDL, and HDL cholesterol were included.

Researchers examined participants' total cholesterol levels before, during, and after the intervention to determine how much it changed. It was vital to monitor LDL levels to see if the ketogenic diet affected them since high levels are linked to cardiovascular disease. HDL cholesterol, known as "good" cholesterol for its health benefits, was also measured because the ketogenic diet improves HDL levels. Also examined were triglyceride changes, another biomarker of fat metabolism. Finally, the ratio of HDL to LDL was calculated to complete the subjects' lipid profiles and show the balance between healthy and unhealthy cholesterol types.

**Statistical Analysis:** Data analysis used several statistical methodologies. Paired t-tests compared lipidomic levels at baseline, 2 and 4 months later. This test measured total cholesterol, LDL, HDL, and triglycerides before and after ketosis.

A repeated measures ANOVA was used to account for various measurements throughout time. This study investigated lipid levels at baseline, mid-study (June), and end-study (August) for statistically significant differences. SPSS executed

statistical tests after processing the data and computing descriptive statistics like mean and standard deviation. We established the significance level for all statistical analyses at  $p < 0.05$  to eliminate chance effects on observed changes. Through four months of the trial, this thorough statistical approach exposed the ketogenic diet's impact on lipid metabolism.

## Results

**Baseline Characteristics:** The patients in the study were 100 people between the ages of 18 and 60, with an average age of  $42.5 \pm 10.4$  years. The group was made up of 42% guys and 58% women.

The average baseline body mass index (BMI) of  $28.3 \pm 3.5$  kg/m<sup>2</sup> indicated that most participants were overweight or slightly obese at the start of the trial. Baseline fasting lipids were measured. Total cholesterol averaged  $220.8 \pm 35.4$  mg/dL, with LDL at  $140.2 \pm 28.5$  mg/dL and HDL at  $45.3 \pm 9.2$  mg/dL. The measured average triglyceride level was  $160.4 \pm 45.7$  mg/dL.

Based on these early assessments, several individuals had dyslipidaemia, defined by increased total cholesterol and LDL levels.

**Table 1: Demographic details**

Baseline Characteristics	Mean $\pm$ SD
Age (years)	$42.5 \pm 10.4$
BMI (kg/m <sup>2</sup> )	$28.3 \pm 3.5$
Total Cholesterol (mg/dL)	$220.8 \pm 35.4$
LDL Cholesterol (mg/dL)	$140.2 \pm 28.5$
HDL Cholesterol (mg/dL)	$45.3 \pm 9.2$
Triglycerides (mg/dL)	$160.4 \pm 45.7$

**Primary Outcomes:** After four months on the ketogenic diet, participants' lipid profiles changed considerably. On average, total cholesterol dropped to  $205.1 \pm 30.2$  mg/dL after 2 months ( $p = 0.03$ ).

During the trial, total cholesterol considerably dropped ( $p < 0.01$ ), reaching a mean value of  $195.7 \pm 27.1$  mg/dL by August. LDL cholesterol followed a similar pattern. The statistical significance of the decrease in LDL to  $130.6 \pm 25.8$  mg/dL after 2 months was not established due to a p-value of only 0.08. At the end of the study, LDL levels decreased significantly to  $125.4 \pm 23.7$  mg/dL ( $p = 0.01$ ),

indicating a significant reduction in atherogenic lipids. However, HDL levels skyrocketed during the study. At 2 months, HDL levels rose to  $48.7 \pm 8.3$  mg/dL ( $p = 0.02$ ), and by the end of the experiment, the average HDL had significantly improved ( $p < 0.01$ ) to  $52.2 \pm 7.9$  mg/dL. On the ketogenic diet, triglycerides reduced dramatically. After 2 months, triglyceride levels dramatically decreased from baseline ( $p = 0.04$ ) to  $140.3 \pm 38.2$  mg/dL. The study found a significant decrease in triglycerides, reaching  $130.5 \pm 35.7$  mg/dL at the end ( $p < 0.01$ ).

**Table 2: Lipid profile outcome**

Lipid Parameter	Baseline	2 Months	4 Months	p-value
Total Cholesterol (mg/dL)	$220.8 \pm 35.4$	$205.1 \pm 30.2$	$195.7 \pm 27.1$	$< 0.01$
LDL Cholesterol (mg/dL)	$140.2 \pm 28.5$	$130.6 \pm 25.8$	$125.4 \pm 23.7$	0.01
HDL Cholesterol (mg/dL)	$45.3 \pm 9.2$	$48.7 \pm 8.3$	$52.2 \pm 7.9$	$< 0.01$
Triglycerides (mg/dL)	$160.4 \pm 45.7$	$140.3 \pm 38.2$	$130.5 \pm 35.7$	$< 0.01$

**Statistical Analysis:** The paired t-test showed statistically significant changes in total cholesterol, LDL, HDL, and triglycerides after the experiment. The ketogenic diet may improve HDL and triglyceride levels, since significant changes were observed ( $p < 0.01$ ). Initial LDL reduction was moderate, but it became statistically significant after 4 months. We found no statistically significant differences in lipid response between gender and age groupings, indicating that the ketogenic diet affected lipid metabolism regardless of demography.

**Adverse Effects:** Some ketogenic diet participants complained gas, constipation, and nausea in the

early weeks. These short-term effects were alleviated by eating more water and fibre. Five individuals suffered transitory fatigue or "keto flu" symptoms in the first month, which resolved.

No serious side effects were observed during the study. Few people had trouble sticking to the ketogenic diet. Finally, the ketogenic diet improved lipid metabolism, specifically HDL cholesterol, triglycerides, and LDL cholesterol.

These enhanced lipid readings suggest the ketogenic diet may reduce cardiovascular risk factors.

## Discussion

This study demonstrated that a ketogenic diet improved several lipid indicators after four months. Total cholesterol dropped significantly and LDL cholesterol dropped more slowly. Triglycerides decreased and HDL cholesterol increased significantly. Due to lipid profile modifications, many participants may have a lower cardiovascular risk profile.

Due to lower total and LDL cholesterol, the ketogenic diet may diminish atherogenic lipoproteins, which contribute to cardiovascular disease (CVD). Although ketogenic diets may raise LDL cholesterol in certain persons, this study showed a net decrease in LDL cholesterol. Fat adaptation, in which the body uses fats as energy and controls lipids better, may be to blame.

HDL cholesterol increases are notable because they lower cardiovascular disease risk. HDL may have increased due to reverse cholesterol transport, which moves excess cholesterol from the arteries to the liver for removal. Triglycerides, which are linked to metabolic syndrome and insulin resistance, drop significantly on the ketogenic diet, suggesting it improves insulin sensitivity and fat metabolism. The ketogenic diet induces ketosis to burn fat instead of carbs. This metabolic shift may explain the positive lipid changes. Fat stores are broken down further into energy-rich free fatty acids and ketones during ketosis. Cut back on carbs to improve insulin sensitivity and lower insulin secretion. Increased insulin sensitivity reduces hepatic fat accumulation, which lowers triglycerides and possibly LDL cholesterol, further controlling lipid metabolism.

## Comparison with Literature

This study supports previous findings that the ketogenic diet lowers triglycerides and raises HDL cholesterol. [11] Study and a 2021 meta-analysis of ketogenic diet trials indicated that the diet lowered triglycerides and improved HDL. Lipid markers improve with the ketogenic diet, suggesting it aids metabolism.

This is especially true for metabolic syndrome risk factors. Some evidence suggests that the ketogenic diet may raise harmful cholesterol in those with certain genetic predispositions. This study found a significant LDL drop, which may be due to the intervention's length or macronutrient content. Due to strict diet adherence and ketosis monitoring, this study may have had more consistent metabolic effects, minimising LDL response heterogeneity. This study's noteworthy finding is that HDL cholesterol increased more than in shorter-term studies. As a patient stays in ketosis longer, HDL declines, which could harm their heart.

## Clinical Implications

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This study suggests the ketogenic diet may assist dyslipidaemia and cardiovascular risk patients. Patients with metabolic syndrome or insulin resistance may be encouraged by HDL cholesterol and triglyceride improvements. The ketogenic diet, with medical monitoring to assess lipid levels and ensure compliance, may minimise cardiovascular risk factors in these groups. We must consider the risks, especially with LDL cholesterol. Although this study found a decrease in LDL, other research have indicated that the ketogenic diet can elevate LDL in some persons, increasing their risk of cardiovascular disease. Monitor patients' LDL levels and respond to any negative changes. If levels rise dramatically, other therapies may be needed. Doctors should consider patients' risk factors and prescribe cholesterol-lowering nutrition, exercise, and medication.

## Limitations

The very short four-month study duration is one of its main disadvantages. Lipid metabolism changed, although the long-term effects are unknown. There is no control group to determine if the lipid changes we noticed were caused by the ketogenic diet or something else. The researchers tracked ketogenic diet adherence using self-reported meal diaries, which may have introduced bias. Periodic ketone testing confirmed ketosis, however diet adherence may have altered outcomes. The research ignored genetic variability in lipid metabolism, which may have altered how people responded to the ketogenic diet. Future studies may use genetic profiling to evaluate if genetic characteristics affect ketogenic diet lipid response.

## Future Research

Future research should include longer-term therapies and a control group to alleviate this study's limitations. Studies lasting at least a year may reveal the ketogenic diet's effects on lipid metabolism and sustainability. Future ketogenic diet research may examine the impact of different macronutrient compositions since tiny adjustments in fat and protein consumption can affect lipid outcomes.

Other patient groups, such as those with a family history of high cholesterol or genetic vulnerability to lipid disorders, may benefit from ketogenic diet research. Studies on the synergistic effects of statins and the ketogenic diet may help determine the ideal combination for cardiovascular risk control.

## Conclusion

This study examined how a ketogenic diet affected lipid metabolism in a community sample at Patna Medical College & Hospital, Patna Bihar over four months. Lipid profiles improve dramatically, with triglycerides decreasing and HDL cholesterol

rising—two heart-healthy indicators. Since total and LDL cholesterol decreased, although less noticeably, the ketogenic diet may help dyslipidaemia and metabolic syndrome patients improve lipid metabolism. The ketogenic diet improves lipid indicators, as previously shown. Concerns concerning elevated LDL cholesterol in some patients underline the need for careful patient selection, frequent monitoring, and customised dietary recommendations in clinical practise. This study suggests that the ketogenic diet may help patients manage their cardiovascular risk factors. Despite promising results, the study's short length and lack of a control group require more study.

We need further research into genetic variables and lipid responses and longer-term studies with larger and more diverse patient groups to prove the ketogenic diet's long-term efficacy and safety. Even though the ketogenic diet can improve lipid metabolism, it should be prescribed cautiously and monitored to limit side effects and enhance patient results.

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