

Research Article

Independent Association of Serum Triglycerides with Liver Enzymes Among Apparently Healthy Iraqi Adults: A Cross-Sectional Study

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Abstract

Background: Hepatic lipid metabolism establishes a strong relationship between blood lipid parameters and liver function indicators. Subtle changes in liver enzymes may indicate early metabolic disorders linked to dyslipidemia and an elevated risk of cardiovascular disease, even in apparently healthy individuals. Understanding these associations might help identify those who are at risk before overt liver or metabolic diseases manifest. **Aim of the Study:** To Check out at the relationship between serum triglyceride and total cholesterol concentrations and liver function biomarkers in apparently healthy Iraqi individuals. **Methods:** A total of 150 adults were initially screened, and 146 participants were included in the final analysis after applying the exclusion criteria in a cross-sectional research. Age, sex, height, and weight were reported as demographic traits. Along with liver function biomarkers like aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and total bilirubin (TB), the serum lipid profile, which includes total cholesterol, triglycerides. Multiple linear regression, Among the statistical techniques employed were descriptive statistics, the independent-samples t-test, and Spearman's rank correlation analysis. Statistical significance was defined as a p-value of less than 0.05. **Results:** The final analysis comprised 146 individuals in total. Significant positive associations were seen between serum triglycerides and ALT ($p = 0.312$, $p < 0.001$), AST ($p = 0.196$, $p = 0.018$), and ALP ($p = 0.226$, $p = 0.006$). Triglycerides continued to have an independent relationship with ALT ($\beta = 0.269$, $p = 0.004$) following multivariable robust regression analysis, but total cholesterol did not have an independent relationship with any liver biomarker. **Study limitation:** There are a number of limitations to this study. Because of its cross-sectional nature, causal inference is not possible, and the results might not apply to other research populations. Furthermore, results were based on a single blood sample from each participant, and lifestyle variables and some metabolic indicators that might affect lipid profile and liver function were not assessed. **Conclusion:** Among Iraqi adults who seemed to be in good health, serum triglycerides were independently linked to liver enzyme activity, especially ALT. Regular evaluation of blood triglycerides and liver enzymes may help identify metabolic abnormalities early and enhance cardiovascular risk assessment.

1. Introduction

Dyslipidemia is a key modifiable risk factor for cardiovascular disease (CVD), which remains the leading cause of morbidity and death globally. Abnormal concentrations of serum lipids, Thru endothelial dysfunction, oxidative stress, and persistent vascular inflammation, factors such as increased total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and decreased high-density lipoprotein cholesterol (HDL-C) contribute to the development of atherosclerosis [1]. Consequently, early detection of metabolic abnormalities associated with dyslipidemia is critical for lowering the burden of cardiovascular disease [2]. Because it controls lipoprotein production, storage, transit, and clearance, the liver is essential to lipid metabolism. It is in charge of lipoprotein assembly, bile acid generation, triglyceride metabolism, and cholesterol biosynthesis. Before overt clinical signs of liver illness appear, even minor disruptions in hepatic function may change the amounts of lipids in the blood [3]. As a result, liver function indicators may offer important insights into early metabolic alterations linked to dyslipidemia. Even before clinically obvious liver illness appears, hepatic lipid accumulation especially in Moderate elevations in liver enzymes are frequently associated with non-alcoholic fatty liver disease (NAFLD) and is regarded as one of the early signs of metabolic dysfunction [4]. Alkaline phosphatase (ALP) indicates cholestatic or biliary problems, whereas ALT and AST are often used biomarkers of hepatocellular integrity [5]. Traditionally thought of as a measure of hepatic excretory function, total bilirubin (TB) has also drawn more attention because of its antioxidant and anti-inflammatory properties qualities, which may have an impact on metabolic and cardiovascular health [6]. According to recent research, people with metabolic disorders may see changes in these indicators even if they do not have a diagnosis of liver disease [7]. Significant correlations between higher liver enzymes and adverse lipid profiles, Metabolic syndrome, obesity, insulin resistance, and non-alcoholic fatty liver disease (NAFLD) have been shown in a number of epidemiological studies [8]. While decreased HDL-C is commonly seen in people with metabolic dysfunction, elevated ALT and AST levels have been associated with higher triglycerides and LDL-C. Additionally, although their clinical importance is still unclear, elevations in ALP and bilirubin have also been linked to cardiometabolic risk [9]. Despite the growing body of international evidence, there is still limited information regarding the association between serum lipid parameters and liver function biomarkers among apparently healthy Iraqi adults, despite the increasing amount of global research. Because biochemical measurements might differ based on genetic background, dietary habits, environmental exposures, and lifestyle variables, population-specific investigations are crucial [10, 11]. As a result, producing local evidence might facilitate the early detection of those with elevated cardiometabolic risk and enhance the interpretation of normal laboratory results [12]. Therefore, the purpose of the current study was to examine the relationship between several blood lipid parameters, specifically total cholesterol and triglycerides, and liver function indicators (AST, ALT, ALP, and total bilirubin) in apparently healthy adult Iraqis [13].

2. Materials and Methods

2.1. Study Design and Participants

During the research period, persons who visited a private clinical laboratory for routine health check-up exams participated in this laboratory-based cross-sectional study. Initially, 150 people were checked for eligibility. 146 seemingly healthy adults—85 men and 61 women—were included in the final study when the predetermined exclusion criteria were applied. Each participant's demographic details, such as age and sex, were noted. Standardized protocols were used to collect anthropometric measures, such as body weight (kg) and height (cm). Weight (kg) divided by height squared (m^2) yielded the body mass index (BMI).

2.2. Data Collection

Each participant's demographic details, such as age and sex, were noted. Standardized protocols were used to collect anthropometric measures, such as body weight (kg) and height (cm).

2.3. Inclusion and Exclusion Criteria

Iraqi individuals who were at least eighteen years old, had fasted for ten to twelve hours prior to the collection of a blood sample, and had comprehensive demographic and biochemical information, including liver function tests and serum lipid profiles, were eligible to participate. People with a history of chronic renal disease, chronic liver disease, diabetes mellitus, cardiovascular disease, active cancer, acute or chronic inflammatory diseases, or pregnancy were not allowed to participate. People with inadequate laboratory or demographic information, as well as those using hepatotoxic or lipid-lowering drugs, were also eliminated. Information about smoking status, alcohol use, dietary habits, physical activity, and medication history was not consistently accessible and was not included in the analysis because this was a laboratory-based cross-sectional study utilizing routinely gathered data.

2.4. Sample Collection and Processing

Each participant had a 10- to 12-hour overnight fast before a normal venipuncture was used to draw around 5 mL of venous blood into simple vacuum tubes. After letting the blood coagulate for 20 to 30 minutes at room temperature, the samples were centrifuged for 10 minutes at 3,000 rpm to extract serum. Using standard clinical chemistry techniques, the isolated serum was examined that same day. Along with the liver function biomarkers AST, ALT, ALP, and TB, the biochemical parameters included total cholesterol (TC) and TG as the chosen serum lipid parameters for the current investigation. Commercial diagnostic kits were used for all measures, and the laboratory's normal operating procedures and the manufacturers' instructions were followed. Internal quality control procedures were routinely performed to guaranty the precision and dependability of the analytical findings.

2.5. Statistical Analysis

For statistical analysis, IBM SPSS Statistics (Version 29.0; IBM Corp., Armonk, NY, USA) was utilized. Continuous variables were represented as median (interquartile range [IQR]), whilst categorical data were displayed as frequencies and percentages. To ascertain if the data distribution was normal, the Shapiro-Wilk test was employed. Spearman's rank correlation analysis was employed to assess the relationships between liver function indicators and serum lipid parameters as the majority of biochemical variables were not regularly distributed. After controlling for age and sex, independent connections were found using multivariable robust linear regression analysis. A two-tailed p value of less than 0.05 was considered statistically significant.

2.6. Ethical Considerations

The Declaration of Helsinki's guiding principles were followed in conducting the study. Prior to participation, each subject provided written informed permission. Throughout the study, participant confidentiality was protected by anonymizing all information gathered, and the relevant institutional ethics committee accepted the study protocol prior to its start.

3. Results

Initially, 150 laboratory reports were examined. One individual with missing liver function data and three participants under the age of eighteen were eliminated. As a result, the final analysis comprised 146 adults (61 females and 85 men). The participants' median age was 47.5 years (IQR: 35.0–58.0 years). Table 1 shows the median blood levels of total cholesterol, triglycerides, AST, ALT, ALP, and total bilirubin.

Table 1: Demographic and biochemical characteristics of the study participants ($n = 146$)

Variable	n	Median	Q1	Q3	Minimum	Maximum
Sex, n (%)						
Male	85	58.2%	–	–	–	–
Female	61	41.8%	–	–	–	–
Age (years)	146	47.50	35.00	58.00	19.00	77.00
Total cholesterol (mg/dL)	146	181.00	155.25	208.75	83.00	418.00
Triglycerides (mg/dL)	146	140.50	93.00	204.75	30.00	967.00
AST (U/L)	146	23.05	19.20	29.38	11.00	85.80
ALT (U/L)	146	22.55	16.75	31.50	4.80	139.00
ALP (U/L)	146	79.15	65.08	94.98	34.80	222.00
Total bilirubin (mg/dL)	146	0.58	0.42	0.75	0.03	29.60

The first quartile (Q1), third quartile (Q3), median, minimum, and maximum values are displayed. Number (n) and percentage (%) are used to express categorical variables. Aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), and total bilirubin (TB).

Spearman's rank correlation analysis was used since the biochemical variables were not regularly distributed. Significant positive associations were seen between serum triglyceride concentrations and AST ($\rho = 0.196$, $p = 0.018$), ALT ($\rho = 0.312$, $p < 0.001$), and ALP ($\rho = 0.226$, $p = 0.006$), with ALT showing the highest link. While total cholesterol did not substantially correlate with AST ($\rho = 0.007$, $p = 0.935$) or ALT ($\rho = 0.030$, $p = 0.719$), it did exhibit a significant positive connection with ALP ($\rho = 0.218$, $p = 0.008$). Triglycerides ($\rho = -0.029$, $p = 0.732$) and total cholesterol ($\rho = -0.058$, $p = 0.488$) did not significantly correlate with total bilirubin. Table 2 displays the results of the correlation study.

Table 2: Spearman's rank correlations between selected serum lipid parameters and liver function biomarkers

Liver biomarker	Lipid parameter	Spearman's ρ	p value
AST	Total cholesterol	0.007	0.935
AST	Triglycerides	0.196	0.018
ALT	Total cholesterol	0.030	0.719
ALT	Triglycerides	0.312	<0.001
ALP	Total cholesterol	0.218	0.008
ALP	Triglycerides	0.226	0.006
TB	Total cholesterol	-0.058	0.488
TB	Triglycerides	-0.029	0.732

The correlation coefficients (ρ) and two-tailed p values are shown. Spearman's rank correlation analysis was used since the biochemical variables were not regularly distributed. $P < 0.05$ was established as the cutoff point for statistical significance. Total bilirubin (TB), alkaline phosphatase (ALP), aspartate aminotransferase (AST), and alanine aminotransferase (ALT).

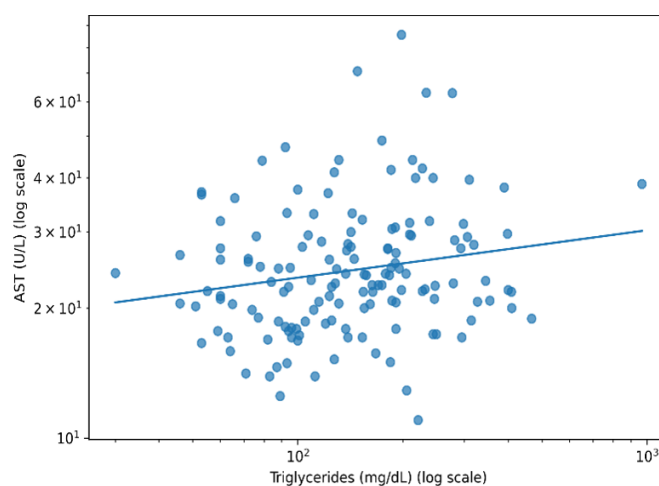


Figure 1: Scatter plot illustrating the association between serum triglyceride and aspartate aminotransferase (AST) concentrations among the study participants

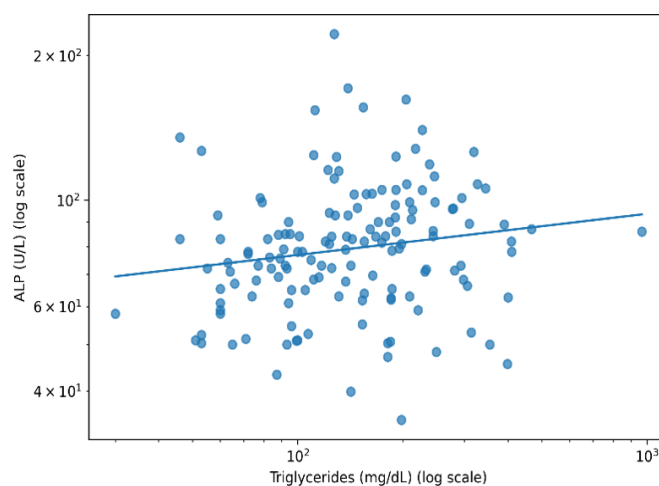


Figure 2: Scatter plot illustrating the association between serum triglyceride and alkaline phosphatase (ALP) concentrations among the study participants

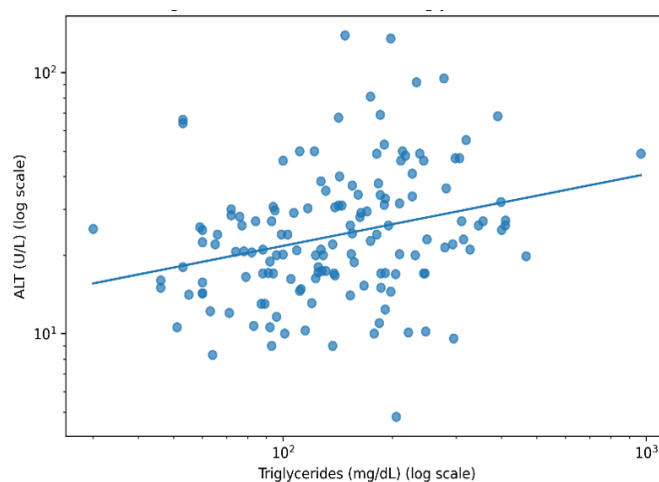


Figure 3: Scatter plot illustrating the association between serum triglyceride and alanine aminotransferase (ALT) concentrations among the study participants

Log-transformed liver biomarkers and triglyceride concentrations were used in multivariable robust linear regression analysis to see if the observed relationships persisted after controlling for any confounding variables. Age, sex, total cholesterol, and triglycerides were taken into account while adjusting the regression models.

After normalization, serum triglycerides continued to be independently correlated with ALT (standardized $\beta = 0.269$, $p = 0.004$). Furthermore, greater ALT concentrations were independently linked to male sex (standardized $\beta = 0.506$, $p = 0.003$). 16.5% of the variation in ALT concentrations was explained by the final ALT model ($R^2 = 0.165$). Additionally, greater total bilirubin concentrations were independently linked to male sex (standardized $\beta = 0.515$, $p = 0.006$). Following multivariable correction, no independent correlations between total cholesterol and AST, ALT, ALP, or total bilirubin were found. Similarly, there was no longer any statistically significant correlation between triglycerides and either AST or ALP. Table 3 displays the multivariable regression analysis's findings.

Table 3: Multivariable robust linear regression analysis of log-transformed liver function biomarkers

Outcome	Predictor	Standardized β	Robust SE	95% CI lower	95% CI upper	p value	Model R^2
AST	Age	0.043	0.076	-0.106	0.192	0.575	0.067
AST	Male sex	0.347	0.181	-0.007	0.702	0.055	0.067
AST	Total cholesterol	-0.036	0.084	-0.201	0.129	0.668	0.067
AST	Triglycerides	0.155	0.097	-0.035	0.344	0.110	0.067
ALT	Age	-0.123	0.069	-0.258	0.011	0.072	0.165
ALT	Male sex	0.506	0.170	0.174	0.839	0.003	0.165
ALT	Total cholesterol	-0.083	0.084	-0.248	0.082	0.325	0.165
ALT	Triglycerides	0.269	0.093	0.087	0.452	0.004	0.165
ALP	Age	0.085	0.084	-0.079	0.249	0.311	0.070
ALP	Male sex	-0.295	0.174	-0.636	0.046	0.090	0.070
ALP	Total cholesterol	0.113	0.086	-0.055	0.282	0.187	0.070
ALP	Triglycerides	0.137	0.085	-0.030	0.304	0.107	0.070
TB	Age	-0.077	0.072	-0.218	0.064	0.287	0.065
TB	Male sex	0.515	0.187	0.148	0.881	0.006	0.065
TB	Total cholesterol	0.031	0.120	-0.203	0.266	0.793	0.065
TB	Triglycerides	-0.078	0.084	-0.242	0.085	0.347	0.065

Age, sex, total cholesterol, and triglycerides were taken into account while adjusting regression models. Triglyceride levels and liver biomarkers were logarithmically converted prior to analysis. Model coefficients of determination (R^2), p values, robust standard errors (SE), 95% confidence intervals (CI), and standardized β coefficients are all displayed. The threshold for statistical significance was set at $p < 0.05$.

Overall, these results show that liver enzyme activity, especially ALT, is independently correlated with serum triglycerides rather than total cholesterol, indicating a possible link between triglyceride-related metabolic dysfunction and early hepatocellular changes in adults undergoing routine laboratory health evaluations.

Abbreviations: Aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP), total bilirubin (TB), total cholesterol (TC), triglycerides (TG), confidence interval (CI), standard error (SE), and interquartile range (IQR).

4. Discussion

The current cross-sectional investigation examined the association between several blood lipid parameters and liver function biomarkers in Iraqi individuals receiving standard laboratory health evaluations [14]. The principal findings of the present study demonstrated that total cholesterol only had a modest correlation with ALP and no significant correlation with either AST or ALT, however serum triglyceride concentrations were positively correlated with liver enzymes, especially ALT [15]. Triglycerides continued to be an independent predictor of ALT activity after controlling for age, sex, and total cholesterol, suggesting that triglyceride metabolism may be more strongly associated with early hepatocellular alterations than total cholesterol [16]. Triglycerides and ALT showed the greatest correlation in the current investigation. One of the most sensitive biochemical indicators of moderate hepatic damage, ALT is mostly found inside hepatocytes [17]. Increased transport of free fatty acids to the liver and improved de novo lipogenesis are two ways whereby elevated triglyceride concentrations encourage hepatic lipid buildup [18]. Hepatocyte damage and consequent ALT leakage into the bloodstream are caused by excess intracellular triglycerides, can also result in endoplasmic reticulum stress, oxidative stress, mitochondrial dysfunction, and inflammatory signaling. Even in those having regular health examination, the persistence of this connection following multivariable correction implies that triglycerides independently contribute to changes in liver function [19, 20].

Additionally, a smaller but statistically significant positive connection was seen between AST and triglycerides. AST is less selective for liver damage than ALT since it is found in a variety of tissues, such as cardiac and skeletal muscle [21]. As a result, the decreased connection found in this study is compatible with the established diagnostic features of AST and is biologically justifiable Figure 2. Further evidence that AST is impacted by several physiological parameters other than lipid metabolism comes from the lack of an independent correlation following regression analysis [22].

Triglycerides and ALP have a positive correlation, which may indicate early metabolic problems impacting hepatobiliary function Figure 3. While ALP is typically thought of as a sign of cholestasis, there is growing evidence that modestly raised ALP concentrations can also be associated with metabolic syndrome, obesity, insulin resistance, and hepatic steatosis [23]. This association may be partially explained by low-grade hepatic inflammation and altered bile acid metabolism associated with higher serum triglyceride concentrations. However, the contribution of triglycerides to ALP variability seems to be somewhat small because the connection vanished after controlling for possible confounders [24, 25].

Total cholesterol did not substantially correlate with either AST or ALT, and it only had a slight positive connection with ALP.

Hepatic production, intestinal absorption, biliary excretion, and receptor-mediated clearance all work together to closely control cholesterol homeostasis [26]. As a result, early hepatic metabolic impairment may not be effectively reflected by isolated blood total cholesterol values. Triglycerides, on the other hand, have a better correlation with liver enzyme activity because they are a more dynamic indicator of abnormal lipid metabolism and hepatic fat buildup [27].

There was no discernible correlation found between total bilirubin and triglycerides or total cholesterol. Because of its anti-inflammatory and antioxidant qualities, bilirubin may offer defense against oxidative stress and atherosclerosis [28]. However, in healthy individuals, bilirubin concentrations often stay within a small physiological range, making it more difficult to find meaningful correlations in cross-sectional research. Additionally, a number of physiological and genetic variables that were not examined in this study have an impact on bilirubin metabolism [29, 30].

The independent correlation between male sex and total bilirubin concentrations an additional finding of the present study was the independent association between male sex and total bilirubin concentrations of the current investigation [31]. Hepatic enzyme activity, erythrocyte turnover, and hormonal effects have all been linked to sex-related variations in bilirubin metabolism. This finding is consistent with other publications showing greater bilirubin concentrations in males than females, even if the underlying processes were outside the purview of this investigation [32].

After controlling for age, sex, and total cholesterol, the regression analysis showed that triglycerides continued to be independently related with ALT Figure 1, but cholesterol did not independently predict any liver biomarker [33]. These results provide credence to the theory that hypertriglyceridemia, rather than hypercholesterolemia, may be an early biochemical marker of metabolic liver stress. Clinically, concurrent measurement of ALT and triglycerides during standard laboratory testing may help identify those who are more likely to develop metabolic dysfunction and cardiometabolic illness in the future. [34].

The current results are in line with earlier epidemiological research that found positive correlations between increased triglycerides and liver enzymes, especially ALT, in populations with metabolic syndrome or non-alcoholic fatty liver disease as well as in seemingly healthy persons [35]. While total cholesterol shows lower and less consistent relationships with liver function tests, several studies have demonstrated that ALT gradually rises with increasing dyslipidemia and hepatic fat buildup. As a result, the present study expands these findings to an adult Iraqi population and offers further local proof of the metabolic relationship between hepatocellular integrity and triglyceride metabolism [36].

When evaluating the results of the current investigation, a number of limitations should be taken into account. First, it is unable to demonstrate causal correlations between liver function indicators and serum lipid parameters due to the cross-sectional design. Second, the results may not be as applicable to different groups because individuals were chosen from a single private clinical laboratory [37]. Furthermore, because the study was based on routinely gathered laboratory data, specific information about medication history, smoking status, alcohol use, dietary habits, and physical activity was not consistently accessible. Additionally, metabolic indicators including insulin, fasting blood glucose, inflammatory markers, and imaging evaluation of hepatic steatosis were unavailable [38]. Notwithstanding these drawbacks, the study offers useful data based on frequently examined biochemical indicators that are accessible, affordable, and useful in day-to-day clinical practice [39].

In conclusion, ALT showed the highest independent correlation with blood triglyceride concentrations among the assessed liver function indicators in this group of adult Iraqis. Before clinically noticeable liver disease manifests, elevated triglyceride levels may be an early sign of mild hepatocellular dysfunction. These results emphasize how crucial it is to measure blood triglyceride levels and liver enzymes during routine health examinations in order to help identify people who are more at risk for metabolic and cardiovascular problems early on.

Article Information

Ethical Approval: The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval and authorization to conduct the study were obtained through the College of Medicine, University of Al-Kafeel, with approval from the Najaf Health Directorate prior to participant recruitment and sample collection.

Informed Consent: Informed consent was obtained from all participants prior to their inclusion in the study.

Consent for Publication: Not applicable.

Data Availability Statement: The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of Interest: The author declare that they have no competing interests.

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Code Availability: Not applicable.

AI Use Disclosure: No generative artificial intelligence tools were used in the preparation of this manuscript.

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