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Article

Lipid Profiles and Liver Enzymes in Autistic Patients in Iraq, a Case-Control Study

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Abstract: his study investigated possible differences in lipid profile and liver enzymes between autistic children and healthy controls. The study included 32 autistic patients (26 males, 6 females, 5-10 years) and 32 age- and gender-matched healthy subjects. Blood samples were taken from all participants, and cholesterol, triglycerides, HDL, LDL, VLDL, ALP, ALT, and AST levels were measured. The results showed that the levels of cholesterol, triglycerides, VLDL, ALT, and AST were significantly reduced in the autistic group compared to the control group No significant differences were observed in the levels of HDL, LDL and ALP. ROC analysis revealed strong discriminatory power for ALT and AST to discriminate between autistic and healthy children. The Pearson correlation matrix showed strong positive correlations between most of the measured parameters. These findings are consistent with previous studies suggesting altered lipid metabolism in autism. The observed reduction in lipid levels may be related to its important role in brain development and synaptogenesis. Low HDL levels may be associated with impaired lipid metabolism in autistic individuals. Significant differences in liver enzymes (ALT and AST) suggest the possibility of mitochondrial dysfunction in autistic children. This study highlights the potential role of lipid profile and liver enzyme testing in the understanding and diagnosis of autism. Further research is needed to investigate the underlying mechanisms by which these factors are associated with autism spectrum disorders.

Keywords: Autism, Lipid Profile, A Liver Enzyme.

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1. Introduction

Autism Spectrum abnormalities (ASDs) are several types of diseases of the brain that often develop in children [1]. ASD is characterized by three main difficulties, which include problems in communication, and challenges in social interaction, in addition to the appearance of repetitive and confined psychological, interest, and patterns of activity [2]. Anxiety, sadness, Relaxation, consuming food difficulties, problems, character outbursts, and violence or self-injury are also prevalent. [3].

ASD can be distinguished as primary in the third year of life based on certain behaviors seen. [4, 5]. Furthermore, boys are approximately three to four times more likely than girls to be detected with autism. [6]. The present incidence of ASD is believed to be 1–2% [7]. In the past three centuries, the occurrence rate of ASD has grown by around 0.065% per year [8]. As the worldwide burden of ASD, a serious Psychiatric disorder, grows, identifying reliable biomarkers is critical for unraveling the pathophysiology and

early analysis of autism [9]. Metabolic variables, which combine inheritance and external factors, are intriguing potential biomarkers for autism [10].

Lipid profiles, including cholesterol, triglycerides, and high-density lipoprotein (HDL) cholesterol, play critical roles in various physiological processes and are widely recognized as important indicators of cardiovascular health. Recently, some research has revealed the relevance of abnormal lipid metabolism, such as the synthesis of cholesterol and fatty acids, in the pathophysiology of autism [11, 12]. Lipids are essential to the body's power storage and transport, as well as architectural elements in cell membranes. They play an important role in developing embryos myelitis, and cerebral growth; physiological abnormalities in lipids are associated with numerous neurological diseases. [13].

Furthermore, liver enzymes such as alanine transaminase (ALT) and aspartate transaminase (AST) are important markers of liver function and can offer information on systemic metabolic disorders[14]. The association between liver enzymes and autism is a complex issue that requires further research to comprehend fully. Some research has revealed that abnormal liver enzymes are connected with autism spectrum disorder (ASD), however, the exact nature of this association is unknown [15, 16].

Liver enzymes are proteins generated by the liver that aid in several metabolic activities, including the breakdown of poisons and medicines. Abnormal liver enzyme levels may suggest liver malfunction or injury [17]. The study aims for whether there are any significant changes in lipid profiles and liver enzyme levels between autistic people and the control group.

2. Materials and Methods

2.1. Study Population

The research group was separated into two groups.: patients and controls. The patient group consisted of 32 autism spectrum disorder (ASD) patients (26 male and 6 female, age range 5-10 years). The individuals diagnosed with autism were evaluated by a specialist. The control group comprised 32 healthy individuals, carefully matched in age and gender to the patient group, with 10 females and 22 males. Between September to October, subjects were drawn from patients who visited the Medical City Hospital in Baghdad Teaching Hospital labs in Baghdad, Iraq.

2.2. Specimen Collection

In the study, all participants, both patients and control subjects, had 5 mL of blood drawn from a vein with reusable plastic needles. The blood was taken in specialized tubes containing gel. The gel tubes were then centrifuged at 3000 rpm for 10 minutes. This centrifugation process effectively separated the serum from the remaining constituents of the blood. The resulting serum was then preserved at a temperature of -20 C^{o} until it could be examined and analyzed.

2.3. Sample Analysis

The concentrations of AST and ALT in the bloodstream have been measured using the colorimetric method outlined in the protocol given by Randox Laboratories Ltd. (UK) and their kits. ALP levels were determined using a colorimetric approach that followed the methodology given by Diasys Diagnostic System GmbH (Germany) using their kits. The lipid profile, which included cholesterol, triglycerides, and HDL, was determined by enzymes using a colorimetric test using the procedure supplied by Linear Chemicals (Spain) and their kits. The levels of LDL and VLDL were estimated using the Friedewald technique.

2.4. Statistical Analysis

The IBM SPSS Statistics program (IBM Corporation, New York, United States) version 25.0 was used in the analysis. The data was examined using descriptive statistics and given as means ± standard deviation (SD). To assess average variations between the

patient and control groups, an independent samples t-test was used. Numerical meaning was defined as $p < 0.05$ with a 95% confidence interval, and extremely significant at $p \leq 0.01$ with an accuracy rate of 99%.

3. Results

Table 1 and Figure 1 show the mean, standard deviation, standard error of the mean, and p-values for each marker in the control and patient groups, respectively. The parameters tested for both groups were Chol (cholesterol), Tri (triglycerides), HDL (high-density lipoprotein), LDL (low-density lipoprotein), VLDL (very-low-density lipoprotein), ALP (alkaline phosphatase), ALT (alanine transaminase), AST (aspartate transaminase). In result, the results show significant differences between the two groups in terms of cholesterol, triglyceride, VLDL, ALT, and AST levels. However, there are no significant variations between the groups' HDL, LDL, and ALP levels.

Table 1: It compares the demographics of autistic children to those who are healthy.

Group Statistics						
Parameter	**Group**	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**p-value**
chol	control	30	141.0000	17.60682	3.21455	.578
	patient	30	87.8000	15.97282	2.91622	
tri	control	30	140.0000	17.60682	3.21455	.820
	patient	30	78.5000	16.86406	3.07894	
HDL	control	30	51.4567	9.16758	1.67376	.981
	patient	30	52.6600	8.86720	1.61892	
LDL	control	30	59.1267	2.15085	.39269	.414
	patient	30	33.1000	1.76068	.32146	
VLDL	control	30	28.0000	3.52136	.64291	.000
	patient	30	13.1000	1.76068	.32146	
ALP	control	30	88.4667	17.94961	3.27714	.600
	patient	30	407.1000	19.54191	3.56785	
ALT	control	30	23.5767	9.99219	1.82432	.000
	patient	30	92.5000	26.41023	4.82183	
AST	control	30	24.4100	25.13052	4.58818	.027

	pati ent	30	81.7333	26.64186	4.86412	

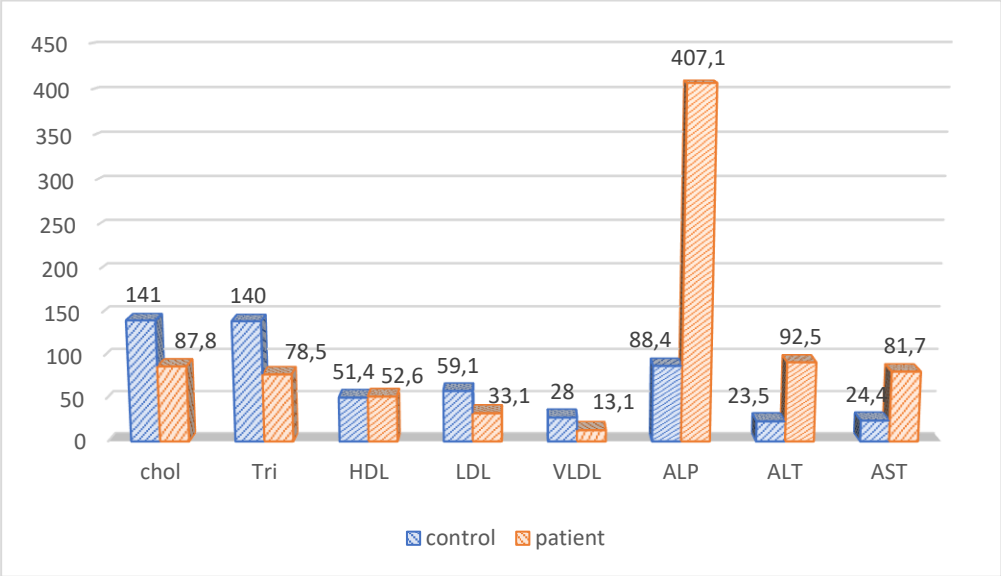

Figure 1: shows the means of the parameters employed in this investigation.

The Receiver Operating Characteristic (ROC) curve depicted in Figure 2 is a graphical depiction of a binary classification model's performance at various threshold levels. It is frequently used to evaluate the trade-off between sensitivity and specificity over a variety of possible cut-off positions for a continuous test result variable. Table 2 shows the Area Under the Curve (AUC), which is a summary metric of the ROC curve that indicates The AUC for cholesterol and HDL, LDL, VLDL, tri was 0.000, showing little discriminatory power. The p-value is also 0.000, indicating strong support against the null hypothesis of an AUC of 0.5.

The null hypothesis is an AUC of 0.5, however, The AUC value for high-density lipoprotein (HDL) is 0.544, indicating moderate discriminating power. The p-value is 0.554, which provides insufficient evidence to reject the null hypothesis of an AUC of 0.5. However, it is vital to highlight that the occurrence of at least one tie between the positive and negative real-state groups may cause statistical bias. Overall, the AUC analysis shows that cholesterol, triglycerides, LDL, and VLDL have little discriminating power. HDL, on the other hand, demonstrates modest discriminating power. However, it is necessary to note the occurrence of ties in the HDL variable, since they may bring some bias into the statistics. The p-values argue against the null hypothesis of an AUC of 0.5 for all variables except HDL.

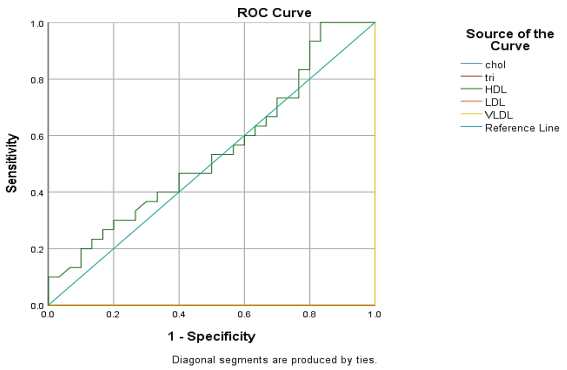

Figure 2: shows the ROC curves for lipids parameters in this investigation.

Table 2: shows the area under the curve for lipids parameter in this research.

Area Under the Curve					
Test Result Variable(s)	**Area**	**Std. Error[a]**	**Asymptotic Sig.[b]**	**Asymptotic 95% Confidence Interval**	
				Lower Bound	Upper Bound
Chol	.000	.000	.000	.000	.000
Tri	.000	.000	.000	.000	.000
HDL	.544	.075	.554	.397	.692
LDL	.000	.000	.000	.000	.000
VLDL	.000	.000	.000	.000	.000

The AUCs for alkaline phosphatase (ALP) and alanine transaminase (ALT) are both 1.000, suggesting perfect discrimination. The p-value is also 0.000, providing strong evidence to reject the null hypothesis of an AUC of 0.5. The AUC for aspartate transaminase (AST) is 0.967, indicating high discriminating power. The p-value is 0.000, indicating strong support against the null hypothesis of an AUC of 0.5. The 95% confidence interval is between 0.902 and 1.000. In the end, the AUC analysis shows that alkaline phosphatase (ALP) and alanine transaminase (ALT) have complete discriminatory power, but aspartate transaminase (AST) has outstanding discriminatory power.

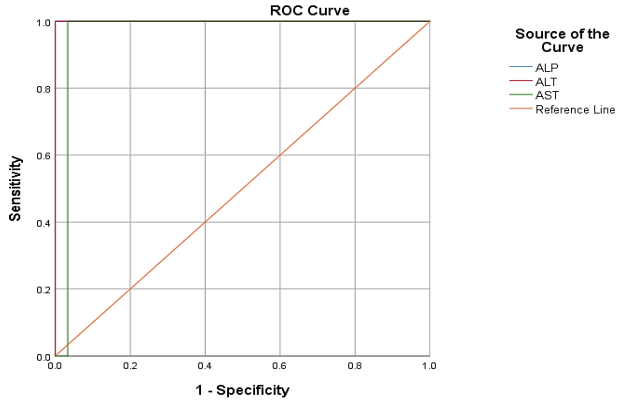

Figure 3: presents the ROC curves for the liver enzyme values for evaluation

Table 3: displays the area under the curve for liver enzyme parameters in this study.

Area Under the Curve					
Test Result Variable(s)	**Area**	**Std. Error[a]**	**Asymptotic Sig.[b]**	**Asymptotic 95% Confidence Interval**	
				Lower Bound	**Upper Bound**
ALP	1.000	.000	.000	1.000	1.000
ALT	1.000	.000	.000	1.000	1.000
AST	.967	.033	.000	.902	1.000

Table 4 shows the Pearson correlation matrix which displays strong and significant relationships between the parameters. Cholesterol, triglycerides, HDL, LDL, VLDL, ALP, ALT, and AST are closely related to each other, with various positive and negative correlations observed. The table you provided displays a correlation matrix that shows the pairwise correlations between different variables

Chol and Tri show an extremely significant positive connection (r = 999). The association is extremely significant ($p < 0.01$). Chol and HDL have a substantial negative connection (r = 992). The relationship is extremely significant ($p < 0.01$). Cholesterol and LDL have a very strong positive association. (r = 995). The association is extremely significant ($p < 0.01$). Chol and VLDL have a very significant positive connection (r = 995). The association is extremely significant ($p < 0.01$). Chol has a very significant positive association with ALP, ALT, and AST, as evidenced by high correlation coefficients (r = 995 and higher). This implies an advantageous relationship between cholesterol levels and alkaline phosphatase, alanine transaminase, and aspartate transaminase. The relationships are quite substantial ($p < 0.01$).

Tri shows very strong positive correlations with HDL, LDL, VLDL, ALP, ALT, and AST, indicated by high correlation coefficients (r=998 and above). This suggests a positive relationship between triglyceride levels and the levels of these variables. The correlations are highly significant ($p < 0.01$).

HDL has strong negative correlations with LDL, VLDL, ALP, ALT, and AST, indicated by correlation coefficients of (r = 992 and above). This means that as HDL levels increase, the levels of LDL, VLDL, ALP, ALT, and AST tend to decrease. The correlations are highly significant ($p < 0.01$).

LDL has a very strong positive correlation with VLDL, ALP, ALT, and AST, indicated by correlation coefficients of (r = 1.000). This suggests that as LDL levels increase, the levels of VLDL, ALP, ALT, and AST also increase. The correlations are highly significant ($p < 0.01$).

VLDL has a very strong positive correlation with ALP, ALT, and AST, indicated by correlation coefficients of(r = 1.000). This means that as VLDL levels increase, the levels of ALP, ALT, and AST also increase. The correlations are highly significant ($p < 0.01$).

ALP has a very strong positive correlation with ALT and AST, indicated by correlation coefficients of (r =1.000). This suggests a positive relationship between the levels of alkaline phosphatase and the levels of alanine transaminase and aspartate transaminase. The correlations are highly significant ($p < 0.01$).

ALT and AST have a very strong positive correlation of (r = 1.000). This indicates a strong positive relationship between the levels of alanine transaminase and aspartate transaminase. The correlation is highly significant ($p < 0.01$).

Table 4: Pearson correlation for autistic children.

Correlations								
Chol		Tri	HDL	LDL	VLDL	ALP	ALT	AST
Chol	1	.999**	.992**	.995**	.995**	.995**	.995**	.994**
Tri	.999**	1	.994**	.998**	.998**	.998**	.998**	.998**
HDL	.992**	.994**	1	.992**	.992**	.992**	.992**	.992**
LDL	.995**	.998**	.992**	1	1.000**	1.000**	1.000**	1.000**
VLDL	.995**	.998**	.992**	1.000**	1	1.000**	1.000**	1.000**
ALP	.995**	.998**	.992**	1.000**	1.000**	1	1.000**	1.000**
ALT	.995**	.998**	.992**	1.000**	1.000**	1.000**	1	1.000**
AST	.994**	.998**	.992**	1.000**	1.000**	1.000**	1.000**	1

4. Discussions

In our current study, a decrease in lipid levels was observed in children with autism compared to vigorous children, and this is consistent with previous studies, Kim et al. propose that there is a potential connection between Autism and changes in the composition of lipids found in the blood plasma. Specifically, they suggest that certain types of lipids in boys diagnosed with autism may display significant variances when compared to boys who do not have the condition.[18]. Matsuzaki et found that male infants with autism exhibited suggestively lower serum levels of total cholesterol and triacylglycerol compared to matched controls who were typically developing males [19]. The same study for Makris G [20], Ansary and Al-Ayadh [21].

In our current study, a decrease in lipid levels was observed in children with autism compared to healthy children, and this is consistent with previous studies that found protective covering of nerve fibers) and those that do not. Alzheimer's syndrome, Smith-Lemli-Opitz Condition, Parkinson's disorder, and Multiple Sclerosis are some examples of neurodegenerative disorders. [22]. The investigation of cholesterol metabolism in neuroscience is motivated by its potential involvement in the onset and progression of neuropsychiatric disorders [22]. The brain has the highest lipid concentration of any organ, accounting for around 22% of the body's total cholesterol. [23]. Cholesterol is essential for synaptogenesis, barrier trafficking, signal transduction, and central nervous system maturation throughout the lifespan.[23]. Maintaining cholesterol balance is believed to be significant in the disease mechanism of ASD. Multiple research projects have found irregularities in cholesterol metabolism among individuals with ASD, suggesting a potential association with the progression and severity of the condition. Neurological disorders with a hereditary basis, are marked by disturbances in the brain's cholesterol homeostasis pathway [22].

These findings are consistent with several research that have discovered that HDL insufficiency in ASD children is caused by a lipid metabolic issue related to autism[18]. Low serum levels of HDL and omega-3 fatty acids seen in autistic children at an early age may indicate defective fatty acid metabolism [24]. Reduced HDL levels can be caused by several causes, including a poor diet, inadequate exercise, genetics, and vitamin deficiencies. A decreased level of HDL and omega-3 fats in autistic children at an early age may suggest impaired fat metabolism. HDL may reduce atherosclerosis through a variety of means [11].

2010 research by the International Society for Autism Research discovered that blood TG and VLDL levels in infants with efficient autism were considerably lower than those in normal control patients. However, our investigation yielded the same results, with the exception that TG and VLDL were negligible. According to Kim et al. (2010), males with autism may have dyslipidemia, which might indicate a link between lipid metabolism and autism. When a triglyceride degrades, it provides the body with fatty acids. Vitamins A, D, E, and K are fatty-soluble; thus the body needs fat to absorb them.

The chylomicrons deliver these vitamins throughout the arteries. Vitamins E, D, and K are also stored in fat. Vitamin shortage occurs when there is insufficient nutritional fat or when a Clinical disorder interacts with the human body's capacity to break down fat. (a condition seen in certain autistic children) [25]. The absence of precise indicators for early diagnosis has motivated research into novel biomarkers that might demonstrate a link between dysregulated cholesterol metabolism and neurodevelopmental disorders such as ASD [26].

In the United States, 36% of children with autistic children showed elevated levels of AST, while 52% exhibited increased levels of ALT [27]. A 2006 study addressing mitochondrial dysfunction and autism revealed that 38% of children with autism exhibited an elevation in serum AST levels [28]. This means that these results are consistent with our

current study Hence, assessing serum ALT and AST levels can be beneficial in evaluating mitochondrial malfunction in patients with autism[29].

Autistic children with mitochondrial dysfunction experience a compromised tricarboxylic acid (TCA) cycle resulting from enzyme deficiency, abnormal nutrient metabolism, or nutritional deficits. This impairment in the TCA cycle leads to elevated levels of AST, and ALT, disrupting aerobic respiration and prompting the initiation of anaerobic respiration [30].

Some individuals with autism may be taking medications that can affect liver function. Certain medications, such as antipsychotics or antiepileptic drugs, may have an impact on liver enzymes. Individuals with autism may have other medical conditions or comorbidities that can affect liver function[31]. These conditions could include gastrointestinal issues, metabolic disorders, or immune system abnormalities. It is possible that these underlying conditions could contribute to liver enzyme abnormalities [32]. Some studies have suggested that individuals with autism may have metabolic abnormalities that could affect liver function. These disturbances may involve imbalances in certain biochemical pathways or impaired detoxification processes. However, more research is needed to establish a clear link between these metabolic disturbances and liver enzyme abnormalities in autism[16, 33]

5. Conclusion

This study found significant differences in lipid profile and liver enzymes between autistic children and healthy controls. Children with autism had lower levels of cholesterol, triglycerides, VLDL, ALT, and AST compared to the control group. Furthermore, strong positive correlations were found between most of the parameters measured. These findings support previous research suggesting altered lipid metabolism in autism. The observed reduction in adiposity is consistent with its known importance in brain development and function. Low HDL levels may be associated with impaired lipid metabolism in autistic individuals. Significant differences in liver enzymes (ALT and AST) suggest the possibility of mitochondrial dysfunction in autistic children. Overall, this study emphasizes the potential importance of lipid profile and liver enzyme tests in understanding and diagnosing autism. Further study is needed to determine the underlying processes by which these variables are linked to autism spectrum disorders.

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