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Article

Biochemical Markers of Lipid Profiles Alterations in Children of Baghdad with Recurrent *Giardia lamblia* Infections

Lubna Hussain Ali[1], Dhuha Sabah Hasan*[2], Lina Adil Jebur[1], Alea Farhan Salman[2], Hashim J. Abdullah[2]

1. Department of Microbiology, College of Medicine, Mustansiriyah University, Baghdad, Iraq
2. National Center of Hematology, Mustansiriyah University, Baghdad, Iraq
*Correspondence: dhuha.sabah@uomustansiriyah.edu.iq

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Abstract: Giardiasis is one of the essential parasitic intestinal diseases, widespread in many countries. Children are the most affected by this disease. The current study aims to see how *Giardia lamblia* affect on lipid profile. From November 2023 to May 2024, this study was done in Baghdad. The participants in the study were 100 children of both sexes. Based on stool examination, the children were separated into two groups: infected with *Giardia lamblia* (n=50) and healthy (n=50). The study results indicate that giardiasis infection, particularly recurrent infection, clearly affects lipid metabolism in children. A significant decrease in triglyceride, HDL, and LDL levels ($P < 0.001$), as well as VLDL levels ($P = 0.03$ and $P = 0.05$) was observed with the frequency of infection, indicating impaired fat absorption or transport resulting from damage to the intestinal villi. While no significant differences were observed in total cholesterol between patients and controls with a first-time infection and two-time infection ($P = 0.18$ and $P = 0.69$), but significant differences were noted in one infected case ($P = 0.04$), there was an upward trend in their levels with repeated infection, which may be attributed to chronic inflammatory processes. These results support the hypothesis that giardia disrupts lipid biomarkers and also affects the body's lipid balance, especially in cases of recurrent infection.

Keywords: Giardia lamblia, Lipid Profiles, Biochemical Markers

Introduction

Giardia lamblia is a flagellated protozoan parasite that infects the small intestine of humans and other mammals, causing giardiasis [1]. Giardiasis is the third most common cause of diarrheal disease globally, with over 300 million cases annually, prevalence ranges from 2–3% in industrialized countries to up to 30% in developing regions [2]. This parasitic infection is transmitted through the fecal-oral route, involving contact with infected individuals, livestock and wild animals, or consuming contaminated water or food containing cysts, and is especially prevalent in areas with poor sanitation [3], [4]. Many factors contribute to the parasite's widespread presence, including its simple life cycle, quick reproduction, ease of transmission through contaminated food and drink, resistance to chlorination, ability to survive for weeks in humid environments and resistance to its hosts in simple life cycles that consist of two forms: the trophozoite and the gastrointestinal sac ([5], [6]. A diseases formation of this parasite is related with effect of trophozoite attachment to upper portion of small intestine, and their proteolytic enzymes (cysteine proteases and glycosidases) [7], [8]. This increases rate of enterocyte apoptosis, loss of barrier function, leading to lymphocyte-mediated microvillus shortening and reduction of absorptive surface area, ultimately are responsible for mal-digestion and malabsorption of nutrients [9], [10].The spectrum of infection ranges from a symptomatic cases to chronic illnesses, presenting symptoms like diarrhea, dehydration, abdominal distension, nausea, vomiting, bloating, and malabsorption, Chronic consequences include fatigue, irritable bowel syndrome, and growth delay in young children [4]-[11].The laboratory diagnosis of Giardia spp. is mainly based on finding and demonstration of microscopic cyst in stool samples, but immunological-based assay and molecular methods also are available and are used for diagnostic or research proposes in developed countries. All diagnostic methods provide different sensitivity and specificity, this condition depends on some factors such as the method of test, the skill of operations and the stage that the test has been performed (12). The aim of this study was to conduct explore the relationship between Giardia lamblia infection and altered lipid parameters in Iraqi children.

Methods

2.1. Study Area/Subject Selection

Between the period extended from 7 November 2023 to 22 May 2024 at Children's Hospital located in Al-Iskan of Baghdad and from various laboratories approved by the Ministry of Health. The study comprised a total of 100 children ranging in age from 2 to 12 years old.

2.2. Ethical Approval

The study received approval from the Ministry of Health and Environment in Baghdad, Iraq, and was also endorsed by the local ethics committee. In addition, consent was obtained from the parents of the participating children.

2.3. Stool Sample Collection

Fresh stool samples were collected from children and were immediately examined microscopically by direct wet smear using 0.9% normal saline solution, direct wet smear using local iodine 1% dye or by ether formalin concentration method with a magnification of 40 X or 100 X for the purpose of detecting the stages of the Giardia lamblia (trophozoite or cyst)

2.4. Blood Sample Collection

A venous blood sample was drawn from children infected with *Giardia lamblia* and healthy. Approximately 5–6 ml of blood was collected into a tube containing EDTA anticoagulant. The samples were then centrifuged (Hittich EBA 20/Germany) for 15 minutes at 3,500 rpm. Following centrifugation, the serum was immediately separated and placed into clean tubes. The samples were then stored at -20°C until analysis.

2.5. Lipid profile

Total cholesterol, LDL cholesterol, HDL cholesterol and triglyceride were determined using semi-automated by using the commercial kit, Human biochemical and diagnostic mbH, Germany by biochemistry analyzer (Chem 100), Italy. Subsequently, very low-density lipoprotein (vLDL)level were calculated for all collected samples.

2.6. Statistical analysis

In this study, statistical analysis was performed using Microsoft Excel. The mean, standard deviation, and p-value were calculated for age, lipid level, and serum lipid level in both affected and healthy girls and boys..

Results

The table 1 and figure 1 show the most common age groups in in the present study, where the first age group from 2 to7 years recorded the largest number between infected and healthy, with a total number of 68, including 33 infected and 35 healthy, followed by the second age group, which is from 8 to 12), with a total number of 32. Among them are 17 infected and 15 healthy. Table 2 and figure 2 shows the percentage distribution of each group by gender. The majority of people studied in the two groups were females, with a total of 61, including 38 infected and 23 healthy, compared to males, with a total 39, including 12 infected with giardia and 27 healthy. Table 3 presents the age groups in this study. Age did not differ significantly between infected and healthy girls. However, lipid profile level analysis revealed a significant decrease ($p < 0.005$). Table 4 displays the age groups of infected and healthy children, with no significant age difference. Lipid analysis showed significant decreases in triglycerides, HDL, and LDL ($p < 0.001$), Also significant decrease in cholesterol levels between healthy and infected groups ($p=0.005$). Table [5] illustrates the recurrence rate in relation to lipid profile levels. Among patients with infection (0, 1, 2), significant reductions were observed in triglyceride, HDL, and LDL levels ($P < 0.001$), as well as VLDL levels ($P = 0.03$ and $P = 0.05$). Cholesterol levels showed no significant difference between patients and controls with a first-time infection and 2 ($P = 0.18$ and $P = 0.69$), but significant differences were noted in one infected case ($P = 0.04$). The same is observed in Figure 1.

Table 1. Result of age in study groups.

Age	2-7	8-12
Infected	33	17
Control	35	15
Total	68	32

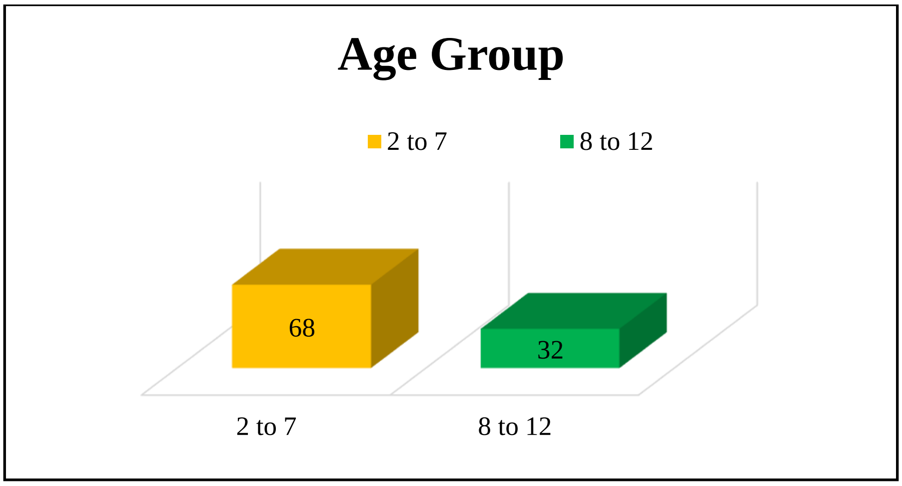

Figure 1. Result of age study groups.

Table 2. Result of gender ratio.

Gender	**Female**	**Male**	**Total Samples**
Infected	38	12	50
Control	23	27	50
Total	61	39	100

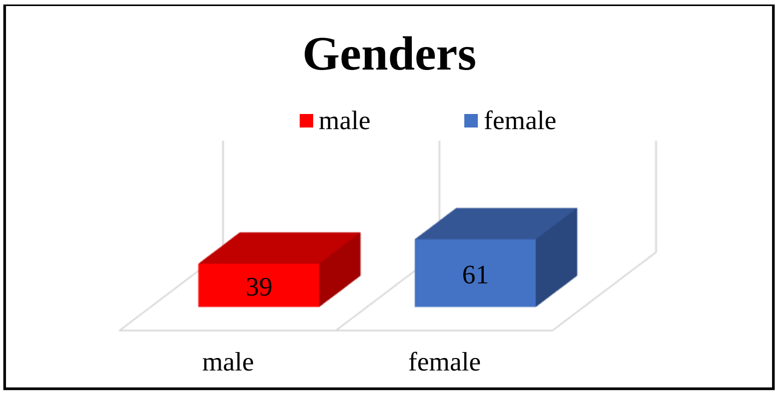

Figure 2. Result of gender group.

Table 3. The lipid profile results of the affected girls' children showed significant differences.

Parameter	Unit	Group N = 34	Mean ± SD	*p*-Value
Age	Year	Control	7.09 ± 2.93	0.108
		Patients	5.85 ± 3.31	
Cholesterol	$mg.dL^{-1}$	Control	165.26 ± 14.96	0.005
		Patients	146.15 ± 35.53	
Triglyceride	$mg.dL^{-1}$	Control	173.15 ± 25.56	0.001>
		Patients	102.85 ± 24.87	
HDL	$mg.dL^{-1}$	Control	54 ± 6.68	0.001>
		Patients	39.59 ± 7.64	
LDL	$mg.dL^{-1}$	Control	94.79 ± 11.19	0.001>
		Patients	97.65 ± 21.8	
VLDL	$mg.dL^{-1}$	Control	34.38 ± 5.09	0.001>
		Patients	20.59 ± 4.99	

Table 4. The lipid profile results of the affected boys' children showed significant differences.

Parameter	Unit	Group N = 20	Mean ± SD	*p*-Value
Age	Year	Control	4.8 ± 3.33	0.067
		Patients	7 ± 4.03	
Chol	$mg.dL^{-1}$	Control	164.75 ± 17.27	0.300
		Patients	175.15 ± 40.74	
Tri	$mg.dL^{-1}$	Control	159.75 ± 33.85	0.001>
		Patients	113.6 ± 35.05	
HDL	$mg.dL^{-1}$	Control	56.15 ± 6.6	0.001>
		Patients	40.1 ± 9.6	
LDL	$mg.dL^{-1}$	Control	97.5 ± 15.75	0.001>
		Patients	95.25 ± 23.28	
VLDL	$mg.dL^{-1}$	Control	31.9 ± 6.77	0.001>
		Patients	22.8 ± 7.14	

Table 5. Lipid profile results in relation to the number of affected individuals (0, 1, 2) for patients versus controls.

Parameter	Group	Infected = 0 N = 25		Infected = 1 N = 16		Infected = 2 N = 8	
		Mean ± SD	***p*-Value**	**Mean ± SD**	***p*-Value**	**Mean ± SD**	***p*-Value**
Age (Year)	Control	6.14 ± 3.24	0.096	6.14 ± 3.24	0.078	6.14 ± 3.24	0.062
	Patients	4.76 ± 3.57		7.75 ± 2.82		8.38 ± 1.77	
Chol ($mg.dL^{-1}$)	Control	164.43 ± 15.68	0.181	164.43 ± 15.68	0.004	164.43 ± 15.68	0.697
	Patients	155.68 ± 40.78		145.75 ± 34.65		161.25 ± 44.41	
Tri ($mg.dL^{-1}$)	Control	167.69 ± 29.7	0.001>	167.69 ± 29.7	0.001>	167.69 ± 29.7	0.001>
	Patients	115.36 ± 36.26		98.69 ± 21.86		102.5 ± 14.92	
HDL ($mg.dL^{-1}$)	Control	54.73 ± 6.62	0.001>	54.73 ± 6.62	0.001>	54.73 ± 6.62	0.001>
	Patients	40.08 ± 9.3		39.69 ± 8.82		40.25 ± 5.04	
LDL ($mg.dL^{-1}$)	Control	96.16 ± 13.17	0.001>	96.16 ± 13.17	0.001>	96.16 ± 13.17	0.001>
	Patients	92.96 ± 20.17		102.81 ± 24.07		95.63 ± 20.4	
VLDL ($mg.dL^{-1}$)	Control	25.21 ± 11.94	0.038	25.21 ± 11.94	0.032	25.21 ± 11.94	0.055
	Patients	19.65 ± 7.84		18.36 ± 6.22		16.75 ± 5.75	

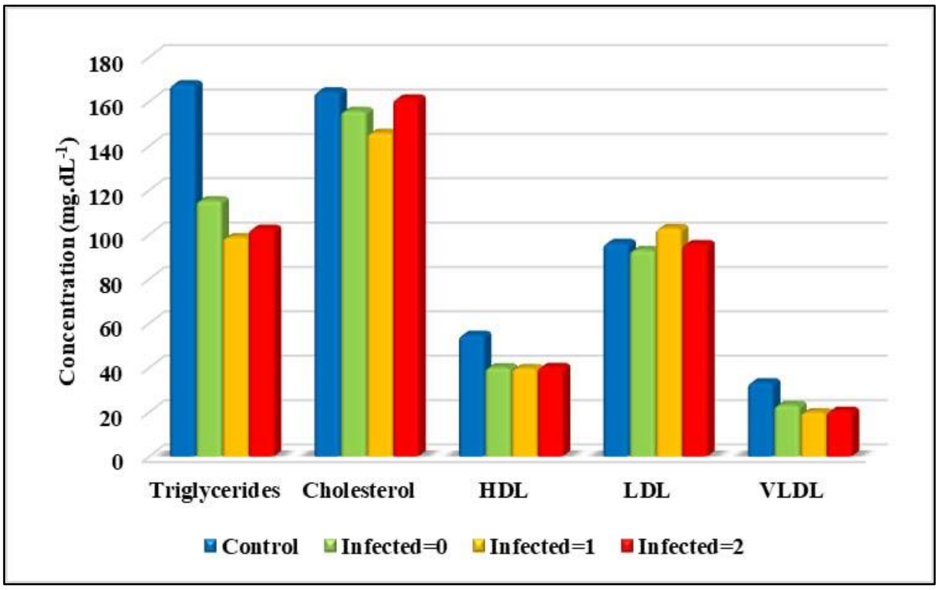

Figure 3. Show number of infected and relationship with lipid profile level.

Discussion

Table 1 and Figure 1 shows a significant increase in Giardia lamblia infection rates among children aged 2 to 8 years. This increase is attributed to the increased likelihood of exposure to sources of infection at this age, particularly through direct or indirect contact with feces. This group is more susceptible to infection due to their reliance on diapers, or their being in the training phase to use sanitation facilities, as well as their presence in group settings such as nurseries and daycare centers. Individuals in contact with this group, whether within the family or educational and care institutions, are considered among the groups at risk of infection due to the increased chances of parasite transmission through direct daily contact.

The data presented in Table 2 and Figure 2, differences in infection rates between the sexes are observed, with Giardia lamblia infection rates being higher in females than in males. Although the parasite does not exhibit a specific biological preference in terms of gender, these differences may be attributed to environmental and behavioral factors, such as the increased likelihood of females being exposed to sources of infection as a result of their participation in activities related to home health care or direct interaction with infected children, which increases the chances of transmission within this group. Therefore, environmental factors and daily behavior remain the most influential factor in explaining this disparity. The results of the table 3 showed clear significant differences in lipid levels between the affected girls and the control group, except for age, where the difference was not significant. A significant decrease was observed in the levels of total cholesterol, this is consistent with a study of Cholesterol starvation induces differentiation of the intestinal parasite Giardia lamblia [13] who found that *G. lamblia* infection can maintain low serum cholesterol. While the cholesterol results in this investigation contradicted those study of Association between Serum Cholesterol Level and Giardia lamblia Infection among Children with Acute Diarrhea in Al-Najaf Governorate [14]. and both bile salt excess and cholesterol deficiency promote encystation by blocking cholesterol uptake. The physical state of bile salt molecules in solution (monomers or micelles) is critical in determining cholesterol uptake by Giardia [14], as for triglycerides, good cholesterol (HDL), and very low-density lipoprotein (VLDL) in the affected girls a significant increase was also observed., indicating the impact of the disease on lipid metabolism disorders. Conversely, a slight increase in LDL was recorded in the affected girls compared to the healthy group, and the difference was also significant. These changes reflect an imbalance in lipid balance that may be linked to the disease's impact on body functions. The results of Table 4 showed significant differences in most lipid parameters between male children infected with and uninfected with Giardia. A significant decrease in triglyceride levels was observed in infected children, indicating that parasite infection may affect lipid metabolism mechanisms. This result is consistent with what Bansal et al. reported, who found that Giardia patients had lower lipid parameters, particularly triglycerides, compared to healthy individuals. These results are also consistent with what Maani and Jaber [15] reported, who found normal triglyceride levels in Giardia patients compared to the control group. The current study also showed variations in both HDL and VLDL levels between the groups examined, as no significant differences were recorded in HDL levels among infected patients compared to the control group. This result is consistent with what Saki [16] reported, who confirmed that Giardia cyst carriers did not show a significant change in HDL levels. As for total cholesterol, no significant difference was observed, despite a relative increase in patients. This suggests that infection with the giardia parasite may cause an imbalance in lipids, particularly beneficial lipids, without significantly affecting total cholesterol. These results support the hypothesis that the parasite has a potential impact on some biomarkers associated with lipid metabolism in infected children. The study results, shown in Table 5 and Figure 3, showed a significant effect of the number of times Giardia parasite infections on lipid levels in infected children compared to the control group (uninfected children). Regarding triglycerides, the group of infected children recorded a significant decrease in mean triglyceride concentrations, and this decrease was more pronounced in recurrent infections. Values decreased from (167.69 ± 29.7) mg/dL in the control group to (115.36 ± 36.26) in the first infection, then (98.69 ± 21.86) and (102.5 ± 14.92) in the second and third infections, respectively.

One of the most important reasons for this decrease is the impact on fat absorption due to damage to the intestinal villi or digestive system dysfunction caused by parasite infection. The significance of these results was confirmed statistically ($p < 0.001$). As for total cholesterol, the results showed slight changes between groups, with a slight decrease in the first infection and then a gradual increase with the number of infections. Although the difference was not statistically significant in most cases ($p > 0.05$), the reason for the increase in recurrent cases may be attributed to compensatory changes or chronic inflammatory processes associated with recurrent infections. The same applies to LDL, where gradual increases in average concentration were recorded with repeated infections, with the differences not reaching statistical significance in most cases. This may also indicate an upward trend in the parasite's contribution to inflammatory processes, which in turn raise LDL concentrations. Regarding the results for good cholesterol(HDL), all groups of patients showed a significant decrease in HDL concentration compared to the control group, with values reaching (40.08 ± 9.3), (39.69 ± 8.82), and (40.25 ± 5.04) in recurrent infections versus (54.73 ± 6.62) in the control group, These results are highly statistically significant ($p < 0.001$) and reflect the possibility of impaired lipid metabolism or oxidative stress in infected children. Likewise, VLDL showed a gradual decrease with increasing infection frequency (25.21 in the control group versus 16.75 in the third infection), and some of these changes were statistically significant ($p = 0.038$, $p = 0.032$), This decrease supports the hypothesis of a defect in the absorption or transport of triglycerides in children infected with giardia. These changes in lipid concentrations during recurrent infections reflect a disturbance in lipid metabolism resulting from intestinal damage caused by parasitic infection, especially in recurrent cases.

Conclusion

Giardiasis infection clearly affects lipid metabolism in children, especially in cases of recurrent infection. A significant decrease in triglyceride, high-density lipoprotein (HDL), and very low-density lipoprotein (VLDL) levels was observed in infected individuals, suggesting impaired fat absorption and transport due to intestinal damage or steatorrhea in children, particularly those under 3 years of age. Although changes in total cholesterol and low-density lipoprotein (LDL) levels were not statistically significant, a gradual increase was observed with recurrent infection, possibly related to chronic inflammation. These findings highlight the importance of monitoring lipid levels in children with giardiasis and call for further research to explore the long-term metabolic effects of infection.

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