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Serum adipokines as predictors of disease severity in children with giardiasis

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Abstract

Background: Giardiasis is an intestinal parasitism infection, which is common in children and is often linked to malnutrition, immune regulatory devices, and fluctuations in the severity of the condition.

Aims of the study: This research was conducted to assess the use of serum adipokines as predictors of the severity of the disease in children with giardiasis, namely leptin and adiponectin, the relationship between them and the manifestations of the disease and nutrition status.

Methodology: The study was a hospital-based case-control study and was carried out between February 10th and August 1st, 2025 and involved 120 children, 80 of whom had giardiasis confirmed by laboratory tests and 40 healthy controls. Microscopic stool examination methods were used in the diagnosis of giardiasis and the severity of the disease was classified as mild, moderate, or severe. Venous blood was taken and the levels of serum leptin and adiponectin assessed by ELISA. The relationship between adipokines, nutritional status and disease severity were determined.

Result: The giardiasis children did not vary significantly with controls in terms of age or sex and had a higher rate of rural residence and a more severely low BMI, which suggests exposure of the environment and nutritional maladjustment. The analysis of serum adipokines showed that the adiponectin and leptin levels in patients were considerably lower. The alterations became stronger as the disease worsened, and the levels of leptin declined and adiponectin rose with every worsening step. Strong links between adipokines and BMI, diarrhea length, weight loss and severity of the disease were supported by correlation analysis, which validates their predictive clinical importance.

Conclusions: The adipokine imbalance, which is marked by low leptin levels and high adiponectin levels, in children with giardiasis is caused by malnutrition, immune dysregulation, and chronic inflammation of the intestine. These changes are closely associated with disease severity, which contributes to adipokines being good and reliable biomarkers in terms of assessing clinical progression.

Keywords: Giardiasis, children, leptin, adiponectin, disease severity, biomarkers

Introduction

Giardiasis has become one of the most prevalent intestinal parasitic infections in children around the globe with poor sanitation and access to clean water being a prominent issue towards the welfare of the populace, and in low- and middle-income nations [1]. Giardia lamblia (also called Giardia duodenalis) is a flagellated protozoan that causes the disease by colonizing the small intestine causing a broad clinical range of asymptomatic carrier to chronic and severe gastrointestinal disease. Giardiasis is particularly of concern in children due to its close involvement with continuous diarrhea, malabsorption, growth retardation, weight loss and cognitive developmental impairment particularly in cases where infections are chronic or not treated [2, 3].

There is a significant clinical range in the severity of giardiasis in infected children despite being subjected to comparable environmental and parasitic conditions. Such variability implies that host-related factors and especially immune and metabolic responses have a significant role on the outcome of the disease [4]. The recent findings reveal the significance of the bi-directional system between the nutritional state, the immune system and the intestinal infection. The impaired nutritional reserves in children tend to have worse symptoms, increased disease strata, and worse recovery states, and it is necessary to have good biomarkers which can not only detect the state of immune activity but also reflect the state of metabolic health during giardial infection [5].

Adipokines are natural active peptides, which are mainly released by adipose tissue and are becoming more and more known as a decisive determinant of immune responses, inflammation, and energy homeostasis. Of them, leptin and adiponectin have received a special focus, as they are antagonistic but complementary in the regulation of immunity [6]. Leptin is largely believed to be a pro-inflammatory adipokine that stimulates T-cell response, Th1 immune response and host defense to infections [7]. Adiponectin, on the contrary, produces rather anti-inflammatory effects and is engaged in the maintenance of metabolic balance and control of immune tolerance. The changes in the levels of these adipokines in the circulation have been reported in different infectious and inflammatory diseases especially the ones that are linked to malnutrition and chronic inflammation [8].

Within the context of the intestinal parasitic infection, recent researches indicate that adipokines can reflect the multifaceted interaction of nutritional condition, intestinal inflammation, and immune protection. A good model to study these interactions is giardiasis, which is associated with the disruption of the barrier forming of the epithelial lining, altered gut permeability, and immune-mediated mucosal injury [9, 10]. Low levels of leptin in children with infections can be one of the factors that lead to the dysfunction of the immune system and the aggravation of disease, and the high levels of adiponectin can be viewed as one of the anti-inflammatory mechanisms that are used to compensate the impaired tissue damage during long-term infection. Nevertheless, the clinical significance of changes and their possible application as disease severity predictors in pediatric giardiasis has not been studied extensively [11].

To enhance clinical therapy, risk stratification, and early intervention of giardiasis in children, it is necessary to identify serum biomarkers that can effectively determine the severity of the disease. In this respect, serum adipokines have a number of benefits since they are readily quantifiable, represent both metabolic and immune health, and can give information on disease progression that is not a part of conventional clinical variables [12, 13].

Consequently, the objective of the current research was to examine the potential power of serum leptin and adiponectin in predicting the severity of the disease in children with giardiasis, as well as to examine the relationship between serum leptin and adiponectin and clinical manifestations and nutritional variables. The knowledge of such associations can lead to a better combined method of diagnosis and treatment of giardiasis among children.

Methodology

This was a hospital based case control study that was carried out between February 10, 2025 and August 1, 2025. The study population was composed of children diagnosed with giardiasis and attending pediatric outpatient clinics and inpatient wards, as well as children that appear to be healthy and were recruited as a control group. 120 children were recruited, 80 of which had confirmed giardiasis, and 40 healthy age and sex controls. The patient group inclusion criteria were children aged 2-12 years old with gastrointestinal symptoms consisting of diarrhea, abdominal pain, bloating, or weight loss and laboratory-confirmed Giardia lamblia infection. The exclusion criteria were: the presence of chronic gastrointestinal diseases, autoimmune disease, metabolic or endocrine disease, malnutrition not related to giardiasis, antiparasitic treatment in the last four weeks, co-infection with other intestinal parasites or bacterial pathogens and immunosuppressed patients. Control children had to have no gastrointestinal and parasitic diseases, no chronic illness history.

All respondents were required to hand over their feces samples in sterile and wide-mouthed containers and subject them to examination using a microscope and a macroscope. Direct wet mount examination, iodine staining, and formalinether concentration technique were used to confirm giardiasis diagnosis by observing Giardia cysts and trophozoite. The severity of the disease was determined using such clinical parameters as the frequency and duration of diarrhea, the extent of dehydration, abdominal pain, and percentage of weight loss, and the patients were categorized as mild, moderate, and severe cases.

In order to conduct the biochemical analysis, 5 mL of venous blood of each participant were aseptically picked using sterile disposable syringes and put on plain gel tubes. Blood samples were left to clot at room temperature (20-30 min) and centrifuged (3000 rpm, 10 min) to separate the serum. The serum samples obtained were aliquoted in Eppendorf tubes labeled and stored at -20 C until analysis. The leptin and adiponectin concentrations in serum were assessed by use of commercial enzyme-linked immunosorbent assay (ELISA) kits as stipulated by the manufacturers. Each of the samples and standards was duplicated to achieve accuracy and reproducibility. The optical density was determined at the recommended wavelength with the help of a microplate reader, and the concentrations were determined with the help of standard calibration curves.

Statistical analysis

The statistical work was done by use of SPSS software (version 26.0). The continuous variables were stated in the form of mean ± standard deviation and categorical variables were stated in the form of frequencies and percentages. Student t-test, one-way ANOVA and Chi-square test were used to perform comparisons among groups where applicable. Pearson correlation coefficient was used to determine correlations between serum adipokines and clinical parameters and P-value below 0.05 was found to be significant.

Ethical approval

The human ethics committee at Marjan Teaching Hospital approved the research, and all the people who participated in the research were informed and requested to sign a consent form. The patient also had an assurance that his information would remain confidential.

Results

Sociodemographic and Clinical Characteristics of Children with Giardiasis and Healthy Controls

The table presents the socio-demographic and clinical features of children with giardiasis in contrast to those healthy group of control. There was no statistically significant difference of mean age or sex distribution between the two groups (p>0.05), which means that the two groups were homogeneous in terms of demographics. Contrastingly, a greater number of children living in the rural setting were identified in the patient group relative to the control group (65.0% vs. 45.0%, P = 0.031) which represents the

contribution of environmental factors and access to healthcare to the risk of infection. The negative effect on nutritional status was also demonstrated by the fact that the body mass index (BMI) of the infected children significantly reduced in comparison with healthy children (14.9±1.8 vs. 16.2±1.6, P = 0.001). The average number of days of diarrhea between the patients was 9.3±3.1 days, which proved the chronicity of the infection and its obvious clinical effect on the children that are infected.

Table 1: Comparative Analysis of Age, Gender, Residence, Nutritional Status, and Clinical Presentation

Variable	Category	Giardiasis Patients (n = 80)	Controls (n = 40)	P-value
Age (years)	Mean ± SD	6.8±2.4	6.5±2.1	0.421
Gender	Male, n (%)	46 (57.5%)	22 (55.0%)	0.784
	Female, n (%)	34 (42.5%)	18 (45.0%)	
Residence	Rural, n (%)	52 (65.0%)	18 (45.0%)	0.031
	Urban, n (%)	28 (35.0%)	22 (55.0%)	
Body Mass Index (BMI)	Mean ± SD	14.9±1.8	16.2±1.6	0.001
Diarrhea Duration	Days (Mean ± SD)	9.3±3.1	—	—

Serum Adipokine Levels in Children with Giardiasis and Healthy Controls

The table indicates that there are statistically significant differences in serum adipokine levels of children with giardiasis and the healthy control group. The level of leptin was markedly lower in the patients than in healthy people (3.12±1.45 vs. 6.48±2.10 ng/mL, $p<0.001$) which indicates the connection between infection and energy deficiency and immune inefficiency. In contrast, adiponectin levels were much higher in infected children than in the control group (18.7±4.9 vs. 12.3±3.6 µg/mL, $p<0.001$), which can be potentially due to the compensatory anti-inflammatory response according to the severity and chronicity of the disease. These results demonstrate the possible importance of adipokines as biomarkers of the interaction between nutritional status and immune response in giardiasis in children.

Table 2: Comparative Evaluation of Leptin and Adiponectin as Biomarkers of Disease Severity

Biomarker	Giardiasis Patients (Mean ± SD)	Controls (Mean ± SD)	P-value
Leptin (ng/mL)	3.12±1.45	6.48±2.10	<0.001
Adiponectin (µg/mL)	18.7±4.9	12.3±3.6	<0.001

Serum Adipokine Levels Across Different Disease Severity Groups in Children with Giardiasis

It is evident in the table that there is a significant difference in the level of serum adiponectin based on the severity of giardiasis in children. There was also a progressive but gradual decline in mean concentrations of leptin with increasing severity of the disease reaching the highest levels of mild disease cases (4.21 + 1.32 ng/ml), followed by a great reduction in moderate cases (3.05 + 1.10 ng/ml), and then a steady decrease in severe cases (1.98 + 0.84 ng/ml). However, adiponectin exhibited the contrary trend with maximum values recorded at the mild cases (15.2±3.8 µg/ml) and then at the severe cases (22.9±5.2 µg/ml). These were very statistically significant ($p<0.001$), which is a strong relationship between adipokinetic imbalance and clinical worsening, which underlines the contribution of leptin and adiponectin as possible biomarkers in the determination of the severity of the disease in giardiasis in children.

Table 3: Severity-Dependent Variations in Leptin and Adiponectin Concentrations

Severity Group	n	Leptin (ng/mL) Mean ± SD	Adiponectin (µg/mL) Mean ± SD	P-value
Mild	26	4.21±1.32	15.2±3.8	
Moderate	31	3.05±1.10	18.6±4.1	<0.001
Severe	23	1.98±0.84	22.9±5.2	

Correlation Between Serum Adipokines and Clinical Parameters in Children with Giardiasis

The analysis of correlations showed that serum adiponectin and clinical and nutritional indicators had strong statistical relationships in children with giardiasis. There was a significant positive association between the levels of leptin and the body mass index (BMI) (r = 0.61, $p<0.001$), with significant negative associations between leptin and duration of diarrhea, percentage of weight loss, and the severity of the disease, indicating that leptin reduction has a negative correlation with the decreasing nutritional status and escalating severity of the symptoms. On the other hand, adiponectin was significantly negatively correlated with BMI (r = -0.48, P = 0.001), whereas it was strongly positively correlated with the duration of diarrhea, weight loss and the severity of the disease, which is in line with its possible contribution as a biomarker of chronic inflammation and the compensatory anti-inflammatory response. Such findings substantiate that clinical alterations in giardiasis are strongly linked to adipokinetic imbalance and can be used as predictive factors of the disease severity in children with giardiasis.

Table 4: Associations of Leptin and Adiponectin with Nutritional Status and Disease Severity

Parameter	Leptin (r)	P-value	Adiponectin (r)	P-value
BMI	**0.61**	<0.001	−0.48	<0.001
Diarrhea Duration	−0.52	<0.001	0.57	<0.001
Weight Loss (%)	−0.46	0.002	0.49	0.001
Disease Severity Score	−0.63	<0.001	0.66	<0.001

Discussion

The current research examined the predictive value of serum adipokines, namely, leptin and adiponectin, in the severity of disease in giardiasis children. The results proved the presence of important changes in the proportions of adipokines in infected children relative to healthy controls and high

correlations between these biomarkers and the indicators of clinical severity. The findings indicate that adipokines can be useful as composite indicators of immune and nutritional condition in pediatric giardiasis.

Sociodemographic and clinical data were analyzed to find that children with giardiasis were found to have much lower body mass index (BMI) than controls, especially in those living in rural locations. The result is in agreement with other preexisting studies that have indicated prevalence and severity of giardiasis in socioeconomically disadvantaged environments, where malnutrition and recurring exposure to contaminated water resources are likely to be observed [14, 15]. The low BMI of infected children is likely due to chronic malabsorption and nutrient loss and lack of appetite due to chronic inflammation of the intestine with Giardia lamblia [16, 17].

Concerning the level of adipokines, the present study showed that the levels of serum leptin significantly decreased with a corresponding increase in adiponectin level in children with giardiasis relative to healthy controls. These results correlate with previous studies that reported lower leptin levels in children with parasitic and chronic gastrointestinal diseases, especially the undernourished ones [18, 19]. Leptin is a key factor in the process of correlating nutritional condition with immune capability by activating T-cell proliferation, macrophage activation and Th1 cytokines. Thus, low leptin during giardiasis can affect the efficient clearance of the parasite by the immune system, which will put children at risk of developing serious or chronic disease [20].

On the other hand, the recorded increment in adiponectin levels of infected children have been congruent with research findings that showed higher levels of adiponectins in chronic inflammatory and infectious disease states with weight loss and catabolic-like symptoms [21, 22]. Adiponectin has anti-inflammatory action and suppresses the production of pro-inflammatory cytokines like TNF- 6 and IL-6, and promotes anti-inflammatory mechanisms. An increased adiponectin in giardiasis can be one of the compensatory alterations, which is intended to reduce intestinal mucosal injury and systemic inflammation caused by sustained parasitic infection.

Notably, the lack of stratification of the patients based on the severity of the disease showed a very clear and progressive trend: the level of leptin in the patients reduced, and the level of adiponectin grew in the severe cases [23]. This trend indicates that the adipokine dysregulation is not only an outcome of infection but a close relationship with the disease progression. Equivalent severity-dependent changes in adipokine concentration have been observed in pediatric infectious diseases like tuberculosis and chronic enteric infections, which supports the idea that adipokines are biomarkers of severity of host-pathogen interaction [24, 25].

These results were further corroborated by correlation analysis which indicated a positive correlation was found to be strong between leptin and BMI and negative correlation between leptin and disease severity score. Adiponectin, on the other hand, had large positive relationships with the duration of diarrhea, weight loss, and severity of disease. Such relationships are biologically reasonable, because production of leptin is strictly correlated with fat mass and energy supply, and adiponectin is inclined to rise when the body is under catabolic and inflammatory stress [26]. Leptin secretion and augmented adiponectin expression because of prolonged diarrhea and malabsorption are likely to increase energy deficit in giardiasis [27].

Nevertheless, some studies have also showed some opposite findings regarding testing of adiponectin parameters during parasitic diseases, whereby other studies have observed that adiponectin is lowered during acute inflammatory diseases [28, 29]. These dissimilarities are accounted by the differences in the number of the population of the studies, age of the participants, nutritional status, chronicity of diseases, and that in the methodology of adipokines measurement. Acute infections may result in adiponectin being first inhibited by an over-response to inflammation but chronic/recurring infections like giardiasis in children may result in adaptive up-regulation in adiponectin to counter an immune system which has been constantly stimulated. In addition, the nutritional practices and other comorbid deficiencies of micronutrients, which weaken the genetic polymorphisms, may also influence the adipokine response in the individuals [30].

Conclusion

Generally, the results of the current research indicate the truth in the hypothesis that serum leptin and adiponectin are useful biomarkers of metabolic and immunological changes in giardiasis children. They are closely linked to disease severity and this fact highlights their possible use as the non-invasive predictor of clinical risk classification. The adipokine measurement technique should be introduced into the clinical assessment of giardiasis in children to improve the early detection of the cases at high risk and lead to the more specific treatment and nutritional interventions.

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