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Study of the Trace Element Composition in Patients with Giardiasis

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Abstract
Giardiasis, caused by Giardia lamblia, remains a widespread global intestinal infection affecting over 200 million people annually, posing significant clinical challenges across both pediatric and adult populations. Although historically regarded as a localized luminal infection, accumulating evidence demonstrates that Giardia colonization triggers profound mucosal damage, secondary malabsorption, and systemic metabolic and immunologic dysfunctions. The mechanical disruption of enterocytes leads to critical trace element depletion (e.g., zinc, iron, selenium), which impairs mucosal immunity and delays clinical recovery. Therefore, there is an urgent clinical need to systematically investigate microelement status in patients with giardiasis and evaluate targeted correction protocols to accelerate mucosal healing, restore immune function, and optimize therapeutic outcomes.

Keywords: Giardia lamblia, trace elements, zinc deficiency, micronutrient supplementation, nutritional correctio, metabolic restoration.

Introduction

Giardiasis, caused by the flagellated protozoan Giardia lamblia (syn. Giardia intestinalis, Giardia duodenalis), remains one of the most prevalent parasitic gastrointestinal infections worldwide, affecting over 200 million people annually [1-3]. The disease presents a substantial public health challenge, particularly in developing regions with inadequate sanitation, while also posing a growing clinical concern in urban and pediatric populations due to high transmissibility and asymptomatic carriage [4]. Although historically regarded as a self-limiting, localized luminal infection, accumulating evidence demonstrates that Giardia colonization induces profound

mucosal disruption, secondary malabsorption, and systemic metabolic and immunologic dysfunctions [5]. The pathogenesis of giardiasis involves the adhesion of trophozoites to the microvillar surface of the upper small intestine the primary site for essential micronutrient absorption. This mechanical attachment, combined with parasite-induced enterocyte apoptosis and tight junction breakdown, leads to diffuse villous atrophy and impaired brush-border enzymatic activity [6].

Consequently, patients frequently develop secondary hypomicroelementosis, characterized by significant depletion of essential trace elements such as zinc (Zn), iron (Fe), magnesium (Mg), and selenium (Se). Trace element deficits create a self-perpetuating pathological cycle wherein micronutrient depletion weakens local mucosal barrier immunity through reduced secretory IgA production, heightens mucosal oxidative stress, and alters cytokine responses, thereby delaying epithelial repair and predisposing patients to recurrent infections and chronic post-parasitic enteropathy. Standard therapeutic protocols predominantly focus on antiparasitic eradication using 5-nitroimidazole derivatives; however, conventional antiparasitic monotherapy does not directly address host micronutrient depletion or accelerate intestinal regeneration, leaving many patients with persistent dyspeptic symptoms, asthenoneurotic manifestations, and prolonged disability [7].

To address this critical clinical gap, the primary objective of this study was to systematically evaluate the baseline trace element status (Zn, Fe, Mg, Se) and clinical-immunological parameters in patients with giardiasis, and to evaluate the therapeutic efficacy of integrating a targeted trace element correction scheme into standard management protocols [8]. To fulfill this objective, the research tasks included quantifying baseline serum concentrations of essential trace elements relative to healthy controls, correlating micronutrient depletion with disease severity, mucosal inflammation markers (IL-6, IL-10), and secretory IgA levels, developing and implementing a targeted trace element correction algorithm within comprehensive patient care, and systematically evaluating the clinical, immunological, and medico-economic outcomes of the proposed intervention in terms of symptom resolution, hospital stay, recurrence rates, and disability duration.

Material and Methods

A prospective clinical cohort study was conducted between 2024 and 2026 to evaluate the baseline trace element status and therapeutic response in patients with confirmed giardiasis. The study enrolled a total of 150 participants, comprising 120 patients with laboratory-confirmed Giardia lamblia infection admitted to the hospital and 30 age- and sex-matched healthy controls. Clinical, laboratory, and demographic data including age, sex, primary complaints, disease duration, and baseline clinical presentation were systematically recorded upon admission. To evaluate systemic response and metabolic derangements, complete blood counts (CBC), comprehensive biochemical panels, systemic inflammatory and immunological markers, and serum trace element profiles were evaluated at baseline and following therapeutic intervention.

Systemic inflammatory activity and cellular immune status were assessed via CBC parameters, specifically quantifying total white blood cells (WBC), lymphocyte subsets, neutrophils, monocytes, and platelet counts. Biochemical markers evaluating organ function and metabolic status, including aspartate aminotransferase (AST), alanine aminotransferase (ALT), serum glucose, urea, creatinine, and C-reactive protein (CRP), were measured using an automated

Mindray BS-30 chemistry analyzer following standardized manufacturer protocols. Immunological profiling encompassed the quantification of serum secretory immunoglobulin A (sIgA) to evaluate mucosal barrier defense, as well as pro-inflammatory (IL-6) and anti-inflammatory (IL-10) cytokines to assess systemic inflammatory signaling.

Trace element profiles were determined using fasting serum samples to accurately reflect acute systemic turnover and tissue bioavailability. Quantitative analysis focused on key essential micro- and macro-elements, specifically zinc (Zn), iron (Fe), magnesium (Mg), and selenium (Se), utilizing atomic absorption spectrometry (AAS). All blood sampling, processing, and analytical procedures adhered strictly to certified laboratory standards, with individual patient values compared against baseline normative reference ranges to identify specific deficits and imbalances.

To evaluate therapeutic efficacy, infected patients (n=120) were stratified into two distinct interventional cohorts: the Main Group (n=60), which received standard antiparasitic therapy supplemented with a targeted trace element correction scheme (Zn, Fe, Mg, Se), and the Comparison Group (n=60), which received standard antiparasitic monotherapy alone. A third cohort consisting of healthy uninfected individuals served as the Control Group (n=30) to establish reference baseline parameters. Treatment efficacy was monitored continuously by tracking clinical symptom resolution, recovery of systemic laboratory and inflammatory indicators, and post-treatment serum trace element levels. Statistical processing was executed using SPSS version 26.0 and GraphPad Prism, utilizing Student's t-test, one-way ANOVA, Mann-Whitney U test, Pearson/Spearman correlation coefficients, and Receiver Operating Characteristic (ROC) curve modeling to assess predictive diagnostic accuracy.

Result

To assess systemic trace element status relative to disease severity and treatment response, fasting serum samples from 150 participants were evaluated using atomic absorption spectrometry (AAS). The study population comprised 120 patients with confirmed giardiasis and 30 healthy controls, with no statistically significant baseline differences regarding age or sex distribution ($p > 0.05$). Patients were stratified into three matched cohorts: the Main Group (n=60; giardiasis patients receiving targeted trace element correction), the Comparison Group (n=60; giardiasis patients receiving standard therapy alone), and the Control Group (n=30; healthy uninfected individuals). Quantitative analysis focused on essential trace elements zinc (Zn), iron (Fe), magnesium (Mg), and selenium (Se)—alongside systemic inflammatory and immunological markers. Comparative statistical analysis revealed pronounced elemental disruptions in infected patients, characterized by a significant depression of essential micronutrients that correlated directly with clinical severity and inflammatory intensity (1-fig.).

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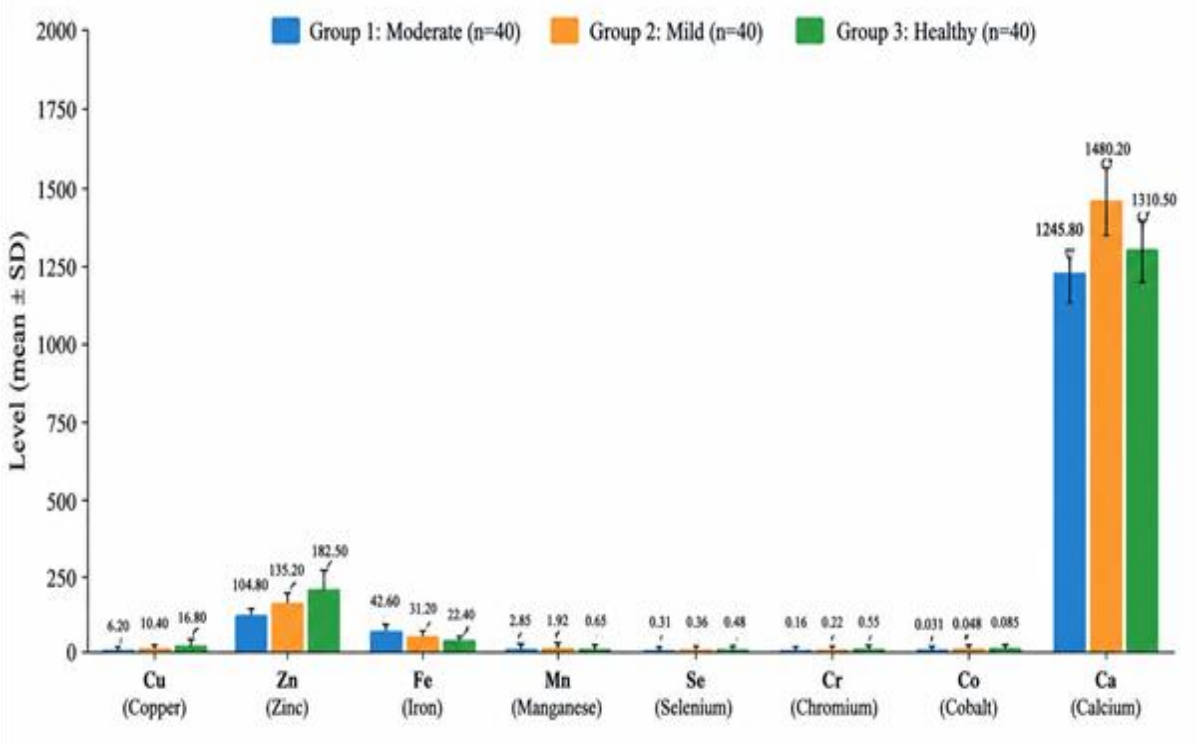

Figure 1. Comparison of Trace Element Levels Among the Moderate, Mild, and Healthy Groups

The diagram demonstrates clear differences in the concentrations of several trace elements among the three study groups. Copper (Cu) and zinc (Zn) levels were progressively higher from the moderate group to the mild and healthy groups, with the lowest values observed in the moderate group (Cu: 6.20 ± 2.10; Zn: 104.80 ± 28.90) and the highest in healthy children (Cu: 16.80 ± 2.10; Zn: 182.50 ± 24.60; $p<0.001$). In contrast, iron (Fe) and manganese (Mn) showed the opposite pattern, with significantly higher concentrations in the moderate group compared with the mild and healthy groups ($p<0.01$). Selenium (Se), chromium (Cr), and cobalt (Co) concentrations were also lower in the moderate group and increased toward the healthy group, with statistically significant differences between groups. Calcium (Ca) levels did not differ significantly among the groups ($p>0.05$). Overall, the findings indicate significant alterations in several trace-element concentrations across the study groups, particularly for Cu, Zn, Fe, Mn, Se, Cr, and Co.

Conclusion

Pediatric Giardia lamblia infection triggers severe systemic trace element dyshomeostasis that directly correlates with clinical severity. Neutron activation analysis of hair tissue reveals a distinct, mixed metabolic profile: significant depletion of key essential elements specifically copper, chromium, zinc, cobalt, and selenium alongside a paradoxical accumulation of iron and manganese in moderate-to-severe forms. These systemic imbalances reflect persistent mucosal injury, impaired enterocyte absorption, and heightened oxidative stress within the proximal intestine. Consequently, effective management of pediatric giardiasis must extend beyond antiparasitic eradication; incorporating targeted micronutrient profiling and tailored trace element correction is essential to restore metabolic balance, bolster antioxidant defenses, and accelerate mucosal recovery.

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