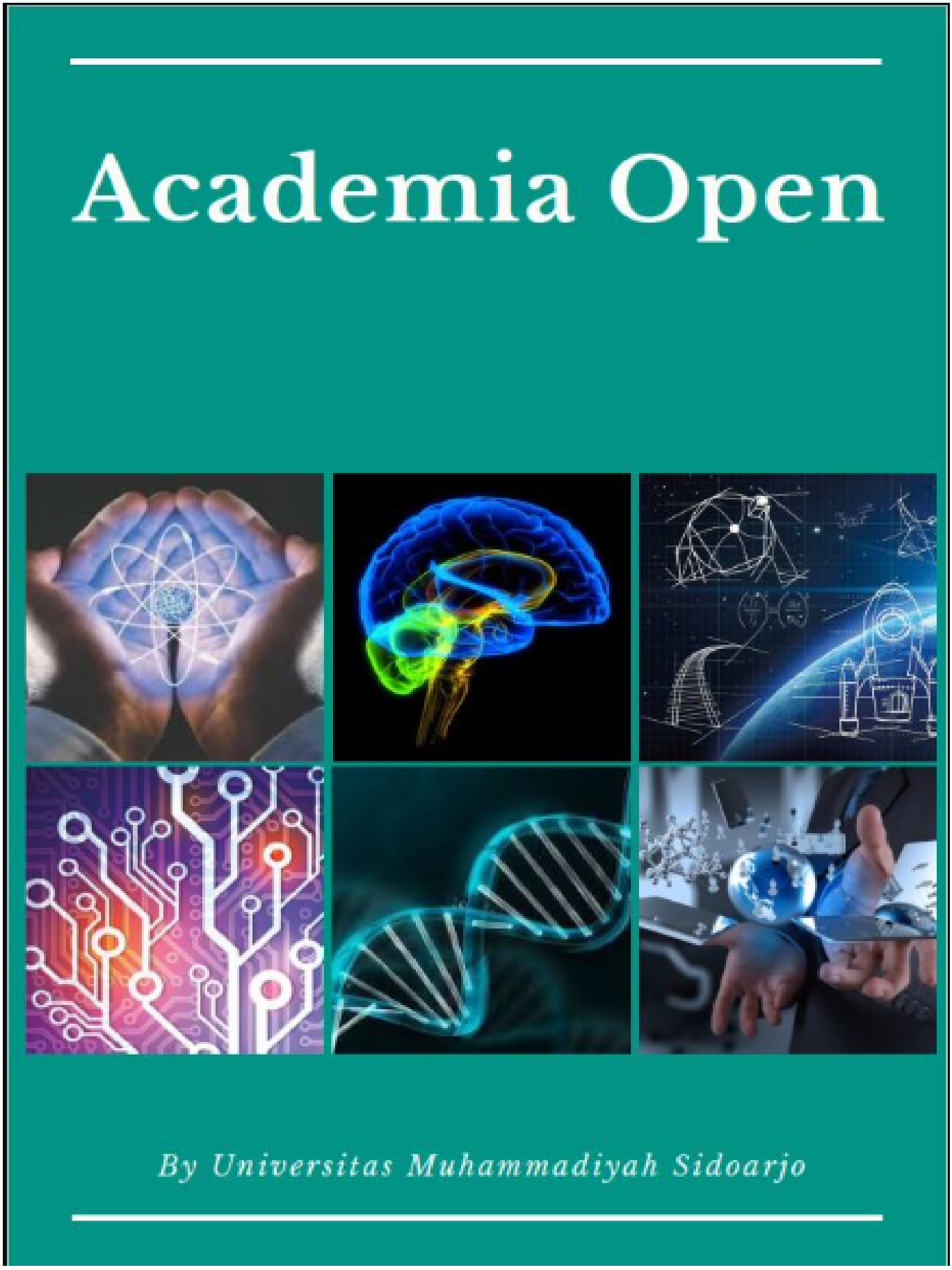
Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201



ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

Table Of Contents

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

Originality Statement

The author[s] declare that this article is their own work and to the best of their knowledge it contains no materials previously published or written by another person, or substantial proportions of material which have been accepted for the published of any other published materials, except where due acknowledgement is made in the article. Any contribution made to the research by others, with whom author[s] have work, is explicitly acknowledged in the article.

Conflict of Interest Statement

The author[s] declare that this article was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Copyright Statement

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

EDITORIAL TEAM

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

Article information

Check this article update (crossmark)

Check this article impact (*)

Save this article to Mendeley

(*) Time for indexing process is various, depends on indexing database platform

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

Physiological and Parasitological Interactions: Investigating Host Responses to Parasitic Infections through Experimental Analysis: Integrasi Kecerdasan Buatan untuk Pemantauan dan Evaluasi Strategi Pengendalian Hayati di Lapangan

Aliaa Kadhem Mohsin, alyaamohsin@uowasit.edu.iq (*)

Ministry of Education, Directorate of Education in Wasit Governorate, Iraq

(*) Corresponding author

Abstract

General Background Parasitic infections remain a major challenge in human and veterinary health due to their systemic physiological and immunological consequences. **Specific Background** Beyond tissue damage, parasites induce metabolic disturbances and immune modulation that influence disease progression. **Knowledge Gap** Integrated experimental evidence linking physiological alterations with immune cell activation and cytokine regulation remains limited. **Aims** This study aimed to investigate host physiological responses and immune dynamics during experimental Toxoplasma gondii and Plasmodium berghei infections. **Results** Infected hosts exhibited significant weight loss, fever, hypoglycemia, elevated CD4+ and CD8+ T cell activation, increased pro-inflammatory cytokines IL-6, TNF-α, IFN-γ, and concurrent upregulation of IL-10. Gene expression analysis confirmed significant modulation of IL-6 and IL-10. **Novelty** The study provides an integrated assessment of physiological parameters, immune activation, cytokine production, and gene expression within a single experimental framework. **Implications** These findings highlight the complex balance between immune activation and regulation during parasitic infections and support the need for therapeutic strategies targeting immune modulation to improve parasite control while limiting immunopathology.

Keywords: Parasitic Infection, Host Physiology, Immune Response, Cytokine Regulation, Experimental Model

Key Findings Highlights:

1. Experimental infection induced marked metabolic and thermoregulatory alterations in hosts.
2. Adaptive immune activation involved significant CD4+ and CD8+ T cell responses.
3. Concurrent pro- and anti-inflammatory signaling reflected immune regulation during infection.

Published date: 2026-01-05

Academia Open
Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

Introduction

Low-income countries are associated with a high prevalence of parasitic infections which affect millions of people living in various parts of the world, found mainly in tropical and subtropical regions. Such groups of parasites ranging from protozoa helminths to ectoparasites cover a broad spectrum of hosts and give rise to such common diseases like malaria, schistosomiasis and leishmaniasis among many others (1). Such infections can be particularly debilitating and sometimes lead to deaths especially among immunosuppressed individuals. Apart from the direct damage caused by parasites, they also induce complex physiological as well as immunological changes in their hosts that would interfere with metabolic processes immune homeostasis, and tissue integrity thereby affecting normal functions (2). Parasite physiology would thus be crucial for understanding the host defense strategies as well as the different strategies that the parasites use in escaping immune responses. This is important information that is needed for enhancing diagnostic treatment as well as prophylactic strategies for infections with parasites (3).

Both the host and parasite immune responses are complex dynamic systems. While the host's immune responses are immediately directed against incoming parasites, the parasite has immunosuppressive strategies to evade these responses. Parasites are extraordinarily successful because they know how to manipulate the immune responses of their hosts in their favor, controlling or clearing infections. The host's immune system spends an enormous amount of energy trying to get rid of something that the parasite tries to balance. Sometimes parasites even secrete or express host-like molecules on their surface so as not to trigger a ‘danger signal’, putting them in a position to manipulate their host’s immune response (4).

The outcome of parasitic infections is influenced by the dynamic interaction that arises between the parasite and the host’s immune system. On infection, the host responds with a series of immune responses having been initiated by the activation of its innate immune system. These are among some cells that hold a critical early-detection role in releasing kinds of cytokines and chemokines that cause inflammation to start. Major pro-inflammatory cytokines are interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF- α), and interferon-gamma (IFN- γ). They are all geared at limiting the replication of the parasite and helping more immune cells be brought to the infection site (5).

Besides the natural immune effectors, protection against parasitic infections is dominated by adaptive immune reactions. Helper T cells, which are in the CD4+ T cell subset, direct this immune response by switching on other immune cells, and cytotoxic T cells in the CD8+ cell subset have an impact on and kill infected cells. The balance between pro-inflammatory and anti-inflammatory states will be quite crucial to controlling the infection as well as tissue damage (6). Yet, many parasites are adept at manipulating these responses so as to survive within the host. For some parasites, interleukin-10 production gets provoked—an outlawing cytokine for immunity that silences immune activation, allowing the infection to be persistent and chronic (7).

Physiological changes during parasitic infections

Among the most evident physiological responses to parasitic infections are those elicited by the immune system and those provoked by the metabolism of the host by the parasite itself. Generally, the physiological changes associated are fever, loss of weight, metabolic disturbances, and tissue inflammation. Fever usually appears early in the course as a defense mechanism aiming at creating unfriendly conditions for survival to the parasites. Prolonged fever and inflammation further deprive energy reserves, present fatigue, and loss of weight. On another front, they also affect glucose homeostasis hence metabolic processes of a body that they have just infected. Example; Plasmodium parasites, which cause malaria in humans, consume such high rates of glucose that the host ends up being hypoglyceamic. They also interfere with lipid metabolism, leading to nutritional exhaustion and minimal levels of energy in their hosts (9).

In some severe infections, these physiological disturbances can yield protracted outcomes such as malnutrition, anemia, and chronic inflammation. This discussion of systemic effects is important in developing therapeutic strategies that will address direct as well as indirect impacts of parasitic infection. Also, the relationship between physiological changes and immune responses is important for the determination of the severity and progression of the infection (10).

Because parasites have many interactions with their host, understanding the mechanisms involved cannot be understood without experimental approaches. Traditional studies mainly focused on direct effects causing pathology due to parasites like damaging tissues and dysfunctional organs. However, less is known about the broader physiological changes associated with these infections (11). Animal studies, in vitro cell culture, and controlled infection systems are some experimental models that have thrown some valuable light on how parasites manipulate the physiology and immune responses of their hosts. In these models, it is possible to get specific parameters - for example, the production of cytokines, activation of immune cells, and changes in metabolism - under control (12,13)

Material and methods

Study Design

Experimental studies were performed in order to determine phyisiological and immunological responses by carrying out parasitic infection. Animal models and culturs of cells were used in the laboratory to conduct controlled experiments to assess immune response, and cytokine productions, as well as physiological changes following infection. Data collected were analyzed using described statistical method (14).

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

The experimental animals included mice of BALB/c and C57BL/6 strains and they were purchased from a laboratory animal research center. All animal practices which came under experiments were approved by the institutional animal care and ethics committee. The immune cell line in the study was macrophages RAW 264.7 cultured in RPMI-1640 and DMEM media each containing 10% fetal bovine serum (15). T. gondii (Type II strain) and P. berghei for the malaria model were purchased from an accredited parasitology laboratory. The cytokines IFN-γ, IL-6, IL-10, TNF-α standard like TRIzol r eagent for RNA extraction we re commercially available. Anti-CD4, anti-CD8, and anti-MHC Class II fluorescent labeled antibodies were used for flow cytometry analysis. Equipment used in this study include Flow cytometer, Real time PCR machine, Microplate reader, Analytical balance and Thermometer (16).

Animal Infection Models

Mice were randomly divided into 2 groups: Group 1, infected with the toxoplasma parasite T. gondii, or Plasmodium berghei parasites, and Group 2, control group in which saline was inoculated in place of parasites. The doses administered in actual numbers were 1×10^6 tachyzoites for T. gondii and 1×10^5 sporozoites for P. berghei The development of an infection was monitored over a period of 14 d, recording daily the general state of health and the percentage of surviving mice. During the above period physiological parameters that are indicative of the condition of infected mice like body weights, body temperatures were recorded at the beginning and then at every twenty-four-hour interval while blood glucose was measured on days 1, 7, and 14.

Mice were sacrificed and histological examination carried out while different tissues like spleen, liver, and brain were collected for RNA extraction at the study end-point (17).

For in vitro infection assays, 1×10^5 RAW 264.7 macrophages had been seeded per well in a 6-well plate. The cells were infected with T. gondii tachyzoites at an MOI of 3:1, whereas just culture media had been given to control wells. Thereafter both infected and control cells were further stimulated with IFN-γ at 50 ng/mL and TNF-α at 20 ng/mL. After 24 hours, supernatants were collected for further cytokine analysis (18).

Flow Cytometry Analysis of Immune Cell Activation

Spleens from infected and control mice were homogenized to obtain single-cell suspensions. Red blood cells were lysed, and the cells were washed and resuspended in PBS. The cells were stained with the fluorescent-labeled antibodies specific to the antigens anti-CD4, anti-CD8, or anti-MHC class II for 30 min at 4°C. After staining, they were washed again and resuspended in flow cytometry buffer for further use in analysis. Flow cytometry was used to measure cellular fluorescence, particularly T cell activation profile related to CD4+ and CD8+ T cells (19).

Cytokine measurement. Cytokine measurement was done on serum samples from both infected and control mice collected on days 1, 7, and 14 postinfection and culture supernatants from infected macrophages. The levels of Interleukin-6 (IL-6), IL-10, Tumor Necrosis Factor-α(TNF-α), and Interferon- γ (IFN-γ) were then quantified by specific commercially available ELISA kits by reading the absorbance at 450 nm in a microplate reader (20).

Gene expression was evaluated by the RT-PCR technique.

Total RNA was extracted from the infected tissues and macrophages cells using TRIzol reagent following the manufacturer's protocol. The concentration and purity of RNA were quantified by spectrophotometer, and the total RNA was used for cDNA synthesis. The reverse transcription was performed using 1 µg of total RNA. Quantitative determination of pro-inflammatory (IL-6) and anti-inflammatory (IL-10) marker gene expression was assessed by SYBR Green based qPCR. The relative expression levels of pro-inflammatory and anti-inflammatory markers were calculated by the $2^{-\Delta\Delta CT}$ method using GAPDH as the house keeping gene for normalization (21).

Statistical Analysis

All experiments were repeated thrice, and the data were presented as mean ± SD. The statistical comparison between groups was tested by the Student's t-test or one-way ANOVA analysis with Tukey's post-hoc test, where $p < 0.05$ was considered as a significant difference. Statistical analyses were conducted using GraphPad Prism version 8.0 and FlowJo software for analyzing flow cytometry data (22).

Ethical Considerations

All animal handling and experimental procedures were conducted in compliance with institutional and national guidelines for the care and use of laboratory animals. Ethical approval was obtained from the university's animal ethics committee before starting the experiments (23).

Results

This figure has our observations on the physiological and immunological effects against the parasitic infection in animal models as well as cell culture systems. The results include standard values of physiological parameters, immune cell activation, production of cytokines, and gene expression.

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo

Academia Open
Vol. 11 No. 1 (2026): June
DOI: 10.21070/acopen.11.2026.13201

Table 1 Body weight, body temperature, and blood glucose in mice infected with T. gondii and P. berghei versus the control group over 14 days post-infection. Data are represented as mean ± SEM of 5 mice. **p < 0.01 compared to the control group. Parameter Control T. gondii P. berghei Body Weight (g) 21.30±2.3 18.5±1** 20±2** Temperature (°C) 37±1 39±2** 38±2** Glucose (mmol/L) 4.5±0.5 3±0.5** 3±0.5**

Parameter	Day 0 (Baseline)	Day 7	Day 14	Control Group
Body Weight (g)	23.5 ± 0.5	20.8 ± 0.6*	18.9 ± 0.7*	23.2 ± 0.4
Body Temperature (°C)	36.8 ± 0.3	39.1 ± 0.2*	38.5 ± 0.4*	36.9 ± 0.2
Blood Glucose (mg/dL)	85.4 ± 4.2	65.2 ± 3.8*	60.1 ± 3.4*	87.3 ± 3.9

*Values are mean ± SD. $p < 0.05$ compared to control group.

ISSN 2714-7444 (online), https://acopen.umsida.ac.id, published by Universitas Muhammadiyah Sidoarjo