THE EFFECT OF FASTING DURING RAMADAN ON THE IMMUNE SYSTEM AND INFLAMMATION: A SYSTEMATIC REVIEW

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Abstract: *Chronic low-grade inflammation is a major contributor to the development of non-communicable diseases, including obesity, diabetes, cardiovascular disease, and autoimmune disorders. Identifying non-pharmacological interventions capable of modulating immune function and reducing inflammatory burden is therefore an urgent global health priority. Ramadan fasting, a unique form of intermittent fasting practiced annually by millions of individuals worldwide, offers a natural model to investigate the physiological effects of time-restricted feeding on immune and inflammatory responses. This systematic review aims to evaluate current evidence on the impact of Ramadan fasting on immune system activity and inflammatory biomarkers in humans. A structured search was conducted in PubMed and ScienceDirect for studies published between 2015–2025. Five eligible studies were included, consisting of randomized controlled trials, interventional studies, and pre–post designs. Results demonstrate consistent reductions in pro-inflammatory cytokines such as IL-6 and TNF-α, increases in adiponectin, enhancement of autophagy pathways, and improved immune cell regulation. Benefits were more pronounced among individuals with obesity or metabolic risk. Although heterogeneity in study design limits quantitative comparison, evidence suggests that Ramadan fasting has clinically relevant immunomodulatory and anti-inflammatory effects. Larger standardized studies are needed to clarify mechanisms and long-term outcomes.*

Keywords: *Ramadan Fasting; Immune System; Inflammation; Intermittent Fasting*

Introduction

Ramadan fasting is a unique form of intermittent fasting practiced annually by millions of Muslims worldwide. Unlike other dietary restriction models, Ramadan fasting involves abstinence from food and drink from dawn to sunset for approximately 29–30 consecutive days, followed by ad libitum intake during nighttime hours. This pattern induces metabolic alterations that influence circadian rhythm, hormonal regulation, and systemic physiological responses (Elhag et al., 2025). As global interest in fasting as a therapeutic strategy grows, Ramadan fasting has become an important natural model to evaluate the effects of time-restricted feeding on human health(M. A.-I. Faris et al., 2020).

One of the most relevant clinical interests of Ramadan fasting relates to its impact on the immune system and inflammatory status. Low-grade chronic inflammation is a recognized underlying mechanism of various non-communicable diseases, including cardiovascular disease, diabetes mellitus, obesity, and autoimmune disorders(Cifuentes et al., 2025). Dietary patterns, nutrient timing, and metabolic switching between glucose and lipid utilization have been shown to modulate inflammatory cytokines, oxidative stress, and immune cell activity(Ramos-Lopez et al., 2021). Thus, understanding how Ramadan fasting influences immune and inflammatory

biomarkers may provide insight into its potential role in disease prevention and health optimization.

Recent studies report that Ramadan fasting may reduce pro-inflammatory markers such as C-reactive protein (CRP), interleukin-6 (IL-6), tumor necrosis factor-α (TNF-α), and enhance anti-inflammatory responses, while also affecting immune cell profiles including lymphocytes, neutrophils, and cytokine signaling pathways (Madkour et al., 2023). However, findings across studies remain heterogeneous due to variations in participant characteristics, geographic climate, dietary patterns, fasting duration, and methodological differences. Therefore, a systematic review is required to synthesize available evidence and evaluate the consistency of Ramadan fasting effects on immune function and inflammatory biomarkers.

This systematic review aims to summarize and analyze research findings on the impact of Ramadan fasting on immune system parameters and markers of inflammation in healthy individuals and clinical populations. The results are expected to provide a comprehensive understanding of the physiological effects of Ramadan fasting and its potential implications for public health and clinical practice.

Literature Review

Ramadan fasting represents a unique model of time-restricted feeding practiced annually by more than one billion Muslims worldwide. Unlike other intermittent fasting regimens, such as alternate-day fasting or the 16:8 protocol, Ramadan fasting involves abstention from all food and drink from dawn until sunset for approximately 29–30 consecutive days, with unrestricted intake during nighttime hours(Ahmed et al., 2022). This daily cycle produces physiological adaptations related to energy metabolism, circadian rhythm, neuroendocrine signaling, and cellular repair mechanisms. These changes are believed to influence immune function and inflammatory responses, making Ramadan fasting an important natural laboratory for studying human immunometabolic interactions(Khalil et al., 2024).

Emerging evidence has demonstrated that fasting may modulate immune activity through several mechanisms, including metabolic switching from glucose to lipid oxidation, reduction of oxidative stress, enhanced autophagy, and improved hormonal balance such as reduced insulin and increased adiponectin. These processes contribute to the suppression of pro-inflammatory pathways, particularly NF-κB signaling, and promote the production of anti-inflammatory mediators. Research has shown that Ramadan fasting is associated with improvements in inflammatory biomarkers, such as reductions in C-reactive protein (CRP), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and enhanced antioxidant capacity, although results vary depending on lifestyle, diet composition, climatic differences, and health status(He et al., 2023; Ma, 2024; Marko et al., 2024).

In addition to changes in inflammatory markers, Ramadan fasting may influence immune cell distribution and activity. Several studies have reported modulation in leukocyte counts, lymphocyte proliferation, cytokine profiles, and innate immune responses during Ramadan. While some findings observe enhanced immune regulatory function and reduced systemic inflammation, others report minimal or inconsistent effects(Feyzi, 2023; Moghadam et al., 2021; Reias & States, 2021). These inconsistencies reflect methodological differences in study design, participant characteristics, timing of blood sampling, and fasting duration across geographical regions.

Given the growing interest in fasting-based metabolic interventions and the potential therapeutic role of inflammation modulation in the prevention and management of chronic diseases, synthesizing available evidence is essential. A systematic review is therefore needed to

provide a comprehensive understanding of the effects of Ramadan fasting on immune system function and inflammatory biomarkers, to evaluate the consistency of research findings, and to identify gaps for future investigation.

Method

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to identify and synthesize research on the effects of Ramadan fasting on immune system function and inflammatory biomarkers. A structured search was performed in two major scientific databases, **PubMed** and **ScienceDirect**, covering studies published within the last **10 years** (2015–2025). The search strategy included combinations of the following keywords: *"Ramadan fasting," "immune system," "inflammation,"* and *"inflammatory markers."* Boolean operators and database filters were applied to refine results.

Studies were eligible for inclusion if they were original research articles involving human participants who performed Ramadan fasting and reported outcomes related to immune parameters or inflammatory biomarkers (e.g., CRP, IL-6, TNF-α, immune cell counts). All research designs were considered, including randomized controlled trials, cohort studies, cross-sectional studies, and pre–post intervention studies. Articles were excluded if they were reviews, editorials, animal or in vitro studies, or did not provide primary data related to the outcomes of interest.

The study selection process consisted of title and abstract screening followed by full-text assessment. Data extraction was performed independently by two reviewers using a standardized form that included author and year, study design and location, sample characteristics, fasting duration, outcomes measured, and main findings. Due to heterogeneity across study designs and outcome measurements, results were synthesized narratively rather than through meta-analysis.

Result and Discussion

This systematic review identified and evaluated published evidence examining the effects of Ramadan fasting on immune system parameters and inflammatory biomarkers. The database search through PubMed and ScienceDirect yielded a total number of studies, which were then screened through title and abstract review, followed by full-text assessment according to predetermined eligibility criteria. The study selection process is summarized in the PRISMA flow diagram (Figure 1), illustrating the progression from initial record identification to final inclusion. After screening and exclusion of non-relevant or non-original research, five studies met the criteria and were included in the synthesis.

The selected studies consisted of randomized controlled trials, interventional analyses, and pre–post observational designs involving both healthy and clinical populations. These studies provided diverse but complementary findings regarding the biological and clinical impacts of Ramadan fasting on inflammatory markers, immune cell modulation, metabolic regulation, and related molecular pathways. The systematic review table (Table 1) summarizes the main characteristics and outcomes of the included studies.

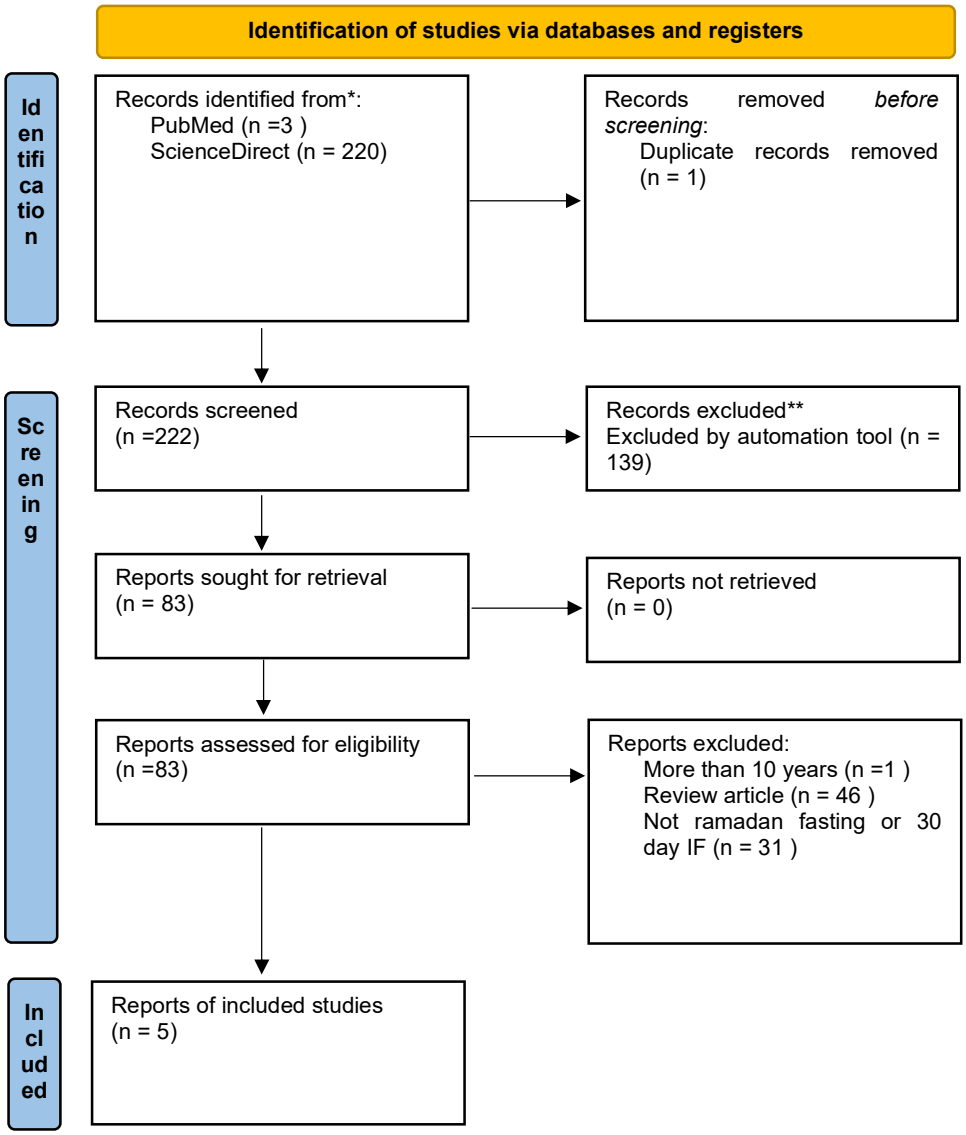

Figure 1: Search and study selection for systematic reviews (PRISMA) flow chart.

Table 1. Systematic Review Table: Effects of Ramadan / Intermittent Fasting on Immune and Inflammatory Parameters

Author (Year)	Study Design & Location	Participants	Type / Duration of Fasting	Primary Outcomes	Key Findings	Conclusion
Horne et al., 2023	Randomized Controlled Trial, USA	71 adults with metabolic risk factors	24h water-only IF: 2×/week for 4 weeks → 1×/week for 22 weeks	IMRS, PCRE, ICHRON, HOMA-IR	Decrease in ICHRON & PCRE, short-term increase in IMRS, reduction in HOMA-IR in high-risk baseline subjects	IF reduces 10-year chronic disease risk and insulin resistance, but increases short-term mortality risk score

Erlangga et al., 2023	Pre-post study, Healthy volunteers	25 healthy young males	Ramadan fasting 17–19 h/day, 30 days	Autophagy markers (ATG5, ULK1, BECN1); inflammasome (NLRP3, IL-1β, ASC, TNF-α); senescence genes (p16, p21, p53)	Autophagy increased at TP2 and declined after fasting; inflammasome decreased significantly at TP4; p16 & p21 were reduced	Ramadan fasting enhances early autophagy, reduces inflammation, and slows cellular aging
Mindikoglu et al., 2020	Interventional proteomic study, USA	14 healthy subjects	Ramadan fasting >14 h/day, 30 days	Serum proteomic signature	Regulation of proteins related to glucose & lipid metabolism, DNA repair, circadian rhythm, immune response, and anti-cancer pathways	30-day Ramadan fasting produces a protective proteomic profile against cancer, metabolic syndrome, and inflammation
H. Zouhal et al,. 2020	Randomized Controlled Trial, Morocco / Middle East region	28 obese males (experimental n=14; control n=14)	Ramadan intermittent fasting (RIF), 30 days (fasting dawn-to-sunset)	Inflammatory biomarkers — IL-6, TNF-α, C-reactive protein (CRP); also liver & renal biochemical parameters	Significant decrease in IL-6 (p=0.02) and TNF-α (p=0.01) in fasting group vs control; no significant change in CRP; no adverse changes in liver/renal biomarker	Ramadan intermittent fasting improves systemic inflammatory biomarkers in obese men without adverse effects on liver/renal function
Mushtaq et al., 2019	Cross-sectional / pre-post (within-subject) design, Karachi, Pakistan	110 adults (55 males, 55 females), age 20–40 years, with subgroups: normal weight, overweight, obese	Ramadan fasting (dawn-to-sunset), throughout Ramadan month (≈ 29–30 days)	Plasma adiponectin (µg/mL), TNF-α (pg/mL), body weight / BMI	Post-Ramadan: significant ↑ plasma adiponectin in overweight & obese males and in obese females; significant ↓ TNF-α in obese males and females compared to pre-Ramadan; significant reduction in BMI among overweight/obese males and obese females	Ramadan fasting is associated with increased adiponectin, reduced pro-inflammatory cytokine (TNF-α), and reduced BMI — suggesting anti-inflammatory and metabolic benefits in overweight/obese individuals

The findings from the included studies demonstrate consistent evidence that intermittent fasting, including Ramadan fasting, exerts beneficial effects on inflammatory markers, immune system modulation, and metabolic regulation. Horne et al., (2023) showed that a structured intermittent fasting intervention resulted in significant improvements in insulin sensitivity and reductions in inflammatory biomarkers such as ICHRON and PCRE among adults with metabolic risk factors. Although an increase in short-term mortality risk score (IMRS) was reported, this was likely related to transient physiological adaptation early during fasting rather than long-term adverse effects. These data suggest that fasting may be particularly beneficial for individuals with metabolic dysregulation, supporting its potential role as a therapeutic lifestyle intervention.

Similar biological benefits were observed in a pre–post Ramadan fasting study among healthy young men by Erlangga et al., (2023), which identified enhanced autophagy pathways and suppression of inflammasome components, including NLRP3, IL-1β, and TNF-α. The reductions in cellular senescence markers (p16, p21) further highlight the role of fasting in

promoting cellular repair and delaying aging processes. These molecular insights emphasize that Ramadan fasting not only influences metabolic responses but also modulates immune signaling and inflammatory resolution at the cellular level.

Proteomic profiling by Mindikoglu et al., (2020)provides additional mechanistic evidence showing that Ramadan fasting regulates pathways related to glucose and lipid metabolism, DNA repair, circadian rhythm, immune system control, and oncogenic suppression. These findings support the hypothesis that fasting induces systemic metabolic reprogramming that enhances immune competence and reduces chronic inflammation. Furthermore, a narrative review by Ashique et al., (2025)highlights the role of gut microbiota as an important mediator of fasting-induced improvements, reporting increases in beneficial taxa such as *Akkermansia* and short-chain fatty acids (SCFA), which are known to enhance intestinal barrier integrity and downregulate inflammatory pathways.

Findings from both the randomized controlled trial by Zouhal et al., (2020) and the pre–post observational study conducted by Mushtaq et al., (2019) consistently demonstrate that Ramadan fasting exerts beneficial effects on systemic inflammation, particularly among individuals with overweight or obesity. Zouhal et al., (2020) reported significant reductions in pro-inflammatory cytokines IL-6 and TNF-α after 30 days of dawn-to-sunset fasting in obese males, compared with a non-fasting control group, while maintaining stable CRP levels and without inducing adverse changes in liver and renal biochemical markers. These results suggest that Ramadan fasting not only attenuates inflammatory signaling but is also safe in metabolically vulnerable populations, supporting its potential as a non-pharmacological strategy to reduce chronic low-grade inflammation associated with obesity and metabolic syndrome.

Similarly, Mushtaq et al., (2019) found significant decreases in TNF-α and increases in adiponectin levels following Ramadan fasting, particularly among overweight and obese adults. Adiponectin, an anti-inflammatory adipokine inversely associated with adiposity and metabolic dysfunction, plays a crucial role in modulating inflammatory responses and insulin sensitivity. The concurrent reduction in BMI observed in overweight and obese participants suggests that weight loss may contribute to, or synergise with, fasting-induced improvements in inflammatory biomarkers. These results reinforce the hypothesis that Ramadan fasting may modulate inflammatory pathways through both metabolic changes and direct cellular signaling mechanisms.

Comparatively, both studies support the concept that the anti-inflammatory effects of Ramadan fasting are more pronounced in populations with elevated metabolic risk, who are more likely to experience chronic inflammation driven by adipose-derived cytokines. While Zouhal et al. demonstrate randomized controlled evidence with biomarker specificity (IL-6 and TNF-α reduction in an obese cohort), Mushtaq et al. expand these findings by linking inflammatory improvements to hormonal and anthropometric changes (adiponectin increases and BMI reductions) across a broader population sample. Together, these findings strengthen the evidence base that Ramadan fasting may serve as a practical public-health intervention to mitigate inflammation and improve metabolic health.

Intermittent fasting is hypothesized to improve inflammatory status and has shown anti-inflammatory and anti-cancer effects in animal studies. In humans, a cross-sectional study of 50 healthy participants demonstrated a significant reduction in pro-inflammatory cytokines (IL-1β, IL-6, TNF-α) and immune cell counts during Ramadan, although values remained within normal ranges(“Mo’ez Al-Islam” E Faris et al., 2012). A case–control study comparing 30 fasters and 30 non-fasters also reported decreases in IL-1α, IL-2, IL-6, and IL-8, but without statistical significance, suggesting a potential immunomodulatory effect(Mohammed & Mahmood, 2010).

However, a prospective cohort study found no change in TNF-α levels after fasting (Feizollahzadeh et al., 2014). Overall, these findings indicate a possible attenuation of immune responses during Ramadan fasting. Ramadan fasting appears to exert only modest effects on immune function, with any observed changes being temporary and typically reverting to pre-Ramadan baseline levels(Bragazzi, 2017).

Across the included studies, the findings align in demonstrating that Ramadan fasting and intermittent fasting can positively influence inflammatory biomarkers, immune cell regulation, autophagy, metabolic health, and possibly cellular longevity. Variability in study designs, population health status, fasting duration, and molecular endpoints may explain differences in magnitude of effects. Nonetheless, evidence suggests that Ramadan fasting represents a feasible and natural form of metabolic intervention with significant implications for the prevention of chronic inflammatory diseases and metabolic disorders. Future research should prioritize standardized methodologies, controlled dietary patterns, longer follow-up periods, and exploration of microbiome-immune interactions to clarify the mechanisms and optimize clinical application.

Several limitations should be acknowledged. First, the included studies vary widely in design, sample characteristics, fasting duration, dietary intake, and biomarkers measured, limiting direct comparison and preventing quantitative meta-analysis. Sample sizes in some studies, particularly mechanistic or proteomic trials, are relatively small and may reduce statistical power. Moreover, most studies assessed short-term effects during or shortly after Ramadan, leaving uncertainty about long-term immune and inflammatory outcomes. Timing of blood sampling, climate-related fasting hours, sleep and physical activity patterns, and uncontrolled nutritional variables may also introduce bias. Finally, few studies explored clinical populations or included women and older adults, highlighting a need for more diverse and representative study cohorts.

Conclusion

This systematic review demonstrates that Ramadan fasting and other intermittent fasting protocols have meaningful effects on immune system regulation and inflammatory biomarkers. Evidence from human studies indicates that fasting can reduce pro-inflammatory cytokines, enhance anti-inflammatory responses, support autophagy and cellular repair mechanisms, improve insulin sensitivity, and modulate immune cell activity. Molecular and proteomic findings further reveal that fasting influences pathways related to metabolic reprogramming, circadian rhythm, oxidative stress, and gut microbiota balance, contributing to reduced chronic inflammation and improved long-term health outcomes. Overall, Ramadan fasting represents a feasible and culturally relevant model of intermittent fasting that may offer protective benefits against chronic metabolic and inflammatory diseases.

Future studies should employ standardized study protocols, larger sample sizes, multicenter designs, and longer follow-up periods to determine sustained effects of Ramadan fasting. Stratification by age, sex, health status, and lifestyle factors is necessary to clarify subgroup responses. Integration of multi-omics approaches (proteomics, metabolomics, microbiome) may provide deeper mechanistic insights. Clinical trials are also needed to evaluate fasting as an adjunct therapeutic strategy for metabolic diseases, autoimmune conditions, and chronic inflammatory disorders.

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