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Ramadan Fasting and Cardiovascular Risk: Evidence from Clinical Studies and Trials

Almoutaz Alkhier Ahmed*

A/Professor - Family Medicine- MBRU, SSR family medicine -Nad Alhamar Health Center. DAHC

FRCGP [int], MSc Diabetes, MSc endocrinology, Senior fellow of IDF, MPH, FESC, FASLM, Dip IBLM, ELMC, Pg Cer medical education.

Abstract

Background: Ramadan fasting represents a unique form of dawn-to-sunset intermittent fasting that results in alterations in meal timing, hydration, sleep patterns, physical activity, and circadian rhythm. Recent evidence indicates potential improvements in cardiovascular risk factors; however, uncertainties persist regarding individual attitudes, the sustainability of these practices, and the clinical significance of the observed changes.

Objective: To critically evaluate current evidence on the effects of Ramadan fasting on cardiovascular risk factors, vascular function and cardiovascular outcomes.

Methods: A structured literature search was conducted using PubMed/MEDLINE, Scopus, and Google Scholar to identify studies assessing the cardiovascular effects of Ramadan fasting. We systematically identified and critically appraised relevant prospective observational studies, controlled interventional studies, randomized controlled trials, systematic reviews, and meta-analyses. The primary outcomes of interest were changes in body weight, blood pressure, lipid parameters, glycaemic control, inflammatory biomarkers, endothelial function, hypoglycaemic events, and major adverse cardiovascular events (MACE). In interpreting the evidence, we considered study design, participant characteristics, fasting duration, and methodological limitations.

Results: Ramadan fasting is associated with modest, short-term improvements in several cardiometabolic risk factors. The London Ramadan Study and a meta-analysis of 33 studies (n=3,213) reported reductions in systolic and diastolic blood pressure of approximately 3.2 and 2.3 mmHg, respectively. Additionally, another meta-analysis indicated reductions in body weight, waist circumference, fasting glucose, triglycerides, and LDL cholesterol, with potential increases in HDL cholesterol. Small mechanistic studies have observed improved flow-mediated dilation and reductions in inflammatory markers. Nevertheless, substantial heterogeneity exists due to variations in fasting duration, diet, sleep, physical activity, geography, and baseline health status. In individuals with diabetes, the EPIDIAR study identified an increased risk of severe hypoglycaemia during Ramadan, while subsequent intervention studies demonstrated that structured education, medication adjustment, and monitoring can substantially improve fasting safety. However, evidence supporting reductions in myocardial infarction, stroke, or cardiovascular mortality remains insufficient. Observational studies suggest that appropriately selected patients with stable cardiovascular disease and heart failure may tolerate fasting.

Conclusion: Ramadan fasting presents a potential opportunity for short-term modification of cardiovascular risk factors; however, current evidence does not demonstrate a reduction in major cardiovascular events. Integrating Ramadan fasting with established pillars of lifestyle medicine, appropriate medication adjustments, and structured clinical support could transform Ramadan into a meaningful opportunity for sustainable cardiovascular prevention.

Keywords: Ramadan fasting; Cardiovascular risk; Intermittent fasting; Cardiometabolic health; Cardiovascular prevention.

Introduction

Cardiovascular disease (CVD) continues to be a primary cause of morbidity and mortality globally. Hypertension, dyslipidaemia, obesity, insulin resistance, type 2 diabetes mellitus (T2DM), smoking, physical inactivity, inflammation, and endothelial dysfunction are key contributors to atherosclerotic cardiovascular disease [1]. As a result, there is significant interest in dietary and behavioural interventions aimed at modifying these risk factors. Ramadan fasting constitutes a unique form of intermittent fasting observed annually by Muslims worldwide [2]. During Ramadan, individuals abstain from both food and drink from dawn until sunset for approximately 29 to 30 consecutive days [2]. In contrast to many conventional intermittent fasting regimens, Ramadan fasting involves dry fasting during daylight hours, with all food and fluid intake confined to the period between sunset and dawn [1]. This practice is also associated with alterations in meal timing, sleep patterns, physical activity, social interactions, and circadian rhythms [3]. These features position Ramadan as a distinctive natural model for investigating the effects of repeated fasting and feeding cycles on cardiovascular physiology [4].

Current evidence indicates that Ramadan fasting may lead to modest improvements in body weight, waist circumference, blood pressure, glucose metabolism, lipid profiles, inflammation, and endothelial function [5]. However, these outcomes are variable and are significantly affected by baseline health status, dietary quality, sleep patterns, physical activity, fasting duration, medication use, and behaviours following Ramadan. It is important to note that improvements in cardiovascular risk markers should not be interpreted as definitive evidence that Ramadan fasting prevents myocardial infarction, stroke, or cardiovascular mortality. Most Ramadan studies are of

***Corresponding Author:** *Almoutaz Alkhier Ahmed, A/Professor -MBRU, SSR family medicine -Nad Alhamar Health Center. DAHC

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short duration and primarily assess surrogate endpoints rather than major cardiovascular events.

Metabolic Adaptations Associated with Ramadan Fasting (Figure 1)
During fasting, reductions in circulating glucose and insulin concentrations shift metabolism from primarily glucose-based pathways to increased lipolysis and fatty acid oxidation (6). As hepatic glycogen stores are depleted, free fatty acids contribute more substantially to energy production, and ketogenesis may increase modestly [6].
Reduced insulin exposure and repeated periods of low energy availability may enhance insulin sensitivity, especially when Ramadan fasting is accompanied by decreased overall caloric intake and weight loss [7]. These metabolic adaptations may influence cardiovascular risk by reducing adiposity, glucose concentrations, blood pressure, and atherogenic lipid abnormalities.
However, Ramadan fasting should not be regarded solely as caloric restriction. Some individuals compensate for daytime fasting by consuming energy-dense meals at Iftar and Suhoor [6]. High intake of refined carbohydrates, saturated fats, sweets, and salt may attenuate or even negate potential cardiometabolic benefits [6]. The extent of these metabolic and cardiovascular effects is strongly influenced by lifestyle behaviours during non-fasting hours [8].

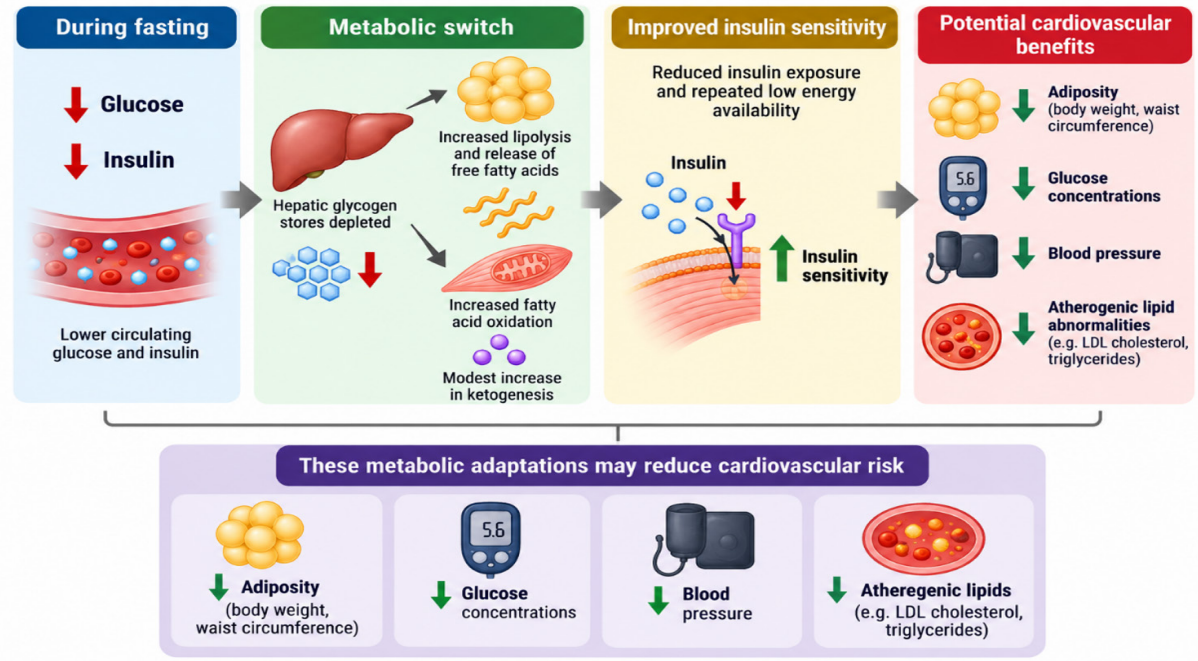

Figure 1: *Metabolic Adaptations Associated with Ramadan Fasting.*

Effects of Ramadan fasting on Cardiometabolic health (Figure 2)
Ramadan fasting is associated with modest cardiometabolic benefits, potentially mediated by alterations in energy metabolism, dietary intake, and circadian regulation. Systematic reviews and meta-analyses have documented reductions in body weight, waist circumference, systolic and diastolic blood pressure, triglycerides, LDL cholesterol, and fasting glucose, as well as improvements in HDL cholesterol [1-2]. Recent studies also indicate possible enhancements in insulin sensitivity, endothelial function, and nitric oxide bioavailability [7]. The magnitude of these effects depends on baseline metabolic health, dietary quality, physical activity, sleep patterns, and medication adherence. Individualized risk assessment, structured education, and appropriate treatment modifications are essential, particularly for individuals with diabetes or established cardiovascular disease.

Effects on Body Weight and Central Adiposity
Obesity, especially visceral adiposity, is a primary contributor to hypertension, insulin resistance, dyslipidaemia, and systemic inflammation [9]. Consequently, modest reductions in body weight and waist circumference may lower cardiovascular risk [10]. An umbrella review and meta-analysis of 11 systematic reviews reported that Ramadan fasting was associated with reductions in body weight and waist circumference [5]. The pooled standardized mean difference was approximately −0.34 for body weight and −0.30 for waist circumference [5]. However, the methodological quality of the included reviews ranged from low to critically low, indicating that these findings should be interpreted with caution [5]. Previous evidence also indicated modest weight reduction. Kul et al, analysed 30 studies and observed weight reduction, particularly among men, although results varied considerably across studies [11].

The cardiovascular relevance of these findings is supported by biological plausibility. Reduced visceral adiposity may enhance insulin sensitivity, decrease sympathetic activity, and reduce inflammatory signalling. However, weight loss during Ramadan is often modest and may be regained after the fasting period [12]. Thus, Ramadan may function more effectively as an entry point for sustained lifestyle modification rather than as a standalone weight-loss intervention.

Effect on blood Pressure
There is relatively consistent evidence that Ramadan fasting leads to modest improvements in blood pressure. The London Ramadan Study (LORANS) assessed blood pressure before and after Ramadan in 85 participants. After adjusting for potential confounders, systolic blood pressure decreased by approximately 7.3 mmHg and diastolic pressure by about 3.4 mmHg following Ramadan [13]. The investigators also conducted a systematic review and meta-analysis of 33 studies involving 3,213 participants [13]. Across these studies, Ramadan fasting was associated with reductions of approximately 3.19 mmHg in systolic blood pressure and 2.26 mmHg in diastolic blood pressure [13].

A more recent meta-analysis comparing religious fasting with non-fasting controls also found a reduction in systolic blood pressure of approximately 3.8 mmHg associated with Ramadan fasting [14]. Although these reductions are relatively small, even modest changes in blood pressure at the population level may significantly affect long-term cardiovascular risk.

Several mechanisms may contribute to these effects:
These mechanisms include reduced body weight and visceral adiposity, improved insulin sensitivity, decreased sodium or total caloric intake in some individuals, changes in sympathetic nervous system activity, improved endothelial function, and alterations in circadian blood pressure regulation [13].

However, dehydration, excessive caffeine withdrawal, inadequate sleep, and consumption of high-sodium Iftar meals may counteract these beneficial effects [15]. Patients taking antihypertensive agents or diuretics require individualized assessment, as prolonged fasting, especially in hot environments, can increase the risk of hypotension or volume depletion in susceptible individuals [15].

Effect on lipid Profile
Ramadan fasting has been shown to influence lipid metabolism. A systematic review and meta-analysis of 91 studies involving 4,431 adults reported modest improvements in several cardiometabolic risk factors [16]. Ramadan fasting was associated with increased HDL cholesterol and reduced LDL cholesterol, while changes in total cholesterol and triglycerides were minor and varied across studies [5].
Similarly, a 2024 umbrella review identified favourable pooled effects on HDL cholesterol, LDL cholesterol, total cholesterol, and triglycerides [5].

An earlier meta-analysis by Kul et al. [11] demonstrated reductions in LDL cholesterol and fasting glucose, with especially favourable lipid changes observed among male participants. Potential mechanisms underlying these effects include increased fatty-acid oxidation, reduced insulin concentrations, modest weight loss, and alterations in dietary composition. However, diet quality remains a critical factor. A dietary pattern during Ramadan that emphasizes vegetables, whole grains, legumes, fruits, nuts, fish, and unsaturated fats may enhance lipid benefits. In contrast, frequent consumption of fried foods, desserts, refined carbohydrates, and saturated fats may negate these positive effects.

Effect on glucose Metabolism, Insulin Resistance and Diabetes
Insulin resistance is a key factor linking obesity, type 2 diabetes mellitus (T2DM), and cardiovascular disease [17]. Repeated fasting periods have been shown to reduce circulating insulin levels and promote metabolic flexibility, which may improve glucose regulation [7]. A systematic review of 85 studies involving 4,326 participants identified modest improvements in several components of metabolic syndrome, including waist circumference, systolic blood pressure, triglycerides, fasting glucose, and HDL cholesterol [18].

More recent evidence focusing on individuals with type 2 diabetes mellitus (T2DM) provides further insight. A 2026 systematic review and meta-analysis of 34 clinical studies involving 11,925 adults with T2DM found that Ramadan fasting was associated with reductions in fasting glucose by approximately 11.5 mg/dL, HbA1c by 0.46 percentage points, LDL cholesterol by approximately 6.3 mg/dL, and triglycerides by approximately 15.2 mg/dL [19]. However, heterogeneity among studies was substantial, and clinically significant hypoglycaemia and hyperglycaemia remained important concerns [19]. This finding highlights a key cardiovascular principle: while fasting may improve metabolic risk factors, metabolic instability can counteract potential benefits in vulnerable patient populations. The EPIDIAR study [20] included more than 12,000 people with diabetes across 13 countries. The study [20] showed that Severe hypoglycaemic episodes increased during Ramadan, particularly among patients receiving glucose-lowering therapy. Therefore, potential cardiovascular benefits should always be evaluated in conjunction with the safety of fasting in individuals with diabetes.

Effect on endothelial Function
The vascular endothelium plays a central role in atherosclerosis by regulating vascular tone, nitric oxide production, inflammation, platelet activity, and oxidative stress [21]. Emerging evidence indicates that Ramadan fasting may improve endothelial function [22]. A review of 66 studies [22] concluded that Ramadan fasting may enhance specific markers of endothelial function, such as nitric oxide bioavailability and vascular inflammatory biomarkers. The authors also highlighted the necessity for larger, rigorously controlled studies. In patients with cardiovascular disease, Ramadan fasting was associated with increased nitric oxide concentrations and decreased asymmetric dimethylarginine, an endogenous inhibitor of nitric oxide synthase [23].

A study of 64 hypertensive patients found significant improvement in flow-mediated dilation after Ramadan [25]. C-reactive protein and cortisol concentrations also decreased, and these changes were associated with improvement in endothelial function [25]. A recent review of 66 studies concluded that Ramadan fasting may increase nitric oxide bioavailability and improve certain markers of endothelial dysfunction. However, the authors emphasized the need for more robust clinical research [22].

Potential mechanisms include:
Insulin sensitivity
Ramadan fasting may reduce oxidative stress and inflammation and improve insulin sensitivity, which could increase nitric oxide bioavailability, enhance endothelial function, and potentially lower atherosclerotic risk [22].These findings are promising but are predominantly based on surrogate vascular markers rather than on cardiovascular event trials.

Inflammation and Oxidative Stress
Chronic low-grade inflammation contributes to atherosclerosis, plaque instability, and insulin resistance [29]. Some Ramadan studies have demonstrated reductions in C-reactive protein and other inflammatory mediators [22]. In hypertensive cohort [24] researchers showed that lower CRP concentrations after Ramadan, accompanied by improvement in flow-mediated dilation. Weight loss, reduced glucose exposure, increased fatty acid oxidation, and changes in dietary patterns may each contribute to the observed anti-inflammatory effect. However, inflammatory responses are heterogeneous [24]. Factors such as sleep deprivation, excessive nocturnal eating, smoking after Iftar, and reduced physical activity may counteract potential benefits (24).

Importance of Pre-Ramadan Education
Clinical trials indicate that structured preparation significantly alters the risk–benefit profile. A prospective intervention involving 262 individuals with type 2 diabetes mellitus (T2DM) found that individualized Ramadan education and medication adjustment reduced hypoglycaemic risk and improved HbA1c and LDL cholesterol compared with standard care [26]. A systematic review of Ramadan-focused diabetes education reported an approximately 81% reduction in hypoglycaemic risk among patients receiving structured education compared with those receiving conventional care [27]. A randomized controlled trial evaluating pre-Ramadan assessment, education, and treatment adjustment also reported substantially fewer severe hypoglycaemic episodes, with an odds ratio of approximately 0.20, as well as improved metabolic outcomes [27]. Technological interventions may further enhance safety. A pilot randomized trial [28] involving 37 individuals with T2DM found that telemonitoring combined with

Ramadan-focused education significantly reduced the likelihood of hypoglycaemia compared with education alone.

These studies suggest that Ramadan should not be regarded solely as a fasting exposure. Preparation, education, medication adjustment, glucose monitoring, and lifestyle behaviours collectively determine clinical outcomes.

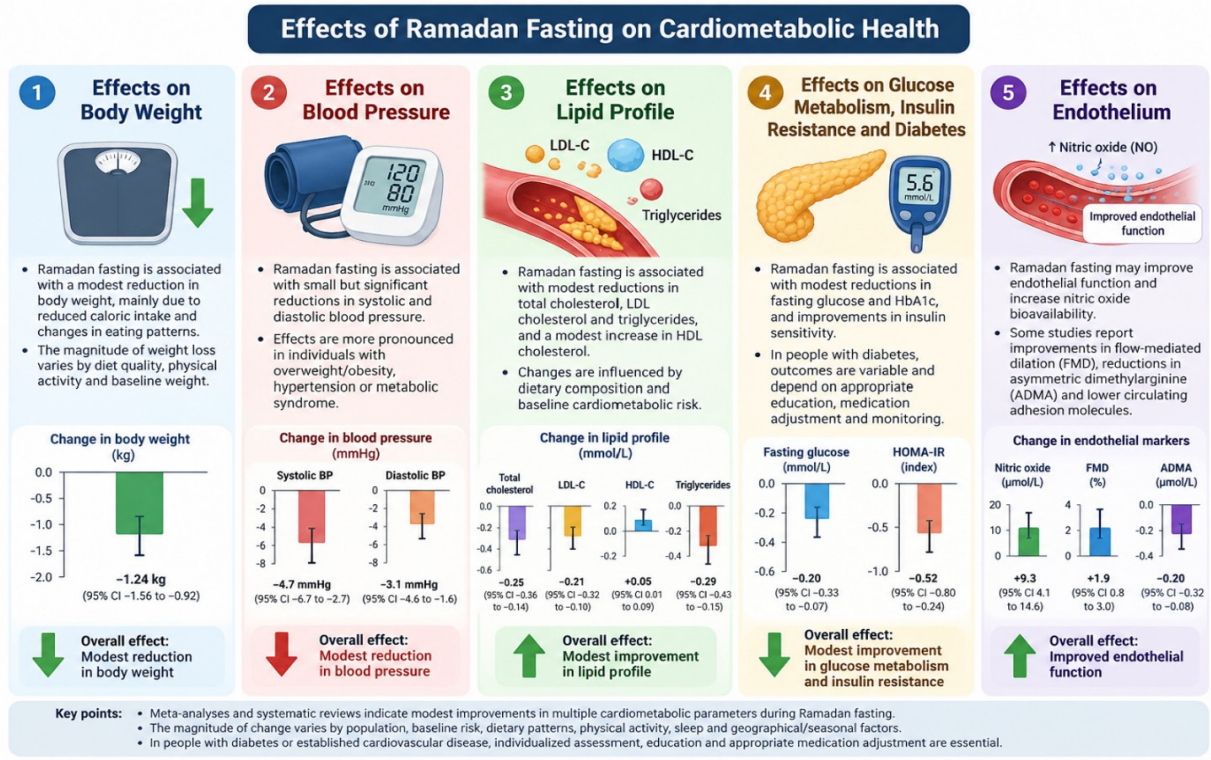

Figure 2: *Effects of Ramadan fasting on cardiometabolic health.*

Ramadan Fasting in Established Cardiovascular Disease

A key clinical consideration is whether individuals with established cardiovascular disease can safely participate in fasting. A multicentre prospective study of 465 cardiac patients from Qatar, Kuwait, the United Arab Emirates and Bahrain included patients with angina, previous myocardial infarction, heart failure, atrial fibrillation, previous coronary intervention and valvular disease [30]. Approximately 91% were able to fast, while 6.7% reported worsening symptoms [30] and nineteen patients required hospitalization for cardiovascular reasons. The investigators concluded that fasting had relatively limited adverse effects among appropriately selected patients with stable cardiovascular disease [30].

An earlier study of 86 patients with stable cardiac disease similarly found no significant deterioration in NYHA functional class or major biochemical parameters during Ramadan [31]. Heart failure requires particular attention. In a study of 249 patients with chronic heart failure, 227 fasted throughout Ramadan [32]. Approximately 92% remained hemodynamically stable, whereas 8% developed instability [32]. Poor medication and dietary adherence were considerably more common among unstable patients [32]. In comparison to Ramadan fasting, a systematic review [33] of intermittent fasting in chronic heart failure included five observational studies and found no clear increase in short-term heart-failure decompensation, major cardiovascular events, or mortality among clinically stable patients.

Nevertheless, the evidence remained observational rather than de rived from large, randomized outcome trials. Thus, the available evidence applies primarily to clinically stable and appropriately selected patients and should not be extrapolated to unstable cardiovascular disease.

Does Ramadan Reduce Myocardial Infarction or Stroke?

This distinction is critical for accurate interpretation of the existing literature. Although Ramadan fasting can improve several cardiovascular risk markers, evidence that it directly prevents myocardial infarction, stroke, heart failure hospitalization or cardiovascular mortality remains insufficient. A systematic review and meta-analysis examining stroke, myocardial infarction and congestive heart failure found that the incidence of cardiovascular events during Ramadan was broadly similar to non-fasting periods [34]. An earlier systematic review reached a similar conclusion: Ramadan fasting was not associated with a clear increase in acute cardiovascular illness, while many cardiometabolic risk factors improved [35].

<u>In summary, the current body of evidence can be categorized as follows:</u>

Strongest evidence: modest short-term improvement in cardiovascular risk factors.

Moderate/limited evidence: improvement in endothelial and inflammatory markers.

Observational evidence: fasting appears feasible for many carefully selected patients with stable cardiovascular disease.

Insufficient evidence: reduction in myocardial infarction, stroke or cardiovascular mortality.

Potential Cardiovascular Risks of Ramadan Fasting

Ramadan fasting does not confer universal cardiovascular protection. Potential adverse effects include dehydration, electrolyte disturbances, hypotension, medication non-adherence, hypoglycaemia, hyperglycaemia, sleep deprivation, and excessive caloric intake following the fast [36].

The greatest concern occurs in patients with unstable or recently decompensated cardiovascular disease, severe renal impairment, poorly controlled diabetes or conditions requiring medications that cannot safely be reorganized around the fasting period. Furthermore, circadian disruption deserves greater attention. Late-night meals, reduced sleep duration, and fragmented sleep may increase sympathetic activity and impair glucose metabolism. Thus, fasting com-

bined with poor sleep may produce a very different cardiovascular response from fasting accompanied by adequate sleep and healthy nutrition [37].

A Lifestyle Medicine Interpretation

A more comprehensive conceptual approach is to consider Ramadan as a month-long, multidimensional lifestyle intervention rather than solely a period of fasting.

Its cardiovascular effect can be represented as:

Ramadan fasting

↓ meal frequency and altered energy timing↓ insulin exposure
↑ fat oxidation
Combined with
Healthy Iftar/Suhoor nutrition
Regular physical activity
Adequate sleep
Hydration during non-fasting hours
Tobacco avoidance
Stress regulation and spiritual wellbeing
This multidimensional approach can leads to :
↓ Weight and waist circumference ↓
↓ Blood pressure
↑ Insulin sensitivity
↑ Glucose control
↓ Triglycerides/LDL
↑ HDL potentially
↓ Inflammation
↑ Endothelial function

This framework elucidates the substantial variability in outcomes observed across studies. While Ramadan provides a structured fasting period, associated behaviours ultimately determine whether the metabolic effects are beneficial or adverse [37].

Key Clinical Studies and Evidence

The body of evidence regarding Ramadan fasting and cardiovascular risk comprises prospective observational studies, controlled interventions, randomized trials involving individuals with diabetes, and systematic reviews or meta-analyses. The evidence is most robust for short-term modifications in cardiovascular risk factors, while support for the prevention of major cardiovascular events remains limited.

Critical Appraisal of the Evidence

The evidence supporting improvements in cardiovascular risk factors is more robust than that for reductions in cardiovascular events. Across the Ramadan literature, the most consistent finding is a modest improvement in intermediate cardiovascular risk factors, rather than clear evidence of prevention of cardiovascular events. Blood pressure serves as a particularly illustrative example. LORANS study [13] reported reductions of 7.29 mmHg in systolic and 3.42 mmHg in diastolic pressure among 85 participants. Furthermore, its meta-analysis of 33 studies involving 3,213 participants [13] found pooled reductions of 3.19 mmHg in systolic blood pressure (SBP) and 2.26 mmHg in diastolic blood pressure (DBP). Similarly, a meta-analyses [18] demonstrate modest improvements in waist circumference, triglycerides, high-density lipoprotein (HDL) cholesterol, glucose, and other components of metabolic syndrome. These findings are biologically relevant, as hypertension, dyslipidaemia, central obesity, and dysglycaemia are established cardiovascular risk factors. However, improvements in these surrogate markers should not be assumed to directly result in reductions in myocardial infarction, stroke, or cardiovascular mortality.

Limitations (Figure 3)**:**

Lack of large randomized cardiovascular outcome trials

A fundamental limitation is the absence of large, randomized trials comparing Ramadan fasting with non-fasting for cardiovascular outcomes. Randomization is inherently difficult because Ramadan fasting is a religious practice determined by personal choice. Consequently, most studies employ: before Ramadan → during Ramadan → after Ramadan comparisons. This study design introduces several potential confounders. Participants concurrently alter meal timing, caloric intake, dietary composition, sleep patterns, physical activity, caffeine consumption, smoking behaviour, and social interactions. Therefore, an observed reduction in blood pressure cannot be attributed solely to fasting.

Heterogeneity between studies

There is considerable clinical heterogeneity among studies. Ramadan moves approximately 10–11 days earlier each solar year, meaning fasting duration and environmental exposure vary substantially by geography and season [37]. A participant fasting for approximately 12 hours in a temperate climate is exposed to different physiological conditions compared to an individual fasting for 17–18 hours in a hot environment. Other important sources of variation include age, sex, ethnicity, baseline body mass index (BMI), diabetes prevalence, medication use, physical activity, Iftar meal composition, and sleep patterns. This heterogeneity is evident in statistical analyses. In the LORANS meta-analysis [13], heterogeneity was approximately I^2=48% for systolic blood pressure and 66% for diastolic blood pressure. Thus, pooled estimates represent average effects across substantially diverse Ramadan experiences.

Weight loss is a major potential mediator and confounder.

Ramadan fasting is frequently associated with modest reductions in body weight. 2024 umbrella review [16] found pooled favourable effects on body weight, waist circumference, blood pressure, lipids, and fasting glucose. This observation raises an important mechanistic question: Are cardiovascular improvements attributable to fasting itself, or to the associated weight loss?

The underlying mechanisms are likely multifactorial. Interestingly, LORANS [13] reported blood-pressure improvement even after adjustment for changes in weight, body water and fat mass, suggesting that weight loss may not fully explain the BP effect. Nevertheless, future studies require more rigorous mediation analyses to disentangle the effects of caloric restriction, weight loss, meal timing, and fasting duration.

Evidence regarding endothelial function is biologically relevant but remains preliminary.

Endothelial dysfunction represents an early stage of atherosclerotic cardiovascular disease. Demirci and Özkan [24] showed increased flow-mediated dilation after Ramadan fasting in 64 hypertensive adults. CRP and cortisol also decreased, and reductions in these biomarkers predicted improvements in flow-mediated dilation (FMD). This evidence suggests a plausible biological pathway: Ramadan fasting
→ ↓ inflammatory activity / oxidative stress
→ ↑ nitric oxide bioavailability
→ ↑ flow-mediated dilation
→ improved vascular function.

A broader review of 66 studies [22] similarly concluded that Ramadan fasting may improve nitric oxide availability and several indicators of endothelial dysfunction,

while emphasizing the need for higher-quality research. A key limitation is that flow-mediated dilation (FMD), nitric oxide, and C-reactive protein (CRP) are surrogate endpoints. Whether these changes persist after Ramadan or result in fewer cardiovascular events remains unknown.

Table 1: **Key Studies Examining Ramadan Fasting and Cardiovascular Risk.**

SBP=Systolic Blood Pressure, DBP=Diastolic Blood Pressure, TG= Triglyceride=High Density Lipoprotein, LDL=Low Density Lipoprotein, TC=Total Cholesterol, CRP=C Reactive Protein, T2DM=Type 2 Diabetes Mellitus, HbA1c=Glycated Haemoglobin, OR=Odd Ratio, CI=Confidence Interval, RCT=Randomized Control Trial, NYHA=New York Heart Association, MI=Myocardial Infarction, HF=Heart Failure, HFrEF=Heart Failure with reduced Ejection Fraction.

Study	Design / population	Main outcomes	Key findings	Critical interpretation
Al-Jafar et al. LORANS, 2021 [13]	Prospective observational study, n=85; accompanying meta-analysis of 33 studies, n=3,213	SBP, DBP	LORANS: SBP ↓7.29 mmHg and DBP ↓3.42 mmHg. Meta-analysis: SBP ↓3.19 mmHg and DBP ↓2.26 mmHg.	BP meta-analysis showed moderate heterogeneity.
Faris et al. 2020 [18]	Systematic review/meta-analysis; 85 studies, n=4,326 healthy participants	Waist circumference, SBP, glucose, TG, HDL	Small reductions in waist circumference, SBP, fasting glucose and TG, with increased HDL.	Heterogeneity limits causal inference.
Jahrami et al. 2021 [38]	Systematic review/meta-analysis; 91 studies, n=4,431	Cardiometabolic risk factors	Favourable changes in several cardiometabolic parameters following Ramadan fasting.	Large evidence synthesis but dominated by before-after observational studies rather than randomized trials.
Jahrami et al. 2022 [39]	Systematic review/meta-analysis	Metabolic syndrome components	HDL increased; TG, fasting glucose, waist circumference, SBP and DBP decreased.	Supports multidimensional metabolic benefit.
Umbrella review, 2025[16]	11 systematic reviews/meta-analyses	Weight, waist, BP, glucose and lipids	Improvements in weight, waist circumference, HDL, LDL, TC, TG, SBP, DBP and fasting glucose.	High-level synthesis, but methodological quality of included reviews ranged from low to critically low.
Demirci & Özkan, 2023 [24]	Prospective study; 64 patients with hypertension	Flow-mediated dilation, CRP, cortisol	FMD improved significantly; CRP and cortisol decreased after Ramadan.	Provides mechanistic evidence of improved endothelial function, but small sample, no randomized non-fasting comparator and surrogate endpoint.
Salti et al. EPIDIAR, 2004 [20]	Population-based survey; 12,243 patients with diabetes from 13 countries	Hypoglycaemia, hyperglycaemia, treatment patterns	Severe hypoglycaemia increased during Ramadan in both T1DM and T2DM.	Large multinational population, but retrospective observational design and older diabetes therapies limit application to contemporary treatment.
Tourkmani et al. 2016 [25]	Prospective controlled intervention; n=262 T2DM	Hypoglycaemia, HbA1c, LDL	Structured education reduced hypoglycaemia scores and improved HbA1c and LDL compared with standard care.	Demonstrates that the clinical effect of Ramadan depends on preparation and treatment adjustment; non-randomized design remains a limitation.
Tourkmani et al. 2021 [26]	Systematic review; 17 studies	Hypoglycaemia and metabolic control	Ramadan-focused education associated with ~81% lower odds of hypoglycaemia (OR 0.19, 95% CI 0.08–0.46).	Strong support for structured education, but only five studies were suitable for pooled analysis and designs were heterogeneous.
Ramadan diabetes RCT, 2022/23 [27]	Randomized controlled trial, T2DM	Severe hypoglycaemia, HbA1c, weight, HDL	Pre-Ramadan assessment, education and medication adjustment reduced severe hypoglycaemia and improved metabolic control.	Preparation modifies fasting safety; not designed to assess cardiovascular events.
Lee et al. 2015 [28]	Pilot RCT; n=37 T2DM	Hypoglycaemia	Telemonitoring plus education reduced odds of hypoglycaemia (OR 0.1273, 95% CI 0.0267–0.6059).	Supports technology-assisted Ramadan care but is substantially underpowered for cardiovascular or long-term metabolic outcomes.
Chamsi-Pasha & Ahmed, 2004 [31]	Prospective observational study; n=86 stable cardiac patients	Symptoms, NYHA class, biochemical measures	86% completed the entire fast; no major deterioration in clinical status was identified.	Reassuring for selected stable patients, but small study and substantial selection bias.
Al Suwaidi et al., 2004 [40]	Prospective multicentre study; n=465 cardiac patients across Gulf countries	Symptoms, hospitalization	91.2% could fast; 6.7% felt worse; 19 cardiovascular hospitalizations occurred.	Valuable multicentre real-world evidence, including patients with prior MI and HF, but no randomized non-fasting comparison.
Abazid et al. 2018 [32]	Prospective study; n=249 HFrEF	Haemodynamic stability, NYHA, hospitalization	Of 227 completing Ramadan fasting, 92% remained stable; instability was associated with poorer medication and dietary adherence.	Suggests selected stable HFrEF patients may tolerate fasting, but strong healthy-faster selection bias prevents generalization to advanced HF.
Turin et al. 2016 [34]	Systematic review/meta-analysis; 15 studies	MI, stroke, congestive HF	Incidence of acute cardiovascular events during Ramadan was broadly similar to non-fasting periods.	Important distinction: no signal of increased population-level acute events, but this does not establish cardiovascular protection.

Diabetes illustrates both potential benefits and risks associated with Ramadan fasting.

Diabetes provides a clear example of why Ramadan fasting cannot be universally described as cardioprotective. EPIDIAR study [20] included 12,243 individuals with diabetes across 13 countries. Severe hypoglycaemia increased during Ramadan from 0.03 to 0.14 episodes/month in T1DM and from 0.004 to 0.03 episodes/month in T2DM. Hypoglycaemia can provoke sympathetic activation, tachycardia, blood pressure fluctuations, QT interval prolongation, and arrhythmias, potentially increasing cardiovascular vulnerability in susceptible individuals. However, subsequent interventional studies demonstrate that much of this risk can be mitigated. Tourkmani et al. showed that individualized education and medication adjustment reduced hypoglycaemic risk and improved HbA1c and LDL cholesterol [25]. A subsequent systematic review found an 81% reduction in the odds of hypoglycaemia with Ramadan-focused education [26]. Randomized evidence further showed that pre-Ramadan assessment, education, and treatment adjustment reduced severe hypoglycaemia [27].

Thus:

Ramadan fasting alone ≠ automatically beneficial whereas Risk assessment + education + medication adjustment + monitoring + healthy lifestyle → safer Ramadan fasting. This distinction holds significant clinical importance.

Evidence regarding Ramadan fasting in individuals with established cardiovascular disease is somewhat reasuring but is derived from highly selected populations.

Observational studies suggest that many patients with stable cardiovascular disease can complete Ramadan fasting without obvious short-term deterioration. In the multicentre Gulf study involving 465 cardiac patients, 91.2% were able to fast, while 6.7% reported worsening symptoms and 19 patients required hospitalization for cardiovascular reasons [40]. Similarly, among 249 patients with HFrEF, 227 fasted throughout Ramadan and approximately 92% remained hemodynamically stable [40]. Patients developing instability had substantially poorer medication and dietary adherence [40]. These results are susceptible to healthy-faster bias. Patients who choose to fast are likely healthier and more clinically stable than those who do not. In the heart failure with reduced ejection fraction (HFrEF) study, non-fasting patients had a higher New York Heart Association (NYHA) functional class and poorer adherence characteristics [32]. Therefore, these studies should not be interpreted as evidence that Ramadan fasting is safe for all individuals with heart failure.

Hard cardiovascular outcomes remain uncertain.

Turin et al. [16] pooled 15 studies examining stroke, myocardial infarction and congestive heart failure and found that acute cardiovascular-event incidence during Ramadan was broadly similar to non-fasting periods. This finding is clinically reassuring but requires careful interpretation.

It demonstrates approximately:

No convincing increase in cardiovascular events during Ramadan.

It does not demonstrate:

Ramadan fasting prevents cardiovascular events.

These represent fundamentally different conclusions. Large prospective cohorts with long-term follow-up or pragmatic trials of Ramadan-focused lifestyle interventions are necessary to determine whether repeated annual Ramadan fasting influences long-term major adverse cardiovascular events (MACE).

The durability of observed benefits remains uncertain.

Many Ramadan studies measure participants immediately before Ramadan and during the final days of fasting. This demonstrates acute physiological adaptation but provides limited information regarding cardiovascular health at six or twelve months post-Ramadan. Individuals may regain weight lost during Ramadan, and dietary patterns, physical activity, and sleep schedules typically revert to pre-Ramadan norms. Consequently, the most important future research question may not be: Does Ramadan improve cardiovascular risk? but rather: Can cardiovascular improvements achieved during Ramadan be converted into sustained behavioural and cardiometabolic improvements after Ramadan? This observation highlights a particularly strong connection with the principles of lifestyle medicine.

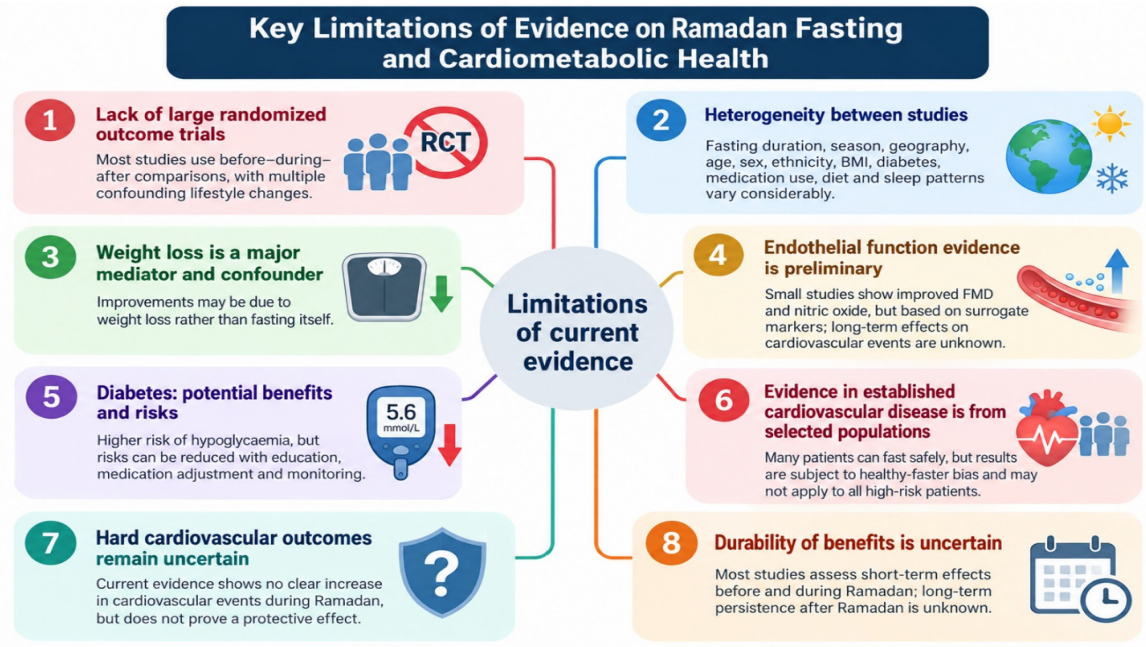

Figure 3: *Limitations of current evidence.*

Critical Appraisal of Ramadan Fasting and Cardiovascular Studies

LORANS – Al-Jafar et al. [13]

Study design and findings: The London Ramadan Study was a prospective observational study examining blood pressure before and after Ramadan. Eighty-five participants provided paired blood-pressure measurements. Ramadan fasting was associated with reductions of approximately 7.3 mmHg in systolic blood pressure and 3.4 mmHg in diastolic blood pressure. Importantly, the investigators also conducted a meta-analysis of 33 studies involving 3,213 participants and found pooled reductions of approximately 3.19 mmHg in SBP and 2.26 mmHg in DBP.

Strengths: A major strength is the use of paired measurements, allowing participants to act partly as their own controls. The investigators considered potential confounders including changes in weight and body composition. The accompanying meta-analysis considerably strengthened the external evidence supporting the direction of the blood-pressure effect. The magnitude of the pooled blood pressure reduction may be clinically meaningful if sustained over time.

Limitations: The principal weakness is the absence of a contemporaneous non-fasting control group. Therefore, temporal changes, diet, physical activity, sleep, medication adherence, or regression to the mean could partly explain the findings. The primary cohort was relatively small, and blood pressure was assessed over a relatively short period. More importantly, the meta-analysis incorporated heterogeneous observational studies with differences in geography, fasting duration, population characteristics, and BP measurement protocols.

Interpretation: LORANS provides reasonably convincing evidence that Ramadan is associated with modest short-term reductions in blood pressure. However, it does not establish that fasting itself is the sole cause of this effect or that blood pressure reduction persists after Ramadan.

Faris et al. – Metabolic Syndrome Meta-analysis [18]

Study design: This systematic review included 85 studies involving more than 4,000 participants and evaluated several components of metabolic syndrome.

Strengths: The major advantage is the comprehensive assessment of multiple cardiovascular risk pathways rather than a single biomarker. Changes in waist circumference, glucose, triglycerides, HDL, and blood pressure provide biological coherence: several related risk factors appear to move in a favourable direction simultaneously. Meta-analysis offers greater statistical power compared to individual Ramadan studies.

Limitations: The major problem is that pooling many weak observational studies does not transform them into randomized evidence. The underlying studies differed substantially in age, sex, ethnicity, fasting duration, climate, dietary behaviour, and baseline cardiometabolic health. Dietary intake and physical activity were often inadequately measured.

Publication bias is another concern because small Ramadan studies demonstrating favorable metabolic changes may be more likely to be published than studies showing no effect.

Interpretation: The study supports a multidimensional cardiometabolic effect; however, the magnitude of benefit should be interpreted with caution due to substantial residual confounding and heterogeneity.

Jahrami et al. Meta-analyses [16](38-39)

Study design: The Jahrami group has produced several systematic reviews examining Ramadan fasting and cardiometabolic health.

Strengths: These analyses provide a broad synthesis of evidence across weight, glucose, lipid, and blood-pressure outcomes. Some reports used meta-regression and subgroup analyses to explore sources of heterogeneity. The consistency of several outcomes across independent populations strengthens the argument that Ramadan fasting may produce genuine physiological changes.

Limitations: Again, the major limitation originates from the primary literature. Most included studies used pre-post designs. There is also considerable statistical heterogeneity. When populations, climates, fasting durations, and dietary practices differ markedly, a single pooled estimate may conceal clinically important differences. For example, a 16-hour fast in summer cannot necessarily be considered equivalent to a 12-hour fast in winter.

Interpretation: These meta-analyses increase confidence in the existence of small average cardiometabolic changes, although certainty regarding their exact magnitude remains limited.

4.2024 Umbrella Review [16]

Study design: The umbrella review synthesizing 11 systematic reviews/meta-analyses represents one of the highest levels of evidence available.

Strengths: An umbrella review permits examination of consistency across multiple meta-analyses rather than individual studies. The review identified favorable pooled effects for body weight, waist circumference, BP, fasting glucose, and several lipid parameters. This pattern indicates biological coherence among the observed outcomes.

Critical limitation: The most important finding is actually methodological: the quality of the included systematic reviews ranged from low to critically low.

An umbrella review cannot overcome weaknesses in the original evidence.

The hierarchy therefore becomes: many small observational studies
→ systematic reviews of those studies
→ umbrella review of those systematic reviews

The number of studies increases, but the underlying limitations concerning randomization, confounding and outcome selection remain.

Interpretation: This constitutes strong evidence that a signal exists, but provides substantially weaker evidence that Ramadan fasting independently confers clinically significant cardiovascular protection.

5.EPIDIAR – Salti et al [20]

Study design: EPIDIAR is particularly important as it provides a counterbalance to studies that emphasize metabolic benefits. The study included 12,243 people with diabetes from 13 countries and demonstrated increased severe hypoglycaemia during Ramadan.

Strengths: Its greatest strength is scale and geographical diversity. It provided real-world information about fasting among people with diabetes rather than restricting analysis to highly selected trial participants. It also evaluated clinically meaningful adverse events rather than relying exclusively on biochemical markers.

Limitations: EPIDIAR was observational and relied partly on participant recall, creating potential recall and reporting bias. It was conducted more than two decades ago. Diabetes treatment has since changed considerably, with greater use of DPP-4 inhibitors, GLP-1 receptor agonists, SGLT2 inhibitors, modern basal insulins, CGM, and structured Ramadan education. Therefore, the absolute hypoglycaemia rates should not automatically be applied to contemporary diabetes practice.

Interpretation: EPIDIAR remains landmark evidence that Ramadan fasting is not inherently risk-free for individuals with diabetes. Its primary contemporary relevance lies in the principle that treatment and fasting should be individualized, rather than in its exact historical event rates.

7.Tourkmani et al. – Ramadan-Focused Education [25]

Study design: The Tourkmani studies evaluated structured pre-Ramadan education, medication adjustment, and diabetes management.

Strengths: These studies move beyond simply observing what happens during Ramadan and test a modifiable clinical intervention. The finding that structured education reduces hypoglycemia while improving HbA1c and LDL underscores an important practical message: outcomes depend in part on the management of Ramadan fasting. The subsequent systematic review reported substantially lower hypoglycemia among participants receiving Ramadan-focused education.
Limitations: Several included studies were no randomized, creating potential selection bias. Patients who choose or receive intensive education may be more health-conscious, adherent, and motivated than controls. This "healthy adherer" effect may exaggerate the apparent benefit of education.

Studies also tended to be relatively small and were not powered for cardiovascular outcomes. Evidence supporting structured Ramadan education is stronger than evidence supporting fasting as a cardiovascular intervention, as education represents a defined and modifiable intervention.e intervention. However, the evidence primarily shows improved safety and metabolic control, not reduced cardiovascular events.

8.Diabetes Telemonitoring RCT – Lee et al. [28]
Study design: This pilot randomized trial compared Ramadan-focused education with education plus telemonitoring in 37 patients with T2DM.
Strengths: Randomization substantially reduces confounding and is a key methodological advantage over most Ramadan studies. Telemonitoring was associated with a marked reduction in hypoglycaemia.
Limitations: The major limitation is the small sample size of 37 participants.
With such a small trial, confidence intervals are wide, rare adverse events cannot be assessed reliably, and external validity is limited. The study was also not designed to assess cardiovascular outcomes.
Interpretation: The trial should be considered proof-of-concept evidence supporting digital Ramadan management, rather than definitive evidence of clinical outcomes.

9.Demirci and Özkan – Endothelial Function [24]
Study design: This prospective study examined about 64 patients with hypertension and reported improved flow-mediated dilation after Ramadan, along with reductions in CRP and cortisol.
Strengths: In contrast to studies that examine only weight or glucose, this study directly investigated vascular physiology. Flow-mediated dilation provides a plausible mechanistic bridge between metabolic changes and cardiovascular disease: fasting → inflammatory/metabolic changes → ntric oxide/endothelial function → vascular health.
The concurrent changes in CRP and cortisol increase biological plausibility.
Limitations: The study remained small and non-randomized. FMD is technically sensitive and operator-dependent. Measurement conditions, hydration, caffeine exposure, sleep, and circadian timing can affect vascular responses.
Furthermore, FMD is a surrogate marker, not a cardiovascular event.
Interpretation: This study provides mechanistic evidence and should be considered hypothesis-supporting, rather than evidence that Ramadan fasting prevents atherosclerotic events.

9.Stable Cardiovascular Disease – Al Suwaidi et al. [40]
Study design: The multicentre Gulf study included 465 patients with cardiovascular disease-most completed Ramadan fasting without major clinical deterioration.
Strengths: The multicentre design and inclusion of patients with established cardiovascular disease enhance the clinical relevance of the findings. The population included patients with previous myocardial infarction, angina, heart failure, atrial fibrillation, and previous coronary intervention, making the study more relevant than studies limited to healthy volunteers.

Limitations: Selection bias is substantial.
Patients who believed they could safely fast were more likely to participate and continue fasting. Individuals with severe or unstable disease would reasonably have been less likely to fast.
There was no randomized non-fasting comparator.
This creates healthy-faster bias: stable/healthier cardiac patient
→ more likely to choose fasting
→ better observed outcome
rather than necessarily:fasting → better cardiac outcome.
The study provides reassuring evidence regarding the feasibility of fasting in selected stable cardiac patients; however, it does not establish universal safety or cardiovascular benefit.

9.Abazid et al. – Heart Failure [32]
Study design: Among 249 patients with HFrEF, 227 fasted throughout Ramadan and approximately 92% remained hemodynamically stable.
Strengths: Patients with heart failure represent a clinically important population because dehydration, hypotension, renal dysfunction and medication changes could theoretically increase fasting risk. The study therefore addressed a clinically relevant evidence gap. The association between clinical instability and poorer medication or dietary adherence further emphasizes the importance of behavioral factors.
Limitations: This study has particularly important selection bias. Patients who did not fast were generally less clinically suitable for fasting. Therefore, comparing fasters with non-fasters would produce substantial confounding by indication or health status. The number of unstable events was relatively small, limiting multivariable analysis. The study was also short-term.

Interpretation: The appropriate conclusion is not that Ramadan fasting benefits patients with heart failure. Rather: Selected clinically stable patients with heart failure with reduced ejection fraction (HFrEF) may be able to fast without short-term deterioration, provided that medication and dietary adherence are maintained. This conclusion should not be extrapolated to recently decompensated or advanced heart failure.

10.Turin et al. – Cardiovascular Events Meta-analysis [34
This systematic review/meta-analysis evaluated myocardial infarction, stroke, and congestive heart failure during Ramadan. This is particularly important as it extends the analysis beyond surrogate biomarkers to actual cardiovascular disease events. Strengths: The study addressed clinically meaningful outcomes rather than laboratory measures. The overall incidence of cardiovascular events was broadly similar during Ramadan and non-Ram This finding is reassuring, as widespread Ramadan fasting does not appear to produce a strong population-level signal of increased cardiovascular events. scular events.
Limitations: The underlying studies were predominantly observational. Cardiovascular event studies are vulnerable to several biases, including changes in healthcare-seeking behaviour during Ramadan, differences in hospital admission patterns, seasonal effects, and inaccurate determination of whether individual patients were actually fasting. A particularly important limitation is misclassification of ecological exposure. Some studies compare events occurring during the calendar month of Ramadan with events outside Ramadan without confirming that every individual was fasting.

Interpretation

The findings support

"No convincing evidence of increased cardiovascular-event incidence during Ramadan."

Major Sources of Bias Across the Literature

Five methodological problems repeatedly affect Ramadan cardiovascular studies.

First, selection bias is present. Individuals who fast, particularly those with chronic disease, are often healthier than those advised not to fast. This may create the appearance of cardiovascular safety or benefit. **Second**, confounding is a significant concern. Ramadan simultaneously alters diet, caloric intake, body weight, physical activity, sleep patterns, smoking habits, and medication timing. As a result, isolating the independent effect of fasting is challenging. **Third**, measurement bias may occur. Blood pressure, glucose, vascular measurements, and biochemical samples are often obtained at varying times of day. This issue is particularly relevant during Ramadan, when circadian physiology is substantially altered. **Fourth**, short follow-up periods are common. Most studies assess approximately four weeks of fasting, whereas cardiovascular disease develops over several years. A one-month improvement in LDL, blood pressure, or glucose should not be equated with long-term cardiovascular prevention. **Fifth**, surrogate endpoint dependence. Most studies evaluate: weight → BP → glucose → lipids → CRP → FMD rather than:

MI → stroke → HF hospitalization → cardiovascular death.

Ultimately, the latter outcomes are necessary to establish definitive evidence of cardiovascular protection.

Research Gaps and Future Trials

Future Ramadan cardiovascular research should move beyond small before-and-after studies. Priorities include multicentre prospective cohorts with standardized protocols, ambulatory rather than clinic-based blood pressure monitoring, continuous glucose monitoring in diabetes, objective measurements of physical activity and sleep, standardized assessment of caloric intake and diet quality, evaluation of vascular biomarkers such as flow-mediated dilation and arterial stiffness, and follow-up for 3 to 12 months after Ramadan.

Pragmatic randomized trials comparing standard Ramadan advice with a comprehensive Ramadan lifestyle medicine program that incorporates Mediterranean-style nutrition, exercise prescription, sleep optimization, smoking cessation, hydration planning, medication adjustment, and digital monitoring would be particularly valuable. Key outcomes should include not only weight and HbA1c but also blood pressure, LDL-C, UACR, inflammatory markers, vascular function, and, in sufficiently large studies, cardiovascular hospitalization and MACE. Such research could shift Ramadan medicine from simply asking "Is fasting safe?" toward the broader question: "How can Ramadan be used as a structured opportunity for sustained cardiovascular risk reduction?"

Conclusion

Ramadan fasting represents a distinctive natural model of intermittent fasting that may simultaneously affect multiple cardiovascular risk pathways. Evidence from clinical studies and meta-analyses indicates modest reductions in body weight, waist circumference, systolic and diastolic blood pressure, fasting glucose, triglycerides, and LDL cholesterol, with potential increases in HDL cholesterol. Additionally, Ramadan fasting may enhance endothelial function by increasing nitric oxide bioavailability and reduce inflammation. The LORANS study demonstrated clinically significant reductions in blood pressure, while large meta-analyses have reported favourable changes across multiple metabolic syndrome components. Research in diabetes indicates that metabolic outcomes can improve; however, EPIDIAR and other studies highlight the risks of hypoglycaemia in the absence of appropriate preparation. Randomized and controlled trials suggest that structured pre-Ramadan education, medication adjustment, and telemonitoring can substantially enhance fasting safety.an substantially improve fasting safety.

For individuals with stable cardiovascular disease, observational studies generally indicate that appropriately selected patients can tolerate Ramadan fasting without significant clinical deterioration. However, these findings should not be extrapolated to cases of unstable angina, recent acute cardiovascular events, decompensated heart failure, or other high-risk conditions.

Notably, evidence supporting improvements in cardiovascular risk factors is substantially stronger than evidence for reductions in cardiovascular events. Current studies have not established that Ramadan fasting decreases the incidence of myocardial infarction. Ramadan should be conceptualized as a natural opportunity for lifestyle medicine rather than merely a period of food restriction. When fasting is combined with Mediterranean-style or minimally processed nutrition, appropriate physical activity, adequate nocturnal hydration, sufficient sleep, smoking cessation, medication adherence, and structured clinical support, the month may provide a valuable opportunity to initiate favourable cardiometabolic behaviours. The primary challenge is to translate short-term improvements achieved during Ramadan into sustained cardiovascular risk reduction throughout the remainder of the year.

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