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Ramadan fasting: recommendations for patients with cardiovascular disease

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ABSTRACT

Ramadan fasting is observed by most of the 1.8 billion Muslims around the world. It lasts for 1 month per the lunar calendar year and is the abstinence from any food and drink from dawn to sunset. While recommendations on 'safe' fasting exist for patients with some chronic conditions, such as diabetes mellitus, guidance for patients with cardiovascular disease is lacking. We reviewed the literature to help healthcare professionals educate, discuss and manage patients with cardiovascular conditions, who are considering fasting. Studies on the safety of Ramadan fasting in patients with cardiac disease are sparse, observational, of small sample size and have short follow-up. Using expert consensus and a recognised framework, we risk stratified patients into 'low or moderate risk', for example, stable angina or non-severe heart failure; 'high risk', for example, poorly controlled arrhythmias or recent myocardial infarction; and 'very high risk', for example, advanced heart failure. The 'low-moderate risk' group may fast, provided their medications and clinical conditions allow. The 'high' or 'very high risk' groups should not fast and may consider safe alternatives such as non-consecutive fasts or fasting shorter days, for example, during winter. All patients who are fasting should be educated before Ramadan on their risk and management (including the risk of dehydration, fluid overload and terminating the fast if they become unwell) and reviewed after Ramadan to reassess their risk status and condition. Further studies to clarify the benefits and risks of fasting on the cardiovascular system in patients with different cardiovascular conditions should help refine these recommendations.

INTRODUCTION

There are approximately 1.8 billion Muslims in the world and 3.4 million Muslims in the UK, 93% of whom are likely to observe Ramadan fasting.¹ With a significantly high and increasing prevalence of cardiovascular disease in Muslim communities, including the UK,² healthcare professionals (HCPs) are likely to come across requests from patients asking for their suitability for Ramadan fasting.

Adult Muslims are obligated to fast during the month of Ramadan if it is safe to do so (see [table 1](#) for fasting in major religions).³ Ramadan fasting is the abstinence of all food and drink from dawn until sunset. Taking medicines orally or intranasally is considered breaking one's fast.^{4,5} Outside of the pre-dawn to sunset window, Muslims can eat, drink and take medications as normal. In a typical fast, Muslims have a pre-dawn meal (termed 'suhoor') and a meal at sunset to break their fast (termed 'iftaar'). An Islamic lunar month can be 29 or 30

days and falls 11 days earlier each year compared with the Gregorian solar calendar.¹ In temperate regions, when Ramadan falls in the winter, fasts are shorter. Conversely, summer fasts in some countries can be as long as 20 hours per day.³

Exemptions to Ramadan fasting exist for individuals whose health may come to significant harm from it.^{3,6} Groups such as the frail elderly and those with significant mental and/or physical health illness are exempt from fasting.^{7,8} Muslims are permitted to break their fast if they become unwell and can make up their fast if and when they fully recover.³ If Muslims are in doubt about their obligation to fast with respect to their medical condition, they are encouraged to consult with their HCPs and their local Islamic scholar. Many individuals who have been advised not to fast by their HCP may still choose to do so.⁹

Due to the absence of randomised controlled trials, guidelines or expert statements on the management of patients with cardiovascular disease who wish to undertake Ramadan fasting, we undertook a narrative review of the existing literature to underpin guidance for HCPs managing patients with cardiovascular conditions desiring to fast in Ramadan. Our work builds on a limited survey of the literature with brief recommendations by the authors of this manuscript, on behalf of the British Islamic Medical Association.¹⁰

Patients with cardiovascular disease frequently have comorbidities such as diabetes mellitus (DM) and chronic kidney disease (CKD). These conditions can interact with cardiovascular disease, such as iatrogenic hypoglycaemia triggering arrhythmias in a patient with DM.¹¹ Therefore, it is essential to take a holistic approach when advising patients with cardiac disease undertaking Ramadan fasting. Guidance on managing patients with DM, epilepsy, adrenal insufficiency and CKD has recently been published.^{3,9,10,12–15}

METHODS

We identified publications in PubMed and Embase using the following predefined terms in various combinations: "intermittent fasting", "fasting", "Ramadan", "restricted feeding", "cardiovascular disease", "atrial fibrillation", "hypertension", "channelopathies", "cardiomyopathy" and "valvular heart disease". We included studies that examined 'intermittent fasting' to broaden our evidence base, although we appreciate that some forms of intermittent fasting differ from Ramadan fasting, particularly with regard to water fasting.



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Table 1 Summary of the different fasting practices in major world religions* (reproduced based on¹⁰, with permission)

Religion	Form of fasting
Islam	It is obligatory for Muslims to fast the month of Ramadan (30–31 days) which consists of no food or drink from dawn to sunset. Muslims also commonly fast the first 10 days of the Islamic lunar month Dhul-Hijjah and some Muslims commonly fast the Monday and Thursday of each week and/or the middle 3 days of each fast. ⁴⁹
Christianity	Catholic Christians abstain from eating meat, but not fish, on Fridays in the 6-week period before Easter, called Lent. Many Catholics also only eat one full meal a day on the days of Ash Wednesday, the first day of Lent, and Good Friday. ⁴⁹ Some Protestants observe Lent by abstaining from certain favourite foods or habits such as smoking. A similar method of fasting is the 'Daniel fast' which lasts 21 days. ⁴⁹ The Eastern Orthodox church has different fasting periods exist including Lent as well as the Nativity fast, Apostles' Fast and Dormition Fast. These are often several weeks long and entail fasting from specific food items such as red meat and poultry and sometimes fish, oil and wine. None of the major denominations in Christianity prohibit taking medications while fasting. ⁴⁹
Judaism	There are several days of fasting in Judaism. These include Yom Kippur, Tisha B'Av, the Fast of Gedalia, the Tenth of Tevet, the Seventeenth of Tammuz and the Fast of Esther. These are single days of fasting from all forms of eating and drinking during this period—with the exception of Yom Kippur and Tisha B'Av where Jews abstained from all oral intake (including water) for 24 hours (from sunset to sunset). Historically, reform Jews only observed the Yom Kippur fast while Orthodox Jews the above-mentioned fasts. According to Jewish Law, important and/or regular medications can be taken with drink, and if necessary, with food as well but a patient's medications should be reviewed by a healthcare professional to ensure the fast as compliant as possible. ⁴⁹
Hinduism	Fasting takes many forms from abstaining from meat to only drinking water and milk. The most common fast in Hinduism is Ekadasi, which takes place twice a month and often consists of eating only fruits, vegetables and milk products (although a small minority abstain from all eating and drinking for 24 hours). Many Hindus also fast during the month of Shravan. Hindus are permitted to take medications while fasting. ⁴⁹
Buddhism	Lay Buddhists fast by abstaining from meat and certain types of food such as processed foods, two or more times per month. Some Buddhists stop eating after midday every day and some monks go further by abstaining from food for 18 days, drinking only a small portion of water (Lee <i>et al</i> 2009).
Sikhism	Sikhism does not promote fasting except for medical reasons. ⁴⁹
Baha'i	Fasting is observed from sunrise to sunset during the Baha'i month of 'Ala with the complete abstention of food and drink. Patients are permitted to take medications while fasting. ⁴⁹

*Religious practice is heterogeneous. While certain fasting practices are mentioned, patients may not practise them or may practise them in a manner dissimilar to that described above.

We used any relevant studies, our clinical experience of managing Muslim patients fasting in Ramadan and the well-established International Diabetes Federation and the Diabetes and Ramadan International Alliance (IDF-DAR) risk stratification model¹⁶ to form a consensus statement and provide risk stratification and management recommendations for safe fasting. Although the more recently published IDF-DAR Ramadan

guidelines¹⁴ introduce a scoring system, this has not been validated and is based on physician opinion derived from an online survey with a limited evidence base. As this is a very new introduction, even from a diabetes perspective, it is not known if it is better than the previous risk stratification.¹⁷ We therefore relied on their well-established risk stratification model, but as more evidence emerges in this area, a scoring system could

Table 2 Risk stratification for fasting in patients with cardiovascular conditions based on the IDF-DAR risk categories (reproduced based on¹⁰, with permission)

Risk level	Moderate/low risk	High risk	Very high risk
Advice	<p>May be able to fast - listen to medical advice</p> <ul style="list-style-type: none"> ▶ Stable hypertension ▶ Stable angina* ▶ Stable†, non-severe heart failure: LVEF >35%, HFpEF‡ ▶ Implantable loop recorder ▶ Permanent pacemaker (single or dual chamber) ▶ Mild/mild-moderate valvular disease ▶ Supraventricular tachycardias/atrial fibrillation/non-sustained ventricular tachycardia ▶ Mild/moderate pulmonary hypertension§ 	<p>Should not fast</p> <ul style="list-style-type: none"> ▶ Poorly controlled hypertension (as defined by your specialist) ▶ Recent acute coronary syndrome/myocardial infarction (<6 weeks) ▶ Hypertrophic cardiomyopathy with obstruction¶ ▶ Severe valvular disease ▶ Severe heart failure without advanced features ▶ Poorly controlled arrhythmias (as defined by your specialist) ▶ High risk of fatal arrhythmias (eg, inherited arrhythmic syndromes, arrhythmogenic cardiomyopathy) ▶ Implantable cardioverter defibrillator±cardiac resynchronisation therapy 	<p>Must not fast</p> <ul style="list-style-type: none"> ▶ Advanced heart failure** ▶ Severe pulmonary hypertension††
	<p><i>Patients with inherited cardiomyopathy, adult congenital heart disease, left ventricular assist device or heart transplantation should discuss fasting in Ramadan in their next routine appointment</i></p>		

*Episodes of angina are not occurring at rest or increasing significantly in frequency or severity.

†A difficult concept to define but the ESC guidelines define stability as no or mild heart failure symptoms and signs that have not changed recently for at least 1 month according to Ponikowski *et al* (2016).

‡Diagnosed by a combination of symptoms, LVEF ≥45%–50%, Heart Failure Association score, natriuretic peptide levels±imaging (refer for specialist confirmation, if needed).

§Pulmonary artery systolic pressure >25 mm Hg without severe echocardiographic or right heart catheterisation features.

¶With significant left ventricular outflow tract obstruction (>50 mm Hg).

**On optimal medical therapy, LVEF ≤35%, with class III–IV NYHA symptoms, ≥1 hospitalisation in the last 6 months due to decompensated heart failure and severely impaired functional capacity (eg, 6 min walk distance <300 m).

††Defined as WHO/NYHA III–IV classification, right ventricular dysfunction and objective markers on right heart catheterisation, for example, SvO₂ <60%.

ESC, European Society of Cardiology; HFpEF, heart failure with preserved ejection fraction; IDF-DAR, International Diabetes Federation and the Diabetes and Ramadan International Alliance; LVEF, left ventricular ejection fraction; NYHA, New York Heart Association.

be considered. Table 2 can therefore be used by HCPs to risk stratify patients with cardiovascular disease desiring to fast in Ramadan and provide appropriate advice.

What therapies and factors need to be taken into consideration in patients with cardiovascular conditions

Fasting-associated dehydration may lead to electrolyte abnormalities which could be life-threatening in patients with unstable arrhythmias, inherited arrhythmia syndromes (eg, long QT or Brugada syndrome), or on medications such as class Ic antiarrhythmics, digoxin and renin-angiotensin-aldosterone antagonists.¹⁸ Many cardiac medications can induce hypotension, potentially precipitating syncope, particularly in elderly patients with impaired baroreflexes.^{19–20} This may be exacerbated by dehydration or a shortened interval between a bedtime and breakfast dose if medication dosing is altered by patients trying to facilitate fasting.

Aslam and Healy²¹ found 42% of the 81 Southeast Asian Muslim patients they surveyed were adherent to their usual treatment schedule in Ramadan, possibly because of a disruption in their routine as a result of fasting. In patients taking antiplatelets for coronary stent implantation or anticoagulation for stroke prevention in atrial fibrillation, medication non-compliance may be fatal.

Summary of the key studies examining fasting and cardiovascular disease

Hypertension

In a prospective observational study by Aslan *et al*²² assessing the safety of diuretic therapy in patients with hypertension, Ramadan fasting appeared to significantly decrease systolic and diastolic blood pressures in individuals using diuretics, which was well tolerated without complication. Eldeeb *et al*²³ noted improved blood pressure control in patients with hypertension, irrespective of renal function, and improved arterial compliance in those without CKD, in patients undertaking Ramadan fasting.

Chronic coronary syndrome

In an observational study of patients with chronic coronary syndrome (CCS), as defined by the European Society of Cardiology (ESC),²⁴ Khafaji *et al*²⁵ reported that Ramadan fasting was not associated with an increased cardiac mortality or morbidity, with 29% of patients reporting improved cardiac symptoms. Similar findings were seen by Mousavi *et al*²⁶ in patients with CCS and a normal left ventricular function.

Acute coronary syndrome

Temizhan *et al*²⁷ compared the incidence of acute coronary syndrome (ACS), as defined by the ESC, in 1655 patients at a single centre, in the month before, during and after Ramadan, over a 6-year period. They noted no significant differences in the incidence of ACS in Ramadan when compared with the preceding or following month. A multicentre study by Amin and Alaarag²⁸ demonstrated that patients who undertook Ramadan fasting within 3 months of percutaneous coronary intervention had a higher incidence of significant cardiac events than those who did not undertake Ramadan fasting.

Heart failure

Abazid *et al*,²⁹ in an observational study, demonstrated that 92% of patients with heart failure with a reduced ejection fraction (HFrEF) (left ventricular ejection fraction (LVEF) \leq 40%) with 'close monitoring' did not experience worsening HF symptoms.

Patients with a non-ischaemic cardiomyopathy and/or a history of non-compliance with fluid restrictions and/or medications were more likely to experience worsening HF symptoms. A retrospective review of more than 2000 patients hospitalised with HFrEF over a 10-year period found no increase in the number of HF hospitalisations in Ramadan when compared with other months in the year.³⁰

An expert panel examined the safety of sodium-glucose cotransporter 2 inhibitors (SGLT2i) in patients observing Ramadan fasting and agreed on the following: SGLT2i should be initiated at low dose, in the evening and at least 1 month before Ramadan; fluid intake should be increased during non-fasting hours; hypoglycaemia should be avoided by reviewing any concomitant medications for type 2 DM and SGLT2i should be avoided in the elderly, patients with CKD or those receiving loop diuretics.³¹

Arrhythmias

Disrupted cellular metabolism and ion channel function can result in cardiac arrhythmias.³² Kahraman and Dogan³³ report a asymptomatic high burden of premature ventricular complexes in a patient undertaking Ramadan fasting, with recurrences only in subsequent attempts at Ramadan fasting, on further monitoring. The ESC 2020 sports cardiology advises that patients with long QT syndrome should carefully avoid dehydration.³⁴ American Heart Association guidelines state that sleep cycle and eating disturbances, common in Ramadan fasting, could lead to an increased incidence of atrial fibrillation.³⁵ A multi-centre cross-sectional study by Batarfi *et al*³⁶ surveyed a cohort of 809 patients undertaking Ramadan fasting and receiving oral anticoagulation: 68.4% of patients received warfarin, the remaining received direct oral anticoagulants (DOACs); of these 50% modified their anticoagulation regimen (intake time, skipped doses, drugs being taken at the same time two times per day) without prior consultation with their physician. Patients receiving two times per day DOACs were noted to be more likely to change their anticoagulation administration and more likely to be admitted to hospital with a consequence of their changes, for example, bleeding or stroke.

Other cardiovascular conditions

The 2014 ESC and 2020 American College of Cardiology guidelines for hypertrophic obstructive cardiomyopathy (HOCM) recommend that patients should remain well hydrated to reduce the occurrence of potentially life-threatening symptoms such as syncope.^{37–38} Likewise, the 2020 ESC guidelines for patients with adult congenital heart disease (ACHD) also recommend avoiding dehydration in patients with ACHD, particularly cyanotic ACHD.³⁹ Dehydration is also noted as a risk factor for the recurrence of orthostatic intolerance syndromes, including neurogenic and non-neurogenic orthostatic hypotension and postural orthostatic tachycardia syndrome.⁴⁰

Summary of the evidence

The available studies state that with 'close monitoring', fasting may be safely undertaken in patients with CCS or HFrEF. There are very few if no published data on Ramadan fasting in other forms of cardiovascular disease, including cardiomyopathies, arrhythmias or valvular heart disease. The published data on Ramadan fasting are weak, are observational, lack a large sample size with sufficient power, have prolonged follow-up beyond the month of Ramadan, do not clearly define what 'close monitoring' means or have detailed information about the diet of the

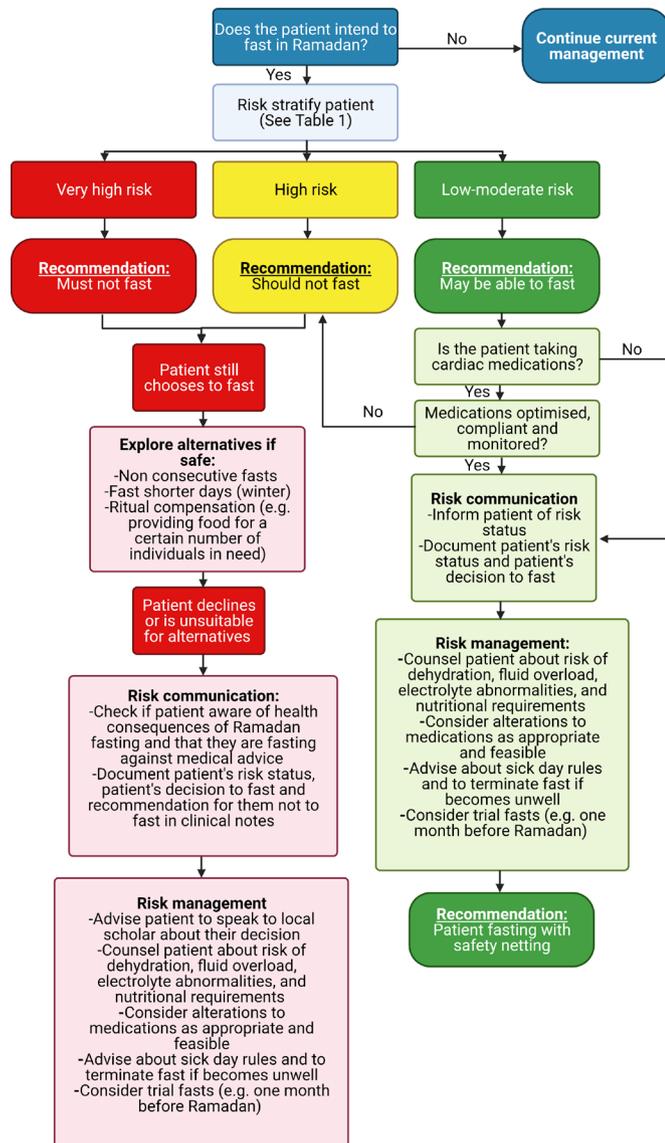


Figure 1 Proposed risk stratification and decision pathway for managing the fasting patient with cardiac disease (created with biorender.com).

patients outside of their fast (see our online supplemental index for a summary of the studies highlighted in our review). This point is echoed by Santos and Macedo⁴¹ in their narrative review of the published data on intermittent fasting on lipid profile.

General recommendations based on the available evidence

Patients with cardiac conditions desiring to fast in Ramadan should be assessed on an individual basis, by their HCP, during a routine consultation before Ramadan. In table 2, we risk stratify patients according to their cardiac conditions, although some patients deemed 'low-moderate' risk for fasting may be at higher risk in view of specific features of their conditions or their comorbidities. In figure 1, we provide a proposed pathway for HCPs managing a fasting patient with cardiac disease. At present, we are not able to provide guidance on the combination of low-moderate risk conditions, whether these are purely cardiovascular or combined with non-cardiac conditions as is frequently the case. Figure 2 provides a suggested consultation checklist for HCPs managing patients with cardiovascular disease desiring to fast in Ramadan.

Suggested pre- and post-Ramadan checklist for reviewing patients with cardiovascular conditions

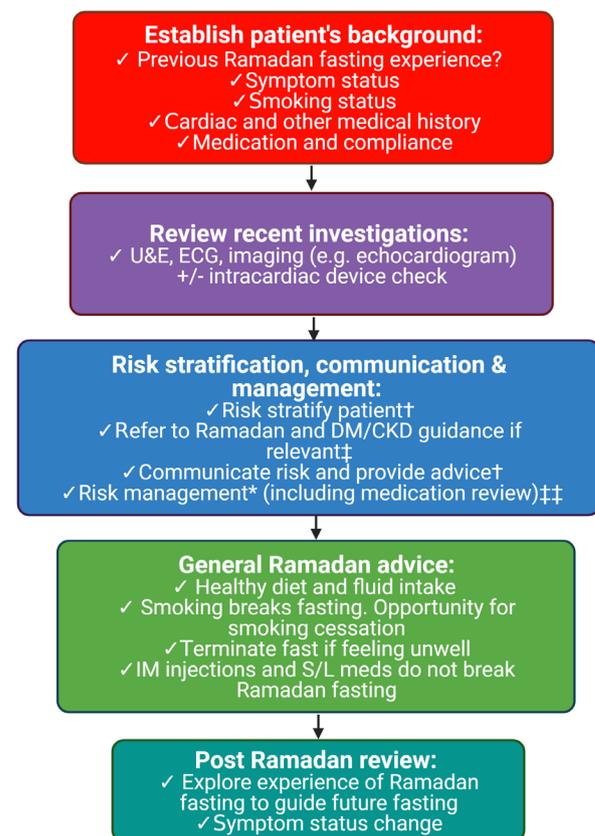


Figure 2 Suggested pre-Ramadan and post-Ramadan checklist for reviewing patients with cardiovascular conditions. CKD, chronic kidney disease; DM, diabetes mellitus; IM, intramuscular; S/L, sublingual; U&E, urea and electrolytes. †See figure 1. ‡Reference ^{39 11-14}. ††See table 3 (created with biorender.com).

Table 3 summarises the risks associated with different classes of cardiac medications and their use while fasting in Ramadan. In a review in the Canadian Pharmacists Journal, Grindrod and Alsabbagh⁴ suggested that if medication adjustments are made to facilitate fasting, strategies could include choosing once-daily medications or long-acting formulations where safe and appropriate to do so and without compromising the treatment offered. When initiating new medication in patients who may wish to fast, once a day dosing of medication should be considered, particularly where safety and efficacy is equivalent to medication with more frequent daily dosing. For patients on established therapies, we would suggest avoiding medication changes where possible.

The following points should be considered when advising patients who wish to fast,¹⁰ although all recommendations should take into consideration the climate, country and season where the patient is fasting:

Hypertension

Blood pressure, kidney function and medications (particularly antihypertensives that have a diuretic component such as aldosterone antagonists or thiazide-like diuretics) should be reviewed by HCPs during a routine appointment to reduce the risk of hypotension and/or worsening kidney function. A home blood

Table 3 Summary of the potential risks that could occur with different classes of cardiac medication used while fasting (reproduced based on¹⁰, with permission)

Drug	Condition used in	Risk in fasting
ACE inhibitor (eg, ramipril) Aldosterone receptor blockers (eg, candesartan) Angiotensin receptor neprilysin inhibitor (ie, sacubitril/valsartan) Antiplatelet medications (eg, aspirin, clopidogrel, prasugrel, ticagrelor)	Hypertension Heart failure Coronary artery disease/myocardial infarction	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness; may compound fasting-associated dehydration resulting in an acute kidney injury and/or life-threatening electrolyte abnormalities, for example, hyperkalaemia. Medication non-compliance may result in uncontrolled hypertension, decompensated heart failure. Medication non-compliance can increase risk of acute stent thrombosis, myocardial infarction and death if antiplatelets are not taken regularly—particularly in patients with recent coronary stent implantation (<6 months). Ticagrelor is taken two times per day and has a half-life of 7 hours (see above section on taking medications more than 12 hours apart and the effect it may have).
Antiarrhythmic drugs (AADs) (eg, amiodarone, flecainide, sotalol)	Atrial tachyarrhythmias Ventricular tachyarrhythmias	Some may worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. Fasting-associated dehydration may result in significant electrolyte abnormalities that may increase risk of AAD toxicity.
Beta blockers (eg, bisoprolol)	Coronary artery disease Heart failure Arrhythmias Hypertension	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. Medication non-compliance may result in worsening angina, decompensated heart failure, more frequent arrhythmias.
Calcium channel blockers (eg, amlodipine, diltiazem)	Hypertension Arrhythmias Coronary artery disease	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. Medication non-compliance may result in worsening angina, more frequent arrhythmias, uncontrolled hypertension.
Cardiac glycosides (eg, digoxin)	Arrhythmias Heart failure	Digoxin toxicity may occur in potential case of fasting-related acute kidney injury.
Direct oral anticoagulants (DOACs) (eg, apixaban, rivaroxaban, edoxaban)	Atrial flutter/atrial fibrillation Deep venous thrombosis/pulmonary embolism	Two times per day DOACs: The half-life of apixaban is 12 hours—if taken early morning, for example, 03:00 (suhoor) and then again at, for example, 20:00 (iftaar), there may be a period in between where the patient is not adequately anticoagulated. Medication non-compliance may result in stroke or death.
Immunosuppressant therapy (eg, tacrolimus)	Heart transplant	May compound fasting-associated dehydration and result in an acute kidney injury and/or life-threatening electrolyte abnormalities, for example, hyperkalaemia. Medication non-compliance may result in organ rejection and death. Tacrolimus is taken two times per day and therefore care must be taken to avoid long periods in between.
Loop diuretics (eg, furosemide, bumetanide) Thiazide diuretics (eg, bendroflumethiazide)	Hypertension Heart failure	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. May worsen fasting-associated dehydration resulting in an acute kidney injury and/or life-threatening electrolyte abnormalities, for example, hyperkalaemia. Medication non-compliance may result in uncontrolled hypertension, decompensated heart failure.
Mineralocorticoid receptor antagonists (eg, spironolactone)	Hypertension Heart failure	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. May worsen fasting-associated dehydration resulting in an acute kidney injury and/or life-threatening electrolyte abnormalities, for example, hyperkalaemia. Medication non-compliance may result in uncontrolled hypertension, decompensated heart failure.
Phosphodiesterase type 5 inhibitors (eg, sildenafil) Prostanoids (eg, epoprostenol)	Pulmonary hypertension Idiopathic pulmonary arterial hypertension	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. May result in diarrhoea, worsening fasting-associated hypotension. May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness.
Statins (eg, atorvastatin) Sodium–glucose cotransporter 2 inhibitors (eg, dapaglifozin)	Coronary artery disease/myocardial infarction Heart failure Diabetes mellitus	Fasting-associated dehydration may increase risk of acute kidney injury. This may compound a rare side effect of statins—rhabdomyolysis. May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness. May worsen fasting-associated dehydration resulting in an acute kidney injury and/or life-threatening electrolyte abnormalities, for example, hyperkalaemia. Medication non-compliance may result in decompensated heart failure and cause/worsen hyperglycaemia in patients with diabetes mellitus.
Soluble guanylate cyclase inhibitors (eg, vericiguat)	Heart failure	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness.
Vasodilators: Long-acting nitrates (eg, isosorbide mononitrate) Alpha blockers (eg, doxazosin, hydralazine)	Hypertension Coronary artery disease Pulmonary hypertension	May worsen fasting-associated hypotension, which may result in dizziness or loss of consciousness.

Suhoor: pre-dawn meal before Muslims initiate fast; iftaar: meal at sunset that breaks fast.

Medication changes may not be possible due to (1) significantly reduced outpatient consultations with specialists and/or GPs due to COVID-19; (2) a specialist may deem alternate medications to be less beneficial for a patient. Medication changes should be planned well in advance of Ramadan and should be discussed in a patient's next routine appointment with their specialist, GP and or pharmacist or if a patient is ever admitted to the hospital under the care of the cardiology team.
GP, general practitioner.

pressure monitor would be useful to observe a patient's blood pressure response to antihypertensive treatment while fasting and provide clarity on any symptoms that could suggest a low blood pressure. Patients with well-controlled blood pressure, as defined by their HCP, would be deemed 'low-moderate' risk for fasting.

CCS and ACS

The few studies in patients with CCS, whom we deem as 'low-moderate risk', undertaking Ramadan fasting, indicate that it is safe for them to do so, provided patients are compliant with their medications. Patients within a 6-week period of an ACS, whom we deem to be at least high risk, or had cardiac surgery, are advised not to fast, particularly as they may not be able to undertake cardiac rehabilitation due to the risk of hypotension from fasting-associated dehydration.⁴²

Heart failure

The few studies in patients with non-severe HFrEF, whom we would deem as 'low-moderate' risk undertaking Ramadan fasting suggest that it is safe for them to do so, in line with guidance from the British Heart Foundation⁴² and the ESC.⁴³ We deem patients with severe (LVEF $\leq 35\%$) HFrEF and advanced HF, as defined by the ESC,⁴⁴ as high and very high risk for Ramadan fasting, respectively. There are no studies investigating patients with HF with preserved ejection fraction (HFpEF) undertaking Ramadan fasting. We propose that stable patients with HFpEF, as defined by the ESC,⁴⁵ are 'low-moderate' risk; however, each patient should be reviewed as particulars about their condition and/or their comorbidities may increase the risk, especially since HFpEF is a heterogeneous group.

Intracardiac devices

There are no studies assessing patients with pacemakers undertaking Ramadan fasting. We deem them to be 'low-moderate' risk provided they have no electrolyte abnormalities and their device clinic feels their device parameters are stable. Patients with cardiac resynchronisation therapy or implantable cardioverter defibrillators would be deemed at least 'high risk' as they are only indicated in patients with severe HFrEF and/or patients at significant risk of ventricular arrhythmias. We advise patients with intracardiac devices to inform their device clinic in their next device check of their desire to fast in Ramadan. A remote or in-person device check just before Ramadan would be ideal to ensure there are no issues that may prevent a patient fasting.

Others

Published studies examining the risk of Ramadan fasting in patients with atrial fibrillation, inherited arrhythmic syndromes, valvular heart disease, pulmonary hypertension, heart transplantation or ACHD are lacking. Ramadan fasting in pregnant patients with cardiovascular conditions has been discussed elsewhere.¹⁰

In the absence of any studies assessing the above conditions in Ramadan fasting, we therefore advise that any disease where there may be a significant risk of dehydration or hypotension should be classed as at least 'high risk'. This includes preload-dependent conditions such as severe aortic stenosis, HOCM with left ventricular outflow tract or mid-cavity obstruction at rest or with Valsalva manoeuvre (ie, peak gradient >50 mm Hg) as well as those with poorly controlled arrhythmias such

as atrial fibrillation or at high risk of potentially fatal arrhythmias such as Brugada, long QT syndrome or arrhythmogenic cardiomyopathy.

Patients with severe pulmonary hypertension, as defined by the ESC (eg, New York Heart Association class III–IV breathlessness or right ventricular systolic impairment),⁴⁶ would be considered very high risk for fasting, particularly those with presyncope and/or syncope.⁴⁶

Patients with heart transplantation or ACHD should discuss Ramadan fasting with their specialist team during routine follow-up, although clearly patients with ACHD with cyanotic heart disease or features of other 'high' risk conditions such as severe valvular heart disease or poorly controlled arrhythmias would be classed as at least 'high' risk.

COVID-19-related cautions

If a patient is unwell with COVID-19, we advise against fasting. In a pandemic or in the post-pandemic phase, routine reviews by specialists or general practitioners, where patients could discuss their risk for Ramadan fasting, may not take place.

In these situations, we advise patients to adhere to professional advice or standard practice that they have received previously, provided there has not been a change in their clinical status that could increase their risk for fasting. Similarly, a bridge between taking an abstinence approach and not being able to access a clinician can be trial fasting in the weeks leading up to Ramadan.³ A patient's previous experiences can also facilitate a clinician's advice particularly if time is limited for a more thorough clinical assessment.³ It is worth noting however that many services, including blood test monitoring or community HF services, that may have facilitated fasting in Ramadan before, may not be available or available to a degree that allows patients to fast safely. Further discussion around fasting during COVID-19 is discussed elsewhere,^{47 48} but HCPs should bear these points in mind when risk stratifying their patient with cardiac disease for Ramadan fasting.

CONCLUSION

The literature on Ramadan fasting in patients with cardiovascular disease is limited. Our review highlights the important role HCPs play in risk assessment, providing advice and education, encouraging medication compliance and monitoring to enable patients, where safe to do so, to fulfil their religious obligation while minimising the potential for harm. As patients with cardiovascular disease often have non-cardiac comorbidities, our recommendations should be used in combination with those for Ramadan fasting in non-cardiac conditions such as CKD, DM and epilepsy. There is a strong need for patients, HCPs and religious/community leaders to engage with each other and discuss these contemporary medical issues. Further studies are needed to explore gaps in knowledge around fasting and to help refine current recommendations.

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Supplementary index**Table 1:** Summary of relevant studies cited in our paper

Study authors	Study design	Cardiac condition	Number of patients	Type of fasting	Study objective	Follow up duration	Main findings	Conclusion
Abazid et al 2018	Prospective nonrandomised study	HFrEF	249	Ramadan fasting	% of patients who became haemodynamic instability and their clinical profile	?1 month (Ramadan)	-92% of patients remained haemodynamically stable -Profile of patients who became haemodynamically unstable: --higher initial NYHA class (2.19±0.9 vs. 1.6±0.8) --less adherence to medications (67% vs 94%) --less likely to have ischaemic cardiomyopathy (33% vs 57%)	“In most patients with chronic HFrEF, Ramadan fasting is considered safe. Non-adherence to medication and diet are significantly associated with decompensated heart failure during Ramadan”
Al Suwaidi et al 2005	Retrospective review population-based study	HFrEF	20,856 Qatari	Ramadan fasting	Whether Ramadan fasting has any effect on the number of hospitalisations for HFrEF in a geographically defined population	Records over a 10-year period were reviewed (January 1991 to December 2001)	-The number of hospitalisations for HFrEF was not significantly different in Ramadan (208 cases) when compared to a month before Ramadan (182 cases) and a month after Ramadan (198 cases) p>0.37. -There was no significant difference found in the baseline clinical characteristics or mortality (11.5%, 7.7% and 9.6%, respectively; p>0.43) in patients presenting in various time periods.	In this defined population, no significant difference was found in number of hospitalisations for HFrEF while fasting in Ramadan when compared to non-fasting months
Aslam M and Healy MA 1986	Prospective review	Not specified. 3 out of 81 had cardiac conditions.	81 Asian	Ramadan fasting	Medication compliance during Ramadan fasting	1 month (Ramadan)	-35 patients missed doses -8 patients took their tablets at different times -4 patients took all their medication as one single daily dose while breaking their fast in the evening	Medication noncompliance remains a significant problem with patients fasting in Ramadan
Babineaux SM et al 2015	Multi-country, retrospective, observational study	Type 2 Diabetes Mellitus	3777 patients 508 physicians	Ramadan fasting	To describe the characteristics and management of patients with diabetes who chose to fast in Ramadan in 2010	?3 months	-Oral antihyperglycemic therapy was the predominant pre-Ramadan therapy for most patients (76.6%) -Treatment regime was modified before Ramadan for 39.3% of all patients -Almost all physicians (96.2%) reported provided fasting-specific advice to patients -62.6% of physicians report using guidelines or recommendations for the management of diabetes during Ramadan	Physicians have increasingly adopted multiple approaches to the management of fasting during Ramadan, including the adoption of international and/or national guidelines, such that patients are able to fast for a greater number of days without acute complications.

							-64% of patients reported fasting every day of Ramadan -94.2% of patients fasted for at least 15 days	
Batarfi A et al 2020	Multi-center cross-sectional study	Patients receiving oral anticoagulation (heart valve disease, rhythm disorder, vein thrombosis)	808 patients	Ramadan fasting	To characterise patient-guided modification of oral anticoagulation intake during Ramadan and any associated complications from doing so	3 months	-68.4% of patients were taking warfarin, 31.6% were taking a direct oral anticoagulant -19.1% of patients were prescribed twice daily anticoagulation -During Ramadan, 46.9% of patients reported taking their anticoagulation as prescribed to them. -The remaining 53.1% of patients reported modifying drug intake in different ways (31.1% adjusting the time of intake, 13.2% skipped intakes and 2.2% double dosed). -Twice daily anticoagulation was a strong independent predictor for modification during Ramadan -The rate of hospital admission due to either bleeding or thromboembolic complications was higher in patients that modified treatment regimens (15.4%) as compared to adherent patients (6.6%).	Patient-guided modification of oral anticoagulation regime is common during Ramadan. Patients on twice daily anticoagulation are more likely to modify their treatment regime and are more likely to encounter bleeding or thromboembolic complications as a result. Patient education and, where possible, pre-Ramadan modification of treatment regimes may help avoid complications from patient non-compliance or uninformed adjustments.
Kul S et al 2014	Meta-analysis of self-controlled cohort studies	Healthy population	1,476 patients	Ramadan fasting	What effect does Ramadan fasting have on body weight, serum lipid levels and fasting blood glucose before and after Ramadan		-After Ramadan fasting, low-density lipoprotein and fasting blood glucose levels were decreased in both males and females compared to levels prior to Ramadan. -In females, body weight, total cholesterol and triglyceride levels remain unchanged, while high density lipoprotein levels were increased. -In males, Ramadan fasting resulted in weight loss, a significant decrease in total cholesterol and low-density lipoprotein levels and a small decrease in triglyceride levels.	Ramadan fasting can effectively change body weight and some biochemical parameters in healthy subjects especially in males compared to pre-Ramadan period
Okoshi K et al 2019	Animal study	Wistar rats with induced myocardial infarction	N/A	Intermittent fasting (fed every other day)	To compare the effects of intermittent fasting before and after myocardial infarction on rat cardiac remodelling and survival	3 months	-Final body weight and total mortality was lower in the intermittent fasting rats when compared to fasts fed every day. -At baseline, there was no difference in echocardiographic parameters. -12 weeks after MI was induced, intermittent fasting rats had a smaller posterior left ventricular wall thickness, reduced MI size, myocyte diameter and left ventricular volume.	Intermittent fasting initiated before or after MI reduces myocyte hypertrophy and LV dilatation. Myocardial fibrosis and fetal gene expression are not modulated by feeding regimens. Benefit is more evident when intermittent fasting is initiated before rather than after MI.

Ma X et al 2019	Animal study	Mice with induced proteotoxic cardiomyopathy	N/A	Intermittent fasting	To test whether TFEB (a master regulator of the autophagy-lysosomal pathway) activation in the myocardium can be harnessed to treat advanced proteotoxic cardiomyopathy		In mice with induced advanced proteotoxic cardiomyopathy, intermittent fasting resulted in restored lysosomal abundance and autophagic flux. Left ventricular dilatation and myocardial hypertrophy was also attenuated, with mice demonstrating increased percentage fractional shortening and increased survival.	Intermittent fasting and TFEB activation are clinically relevant therapeutic strategies to rescue advanced proteotoxic cardiomyopathy by normalising desmin localisation via autophagy-dependent and autophagy-independent mechanisms.
Mousavi M et al 2014	Nonrandomised prospective observational study	Stable coronary artery disease with normal left ventricular function	148 patients	Ramadan fasting	To investigate the effects of Ramadan fasting in patients with coronary artery disease	1 month (Ramadan)	-Mean age of the cohort was 61.5 years. 50% were male -66% of patients completed Ramadan fast with an average of 22 days of fasting -Chest pain and shortness of breath occurrence was not significantly different between the fasting and non-fasting groups	Patients with coronary artery disease were able to observe the Ramadan fast safely and their combined endpoint of chest pain and dyspnoea was not significantly different from that of the non-fasting ones. The authors suggest that patients with stable coronary artery disease and normal left ventricular function could fast during Ramadan.
Nematy M et al 2012	Prospective observational study	Patients with at least one cardiovascular risk factor (previous coronary artery disease, metabolic syndrome or cerebrovascular disease in the last 10 years)	82 patients	Ramadan fasting	The association of Ramadan fasting and cardiovascular risk factors	1 month	-A significant improvement in 10 years coronary heart disease risk (based on the Framingham risk score) was found in patients undergoing Ramadan fasting. -Patients undergoing Ramadan fasting had a significantly higher high-density lipoprotein and lower plasma cholesterol, triglyceride level, systolic blood pressure, body mass index and waist circumference ($p < 0.05$).	A significant improvement in 10 years coronary heart disease risk score and other cardiovascular risk factors were noted after Ramadan fasting in patients with at least one cardiovascular risk factor.
Salam A et al 2017	Prospective multi-centre study	Patients hospitalised with acute heart failure	4,157 patients	Ramadan fasting	The association of Ramadan fasting with outcomes in patients with	12 months	-306 (7.4%) patients were hospitalised with acute heart failure in the month of Ramadan in 2012. -3,851 (92.6%) patients were hospitalised with acute heart failure outside of Ramadan in the period of February to November 2012.	This study represents (at the time of publication) the largest evaluation of the effects of fasting on acute heart failure. It reported an improved volume status in fasting patients. There were also

					acute heart failure		-Patients admitted with acute heart failure during Ramadan had significantly lower prevalence of symptoms and signs of volume overload compared to patients hospitalised in other months. -Atrial arrhythmias were significantly less frequent and cholesterol levels were significantly lower in Ramadan. -Hospitalisation in Ramadan was not independently associated with increased immediate or 1-year mortality.	favourable effects on atrial arrhythmias and total cholesterol and no effects on immediate or long-term outcomes.
Temizhan A et al 1999	Retrospective review	Acute coronary syndrome	1,655 patients	Ramadan fasting (indirect)	The incidence of acute coronary syndrome in Ramadan in comparison to the remainder of the year in a geographically defined population	6 years	The incidence of acute coronary syndrome was significantly lower in Ramadan from 1991 to 1997 in a single centre in Turkey.	The authors speculate that Ramadan fasting does not increase acute coronary syndrome.
Turin T et al 2016	Systematic review and meta-analysis	Coronary heart disease Stroke Congestive heart failure	1,019 patients	Ramadan fasting	To present a summary of key findings of all the published data on Ramadan fasting in patients with cardiovascular disease	Fifteen studies were selected	The incidence of cardiovascular events during Ramadan was similar to those found in the remaining, non-fasting, months of the year.	Ramadan fasting is not associated with any change in incidence of acute cardiovascular disease.

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Babineaux SM et al 2015	Multi-country, retrospective, observational study	Type 2 Diabetes Mellitus	3777 patients 508 physicians	Ramadan fasting	To describe the characteristics and management of patients with diabetes who chose to fast in Ramadan in 2010	?3 months	-Oral antihyperglycemic therapy was the predominant pre-Ramadan therapy for most patients (76.6%) -Treatment regime was modified before Ramadan for 39.3% of all patients -Almost all physicians (96.2%) reported provided fasting-specific advice to patients -62.6% of physicians report using guidelines or recommendations for the management of diabetes during Ramadan	Physicians have increasingly adopted multiple approaches to the management of fasting during Ramadan, including the adoption of international and/or national guidelines, such that patients are able to fast for a greater number of days without acute complications.

							-64% of patients reported fasting every day of Ramadan -94.2% of patients fasted for at least 15 days	
Batarfi A et al 2020	Multi-center cross-sectional study	Patients receiving oral anticoagulation (heart valve disease, rhythm disorder, vein thrombosis)	808 patients	Ramadan fasting	To characterise patient-guided modification of oral anticoagulation intake during Ramadan and any associated complications from doing so	3 months	-68.4% of patients were taking warfarin, 31.6% were taking a direct oral anticoagulant -19.1% of patients were prescribed twice daily anticoagulation -During Ramadan, 46.9% of patients reported taking their anticoagulation as prescribed to them. -The remaining 53.1% of patients reported modifying drug intake in different ways (31.1% adjusting the time of intake, 13.2% skipped intakes and 2.2% double dosed). -Twice daily anticoagulation was a strong independent predictor for modification during Ramadan -The rate of hospital admission due to either bleeding or thromboembolic complications was higher in patients that modified treatment regimens (15.4%) as compared to adherent patients (6.6%).	Patient-guided modification of oral anticoagulation regime is common during Ramadan. Patients on twice daily anticoagulation are more likely to modify their treatment regime and are more likely to encounter bleeding or thromboembolic complications as a result. Patient education and, where possible, pre-Ramadan modification of treatment regimes may help avoid complications from patient non-compliance or uninformed adjustments.
Kul S et al 2014	Meta-analysis of self-controlled cohort studies	Healthy population	1,476 patients	Ramadan fasting	What effect does Ramadan fasting have on body weight, serum lipid levels and fasting blood glucose before and after Ramadan		-After Ramadan fasting, low-density lipoprotein and fasting blood glucose levels were decreased in both males and females compared to levels prior to Ramadan. -In females, body weight, total cholesterol and triglyceride levels remain unchanged, while high density lipoprotein levels were increased. -In males, Ramadan fasting resulted in weight loss, a significant decrease in total cholesterol and low-density lipoprotein levels and a small decrease in triglyceride levels.	Ramadan fasting can effectively change body weight and some biochemical parameters in healthy subjects especially in males compared to pre-Ramadan period
Okoshi K et al 2019	Animal study	Wistar rats with induced myocardial infarction	N/A	Intermittent fasting (fed every other day)	To compare the effects of intermittent fasting before and after myocardial infarction on rat cardiac remodelling and survival	3 months	-Final body weight and total mortality was lower in the intermittent fasting rats when compared to fasts fed every day. -At baseline, there was no difference in echocardiographic parameters. -12 weeks after MI was induced, intermittent fasting rats had a smaller posterior left ventricular wall thickness, reduced MI size, myocyte diameter and left ventricular volume.	Intermittent fasting initiated before or after MI reduces myocyte hypertrophy and LV dilatation. Myocardial fibrosis and fetal gene expression are not modulated by feeding regimens. Benefit is more evident when intermittent fasting is initiated before rather than after MI.

Ma X et al 2019	Animal study	Mice with induced proteotoxic cardiomyopathy	N/A	Intermittent fasting	To test whether TFEB (a master regulator of the autophagy-lysosomal pathway) activation in the myocardium can be harnessed to treat advanced proteotoxic cardiomyopathy		In mice with induced advanced proteotoxic cardiomyopathy, intermittent fasting resulted in restored lysosomal abundance and autophagic flux. Left ventricular dilatation and myocardial hypertrophy was also attenuated, with mice demonstrating increased percentage fractional shortening and increased survival.	Intermittent fasting and TFEB activation are clinically relevant therapeutic strategies to rescue advanced proteotoxic cardiomyopathy by normalising desmin localisation via autophagy-dependent and autophagy-independent mechanisms.
Mousavi M et al 2014	Nonrandomised prospective observational study	Stable coronary artery disease with normal left ventricular function	148 patients	Ramadan fasting	To investigate the effects of Ramadan fasting in patients with coronary artery disease	1 month (Ramadan)	-Mean age of the cohort was 61.5 years. 50% were male -66% of patients completed Ramadan fast with an average of 22 days of fasting -Chest pain and shortness of breath occurrence was not significantly different between the fasting and non-fasting groups	Patients with coronary artery disease were able to observe the Ramadan fast safely and their combined endpoint of chest pain and dyspnoea was not significantly different from that of the non-fasting ones. The authors suggest that patients with stable coronary artery disease and normal left ventricular function could fast during Ramadan.
Nematy M et al 2012	Prospective observational study	Patients with at least one cardiovascular risk factor (previous coronary artery disease, metabolic syndrome or cerebrovascular disease in the last 10 years)	82 patients	Ramadan fasting	The association of Ramadan fasting and cardiovascular risk factors	1 month	-A significant improvement in 10 years coronary heart disease risk (based on the Framingham risk score) was found in patients undergoing Ramadan fasting. -Patients undergoing Ramadan fasting had a significantly higher high-density lipoprotein and lower plasma cholesterol, triglyceride level, systolic blood pressure, body mass index and waist circumference ($p < 0.05$).	A significant improvement in 10 years coronary heart disease risk score and other cardiovascular risk factors were noted after Ramadan fasting in patients with at least one cardiovascular risk factor.
Salam A et al 2017	Prospective multi-centre study	Patients hospitalised with acute heart failure	4,157 patients	Ramadan fasting	The association of Ramadan fasting with outcomes in patients with	12 months	-306 (7.4%) patients were hospitalised with acute heart failure in the month of Ramadan in 2012. -3,851 (92.6%) patients were hospitalised with acute heart failure outside of Ramadan in the period of February to November 2012.	This study represents (at the time of publication) the largest evaluation of the effects of fasting on acute heart failure. It reported an improved volume status in fasting patients. There were also

					acute heart failure		-Patients admitted with acute heart failure during Ramadan had significantly lower prevalence of symptoms and signs of volume overload compared to patients hospitalised in other months. -Atrial arrhythmias were significantly less frequent and cholesterol levels were significantly lower in Ramadan. -Hospitalisation in Ramadan was not independently associated with increased immediate or 1-year mortality.	favourable effects on atrial arrhythmias and total cholesterol and no effects on immediate or long-term outcomes.
Temizhan A et al 1999	Retrospective review	Acute coronary syndrome	1,655 patients	Ramadan fasting (indirect)	The incidence of acute coronary syndrome in Ramadan in comparison to the remainder of the year in a geographically defined population	6 years	The incidence of acute coronary syndrome was significantly lower in Ramadan from 1991 to 1997 in a single centre in Turkey.	The authors speculate that Ramadan fasting does not increase acute coronary syndrome.
Turin T et al 2016	Systematic review and meta-analysis	Coronary heart disease Stroke Congestive heart failure	1,019 patients	Ramadan fasting	To present a summary of key findings of all the published data on Ramadan fasting in patients with cardiovascular disease	Fifteen studies were selected	The incidence of cardiovascular events during Ramadan was similar to those found in the remaining, non-fasting, months of the year.	Ramadan fasting is not associated with any change in incidence of acute cardiovascular disease.

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