Pre-Ramadan Preparation for Safe Fasting in Patients with Type 2 Diabetes Mellitus

Adnan Zaina MD[1,2], Ahmed Khatib MD[1,3], Ali Abid MD[1], and Sameer Kassem PhD[3,4]

[1]Division of Endocrinology and Metabolism, Zvulun Medical Center, Kiryat Bialik, Israel
[2]Azrieli Faculty of Medicine, Bar-Ilan University, Safed, Israel
[3]Rappaport Faculty of Medicine, Technion–Israel Institute of Technology, Haifa, Israel
[4]Department of Internal Medicine, Carmel Medical Center, Haifa, Israel

ABSTRACT Pre-Ramadan fasting planning before the month of Ramadan represents a golden opportunity for better glucose control during the month of Ramadan among patients with type 2 diabetes mellitus (T2DM). Pre-Ramadan begins 1–2 months earlier and represents a crucial period when healthcare practitioners can provide medical instructions, risk assessment, and stratification to minimize the associated risks such as postprandial hyperglycemia and hypoglycemia during Ramadan fasting. This review focuses on two important classes of drugs that are widely used in Israel incretin-based therapy, particularly the glucagon-like peptide-1 receptor (GLP-1Rc) agonists class and the sodium-glucose cotransporter-2 inhibitors (SGLT-2i) class. In addition, we provide data regarding specific populations such as elderly patients and Bedouins living in the Negev area who require specific recommendations for safe Ramadan fasting. Our data are based on previously published guidelines, consensus statements, and our experience..

IMAJ 2025; 27: 667–672

KEY WORDS: Bedouin, incretin-based therapy, pre-Ramadan, sodium-glucose cotransporter-2 inhibitors (SGLT-2i), type 2 diabetes mellitus (T2DM)

Ramadan is the ninth month of the Muslim lunar calendar, and fasting during this holy month is obligatory for all healthy adult Muslims. Fasting during Ramadan represents one of the five pillars of Islam, and its timing varies from year to year. The next Ramadan starts on 17 February 2026 and will conclude on the evening of 18 March 2026, which is the winter season in Israel. Fasting will be approximately 13 hours daily; however, some years, fasting can last up to 20 hours.

Fasting during the holy month of Ramadan requires abstinence from eating, drinking, and smoking each day from sunrise to sunset. During Ramadan, Muslims consume two main meals: a pre-dawn meal (Suhoor) and a fast-breaking meal after sunset (Iftar).

The Muslim population in Israel comprises approximately 17% of the general population, amounting to approximately 1.7 million individuals. According to the Israeli National Health Interview Survey (INHIS-4 2018–2020), the estimated prevalence of type 2 diabetes mellitus (T2DM) in the Arab population is slightly higher than the overall prevalence in Israel (9.4%). Data from epidemiological studies found that approximately 78.7% of T2DM fast during Ramadan [1], which accounts for approximately 120,000 patients in Israel.

Ramadan includes three important periods: pre-Ramadan, Ramadan, and post-Ramadan. In this review, we focused on the pre-Ramadan period, considering the importance of this period on the entire period of Ramadan fasting.

PRE-RAMADAN EDUCATION

The pre-Ramadan period begins 1–2 months before Ramadan. During this period, healthcare practitioners should prepare patients with T2DM who want to fast during Ramadan to withstand the month of fasting [2].

During this period, meetings, media campaigns, and religious leaders should increase the awareness of healthy fasting practices for patients with T2DM who intend to fast. In addition, healthcare practitioners should provide strategies to minimize the associated risks with fasting among patients with T2DM. Educational materials should be designed to be engaging and culturally sensitive [3].

The most important components of any Ramadan-focused educational program should include risk quantification and stratification, instructions on self-monitoring of blood glucose during fasting and non-fasting hours, information on fluid hydration, and dietary advice to avoid

postprandial hyperglycemia and weight gain. In addition, advice on physical activity, including recommendations for timing and intensity of physical activity such as avoiding physical activity or strenuous work before the Iftar meal, should be included for patients who are at risk of hypoglycemia. Walking in small groups after the Iftar meal during Ramadan is common and should be encouraged. Notably, the Taraweeh prayers include mild to moderate physical activity and should be considered during patient instructions. Furthermore, medical management of T2DM, treatment adjustment, recognition of complications, and understanding of when to break the fast should be discussed during the pre-Ramadan period [4].

PRE-RAMADAN PLANNING IS CRUCIAL FOR SAFE RAMADAN FASTING IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

GLYCEMIC CONTROL AND GLUCOSE MONITORING

Patients should be categorized according to their glycemic control during the pre-Ramadan based on glycated hemoglobin, fasting plasma glucose, and self-monitoring of blood glucose. According to the American Diabetes Association consensus, patients can be stratified into three categories (high-risk, moderate-risk, and low-risk) [4] [Table 1].

Table 1. Risk category and general recommendations*

Risk category	Medical recommendations	Fasting safety
Low	Medical evaluation	Fasting is safe
	Medical adjustment	
	Glucose monitoring	
Moderate	Medical evaluation	Fasting is uncertain
	Medical adjustment	
	Strict glucose monitoring	
High	Instruct patients not to fast	Fasting is not safe

*For detailed data, see the Israeli National Health Interview Survey [1], diabetes and Ramadan practical guidelines from 2021 [4], and fasting during Ramadan in Israel [10]

Glucose variability is an important issue that should be addressed during Ramadan fasting, considering that increased glucose variability is associated with increased oxidative stress and accelerated atherosclerosis [5].

Data generated from continuous glucose monitoring studies during Ramadan have shown exaggerated glucose peaks in patients with T2DM after the Iftar meal. This peak occurs in response to a carbohydrate-rich meal and higher glucose excursions appear among patients treated with insulin, followed by sulphonylureas treatment [6]. Therefore, glucose monitoring is important, particularly during the first hours of fasting, around the Iftar meal, and 2 hours later. Special instruction is needed for patients with T2DM who engage in intense physical labor while being treated with anti-diabetic agents due to increased potential risk for hypoglycemia.

In Israel, patients diagnosed with T2DM who are on intensive insulin therapy can purchase a continuous glucose monitor at a subsidized price as part of the health benefits. In general, patients using these monitors can achieve better glycemic control [7]. Therefore, healthcare practitioners should consider the patient's compliance and ability to self-monitor their glucose while assessing the risk of hypoglycemia during pre-Ramadan and Ramadan fasting [6].

During pre-Ramadan, many patients start to fast at least twice a week, mainly on Monday and Thursday, as a religious recommendation whenever feasible. This custom can serve to assess the individual's ability before the daily fasting of Ramadan. Interestingly, many patients with T2DM want to fast during Ramadan. This desire represents an opportunity to empower them to manage their glucose profile better.

DIET AND LIFESTYLE INSTRUCTIONS DURING PRE-RAMADAN

During the month of Ramadan, marked changes in eating patterns occur. Dietary recommendations for patients with T2DM should be provided by a registered dietitian or nutrition professional. They should include principles of healthy eating behaviors focusing on preventing hypoglycemia during fasting and postprandial hyperglycemia after the Iftar meal [8]. In addition, recommendations should be individualized according to patient preferences, lifestyle, age, co-morbidities such as chronic kidney disease and congestive heart failure (CHF), and socioeconomic status. Dietary recommendations must be culturally adapted and accessible [9]. It is important that patients with T2DM intending to Ramadan fasting have their Suhoor meal regularly and remain hydrated. For the Iftar meal, it is recommended to avoid consuming simple carbohydrates and sweets.

Physical activity should be reduced during fasting hours and can be increased after Iftar meals. Activities should be planned holistically and comprehensively, considering the patient's abilities, medication regimens, and nutrition plans.

ANTI-DIABETIC TREATMENT

In the current article, we focused on two main classes: incretin-based therapy and SGLT2i. They are used extensively in managing T2DM [10], but there is a lack of published data concerning SGLT2i use during Ramadan fasting.

INCRETIN BASED THERAPY

Incretin-based therapy includes the glucagon-like peptide-1 receptor (GLP-1Rc) agonists and dipeptidyl peptidase-4 inhibitors (DPP-4i) treatments [11,12]. These two therapies are safe modalities during the month of Ramadan as a monotherapy or in combination with metformin and other anti-diabetic treatments.

Studies concerning these two therapies have demonstrated their safety for T2DM patients fasting during Ramadan [12,13]. These two groups of agents carry a minimal risk of hypoglycemia, and no dose adjustment is required for patients with T2DM during Ramadan fasting. However, frequent self-blood glucose monitoring is needed, particularly for patients using add-on therapy with insulin or insulin secretagogues with a potential risk for hypoglycemia such as sulphonylureas and meglitinides (repaglinide).

INCRETIN-BASED THERAPY (GLP-1RC AGONISTS AND DPP-4I) IS SAFE DURING RAMADAN FASTING.

For GLP-1Rc agonist initiators, it is essential to begin treatment during the pre-Ramadan period to achieve a steady therapeutic dose effect and prevent undesired gastrointestinal adverse reactions. During pre-Ramadan, dose adjustment to achieve glycemic control is acceptable; however, up-titration during Ramadan is not recommended due to the risk of possible gastrointestinal symptoms.

Currently, once weekly, GLP-1Rc agonists are commonly used in Israel. For patients already on weekly GLP-1Rc agonists, no treatment modification is required. Notably, for a fixed-dose combination of insulin degludec and liraglutide (Xultophy® Novo Nordisk, Denmark), we recommend switching the dose to evening and adjusting the dose according to the early morning glucose levels before the Suhoor meal. Similarly, the first oral semaglutide (Rybelsus®, Novo Nordisk) was recently introduced. It is recommended to titrate the dose during pre-Ramadan. As for injectable GLP-1Rc agonists, no dose adjustment is required during Ramadan.

SODIUM-GLUCOSE COTRANSPORTER-2 INHIBITORS

Sodium-glucose cotransporter-2 inhibitors (SGLT-2i) represent a novel class in managing patients with T2DM [14]. The cardiorenal protective effect extends the use of this class of drugs for patients with heart failure and CKD without T2DM [15]. The mechanisms behind these cardiorenal outcomes include a reduction in preload and afterload related mainly to loss of interstitial volume, hematocrit increase related to erythropoietin production, and cardiomyocyte bioenergetics improvement because of increased lipolysis leading to increased ketone bodies. This improvement acts as an efficient energy fuel substrate. The inhibition of sodium–hydrogen exchange represents this class's pivotal mode of action [16]. Moreover, decreased blood pressure and weight reduction are also beneficial effects.

According to previously reported data, using this class during Ramadan fasting seems safe [17]. Recently, Nakhleh and colleagues [18] reported that in the majority of these studies, elderly patients were excluded, the mean age was 52.2 ± 4.5 years; therefore, it is of significant importance to evaluate patients during the pre-Ramadan period, considering the patient's age, the hemodynamic status, and the potential risk of orthostatic hypotension falls and dehydration, particularly in patients using diuretics.

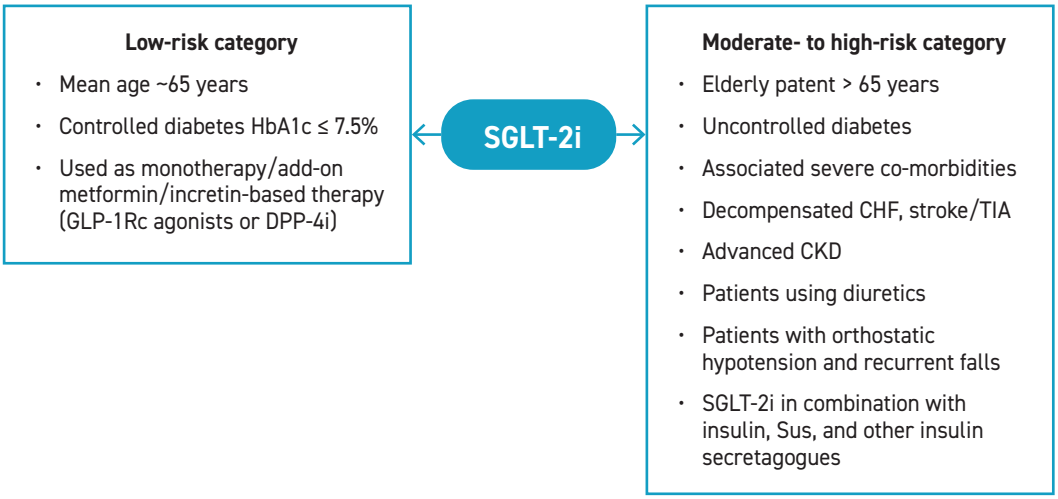
During the pre-Ramadan period, healthcare practitioners can categorize patients using this group according to associated conditions [Figure 1]; thus, patients younger than 65 years with glycemic control and without other co-morbidities, particularly cardiovascular patients, might be categorized as a low-risk group for Ramadan fasting. In contrast, elderly patients with other co-morbidities are at high risk for dehydration, volume depletion, and falling. Thus, this group might be categorized as a moderate to high-risk group for Ramadan fasting.

The current recommendations for SGLT-2i treatment include initiating therapy at least 2-4 weeks before the start of Ramadan, which is recommended to be administered during the Iftar meal. For cardiorenal protection, it is recommended that treatment be initiated during pre-Ramadan with a lower dose. In addition, it is recommended that fluid intake be increased during the non-fasting hours of Ramadan. Dose adjustment is not required; however, a review of these agents and dose adjustment might be needed in patients with other anti-diabetic treatments, particularly for agents with potential hypoglycemic risk.

Please refer to our previously published data on other anti-diabetic treatment modalities, including insulin [10].

Figure 1. Risk stratification of patients with T2DM using SGLT-2i during Ramadan

CHF = congestive heart failure, CKD = chronic kidney disease, DPP-4i = dipeptidyl peptidase-4 inhibitors, GLP-1Rc agonists = glucagon-like peptide-1 receptor agonist, SGLT-2i = sodium-glucose cotransporter 2 inhibitors, SUs = sulphonylureas disease, T2DM = type 2 diabetes mellitus, TIA = transient ischemic attack



SPECIAL POPULATIONS AND CONDITIONS

Elderly patients with T2DM fasting during Ramadan

According to the Diabetes and Ramadan International Alliance global survey, more patients with T2DM under 65 (87%) years of age fast than those above 65 years. Age itself is not considered a reason to categorize patients as high-risk for fasting during Ramadan [19]. Many elderly patients with T2DM fast the entire month of Ramadan safely and without complications; however, associated co-morbidities such as recurrent falls and fractures, essential tremor and Parkinson's disease, dementia, and visual impairment categorize this group of patients at a higher risk for fasting during Ramadan [20]. In addition, elderly patients with long-duration T2DM are more likely to have microvascular (retinopathy, nephropathy, and neuropathy) and macrovascular (coronary artery disease, stroke/transient ischemic attack, and peripheral vascular disease complications. Therefore, healthcare practitioners must assist the risk stratification of this population to provide them with appropriate instructions for safe fasting during Ramadan.

SPECIFIC POPULATIONS, SUCH AS ELDERLY PATIENTS AND BEDOUINS LIVING IN THE NEGEV, NEED THOROUGH ASSESSMENTS AND INSTRUCTIONS DURING THE PRE-RAMADAN PERIOD.

T2DM AND ASSOCIATED CARDIOVASCULAR DISEASE DURING RAMADAN FASTING

CHF data from the Gulf CARE, a multicenter study conducted in the Gulf region, disclosed no difference in the proportion of CHF hospitalization in patients with T2DM during Ramadan and other non-Ramadan days. Favorable effects were reported regarding volume status, reduction in atrial fibrillation, and total cholesterol during Ramadan [21]. A retrospective review of clinical data also disclosed no differences in hospitalizations during pre-Ramadan, Ramadan, and post-Ramadan periods [22]. Moreover, in a meta-analysis reviewing the outcomes of stroke, CHF, and myocardial infarction, the incidence of cardiovascular events during Ramadan fasting was similar to non-fasting periods [23]. Data regarding stroke during Ramadan among patients with T2DM are conflicting. In a cross-sectional study, Assy et al. found that T2DM patients were not hospitalized more for ischemic or hemorrhagic stroke during Ramadan than in pre- and post-Ramadan periods [24,25].

In contrast, others reported an increased association of stroke during Ramadan fasting [26]. Overall, there is no increase in cardiovascular outcomes during Ramadan

fasting. Therefore, patients who insist on fasting should receive a thorough risk assessment during the pre-Ramadan period from healthcare practitioners who can provide fasting instructions for safe fasting with T2DM. Treatment adjustment following their clinical symptoms and laboratory tests, including diuretics, anti-diabetic treatment, and insulin regimens, is mandatory.

DIABETES AND RENAL FUNCTION DURING RAMADAN FASTING

CKD and diabetic nephropathy represent a crucial microvascular complication in patients with T2DM. The International Diabetes Federation and Diabetes and Ramadan International Alliance (IDF-DAR) guidelines stratify patients with T2DM and CKD based on their stage and estimated glomerular filtration rate (eGFR), with patients at stage 3 and above require closer monitoring [4]. In our previously published articles in the *Israel Medical Association Journal* [10,27], we stratified patients with overt proteinuria and nephrotic syndrome in a high-risk category for Ramadan fasting, considering the increased risk of thrombosis among this group of patients and the increased rate of this complication in T2DM patients who fast during Ramadan [27,28].

Fasting during Ramadan can impact renal function, particularly in patients with an eGFR < 60 ml/min/1.73m^2 [29]. Extra care should be taken for patients with eGFR less than 45 ml/min/1.73m^2 using SGLT-2i, particularly those with associated CHF treated with diuretics. Renal function tests and treatment adjustments should be conducted during pre-Ramadan and the first week of Ramadan.

BEDOUINS IN THE NEGEV FASTING DURING RAMADAN

Bedouins in the Negev represent a specific population. About 301,308 Bedouins live in the Negev, and the majority (73%) live in planned cities. Rahat is the largest city, with a population of approximately 73,000 citizens. More than 83,000 (23%) live in unrecognized villages with limited access to healthcare facilities, electricity, and water supply. In a retrospective cohort study, Zimhony and co-authors [26] reported a significantly increased risk for ischemic stroke (relative risk 1.48; 95% confidence interval, 1.04–2.09) during the first 2 weeks of Ramadan fasting compared to non-Ramadan periods, with higher prevalence of risk factors such as smoking, dyslipidemia, T2DM, and hypertension among Bedouin Arabs. The prevalence of T2DM is higher among Bedouins than non-Bedouins, particularly in planned cities, and for women [30]. This subgroup was previously stratified as a high-risk category for fasting during Ramadan [10]. Extra care instructions should be provided by well-trained healthcare practitioners who are familiar with Ramadan fasting and T2DM.

CONCLUSIONS

The pre-Ramadan period represents a golden opportunity for healthcare practitioners to provide diabetic patients with instructions for better glycemic control. Adjustments to treatments should be conducted during the pre-Ramadan period. Specific populations, such as elderly and Bedouin patients, patients with CHF, and those with advanced CKD, require extra care instructions for fasting safely during the month of Ramadan. Medical healthcare services, the Israel Diabetes Association, the National Diabetes Council, and the Ministry of Health should use the Ramadan period to help patients with T2DM achieve fasting goals.

Correspondence

Dr. A. Zaina
Division of Endocrinology and Metabolism, Zvulun Medical Center, Kiryat Bialik 2723901, Israel
Phone: (972-4) 878-7700
Fax: (972-4) 878-7568
Email: zainaad@clalit.org.il; zaina_adnan@yahoo.com

References

1. Israeli National Health Interview Survey. [Available from https://www.health.gov.il/UnitsOffice/ICDC/Health_Surveys/Pages/INHIS.aspx]. [Accessed 20 November 2024]. [Hebrew].
2. Shaltout I, Abdelwahab AM, El Meligi A, et al. Risk Stratification in people with diabetes for fasting during Ramadan: consensus from Arabic Association for the Study of Diabetes and Metabolism. *Curr Diabetes Rev* 2024; 20: e201023222409.
3. Bravis V, Hui E, Salih S, et al. Ramadan Education and Awareness in Diabetes (READ) programme for Muslims with type 2 diabetes who fast during Ramadan. *Diabet Med* 2010; 27: 327-31.
4. Hassanein M, Afandi B, Yakoob Ahmedani M, et al. Diabetes and Ramadan: practical guidelines 2021. *Diabetes Res Clin Pract* 2022;185: 109185.
5. Ceriello A, Esposito K, Piconi L, et al. Oscillating glucose is more deleterious to endothelial function and oxidative stress than mean glucose in normal and type 2 diabetic patients. *Diabetes* 2008; 57: 1349-54.
6. Lessan N, Hannoun Z, Hasan H, Barakat MT. Glucose excursions and glycaemic control during Ramadan fasting in diabetic patients: insights from continuous glucose monitoring (CGM). *Diabetes Metab* 2015; 41: 28-36.
7. Ajjan RA, Battelino T, Cos X, et al. Continuous glucose monitoring for the routine care of type 2 diabetes mellitus. *Nat Rev Endocrinol* 2024; 20: 426-40.
8. Ibrahim M, Davies MJ, Ahmad E, et al. Recommendations for management of diabetes during Ramadan: update 2020, applying the principles of the ADA/EASD consensus. *BMJ Open Diabetes Res Care* 2020; 8 (1): e001248.

9. Zainudin SB, Abu Bakar KNB, Abdullah SB, Hussain AB. Diabetes education and medication adjustment in Ramadan (DEAR) program prepares for self-management during fasting with tele-health support from pre-Ramadan to post-Ramadan. *Ther Adv Endocrinol Metab* 2018; 9: 231-40.
10. Adnan Z. Type 2 diabetic patients fasting on Ramadan in Israel. *IMAJ* 2017; 19: 269-74.
11. Al Sifri S, Basiounny A, Echtay A, et al. The incidence of hypoglycaemia in Muslim patients with type 2 diabetes treated with sitagliptin or a sulphonylurea during Ramadan: a randomised trial. *Int J Clin Pract* 2011; 65: 1132-40.
12. Hassanein M, Abdallah K, Schweizer A. A double-blind, randomized trial, including frequent patient physician contacts and Ramadan-focused advice, assessing vildagliptin and gliclazide in patients with type 2 diabetes fasting during Ramadan: the STEADFAST study. *Vasc Health Risk Manag* 2014; 10: 319-25.
13. Azar ST, Echtay A, Wan Bebakar WM, et al. Efficacy and safety of liraglutide compared to sulphonylurea during Ramadan in patients with type 2 diabetes (LIRA-Ramadan): a randomized trial. *Diabetes Obes Metab* 2016; 18: 1025-33
14. Zinman B, Wanner C, Lachin JM, et al. Empagliflozin, cardiovascular outcomes, and mortality in type 2 diabetes. *N Engl J Med* 2015; 373: 2117-28.
15. Kluger AY, Tecson KM, Lee AY, et al. Class effects of SGLT2 inhibitors on cardiorenal outcomes. *Cardiovasc Diabetol* 2019; 18: 99.
16. Chung CC, Lin YK, Chen YC, et al. Empagliflozin suppressed cardiac fibrogenesis through sodium-hydrogen exchanger inhibition and modulation of the calcium homeostasis. *Cardiovasc Diabetol* 2023; 22: 27.
17. Wan Seman WJ, Kori N, Rajoo S, et al. Switching from sulphonylurea to a sodium-glucose cotransporter2 inhibitor in the fasting month of Ramadan is associated with a reduction in hypoglycaemia. *Diabetes Obes Metab* 2016; 18: 628-32.
18. Nakhleh A, Mazareeb J, Darawshi S, Masri A, Shehadeh N. Safety and effectiveness of sodium-glucose cotransporter 2 inhibitors on glycemic control in patients with type 2 diabetes mellitus fasting during Ramadan: a review. *Clin Med Insights Endocrinol Diabetes* 2024; 17: 11795514241238058.
19. Hassanein M, Hussein Z, Shaltout I, et al. The DAR 2020 Global survey: Ramadan fasting during COVID 19 pandemic and the impact of older age on fasting among adults with type 2 diabetes. *Diabetes Res Clin Pract* 2021; 173: 108674.
20. Hassanein M, Al-Arouj M, Hamdy O, et al. Diabetes and Ramadan: practical guidelines. *Diabetes Res Clin Pract* 2017; 126: 303-16.
21. Salam AM, Sulaiman K, Alsheikh-Ali AA, et al. Acute heart failure presentations and outcomes during the fasting month of Ramadan: an observational report from seven Middle Eastern countries. *Curr Med Res Opin* 2018; 34: 237-45.
22. Al Suwaidi J, Bener A, Gehani AA, et al. Does the circadian pattern for acute cardiac events presentation vary with fasting? *J Postgrad Med* 2006; 52: 30-3.
23. Turin TC, Ahmed S, Shommu NS, et al. Ramadan fasting is not usually associated with the risk of cardiovascular events: a systematic review and meta-analysis. *J Family Community Med* 2016; 23: 73-81.
24. Assy MH, Awd M, Elshabrawy AM, Gharieb M. Effect of Ramadan fasting on incidence of cerebrovascular stroke in Egyptian patients with type 2 diabetes mellitus. *Diabetes Res Clin Pract* 2019;151: 299-304.
25. Bener A, Hamad A, Fares A, Al-Sayed HM, Al-Suwaidi J. Is there any effect of Ramadan fasting on stroke incidence? *Singapore Med J* 2006; 47: 404-8.
26. Zimhony N, Abu-Salameh I, Sagy I, et al. Increase in ischemic stroke incident hospitalizations among Bedouin Arabs during Ramadan month. *J Am Heart Assoc* 2018; 7 (10): e008018.
27. Zaina A, Tarabeih W, Abid A, Kassem S. COVID-19 pandemic and Ramadan fasting among patients with type 2 diabetes mellitus. *IMAJ* 2021; 23: 203-7.
28. Alghadyan AA. Retinal vein occlusion in Saudi Arabia: possible role of dehydration. *Ann Ophthalmol* 1993; 25: 394-8
29. Malik S, Bhanji A, Abuleiss H, et al. Effects of fasting on patients with chronic kidney disease during Ramadan and practical guidance for healthcare professionals. *Clin Kidney J* 2021; 14: 1524-34.
30. Amkraut J, Zaina A, Abu-Rabia Y. Diabetes in the Bedouin population in the Israeli Negev - An update 2017. *Diabetes Res Clin Pract* 2018; 140: 55-60.

What power has love but forgiveness?

William Carlos Williams (1883–1963), American poet and physician closely associated with modernism and imagism

Language is a city to the building of which every human being brought a stone.

Ralph Waldo Emerson (1803–1882), American essayist, lecturer and poet, and champion of individualism

Capsule

Transmission prevention target

For malaria parasites, fertilization of gametes occurs in the midgut of female Anopheles mosquitoes. Inhibiting parasite fertilization in mosquitoes prevents malaria parasite transmission from mosquitoes to humans, so transmission-blocking vaccines are important tools for malaria elimination. Using cryo-electron microscopy, **Dietrich** and colleagues determined the structure of the Pfs230-Pfs48/45 core fertilization complex isolated from the sexual stages of malaria parasites. This structure provided insight into the domains that are critical for complex formation. The authors demonstrated the importance of these domains using Pfs230 nanobodies and mRNA-lipid nanoparticles that block transmission. The findings may have potential for the development of transmission-blocking vaccines against malaria parasites.

Science 2025; 389: 1106

Eitan Israeli