

The Year in Ramadan Fasting Research (2017): A Narrative Review

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Abstract

Ramadan fasting is one of the five Pillars of Islam. While there are several exemptions from fasting, many Muslims with medical conditions still choose to fast. This may adversely affect their health if not addressed properly. Recently, there has been an increased interest in the health implications of Ramadan fasting. The authors performed a narrative, nonsystematic review of the literature including case reports, case series, and review articles indexed in PubMed and Google Scholar in a full calendar year. All records were reviewed by two coauthors at least. Studies were reviewed, summarized, and represented to provide a readily comprehensible concise account of the contributions made to research and clinical practice in 1 year (January–December 2017). The publications spanned physiological and clinical aspects and crossed conventional disciplinary lines in various languages, locations, and systems of journal access. A total of 92 and 82 were found in the PubMed and Google Scholar databases, respectively. Diabetes, hypoglycemia, insulin, and body composition were among the most relevant issues addressed this year. Discipline wise, diabetes, physiology, gastrointestinal, cardiovascular, eyes, respiratory, nephrology, neuropsychiatry, and endocrinology were most prominent. Other articles have considered professional competence, education, ethics, culture, and organization of care. Many of the research groups are based in emerging countries with Muslim-majority, but the publications are still widely distributed in internationally recognized journals. Several workers seem to have Ramadan fast at the center of their academic interest inferred from the number of publications to which they have contributed. The authors hope this review will help direct further research and should inform clinical practice guidance.

Keywords: Body composition, cardiovascular, diabetes, ethnicity, gastrointestinal, hypoglycemia, nutrition, physiological parameters, Ramadan fasting, religion, renal, therapy

INTRODUCTION

Ramadan fasting, in which Muslims abstain from specific habits and behaviors from dawn to sunset, is one of the five Pillars of Islam. Physicians and religious scholars are getting closer in their approach to advice given to patients based on objective risk assessment.^[1] While Muslim patients with acute or chronic medical conditions may be exempted from fasting, many do still choose to observe the fast. This may adversely affect their health if not addressed properly by evidence-based recommendations.^[2]

There has been a tremendous recent increase in interest in the health implications of Ramadan fasting. Keeping up with these developments in this area may prove difficult, and hence, a narrative overview under a single cover may be particularly

useful in presenting a digest of the research production in the year to add to the basic reviews.^[3]

This article aims to provide a narrative review of the global research work published in 2017. The review should give a concise bird's eye view of the literature and highlight the evidence for clinical practice guidelines. It should be of value to both hospital and primary care physicians who need to have good working knowledge to look after their fasting Muslim patients with full cultural competence. It should also help direct future research by identification of

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boys at rest and during a 6 min walking test were evaluated in 18 boys who fasted the entire month of Ramadan for the first time in their lives. They concluded that, in nonathletic children, their first fasting influenced their heart rate data but had a minimal effect on oxy-sat values.^[7]

Biochemical parameters

Dietary restrictions during Ramadan have various biochemical and physiological effects on body weight, glucose, and lipid profile. In 2017, several studies were published. The effect of fasting on anthropometry, blood pressure (BP), fasting blood glucose (FBG), lipid profiles, and body composition was investigated in 65 healthy Thai participants.^[8] Measurements were made before, at the end of, and 1 month after Ramadan. No changes were observed in the lipid, anthropometric, and body composition. However, the increased FBG levels after Ramadan were observed in the women. The authors inferred that to improve the favorable biochemical parameters after Ramadan, lifestyle modifications such as increased intake of healthy diets and increased physical activity should be adopted. Furthermore, the changes in body weight, glucose, and lipid profile during Ramadan were investigated in eighty physiotherapy students (aged 18–24 years) in Pakistan.^[9] There was a small reduction in body weight. Nevertheless, a significant reduction in glucose level, total cholesterol (TCh), low-density lipoprotein cholesterol (LDL ch), and triglycerides (TGs) was observed, but some reduction in high-density lipoprotein cholesterol (HDL ch) level was also reported. Similarly, the effect of Ramadan fasting on BP, FBG, lipids, uric acid, glycated hemoglobin (HbA1c), BMI, body adiposity index, and visceral adiposity index was assessed in 35 medical students during Ramadan.^[10] The changes in anthropometric measurements were not significant, but physical activities increased significantly after Ramadan. Changes in BP, FBG, TCh, HbA1c, uric acid, and TGs were not significant. Mean HDL ch significantly decreased, whereas LDL ch increased significantly. During Ramadan, the changes in composition of saliva were also investigated. Unstimulated saliva samples were collected from 35 healthy non-smoking individuals (aged 30–50 years) before, during and at the end of Ramadan. Unstimulated saliva samples were collected before, during, and at the end of Ramadan. There was a significant reduction in the concentration of salivary uric acid and aspartate aminotransferase, whereas the activity of alkaline phosphatase significantly increased. These findings may have implications on investigations that utilize saliva.^[11] Physiological effects of Ramadan on glucose levels in young nondiabetic adults were elucidated. Continuous glucose monitoring (CGM) was employed to measure interstitial glucose (IG) before, in the middle of, and after Ramadan to evaluate glucose exposure and glucose variability.^[12] Both the area under the IG concentration curve for the entire day and the average glucose were positively associated with BMI during and after Ramadan. Atypical CGM patterns were recognized in 11% of participants, distinguished by a prolonged increased glucose exposure, particularly in response to a meal.

Body composition and energy metabolism

The effects of Ramadan fasting on energy intake and anthropometry of 476 patients with Type 2 diabetes mellitus (T2DM) were evaluated before, during, and after Ramadan.^[13] Food intake and anthropometric data were collected during medical consultations in health-care establishments in two regions of Algeria. No significant difference was observed in the energy intake distribution and macronutrients between regions. Patients in one region had a significant energy intake increase during Ramadan, whereas, in the other region, the energy intake decreased after Ramadan. The energy distribution of macronutrients remained stable between the three periods. BMI and the waist-to-hip ratio significantly decreased after Ramadan compared to before Ramadan ($P < 0.05$). The effects of fasting and detraining on body composition, lipid profile, and maximum oxygen uptake were investigated in a specific group of individuals. This included nine inactive fasting menopausal women and ten fasting women with a detraining period (i.e. They exercised regularly before Ramadan but avoided physical activity during this month).^[14] The maximum oxygen uptake decreased in both groups (not significant). Changes were observed in the body composition indicators. HDL ch levels significantly decreased, and LDL ch levels significantly increased, with no significant changes in the levels of TCh and TG's during fasting in the detraining period group. In another study, the effects of Ramadan fasting on substrate oxidation, energy production, blood lipids, and glucose as well as body composition were examined in 18 healthy men.^[15] A significant group \times time interaction revealed that chronic Ramadan fasting reduced body mass and adiposity in fasting, without changing lean mass, whereas the nonfasting participants. In parallel, a significant main diurnal effect (morning vs. evening) of fasting on substrate oxidation (a shift toward lipid oxidation) and blood metabolic profile (a decrease in glucose and an increase in TCh and TG's levels) was observed. However, these changes did not vary over the course of the Ramadan. The effects of intermittent fasting (IF) were compared with calorie restriction (CR) on the same nondiabetic obese patients who were followed for 2 years over a total of 24 months.^[16] They suggested that CR affects metabolic parameters positively which will help especially prediabetic and insulin-resistant patients without any pharmacological approach. Furthermore, IF without CR could enhance health and cellular resistance to disease without losing weight. Such effects may be attributed to different signaling pathways and circulating ketones during fasting. Changes observed during fasting are probably due to the changes in eating and sleeping pattern and thus changes in metabolic rhythm. Minor nonsignificant change was observed in the levels of Vitamin A while the levels of Vitamin E decreased significantly on the 28th day of Ramadan in 30 healthy volunteers.^[17] These findings suggest that food-based interventions might be necessary to modify the diet during Ramadan. In a recent observational, comparative study of patients with T2DM and matched controls, dietary intake decreased from Ramadan, and the intake of lipids increased

from Ramadan, and the intake of polyunsaturated fatty acids, which doubled between the two periods.^[18] Physical activity increased significantly during Ramadan in patients and controls combined due to the night time prayers.

Diabetes

Attitudes and feasibility

Patients' attitude toward fasting, frequency of complications, and impact on glycemic control was assessed in 65 children with type 1 diabetes mellitus (T1DM).^[19] Both self-reported and objective assessments were used. Majority of patients were willing to fast, and 75% were encouraged by parents to do so. Nearly 57% and 26% fasted more than half and all through the month, respectively. Fifty-two percent had, at least, one episode of hypoglycemia and 29% had hyperglycemia with one episode of diabetic ketoacidosis (DKA). There was no significant difference between the frequency of complications in the pump or the multiple daily injection (MDI) groups. Mean HbA1c increased from 8.6% to 8.8%, but the difference was not significant. They concluded that children and adolescents with T1DM are keen to fast and they can fast a significant number of days. Hypoglycemia and hyperglycemia were not uncommon with no difference between pump or in MDI users. Breaking the fast on occurrence of complications makes the fasting safe. Glycemic control might deteriorate during the month and the following feast. In another study, feasibility of fasting was examined in adult patients with T1DM.^[20] Patients aged 18 years or older with T1DM who chose to fast during Ramadan. They were interviewed during their first visit after Ramadan, and their records were reviewed for the number of days in which patients broke the fast, frequency of hypoglycemia, hyperglycemia, DKA, and any hospitalization during Ramadan. The 73 patients included in the study were able to fast an average of 26.8 days which corresponds to 92% of total fasting days. Hypoglycemia and hyperglycemia caused the patients to break the fast in 2.36% and 2.78% of the total fasting days, respectively. The beliefs, experience, and management strategies of T2DM in 53 patients who chose to fast during Ramadan were evaluated using a focus group interview.^[21] Participants reported optimism toward fasting, as they believed that fasting was beneficial to their overall well-being and a time for family bonding. Most participants made limited attempts to discuss with their doctors on the decision to fast and self-adjusted their medication based on experience and symptoms during this period. They also reported difficulty in managing their diet, due to fear of hypoglycemia and the collective social aspect of fasting.

Diabetes self-management

The feasibility of promoting safe Ramadan fasting through diabetes self-management education (DSME) and its effect on hypoglycemic episodes were evaluated in a prospective study.^[22] Participants attending Ramadan reinforcement sessions for participants in the Educational Program for People with Diabetes were enrolled. Participants' HbA1c, serum fructosamine levels, and self-monitoring of blood

glucose (SMBG) logs were examined. Among 21 participants who were intending to fast for Ramadan, 14 completed the program. Their mean HbA1c was 6.7%. SMBG results showed no significant difference, and serum fructosamine after Ramadan decreased by 10% from levels before Ramadan. The number of hypoglycemic events per month declined with DSME.

The Ramadan perspective epidemiology and education in diabetes^[23] aimed to find out the current knowledge, attitude, and practices about Ramadan fasting among people with diabetes in Bangladesh involving 648 diabetic patients. The majority of the patients fasted in Ramadan, and among them, more than half of them received physicians' advice for Ramadan fasting (60.6%) and changed diabetes medication (69.9%) during Ramadan. Although the amount of total food consumption was unchanged in more than one-half of the fasters, about 3 in 4 reduced sugar-sweet intakes, increased fluid drinking, and decreased physical activity during the month. More than one-third of them did not check blood glucose (BG) and more than half of fasters failed to visit their physicians during Ramadan. Among them, 15% experienced mild-to-moderate episodes of hypoglycemia, and none had severe hypoglycemia. More hypoglycemic episodes were seen among insulin users, patients who had received fasting advice from physicians (probably quest to tighter control), and those who had adjusted diabetes drugs before Ramadan. The degree of adherence to treating physicians to educational programs and their influence on the patient's knowledge and behavior was evaluated in a cross-sectional study of 298 patients with diabetes.^[24] Nearly 75.5% of the patients were aged 40 years or older. Only 30% had pre-Ramadan education delivered mainly by diabetic educators or the treating physicians (52% and 44%, respectively). Patients who received the education were younger, had higher educational qualifications, were more likely to be employed, and self-monitored their BG more frequently ($P = 0.0001$). There was no difference between the two groups about their knowledge of diet and exercise. The level of knowledge regarding diabetes and diabetes self-management when fasting during Ramadan was evaluated in 92 Muslim patients in Singapore.^[25] DM treatment consisted of insulin therapy (37.0%), oral glucose-lowering drugs (35.9%), and combined therapy (22.8%). The mean DM knowledge score was 58.8% for general knowledge and 75.9% for fasting knowledge. During the previous Ramadan, although 71.4% of the patients consulted their physicians, 37.3% did not monitor their BG levels, and 47.0% had hypoglycemic episodes. Among those who had hypoglycemia, 10.8% continued to fast. The authors were concerned that some unsafe self-management practices were observed among DM patients who fasted. They called for efforts to be made to bridge the gap between knowledge of DM and self-management of DM. The role of Ramadan-specific diabetes education in the management was evaluated in a prospective study carried out in Pakistan.^[26] Participants were asked to visit the outpatient department after Ramadan. Data regarding compliance with

structured education through different modes was collected during visit post-Ramadan. Comparisons between groups who received education revealed a nonsignificant difference in SMBG, alteration of drug dosage and timing, appreciation of hypoglycemia, and action taken on the development of hypoglycemic symptoms. However, significant differences were noted when the group who received the education was compared individually with the group who did not receive the education.

Glucose monitoring

The impact of a remote BG telemonitoring program with feedback in T2DM patients' fasting during Ramadan compared to conventional self-monitoring method was evaluated in a 12-week cluster randomized study.^[27] Participants who wished to fast for at least 15 days during Ramadan ($n = 85$) were assessed. Self-measurement and transmission of BG results were performed six times daily during Ramadan. Results were transmitted to a secure website for review with feedback from case manager if necessary. The control group received usual care. The main outcome was the number of participants experiencing hypoglycemia during Ramadan and at the end of the study. During Ramadan, the number of participants reporting hypoglycemia was significantly lower in the telemonitoring group. Similarly, the proportion of participants reporting symptomatic hypoglycemia at the end of the study was significantly lower in the telemonitoring group. A greater reduction in HbA1c levels was observed in the telemonitoring group ($P < 0.01$), thus suggesting that telemonitoring was a useful adjunct to reduce the risk of hypoglycemia during Ramadan with no deterioration in glycemic control. The benefit of using the newer technology of flash glucose monitoring system in children and adolescents with T1DM during Ramadan was evaluated in a prospective pilot study of 51 patients.^[28] Participants were able to fast for over two-thirds of the total days eligible for fasting, whereas they did not fast in the remaining third due to either hypoglycemia (15.4%) or nondiabetes-related reasons (17.6%). None developed severe hypoglycemia or DKA. The group from Al Ain, UAE used CGM to assess the impact of fasting on IG in 14 adolescents with T1DM during Ramadan.^[29] The mean IG and durations of hypoglycemia, hyperglycemia, and severe hyperglycemia were recorded. There was no difference in any of the outcome measures between Ramadan and non-Ramadan months (before or after). They also compared the CGM data during fasting in adolescents with T1DM according to their Pre-Ramadan diabetes control.^[30] Children and adolescents who intended to fast were fitted with the CGM during fasting for a minimum of 3 days. Using the same three outcome measures, they concluded that glycemic control before Ramadan in this group might predict BG profiles during Ramadan.

Pharmacological therapies

Oral agents

In principle, T2DM patients with proper education, dietary counseling, drug dosage adjustments, and glycemic control

were thought to be able to remain in safe, acceptable range.^[31] In a more prescriptive approach, the safety of a drug protocol devised to accommodate Ramadan's dietary changes was evaluated.^[32] It involved dose adjustments of four antidiabetic drug regimens in T2DM patients in a prospective, observational, open-label study involving 301 patients. Patients were classified into four groups according to medications' potential for hypoglycemia. During Ramadan, drug doses were adjusted as percentages of their respective pre-Ramadan doses. No cases of severe hyperglycemia were reported. Hypoglycemia occurred in the various groups at different rates which are predictable by their inherent hypoglycemic potential. Analysis of the VIRTUE study demonstrated that anti-hyperglycemic treatment with vildagliptin (308) led to significantly fewer hypoglycemic events compared to sulfonylurea treatment ($n = 265$) during Ramadan.^[33] Good glycemic control, weight control, and safety results supported this outcome. The Canagliflozin in Ramadan Tolerance Observational Study was also reported in 2017.^[34] It compared the tolerability of an sodium-glucose cotransporter 2 (SGLT2) inhibitor (canagliflozin) ($n = 162$) with sulphonylureas (159) in patients with T2DM who fast during Ramadan.^[34] During Ramadan, fewer patients on canagliflozin experienced symptomatic hypoglycemia, but more experienced volume depletion events than sulphonylureas. Missed fasting days were few; medication adherence was high in both groups; and treatments were well tolerated, with low rates of adverse events and no serious adverse events in either group. This is the second member of the SGLT2 inhibitors class to be tested in Ramadan with similar results.

Newer insulins

The efficacy and safety of the insulin degludec/insulin aspart (IDegAsp) were compared with biphasic insulin aspart 30 (BIAsp 30) before, during, and after Ramadan in patients with T2DM.^[35] Treatment period included 8–20-week pre-Ramadan treatment initiation, Ramadan, and 4-week post-Ramadan. IDegAsp seemed more suitable therapeutic agent for patients who need insulin for sustained glucose control before, during, and after Ramadan fasting, with a significantly lower risk of hypoglycemia, versus BIAsp 30, an existing premixed insulin analog.

Drugs and risk stratification

Diabetes treatment and hypoglycemia in individuals with T2DM during Ramadan subset of the multicountry, retrospective, observational study with data captured before, during, and after Ramadan were reported in 2017.^[36] It included a cohort of 3250 individuals with T2DM in four culturally distinct regions. The participants on oral antidiabetic agents alone represented between 68.4% (Middle East) and 80.5% (Asia); the proportion on insulin alone ranged between 3.7% (Middle East) and 8.6% (Europe). The average number of days fasted for individuals with "very high risk" status ranged between 21 in Europe and 25 in the Middle East. The incidence of hypoglycemia in this subgroup with very risk status was 5.6% (Europe), 6.1% (Middle East), 8.7% (Asia),

and 38% (North Africa). The incidence of hypoglycemia, during Ramadan, for the entire cohort was 16.8% with insulin treatment and 5.3% with oral antidiabetic medication. Glucose profiles in patients with T1DM who use the insulin pump ($n = 61$) were compared with those who use MDIs insulin regimen ($n = 95$).^[37] Glucose data collected using SMBG and CGM were examined in the two groups. The overall glycemic control was evaluated by serum fructosamine levels. There was no difference in the rates of mild hypoglycemia, DKA, and severe hypoglycemia between the two groups. Although both serum fructosamine and the number of days in which patients had to stop fasting were not different between the two groups, glucose variability was significantly better in the pump group. The risk stratification categorizes all persons wishing to fast into three or four groups based on potential risk, but there is no consensus. For instance, all persons using premixed insulin are categorized by some as high risk. However, Kalra *et al.* presented data from randomized controlled trials and argued the placement of premixed insulin in the risk stratification framework.^[38] Furthermore, Adnan explained that the risk stratification categories should take into consideration patients' specific conditions and living circumstances.^[39] He suggested categorizing the SGLT2 inhibitors group differently from other agents such as metformin and incretin-based therapy which were studied extensively during Ramadan.

ENDOCRINE AND METABOLIC DISORDERS

In 2017, perhaps the most important issue addressed in endocrinology was the impact of Ramadan fasting on patients with adrenal insufficiency (AI). The risks of fasting were evaluated in 180 hypoadrenal patients.^[40] Of these, 138 were advised by their physicians not to fast and but 91 patients (50.5%) tried to fast. Complications occurred in two-thirds of the patients including asthenia, symptoms of dehydration, intense thirst, and symptoms of hypoglycemia in decreasing frequencies. Only a single patient was hospitalized. Fifty-five patients (60.4%) were able to fast for the whole month. Demographic and clinical characteristics were not different between nonfasters, full fasters, and partial fasters nor between fasters with complications and those without complications. Knowledge about the disease was better in full fasters than partial fasters and in fasters without complications than those with complications. The same group evaluated the hypoglycemic risk determined the associated factors in a prospective case-crossover study including 25 women and 5 men with AI on treatment with a median age of 38.5 years.^[41] Full biochemical profiles were documented, and a 24 h CGM system (CGMS) was performed for each patient during a Ramadan fasting day then again during a nonfasting day. IG levels during the 24 h period, the fasting period, and the fasting period after exclusion of the five postprandial hours were significantly lower during the fasting day than on the nonfasting day. Hypoglycemia occurred in three patients (10%) during the fasting day but not during the nonfasting day. Hypoglycemia was asymptomatic in two cases. Male sex was significantly

associated with the hypoglycemia. An accompanying commentary stressed the seriousness of adrenal insufficiency, and it may be fatal unless this adequately replaced.^[42] However, to avoid metabolic complications and sleeping problems, the author argued against giving prednisolone at sunset and that dexamethasone is a long-acting glucocorticoid and it has a high risk of side effects and should not be used in this setting. The author proposed that a higher conventional hydrocortisone dose in the morning is more suitable than at sunset. Modified release formulations of hydrocortisone delivering more physiological cortisol exposure could potentially reduce complications. He also reiterated the importance of patients' education.

The effects of fasting during Ramadan on the thyroid hormones levels have been considered previously. Ramadan has no undesirable effects on thyroid hormones in healthy people, but people with thyroid disease who are intending to fast during Ramadan are recommended to consult their endocrinologist despite the lack of consensus.^[43] Luteinizing hormone, follicle-stimulating hormone, and prolactin have a key role in lactation. These were not shown to be altered significantly in Ramadan fasting. Carnitine palmitoyltransferase II (CPTII) deficiency is a mitochondrial fatty acid oxidation disorder that can present antenatally as congenital brain malformations or postnatally with lethal neonatal, severe infantile, or the most common adult myopathic forms. A 23-year-old male who presented with seizures and was found to have marked elevation of serum ammonia.^[44] Continuous renal replacement therapy successfully decreased ammonia to a safety level. He had a prolonged history of epilepsies and encephalopathic attacks that were associated with high ammonia level. The molecular diagnosis revealed a homozygous mutation in CPTII. Failure to produce acetyl-CoA, the precursor of urea cycle from fatty acid in the prolonged fasting state in Ramadan month, worsening mitochondrial functions from circulating long chain fatty acid, and valproate toxicities were believed to contribute to this critical metabolic decompensation. A hypothesis was proposed that if food composition, caloric intake, light exposure, sleep schedule, and exercise are controlled for IF will not influence the circadian pattern of melatonin.^[45] To test this, they assessed the effect of fasting on the circadian pattern of melatonin in eight healthy young adults of normal weight on three occasions before and during Ramadan. The light exposure, meal composition, energy expenditure, and sleep schedules remained the same while the participants stayed at the laboratory. The melatonin levels followed the same circadian pattern during the three monitoring periods. The melatonin levels peaked at 02:00 h and its trough were at 11:00 h in all studied periods. Lower melatonin levels at 22:00 h were found during fasting.

Renal function

Two separate groups addressed the impact of Ramadan fasting on renal function in patients with chronic kidney disease (CKD). Ninety-four Stage 3–5 CKD patients with stable renal function were recruited to a prospective observational study 3 months ahead of Ramadan in 2015.^[46]

All patients were instructed regarding possible deleterious effects of dehydration caused by fasting. Forty-five patients chose to fast and 49 chose not to fast. Initial clinical and laboratory parameters were similar in the two groups, except for significantly higher serum creatinine and lowered estimated glomerular filtration rate (eGFR) in the nonfasting group. More than 30% elevation in serum creatinine after Ramadan occurred in 8.8% and 8.1% of fasting and nonfasting patients, respectively. More than 25% drop in eGFR after Ramadan was noted in 7 (15.5%) and 6 (12.2%) fasting and nonfasting patients, respectively. Patients with $\geq 25\%$ drop in eGFR (13 vs. 81) were older and more frequently using diuretics. There were no CKD5 patients in the fasting group in this study, and over two-thirds of the study participants were patients with CKD3. The authors did not comment if the deterioration in kidney functions persisted after the study period. In the other study, 65 patients with Stage 3 or higher CKD were included.^[47] By definition, worsening of renal function (WRF) was considered to have occurred when serum creatinine levels increased by 0.3 mg/dL (26.5 $\mu\text{mol/L}$) from baseline during or within 3 months after Ramadan. Overall, one-third of patients developed WRF. In a multivariate analysis, more advanced CKD stage, higher baseline systolic BP, and younger age were independently associated with WRF. The underlying cause of CKD, use of diuretics, use of renin-angiotensin blockers, gender, and smoking status were not associated with WRF. This study had no control arm, and patients with CKD 3 made up 55% of study participants (only 8% were CKD 5). In 8 out of 22 patients with WRF, renal function seemed to settle back to baseline after Ramadan, resulting in a 22% overall rate of persistent deterioration in renal function in this study.

The significantly different rates of deterioration in renal function demonstrated in these two studies may well be ascribed to either differences in the definition of the deterioration of renal function, and the degree of renal impairment at recruitment including the underrepresentation of CKD5 in the fasting group.^[46] Furthermore, the geographical locations where the two studies were conducted differ significantly in the climate where the warmest temperature in Riyadh exceeds 40°C compared to 26°C in Turkey. The risk of deterioration in renal function associated with fasting in CKD patients probably varies across the various CKD classes, hours of fasting, and other patient-specific comorbidities. It is noteworthy remembering that episodes of acute on chronic renal impairment can be associated with further progression of CKD.^[48] Although randomization in similar studies will be ethically problematic, well-designed observational studies are required to better study the impact of Ramadan fasting in patients across the spectrum of CKD. Clinicians need to exercise caution when advising CKD patients regarding Ramadan fasting particularly in the elderly.

GASTROINTESTINAL AND LIVER DISORDERS

Six studies were published during 2017. The focus was on peptic acid disease and nonalcoholic liver disease (NAFLD).

The effect of fasting on ulcer perforation was investigated in 2,311 patients who were operated on due to peptic ulcer perforation in a referral hospital in Turkey.^[49] Patients were divided into two groups: 506 patients who were operated on during Ramadan (36 months) and 1805 patients who were operated during other periods of the years (396 months). The mean monthly number of surgical intervention rates was greater in the Ramadan group than in the other groups (14.1 vs. 4.6, $P < 0.001$). The rise in the number of male patients during Ramadan times was statistically significant. While omentoplasty with upper midline laparotomy versus other surgical methods was employed significantly more often in Ramadan group, mortality rates were similar in the two groups and no seasonal differences were found between two groups. In another study, the alterations of seven groups of gastrointestinal symptoms in a healthy adult population during Ramadan were evaluated by a questionnaire after Ramadan.^[50] A total of 900 individuals participated, and of these, 87% reported fasting at least 2 weeks during Ramadan. After adjusting for potential confounders, no relationship was found between alteration in frequency of gastrointestinal symptoms and Ramadan fasting, except for increased constipation ($P < 0.05$), particularly in those who fasted for longer periods than 2 weeks.

The effects of Ramadan fasting on NAFLD are hitherto unknown, and there are very limited studies have done in this area. Theoretically, some nutritional and behavioral changes of fasting people in Ramadan can affect NAFLD. Ramadan fasting, and four studies were reported. The changes in serum ALT, one of the important indicators of deterioration of NAFLD, were evaluated in sixty patients with fatty liver disease.^[51] Of these, 34 patients fasted and 26 did not fast. After Ramadan, the mean ALT level increased in fasting and decreased in the nonfasting patients. The change was mainly in patients who had fasted 21–30 days. The effects of caloric restriction during Ramadan fasting on anthropometric indices, metabolic indices, and inflammatory cytokines were evaluated in 83 patients with NAFLD (42 fasting and 41 nonfasting).^[52] A significant decrease occurred in all anthropometric parameters as well as fasting glucose, plasma insulin, and insulin resistance. Fasting significantly reduced circulating inflammatory markers, but changes in BP after Ramadan were not significant. The differences in the levels of certain gut peptides between religious fasting and normal fasting were evaluated.^[53] The authors hypothesized that during Ramadan if the brain knows that the body will be hungry until sunset, there may be differences between leptin, ghrelin, and glucagon-like peptide-1 (GLP-1) levels in Ramadan and non-Ramadan fasting. In the first phase of the study, the participants were asked to skip the dawn meal of Ramadan (*suhour*) and to achieve 12 h of fasting. Participants ceased food intake at midnight and at noon blood was drawn. Eight participants were selected as a subgroup. These participants gave blood three times a day to detect hormonal changes during Ramadan. Six months later, blood samples were obtained at noon from participants after 12 h of fasting. The significant difference

in leptin, ghrelin, and GLP-1 levels was evident between Ramadan and non-Ramadan fasting.

CARDIOVASCULAR DISORDERS AND RISK FACTORS

The studies published in 2017, covered several aspects of cardiovascular disease (CVD) and risk factors. Ambulatory BP in hypertensive patients was evaluated in a prospective, observational study.^[54] Six hypertensive patients treated with two antihypertensive agents and 12 healthy individuals were included in the study. Twenty-four-hour BP monitoring was performed at four-time points: before, during, and after Ramadan. All hypertensive patients followed their twice-daily treatment regimen. Mean 24-h BP and BP values during awake and sleep periods were measured. No significant differences were seen in the trends of systolic and diastolic BP between the hypertensive and nonhypertensive groups during and after Ramadan. Furthermore, the trends of variations in heart rate and body weight were not significantly different in the two groups. In another study, the difference in 24-h BP values during Ramadan and nonfasting individuals with no previous history of hypertension were analyzed.^[55] The percentage changes in BP of the patients were calculated from their BP measurements at 0 h while they were resting. A food frequency questionnaire was filled out by all participants. Forty patients were in the fasting group, and 55 patients were in the nonfasting group. There was a difference between the two groups in percent changes of systolic measurements measured at several times of time hours concerning the baseline measurement at the 0 h (by 5%–10%). A systolic BP increase in fasting patients was observed in measurements around the *iftar* time. The authors believe that an increase of more than 10% in BP at the time of *iftar* is an important result of their study regarding the meal preferences of the individuals at risk. There is evidence that diet and variation in lipid metabolism can influence blood coagulation, but little is known about the effect of Ramadan fasting on plasmatic coagulation pattern. The effect of Ramadan fasting on thrombin generation was investigated in 36 patients with at least two CVD risks factors and thirty controls to assess the effect of lipid profile on thrombin generation parameters.^[56] Coagulation pattern was assessed by both classical clotting times and thrombin generation test and a full lipid profile on two occasions: 1 week before Ramadan and during the last week of the Ramadan. Thrombin generation parameters were not different in patients with CVD risks compared to healthy controls. Furthermore, fasting in Ramadan did not influence the global coagulation pattern in patients with CVD risks.

The changes in the expression of CLOCK and glucocorticoid-controlled genes such as DUSP1 and Interleukin-1 α (IL-1 α) were monitored in 23 adults before and during Ramadan, and the possible associations with selected cardiometabolic risk factors were examined.^[57] During Ramadan, fasting individuals develop severe disturbances in sleeping and feeding patterns. Concomitantly, cortisol

circadian rhythm is abolished, diurnal cortisol levels are elevated, and circulating levels of several adipokines are altered favoring insulin resistance. The expression of CLOCK, DUSP1, and IL-1 α was evaluated in circulating leukocytes. Mean levels of GGT and morning adiponectin decreased, while those of LDL ch/HDL ch and atherogenic index (AI) increased significantly in Ramadan compared to the month before. There was no significant difference between morning and evening adiponectin during Ramadan, while the diurnal rhythm of hsCRP was lost. CLOCK gene expression mean was significantly higher in the morning than in the evening during the preceding month. The improvements in cardiometabolic risk factors seen during Ramadan suggest that IF might have a beneficial component. These benefits may be offset by the previously reported dysregulation in the circadian rhythm, explaining the increased prevalence of cardiometabolic disorders and T2DM. The authors called for more mechanistic studies will need to be carried out in a country in which sleep patterns are not affected during Ramadan to confirm such findings.

RESPIRATORY FUNCTIONS

Three studies conducted on healthy adults, COPD patients, and patients with bronchial asthma were reported during the year of 2017. The three studies are briefly reviewed below. The first study assessed the effects of Ramadan fasting on spirometric values of 29 nonsmoking healthy young adult males.^[58] The assessment was performed before breaking the fast over three periods; before, mid, and after Ramadan. Assessment sessions comprised of forced vital capacity (FVC), forced expiratory volume in 1st s (FEV1), FEV1/FVC, peak expiratory flow (PEF), maximal mid-expiratory flow (MMEF), and forced expiratory flow at x% of FVC to be exhaled (FEF_x%). Spirometric data were expressed in percentages of reference values. No effect of Ramadan on the spirometric values of nonsmoking healthy adult males was evident. In the second study, the effects of Ramadan fasting on spirometric data of 16 male patients (mean age 64 years) with a stable chronic obstructive pulmonary disease (COPD) were assessed.^[59] Spirometry was performed before, mid, and after Ramadan and consistently performed 2.5–4.5 h before fasting break. Assessment sessions comprised of FVC, FEV1, FEV1/FVC, PEF, MMEF, and FEF_x%. A reversibility test was performed only during the before Ramadan session. Spirometric data were expressed in percentages of local reference values. Results revealed that Ramadan fasting did not bring about any significant changes in the spirometric data of male patients with stable COPD. In the third study (a prospective cohort study), the effects of Ramadan fasting on the clinical and spirometric values were evaluated before, during, and after Ramadan in patients with well-controlled asthma.^[60] Patients were classified according to the treatment type they received and results revealed that fasting in hot weather had detrimental effects on asthma control and patients who were taking Symbicort showed better tolerance to fasting.

Neuropsychiatric disorders

Experimental fasting can affect cognitive function, sleep, and wakefulness patterns. However, the effects of experimental fasting cannot be generalized to the intermittent fasting during Ramadan. Hence, an increased interest developed in unraveling the impact of during Ramadan fasting on sleep patterns, daytime sleepiness, cognitive function, sleep architecture, and circadian rhythm.^[61] Available data which controlled for sleep/wake schedule, sleep duration, light exposure, and energy expenditure do not support the notion that Ramadan-type fasting increases daytime sleepiness and alters cognitive function. In addition, recent well-designed studies showed no effect of fasting on circadian rhythms. However, in nonconstrained environments that do not control for lifestyle changes, studies have demonstrated sudden and significant delays in bedtime and wake time. Studies that controlled for environmental factors and sleep/wake schedule reported no significant disturbances in sleep architecture. Nevertheless, several studies have consistently stated that the main change in sleep architecture during fasting is a reduction in the proportion of rapid eye movement sleep phase. The effects of Ramadan fasting on postural balance and attentional capacities were evaluated in 15 adults aged 65 and 80 years.^[62] They were asked to perform a postural balance protocol and a simple reaction time test in four preset testing phases before, during, and after Ramadan. Ramadan fasting affected postural balance and attentional capacities in the elderly mainly in the second week of Ramadan and it may, therefore, increase the risk of fall and fall-related injuries. More than 3 weeks are needed for older adults to recover postural balance impairment due to Ramadan fasting. It is believed that caloric restriction could help the health of the nervous system by affecting the synthesis of neurotrophins and neurotransmitter and oxygen radical metabolism.

Recommendations for medical management of Parkinson disease (PD) during Ramadan were proposed.^[63] Effective treatments exist in PD and usually require several daily drug intakes. Apart from worsening symptoms, interrupting PD treatment might lead to a severe withdrawal syndrome. The general principle is based on switching the patient's treatment to an equivalent dosage of a dopamine agonist that can be administered once daily or by transdermal patch. However, such an option is only feasible for patients who require a moderate amount of PD treatment and can tolerate dopamine agonist therapy. Because many patients with PD require regular multiple daily administration of dopamine-replacement medication, the management of Ramadan fasting may not be easy. Switching the patient's treatment to an equivalent dosage of a dopamine agonist that can be administered once daily or by transdermal patch seems to be a reasonable option to consider for patients treated with a low-to-moderate amount of PD medication. In a different study, plasma levels of serotonin, dopamine, brain-derived neurotrophic factor, and nerve growth factor were measured in 29 healthy participants' fasting during Ramadan.^[64] Plasma levels of all except dopamine significantly

increased during Ramadan. Furthermore, Ramadan fasting by a group of young healthy males did not significantly influence mood, fatigue, and quality of life, when compared to the nonfasting group, there was a benefit to the fasting group about these parameters.^[65]

There are some controversies on the association of Ramadan fasting and cerebral venous sinus thrombosis (CVST). A cross-sectional study evaluated whether Ramadan increases the incidence of CVST.^[66] All patients with any cerebrovascular disease (CVD), ischemic or hemorrhagic/arterial, or venous, were enrolled in a data set. The ratio of CVST to all CVD patients was calculated in Ramadan (38/942) and in all other lunar months (294/12,152), and people were 1.4 times more likely to develop CVST in Ramadan. The CVST-CVD ratio in Ramadan and other months was estimated to be 0.4 and 0.02, respectively. The increased risk of Ramadan can be related to dehydration and hyperviscosity. Furthermore, some women take oral contraceptive pills (OCPs) to prevent menstruation during Ramadan with associated thrombosis risk, thus providing relevant education about water intake and the potential adverse effect of OCP during Ramadan is important.

HEMATOLOGY, ONCOLOGY, AND IMMUNOLOGY

Hematological and biochemical parameters were evaluated prospectively in 88 participants (mean age of 34.5 years) 1 week before and 1 week after Ramadan.^[67] Hematocrit, red blood cell count, and mean corpuscular volume decreased significantly after Ramadan. However, mean corpuscular hemoglobin and mean corpuscular hemoglobin concentration increased. In contrast, no changes were seen in hemoglobin, platelets, and white blood cell after Ramadan. In another study, the influence of Ramadan on platelet reactivity in patients with high cardiovascular risk (CVR), in particular, those with T2DM, was evaluated.^[68] Ninety-eight stable patients with ≥ 2 CVR factors taking clopidogrel at a maintenance dose of 75 mg observed RF. Clinical findings and serum lipid profiles were recorded before Ramadan (pre-R), at the last week of Ramadan (R), and 4 weeks after the end of Ramadan (post-R). In each patient visit, nutrients' intake was calculated and platelet reactivity assessed. In DM patients, the absolute P2Y₁₂ reaction unit (PRU) changes from baseline were +27 ($P = 0.01$) and +16 ($P = 0.02$), respectively, at R and post-R. Furthermore, there was a significant increase of glycemia and TG's levels with a significant decrease of high-density lipoprotein. In non-DM patients, there was no significant change neither absolute PRU nor in metabolic parameters. Clopidogrel resistance rate using two cutoff PRU values (235 and 208) did not change significantly in DM and non-DM patients. Fasting significantly decreased platelet sensitivity to clopidogrel in DM patients during and after Ramadan. The impact of Ramadan was studied prospectively in a group of 18 patients with prosthetic heart valves who were followed up every week for 3 months (pre-Ramadan, Ramadan, and post-Ramadan months). The following parameters were investigated: international normalized ratio (INR), quality of

anticoagulation, and the dose of warfarin administered and measured their blood osmolarity. No significant differences in INR and warfarin dose were found between Ramadan month and months before and after it. The post-Ramadan INR was significantly higher than pre-Ramadan ($P = 0.004$). Blood osmolarity was significantly lower during Ramadan compared to pre- and post-Ramadan months. A significantly better quality of anticoagulation was noticed during Ramadan. A significantly larger ratio of supratherapeutic INR values occurred in the post-Ramadan month. A significantly larger ratio of infra-therapeutic INR values was noticed in the pre-Ramadan month. No significant difference in mean INR or warfarin dose was found, and a better quality of anticoagulation was achieved during Ramadan. A tendency toward supratherapeutic anticoagulation occurred after Ramadan. Thus, a closer follow-up during this period may be reasonable. In another study, the INR trend was evaluated in thirty fasting patients (aged 65 years) undergoing outpatient anticoagulation therapy using the Vitamin K antagonist acenocoumarol for over a year mostly for stroke prevention in atrial fibrillation.^[69] INR values during Ramadan were compared to the latest pre-Ramadan values. All patients were monitored for signs of secondary hemorrhagic complications. Mean INR was significantly higher during Ramadan than baseline. There were also more overdoses during the month of Ramadan than baseline ($P = 0.014$). The increased INR values highlight the need for a close monitoring of INR values during the month of Ramadan, particularly in patients with a high hemorrhagic risk. A potential reason for these changes includes dietary changes most importantly altered Vitamin K intake. Also, the effects of Ramadan on the INR in 105 patients (42 fasting) with mechanical cardiac valves were conducted.^[70] No significant differences were noted in INR values during or 1 month after Ramadan. Similarly, there were no significant differences in rates of hospitalization, valvular dysfunction on echocardiography, thrombus, embolism, bleeding, and clinical complaints between the groups. Thus, it appears that fasting during Ramadan is safe for patients with mechanical prosthetic cardiac valves on warfarin.^[71]

The changes in the immune system are of great interest during fasting. It has been suggested that Ramadan fasting may influence the immune system and the alterations induced are transient, returning to basal pre-Ramadan status shortly afterward.^[72] The effect of Ramadan fasting on visfatin, tumor necrosis factor alpha (TNF- α), and adiponectin level was evaluated in 34 men aged 24–55 years.^[73] A significant decrease in visfatin was evident but there were no significant changes in adiponectin and TNF- α during Ramadan fasting.

Ocular structure and function

Five new reports on the changes observed in ocular structure and dynamics during Ramadan fasting were reported during the year 2017. The intraocular pressure (IOP) and serum electrolytes were as two important factors that are influenced by the human lifestyle in 89 fasting and young adult healthy participants.^[74] All participants were monitored by an expert

examiner, and blood samples were collected and IOP was measured. They proposed that prolonged IF in Ramadan changed IOP and serum electrolytes in healthy people within a normal range. Also, the effects of Ramadan fasting on the central foveal thickness and subfoveal choroidal thickness were evaluated in 42 healthy individuals using enhanced depth imaging optical coherence tomography.^[75] They concluded that Ramadan fasting might lead to a significant increase in subfoveal choroidal thickness without affecting the central foveal thickness. The effects of Ramadan fasting on IOP, refractive error, corneal tomography and biomechanics, ocular biometry, and tear film layer properties in 94 healthy adult volunteers were evaluated.^[76] The study showed that some but not all parameters were different between fasting and nonfasting groups. Interpretations of the significant differences in a clinical context are recommended. Effects of Ramadan fasting on anterior chamber parameters, visual acuity, and IOP in 61 healthy volunteers (31 fasting and 30 nonfasting) were evaluated.^[77] There is a need for more detailed studies to understand better the influence of Ramadan on various ocular parameters. The effects of dehydration and fasting on the IOP and corneal biomechanics during Ramadan in healthy participants in a total of 36 healthy fasting male volunteers were evaluated.^[78] Fasting did not affect corneal biomechanics and IOP values profoundly in healthy volunteers without ocular diseases. When planning corneal refractive surgery and determining IOP, the ocular response analyzer (ORA) measurements can be done safely during a Ramadan fast. Moreover, ORA may be a better alternative for patients that refuse IOP measurement through Goldmann applanation tonometer for examining the accuracy of IOP during fasting. Further studies are needed to better understand the role of these parameters on corneal disease and glaucoma during fasting.

Miscellaneous clinical issues

Routinely collected data accessed from maternity records were interrogated to establish a relationship between exposure to Ramadan *in utero* pregnancy outcome.^[79] After adjusting for several relevant variables, there was no significant difference in birth weight between infants who were conceived during Ramadan ($n = 479$) and those who were not ($n = 4677$). Similarly, there was no difference in rates of premature births in exposed and unexposed women.

Women with gestational diabetes mellitus (GDM) are categorized as at high risk for adverse events during Ramadan fasting. Glucose levels during Ramadan were examined in a prospective observational study of 32 patients with GDM.^[80] CGM data indicated that Ramadan fasting in women with GDM treated with diet alone or with diet plus metformin was associated with lower mean glucose levels and higher rates of hypoglycemia when compared with nonfasting glucose levels. They supported the widely accepted notion that women with GDM should be advised against fasting during Ramadan.

An interesting experience in a smoking cessation clinic during Ramadan was examined.^[81] The efficacy and adverse effects

of once-daily dosing of bupropion or varenicline in a fasting group compared with conventional dosing in a nonfasting group relating to 57 patients who attended the smoking cessation clinic during Ramadan of 2014 and 2015 and at least one follow-up visit.^[81] For the fasting patients, bupropion or varenicline was prescribed after dinner (once daily) as the maintenance therapy. Patients were similar for all relevant variables and adverse effects and quit rates after 6 months of follow-up were similar between the fasting and nonfasting groups.

Professional, economic, and ethical considerations

Professional considerations

Physicians play a pivotal role in helping and advising patients regarding the choice to fast or not. They are also instrumental in organizing and delivering better care of those patients who choose to fast. Diabetologists are expected to provide education to their nonspecialist colleagues, lead research, and develop guidelines. A few reports released in 2017 addressed the Ramadan-specific knowledge of medical practitioners and how well equipped they were to be engaged efficiently in providing care to people with diabetes whether they were a majority or a minority population. Some have debated some ethical aspects, and others discussed management organization.

Health-care professionals enrolled in pre-Ramadan education involving an endocrinologist, diabetes specialized nurse, and dietician were surveyed.^[82] Participants belonged to various professional groups. Half of them practiced in primary care settings. The survey incorporated a knowledge test on fasting and safe practices of diabetes management during Ramadan. Mean knowledge score was 81.1%. Eighty-four percent would counsel people with diabetes for fasting, increasing to 96.7% after education. Those who would not cited a lack of knowledge or experience. During the previous Ramadan, 75.9% reported providing counseling or adjusted medication, while 51.1% managed diabetes complications (63.8% predominantly hypoglycemia and 24.6% only hypoglycemia). Another survey (internet based) of 236 physicians was conducted.^[83] Physicians demonstrated variable levels of knowledge about care of patients with diabetes during Ramadan. Self-reported competence was not matched by actual knowledge and treatment practices. They suggested the need for continued education, mentoring, and support schemes with regular annual assessments before Ramadan fast. The same group appraised the knowledge, attitudes, and practices of medical practitioners regarding the management of people with diabetes during Ramadan.^[84] They suggested that many of the reports were either small or lacked depth. Remarkable degrees of inconsistency in the levels of knowledge, attitudes, and practices among physicians between regions and within the same country were detected. Lack of ethnic-competency was observed in some studies from the west. They expressed concerns that the current level of pre-Ramadan educational activities remains patchy, inconsistent, and too often “ceremonial” as part of pre-Ramadan festivities organized by pharmaceutical companies. They called for improvement and harmonization

of efforts. The changes in emergency department (ED) visits and in frequencies of emergency conditions and impact on clinical outcomes during Ramadan (3536 patients) in a tertiary care center in Beirut, Lebanon.^[85] The daily average ED volume was higher during non-Ramadan months compared with Ramadan. The average ED length of stay was higher during Ramadan. Frequencies and admission rates for the preselected list of diseases were comparable during the two periods, except for patients with acute coronary syndrome and stroke (lower during Ramadan). However, bounce-back rates and mortality at ED discharge were higher during Ramadan. The perspective of community pharmacists about professional services for patients with T2DM who may opt for observing the Ramadan fast was examined in Australia.^[86] The analysis indicated reactive counseling, lack of perceived need for counseling patients, or delegation of patient care in a few instances as well as organizational issues as a practice barrier. Some participants highlighted the need for training and skills development in this area and cited other organizational barriers such as time, infrastructure, and patient expectations/attitudes that might impede service provision. Key themes related to patients included experiencing adverse outcomes of fasting on diabetes, varying levels of self-efficacy, help-seeking behaviors, and negative attitudes to pharmacist involvement. Furthermore, a study examined what conditions influenced how community pharmacists incorporated new information into practice in a Middle East context.^[87] An educational program on the management of fasting in diabetes patients was developed and delivered to 41 pharmacists. Participants then maintained a record of their patient encounters when attempting to screen fasting diabetes patients for risk and offer medication, lifestyle, and monitoring advice. Thirty-five patients subsequently made at least one diary entry during the 3-week preceding and during Ramadan. Three main factors were found to influence pharmacists’ ability to engage use new knowledge and skills: situational, patient, and pharmacist. Patient’s reception made an overwhelming influence.

Two reports explored diabetes management practices among Muslims who chose to fast during Ramadan in the West. Data collected on 47 patients from the United States using a self-administered questionnaire that included measures on participants’ characteristics and diabetes management practices.^[88] The majority (61%) of participants was males; 90% had T2DM and 76% reported fasting during Ramadan. Approximately 26% of fasting participants reported decreasing the number of finger-stick glucose monitoring performed. Fasting participants were more likely to adjust the dose and timing of their medications but also more likely to include their health-care professionals (HCPs) in their health decisions. Almost 90% of fasting participants reported no increase in the amount of food consumed and no change in the consumption of concentrated sweets, greasy foods, and sugary drinks. The authors called for developing educational programs that involve religious leaders as well as HCPs to ensure patients receive health advice combining religious and medical directives. In

the second study, the experiences of diabetic patients during Ramadan 2016 in East London were described.^[89] Patients were surveyed on discussions with a health professional before Ramadan, whether they followed the advice given, the number of fasts undertaken, alterations in medication, and adverse events. Seven hundred and eighteen agreed to the survey; their median age was 52.1 years and diabetes duration was 13.6 years. More than half reported having discussed fasting with an HCP, and one-third was advised not to fast; of whom, 82% elected not to fast. Overall, 55.4% fasted at least once; the median number of days fasted was 16 (range 1–30). Nearly 82% made changes to their therapy; 6% reported episodes of hypoglycemia of whom two (0.3%) required third-party assistance.

Economic and cultural issues

A few articles addressed economic events and practices and some cultural aspects during Ramadan. These will be discussed briefly here. The effect of religious behavior on decision-making in the context of Ramadan was studied.^[90] The authors used an administrative data set of all personal and business bank loans originated in Turkey during 2003–2013. They found that small business loans originated during Ramadan are about 10%–15% more likely to become delinquent within two 2 years of origination than loans originated outside of Ramadan. Despite their worse performance, Ramadan loans had lower credit spreads. Consistent with Ramadan-induced judgment errors committed by individual loan officers, the authors found no relation between origination in Ramadan and the performance of personal loans which are mostly automated and large business loans where approval decisions are made by credit committees. Loans granted by banks whose loan officers are more likely to observe the Ramadan (particularly on hot Ramadan days) performed worse. Their identification strategy addressed alternative explanations including seasonality and changing borrower and loan characteristics during Ramadan. Another economic study addressed an attempt to quantify the impact of Ramadan on both the price and growth of global raw sugar price.^[91] Using two different models, it was found that monthly raw sugar prices in the global market increased by 6.1% every year ahead of Ramadan. There are very limited data on the acceptability of vaccination or blood sampling during Ramadan fasting month in Muslim countries. This could impact vaccination campaigns, clinical trials, or health care during Ramadan. Using a semi-structured questionnaire, a cross-sectional study on 201 practicing Muslims and ten religious leaders in Conakry, Guinea, was conducted in the wake of the recent epidemic Ebola epidemic.^[92] Acceptability of vaccination and blood sampling during Ramadan were investigated as well as reasons for refusal. Vaccination was judged acceptable by 46% of practicing Muslims and 80% of religious leaders whereas blood sampling was judged acceptable by 54% and 80% of religious leaders. Nearly 40% and 80% of the respective groups judged both blood sampling and vaccination acceptable. In decreasing frequencies, reasons for refusal of acts were that nothing should enter

or leave the body, adverse events could lead to breaking the fast, blood should not be seen during Ramadan, and that the Quran explicitly forbids it. Cultural beliefs that South Asian patients with diabetes about diabetes and the challenges that healthcare practitioners could encounter when providing care were examined.^[93] A “pre-Ramadan assessment” initiative was introduced in their surgery in London, which aimed to provide education on the risks associated with fasting and to improve patients’ self-management of their condition, thus reducing potential health complications. Health-related messages in printed media about diabetes care in Qatar during Ramadan using Qatar national newspapers which were published over 10 weeks before and during Ramadan 2012 were scrutinized.^[94] Articles describing diabetes and Ramadan combined were further evaluated according to specific features of prominence. Health-related articles appeared consistently throughout the study period, but few were specifically diabetes related. The authors identified the opportunity to augment the relatively low coverage of diabetes health-related messages in print media during Ramadan.

Ethical conflicts

Some ethical issues arising from fasting during the month of Ramadan for practicing Muslim patients were raised from the literature.^[95] Notable questions include what information was available regarding the fasting behavior of Muslim diabetics during Ramadan? What kind of ethical problems could be identified in the context of this religious practice? Relevant conflicts of interest originating in this situation were analyzed from an ethical perspective. Some problems concerning medication adherence and drug use of practicing Muslim diabetics during Ramadan, notably insufficient compliance, reduced the frequency of consultations with their doctor and inadequate, not sufficiently goal-oriented doctor–patient conversations about fasting. They highlighted that deficiency in medical as well as religious knowledge about fasting in Ramadan and a lack of sensitivity had been found among Muslim patients and doctors. Effective, goal-oriented action plans and projects through, which linguistic and cultural barriers, can be addressed to improve compliance. A specific example was the knowledge and attitude of 265 Muslim cancer patients regarding cancer treatment during Ramadan.^[96] Cancer patients receiving active oncological treatment or on surveillance were included, and patients on only supportive treatment were excluded from the study. The overall mean age was 49 years, and one-third was males. Surprisingly, only half of the patients sought advice on fasting and those having early disease more.

CLOSING REMARKS

Ramadan fasting for the healthy adult is an article of faith that is not subject for much medical interest only to learn on how it may affect people in sickness or during certain stages of life such as the children, the elderly, or pregnant people or times of hardship such as traveling or adverse weather circumstances. The recent increased academic interest in the

health implications of Ramadan fasting reflect in part the general movement toward an ethnically sensitive and culturally competent approach to health care and rising development in health care and research in Muslim-majority regions.

The continuously increasing volume of literature on health-related issues of Ramadan fasting has spanned a wide range of physiological and clinical aspects, crossed conventional disciplinary lines in various languages, locations, and systems of journal access. This volume of literature deserves a scoping narrative over periodically. This is the first of our series “The Year in Ramadan Research.” A narrative review was the most suitable approach as any attempt of systematic review would have excluded the majority of the work published in the year. Diabetes, hypoglycemia, insulin, and body composition were among the most relevant issues addressed this year [Figure 1]. Discipline wise, diabetes, physiology, gastrointestinal, cardiovascular, eyes, respiratory, nephrology, neuropsychiatry, and endocrinology were most prominent. Numerous articles focused on professional competence, education, ethics, culture, and organization of care. Many of the research groups are based in countries with Muslim-majority which should provide great opportunities for collaboration. However, the overwhelming proportion of publications was widely distributed in international journals which should give wider visibility and opportunities for cross-referencing. Several workers and research groups seem to have “the medical aspects of Ramadan fasting” at the center of their academic work inferred from the number of publications to which they have contributed. A spirit of collaboration rather than competition is crucial to address the most important questions with adequate numbers to secure valid answers. The limited availability of funding resources for this area of research calls for prudence as a management strategy to preserve funding and charitable voluntary as the driving motive for participation in the Ramadan research and education work. The authors hope that the present special review brings many people to the same page and help direct further research and inform clinical practice guidelines.

Declaration of patient consent

The authors certify that they have ascertained that appropriate patient consents were documented in the original case reports referred to in this article.

Authors' contribution

All authors contributed to the conception, drafting, revision, and finalization of this manuscript.

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Conflicts of interest

There are no conflicts of interest.

Compliance with ethical principles

No ethical approval is required

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