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ISPAD GUIDELINES

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ISPAD Clinical Practice Consensus Guidelines 2022: Ramadan and other religious fasting by young people with diabetes

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1 | WHAT IS NEW OR DIFFERENT

- The 2022 edition of the guideline provides updates of previous sections and includes fasting in other religions in addition to Ramadan.
- Evidence on the use of continuous glucose monitoring (CGM) and continuous subcutaneous insulin infusion (CSII) during fasting.
- Fasting in young people with type 2 diabetes (T2D).

2 | EXECUTIVE SUMMARY AND RECOMMENDATIONS

2.1 | Pre-fasting counseling

- Pre-fasting counseling and diabetes education is recommended for all children and adolescents with type 1 (T1D) and T2D who want to fast for religious reasons. **E**

- Pre-fasting education addresses insulin type and action, glucose monitoring, nutrition, physical activity, sick days, hyperglycemia, as well as recognition and treatment of hypoglycemia. **E**
- Pre-fasting counseling on the permissibility and necessity of finger prick self-monitoring of blood glucose (SMBG) or insulin injection during fasting to prevent acute complications is important. **E**
- Optimizing glycemia before fasting is an essential measure to ensure safe fasting. **C**
- The presence of hypoglycemia unawareness needs to be excluded pre-fasting and monitored during fasting. **C**

2.2 | Glucose monitoring

- Frequent SMBG or CGM is recommended during fasting to minimize the risk of hypoglycemia and detect periods of hyperglycemia. **B**
- Use of real-time CGM (CGM) or intermittently-scanned CGM (isCGM) may facilitate the adjustments of insulin dosing during fasting. **E**

2.3 | Nutritional management

- Consider the quality and quantity of food offered after breaking the fast to prevent acute complications, excessive weight gain, and adverse changes in lipid profile. **C**
- Consider meals based on low glycemic index carbohydrates and include fruit, vegetables, and lean proteins. Monounsaturated and polyunsaturated fats should be used instead of saturated fats. Sweets and fried foods should be limited, and sweetened drinks avoided. **C**
- For Ramadan fasting, consider consuming the pre-dawn meal (*Suhor*) as late as possible. **E**
- Carbohydrate counting at the pre-dawn and sunset (*Iftar*) meals enables the rapid-acting insulin dose to be matched to the carbohydrate intake. **C**
- Maintain hydration by drinking water and other non-sweetened drinks at regular intervals during non-fasting hours. **E**

3 | BREAKING THE FAST

- Break the fast immediately, regardless of the timing, if hypoglycemia occurs. This applies to symptomatic and asymptomatic hypoglycemia (blood glucose levels [BGL] <70 mg/dl or 3.9 mmol/L). **E**

3.1 | Principles of care

- It is suggested that care for young people with T1D during fasting be undertaken by experts in the management of diabetes in this age group. **C**
- Regular supervision by health-care professionals during the month of Ramadan and periods of fasting in other religions is necessary to minimize potential risks including hyperglycemia, hypoglycemia, ketoacidosis, and dehydration. **C**

3.2 | Medico-religious recommendation

- We suggest that a consensus on the minimum age of fasting needs to be established by task-force members with knowledge and interest in religious fasting. This should be endorsed by religious scholars to unify rules on fasting and exemption. **E**
- Proper understanding of religions' rules on fasting and sickness, which allows individuals with medical conditions to not fast, is important. Liaison with religious scholars should help to persuade those who do not qualify for fasting and avoid their feelings of guilt. **E**

4 | GENERAL RULES OF OBSERVING FASTING IN DIFFERENT RELIGIONS

Fasting is advised, with variable rules, in healthy adults and adolescents in different religions. A common purpose of fasting in these religions is to gain self-restraint, arouse spiritual consciousness, and better understand the plight of the poor and hungry. In this section, general rules and religious guidance on observing and breaking fasting in different religions are given, with emphasis on potential effects on health and glycemic outcomes in children and adolescents with T1D who choose to fast.

4.1 | General rules of Islam on Ramadan fasting

Ramadan fasting is one of the five pillars of Islam and is obligatory for all healthy adult and adolescent Muslims from the time of completing puberty.[1] As per the Islamic rules and guidance from *Sunnah* (the way of prophet Mohamed), an individual becomes subject to *Shari'a* rulings that apply when specific features of puberty are attained.

Approximately 1.9 billion Muslims celebrate the ninth month of the Hijri (lunar) calendar notable for Ramadan fasting all over the world.[2] The Epidemiology of Diabetes and Ramadan (EPIDIAR), a population-based study conducted in 13 countries and involving almost 13,000 adults with diabetes, showed that 78.7% of individuals with type 2 diabetes (T2D) and 42.8% of those with T1D fast for at least for 15 days during Ramadan. Saudi Arabia had the maximum number of individuals with T1D who chose to fast.[3]

The duration of fasting during Ramadan varies based on geographical location and season but is mandated to be between dawn and dusk. During this period, people who fast abstain from eating, drinking, use of oral medications, and smoking. There are no restrictions on food or fluid intake between dusk and dawn.[1,4] Fasting during Ramadan is not intended to bring excessive difficulty or cause any adverse effect to the individual. Islam has allowed many categories of people to be exempted from fasting; for example, menstruating,

pregnant or breastfeeding women, prepubertal children, the elderly, individuals with any acute or chronic illness in whom fasting would be detrimental to health, individuals with an intellectual disability, or individuals who are traveling.[1] These principles formed the basis of all the consensus statements by several groups.[5–7] The provisions of *al-Fitr* (i.e., *Not to observe the fast*) in Ramadan apply if there is any sickness, according to the Almighty saying: "Whoever of you is sick or on a journey, and some of the other days, and on those who support him, ransom poor food."[1] Therefore, if a person fasts and experiences harm or serious hardship while fasting, he/she may be committing a sin.[4]

Various beliefs exist regarding diabetes management practices during Ramadan. In a study of fasting during Ramadan that included 800 individuals with diabetes, 67% indicated that pricking the skin to measure BGLs breaks the fast.[8] Such a belief might endanger individuals with diabetes and predispose them to acute complications. Medical counseling and liaison with Islamic scholars can help correct wrong interpretation as well as understanding and ensure safer fasting. Although some experts would consider fasting, particularly during Ramadan, a practice at high risk for metabolic deterioration, recent studies have demonstrated that individuals with T1D can fast safely during Ramadan, provided they comply with the fasting-focused management plan and are under close professional supervision.[6,9]

4.2 | Relevant rules of Christian "Orthodox" fasting

The Eastern Christian Orthodox Church is the second-largest Christian church, with ~300 million members.[10] Orthodox Fasting (OF) is a basic and traditional component of the religion, practiced by a large proportion of the Orthodox population.[11] OF includes three main fasting periods: 40 days prior to Christmas, 48 days prior to Easter, 14 days prior to Assumption, along with the fasting period prior to the feast of the Holy Apostles (lasting from 0 to 30 days depending on Easter feast), three other daily feasts (January 5, August 29, September 14), as well as every Wednesday and Friday. Individuals 18–59 years old are expected to fast during these periods.

OF is a kind of periodical diet which recommends abstaining from meat, dairy products and eggs for about 180 days annually, and also abstaining from fish for 155 days. The diet during periods of fasting is characterized by increased consumption of cereals, legumes, fruits, vegetables, nuts and seafood. For this reason, it may be considered as a vegetarian dietary pattern, where fasting and non-fasting periods alternate, sharing common features with the classical Mediterranean Diet.[11,12]

Studies on OF followers conducted in three different countries (Greece, United States, and Egypt), reported low total energy intake, low fat (total, saturated and trans), low animal and high vegetable protein intake, high complex carbohydrate and fiber intake, high vitamin C, folate and magnesium intake, low calcium and vitamin D intake during different fasting periods.[13,14]

The OF meal plan tends to be high in carbohydrate content. Thus, it is advisable for people with T1D to choose carbohydrates with a low glycemic index, and consume them in combination with fiber, proteins (legumes, seafood) or fats (olive oil). Rye, barley, oats, brown rice, quinoa or amaranth are also suitable.[15]

Although data on the effect of OF diet on metabolic health are heterogenous, a potential benefit on lipid profile has been suggested, whereas there are no data on the effects on cardiovascular and musculoskeletal outcomes. Negative aspects of OF, primarily attributed to dietary limitations of specific vitamins (D and B12) and minerals (calcium and iron), should not be ignored, and relevant guidance might be provided to people following OF by health care professionals.[13]

4.3 | Relevant rules of Yom Kippur and other fasts in Jewish law

Yom Kippur fasting is a major fast and the holiest day in the Jewish religion and calendar.[16] It is obligatory for all healthy adult and adolescent Jews from the age of 13 years in males and 12 years in females. All observant and most non-observant Jews practice this 25 h long fasting. It starts at dusk (end of the ninth of Tishrei—first month of the Jewish lunar year) and ends on the following day (10th of Tishrei) at sunset.[16] The activity during this fast involves mostly prayer and soul searching within synagogues. Jewish law includes five other days of fasting between dawn and dusk, and these are mostly practiced only by observant Jews.

During fasting, Jews abstain from eating, drinking, and smoking. Fasting is not intended to cause any adverse effect to the individual.[17] Jewish law allows many categories of people to be exempted from fasting; for example, prepubertal children, women in and around delivery days, individuals with illnesses in whom fasting may be detrimental to health, and individuals with an intellectual disability.[17] Jewish law defines an intermediate state where people who need to break their fast due to health reasons can intermittently eat small portions of 30 g in line with a scheduled time plan.[16]

Various approaches for diabetes management during fasting have been used. Initially, prior to the era of glucometers and CGM, people with diabetes were exempt from fasting. In the last two decades, several studies showed that insulin dose adjustments and close monitoring may enable safe fasting for individuals with T1D.[18–21] Jewish law indicates that specific medical counseling and liaison with Jewish legal scholars should facilitate and help to ensure safer fasting for the individual.[19–21]

4.4 | Fasting in Hinduism, Buddhism, Jainism and other religions

Fasting is also common in other religions in the world. It is well known that followers of Hinduism, Buddhism and Jainism believe that the act of fasting would result in the spiritual transformation of the individual or community.

In Hinduism, different forms of fasting are frequently practised throughout the year. Fasting is not considered an obligation, but a

spiritual and moral act, the aim being to purify the body and mind to acquire self-restraint and divine grace. There are different forms of fasting which vary according to personal, family and community beliefs, which may be strict and difficult to follow, or relatively easy and readily amenable to modifications. The fasting period can be for a single day, weekly (on specific day/s throughout the year), bi-monthly (*Pradosha*—13th day of every fortnight of the Hindu calendar), monthly (*Ekadashi*—11th day of the Hindu lunar month, and *Purnima*—the full moon day). Longer fasting periods may last 9 days and are followed once or twice a year (*Navratras*), or of 1-month duration (*Kartik month*). Variability exists according to timing, duration and type of food intake, including no food and water intake, only water allowed; fruit and milk allowed, and broken rice or millets allowed.[22]

In Buddhism, while fasting is generally practiced by monks, lay people may fast voluntarily as part of a personal spiritual observance. Buddhist Lent is the fast and feast observed for three lunar months every year during the rainy season, when Buddhists fast for a 12-h period, from noon to midnight, followed by feasting for 12 h from midnight to noon.[23] Some devout lay Buddhists also follow the rule during special days of religious observance when one must not eat after the noon meal. The duration of fasting can vary from three (*sanzhai*) to 6 days (*liuzhai*).[24] In the first half of the first, fifth, and ninth months, a continuous long fast (*changzhai*) is also observed.

Fasting is similarly prevalent in Jainism, observed during festivals, holy days, birthdays and anniversaries. There are several types of fasts, varying from 24–36 h to several days and months. *Paryushan* is the main festival during the monsoons, which usually lasts eight or 10 days, respectively, in the Swetambara and Digambara Jain tradition (the two main sects of Jainism).[25] Digambar Jains usually will not consume food and/or water (boiled) more than once in a day; while Shwetambar Jains drink only boiled water during their fast days. Many Jains observe a type of fasting by abstaining from food and water after sunset. *Varshitap* (year-long fast) is a type of fasting in Jainism where devotees fast for 13 months and 13 days, in which they fast completely on alternate days and eat a limited diet between sunrise and sunset on the other days.

The Bahais fast for 19 days in the month of Ala (March), when no food or water is consumed from sunrise to sunset by persons 15–70 years old. In Taoism, fasting is observed in the form of "*Bigu*," where grains are avoided.

5 | WHY GUIDELINES ON FASTING FOR YOUNG PEOPLE WITH DIABETES ARE NEEDED?

Many reviews, consensus statements, and expert opinions detailing the principles of diabetes care during fasting (especially during Ramadan) have been published.[5–7,26–28] A comprehensive guide has been developed by the International Islamic Fiqh Academy, along with the Islamic organization of health sciences, after a thorough literature review of possible risks to people with diabetes associated with Ramadan fasting. Among defined risk stratification groups, T1D is considered to be a very high-risk group.[29,30] However, this document is not specific to young people with diabetes, and overall studies on religious fasting in this population are limited.[31]

A survey by Elbarbary et al. highlighted variations among physicians, from 16 predominantly Muslim countries, in the management of children and adolescents with T1D. There are substantial variations in the perceptions, beliefs, general management, and the practice of insulin therapy in this age group during fasting.[32] The survey also highlighted limitations related to relying on data on the safety and metabolic impact of fasting based on studies conducted in adults with T2D.[32] Furthermore, there is minimal literature on fasting-related issues in religions other than Islam.

6 | SHOULD ADOLESCENTS WITH T1D FAST DURING RELIGIOUS OBSERVANCES?

In many diabetes centers managing Muslim populations, healthcare professionals agree that adolescents can fast if they have reasonable glycemic control, good hypoglycemia awareness, and the willingness to frequently monitor their BGLs during fasting.[33] A recent survey indicated that almost 80% of physicians looking after children and adolescents with diabetes would allow them to fast if they wished.[32]

7 | PRE-FASTING DIABETES EDUCATION

Pre-fasting assessment and education are vital to ensure the suitability and safety of fasting in young people with diabetes. Many diabetes units run special education sessions prior to the month of Ramadan to ensure safe fasting.

Strategies for pre-fasting diabetes education and assessment include the following:

1. Fasting-focused education, including nutrition, physical activity, and insulin dose adjustment, as well as emergency management of hypoglycemia, hyperglycemia, and diabetic ketoacidosis (DKA).
2. Medical assessment including evaluation of hypoglycemia awareness.
3. Optimization of glycemia before fasting to reduce the potential risks associated with fasting and minimize glucose fluctuations.
4. Frequent SMBG, or the use of real-time CGM (CGM)/isCGM, along with training on how to interpret readings and actions to take.
5. The requirement is to immediately breakfasting to treat hypoglycemia or prevent acute complications.

The lack of pre-fasting assessment and proper diabetes education are major obstacles for safe fasting in people with T1D.[32,34] Eid et al. showed that an educational program consisting of weekly sessions before and during Ramadan, enabled people with diabetes to fast safely, with a reduced number of hypoglycemic events per month.[35] A systematic review showed that Ramadan-focused diabetes education in T2D resulted in a substantial reduction of hypoglycemia and

improvement in HbA1c.[36] Structured education has also been associated with a 61% decrease in DKA risk in adults with T1D.[37]

The dose adjustment for normal eating (DAFNE) education program highlights the importance of flexible dosing, carbohydrate counting and matching insulin to carbohydrate intake.[38] This, together with rtCGM or isCGM, can help people with uncomplicated T1D to safely fast during Ramadan.[39,40] In a study from Kuwait, people with T1D using CGM and provided with DAFNE training had a reduced incidence of hypoglycemia during Ramadan compared with the pre-Ramadan period. No episodes of severe hypoglycemia, DKA, acute kidney injury, or hospitalization occurred during Ramadan, including no evidence of increased glucose variability.[39,40] Other studies demonstrated that individuals with T1D who received Ramadan-focused education showed more willingness to fast, since they were more capable of managing their diabetes, and they had better glycemic outcomes and fewer complications.[41,42]

Qualitative studies suggest that structured Ramadan-focused education needs to be developed and implemented in clinic practice.[38,41,43] The DAR practical guidelines 2021 also suggested that individuals with diabetes wishing to fast and receiving pre-Ramadan assessment and education, should fast for a few days during the 2 months preceding Ramadan.[9]

In summary, wider implementation of fasting-focused education for both individuals with T1D and T2D, especially those on insulin therapy, is of paramount importance.

8 | TELEMEDICINE

Based on the growing number of technologies that support diabetes care, telemedicine has been proposed as an important solution to meet the need of expanding care for the benefit of people with diabetes, while improving efficiency and containing costs.[44] During the COVID-19 pandemic, telemedicine and telemonitoring have shifted from an aspirational goal to a de facto standard of care for diabetes management.[45]

Limited studies have investigated the role of telemedicine in the management of diabetes during Ramadan or other religious fasting, especially in adolescents with T1D.

In 2020 and 2021, the Holy Month of Ramadan coincided with the COVID-19 pandemic and lockdown. Limited access to healthcare and the continuous need for diabetes assessment and consultation before and during Ramadan highlighted the urgent need for digital health solutions in diabetes care. The DAR Global Survey on 1483 Muslim participants with T1D showed that 26.8% of those aged <18 years and 73.2% of those aged ≥18 years fasted during Ramadan during the 2020 COVID pandemic.[46]

When comparing the short-term benefits of a telemonitoring-supplemented focused diabetes education with education alone in individuals with T2D who fasted during Ramadan, frequency of hypoglycemia was lower in the telemonitored group.[47] Similarly, the "Making Ramadan Fasting A Safer Experience (MRFAST)" study showed reduced episodes of hypoglycemia and greater reduction in HbA1c in participants with T2D assigned to the telemonitoring group compared to the control group.[48] Participants viewed telemedicine as a more convenient alternative, although technological barriers remain a concern. A prospective study assessed the role of a 24-h Helpline Service for people with diabetes during Ramadan and supported its key role in promoting safe fasting and reducing unnecessary hospital visits and admissions.[49] More than half of the 927 calls were queries related to glucose monitoring data and insulin dose adjustment in T1D.

Overall, telemonitoring offers an attractive option for managing diabetes during Ramadan and other religious fasting, but further data in adolescents with diabetes are needed.[50]

9 | PHYSIOLOGY OF FASTING

In healthy individuals, during fasting circulating BGLs tend to fall leading to decreased insulin secretion. In addition, levels of glucagon and catecholamines rise, stimulating glycogenolysis and gluconeogenesis.[51] In the early hours of fasting, glycogenolysis meets the glucose requirements of the body. This is followed by gluconeogenesis, and later ketogenesis, if the duration of fasting is prolonged. Similar responses, albeit to a lesser extent, occur during the intermittent fasting that occurs during Ramadan.

In people with T1D, hypoglycemia that occurs during fasting may not elicit an adequate glucagon response.[52,53] In addition, individuals with autonomic neuropathy can have defective epinephrine secretion to counteract hypoglycemia.[54] In individuals with T1D fasting during Ramadan or other religious observances, abnormalities in the counter-regulatory hormones (glucagon, cortisol and catecholamines) may also be present due to disruption of the normal circadian rhythms and the sleep-wake cycle. In addition, there is risk of hypoglycemia associated with exogenous insulin treatment during fasting with changes in meal timing.[53]

Several studies have focused on the changes in glucose homeostasis during Ramadan fasting. In a study in young adults without diabetes[55] using CGM 1- to 2 weeks before, in the middle and 4 to 6 weeks after Ramadan, an increase in the hyperglycemic area above 140 mg/dl was noted after Ramadan, compared with both before and during Ramadan, along with increased glucose variability.[55] However, limited data are available on the safety and metabolic effects of fasting in children and adolescents with T1D.[3]

In a study assessing the impact of Ramadan fasting on resting metabolic rate (RMR), activity, and total energy expenditure (TEE), fasting was associated with reduced physical activity and reduced RMR, without an overall reduction in TEE. Ramadan differs from both prolonged and short-term starvation, as the former decreases RMR, whereas short-term starvation may increase RMR, and this has been attributed to a rise in norepinephrine concentrations.[56]

10 | PSYCHOLOGY AND ATTITUDE TOWARD FASTING

Many adolescents with T1D prefer to fast to feel equal to their peers without diabetes.[57] Fasting may boost their self-esteem and make

them happier as they feel "mature and capable" in fulfilling their religious obligations. However, considering the risk of acute metabolic complications in individuals with T1D, they are often advised not to fast.[5–7,26,28,58] Despite the fact that having diabetes grants an exemption from fasting, a large number of youth with diabetes are passionate about Ramadan, and undergo fasting based on social and cultural reasons and a religious sense of fulfillment.[3,57] Young people with diabetes may often fast without the knowledge or approval of their physicians.[59]

Predictably, there is a general fear among persons with T1D and their health-care providers about the use of insulin therapy during the fast, due to the increased risk of hypoglycemia.[60] Hypoglycemia during the daytime is the most disliked complication as its treatment entails the intake of carbohydrate and therefore leads to breaking the fast prematurely. The interruption of fasting may induce a sense of guilt and failure.[61] Data indicate that the majority of Muslim adolescents and older children with T1D are able to fast during Ramadan, with a high proportion of them encouraged by their parents to do so.[61] Their expectations of developing complications are realistic, but they underestimate the deterioration in glycemic control during the month. It is reassuring that the majority agree to break their fast should complications arise, which makes fasting safer for them.

The DEAR program (Diabetes Education and medication Adjustment in Ramadan) aimed to optimize glycemic control prior to Ramadan, and provide risk assessment, preparation, monitoring and intervention pre-, during and post-Ramadan.[62] The program was also initiated to focus on covering the relevant religious and medical aspects through engaging a religious leader and Muslim healthcare professional team. The study highlighted that deficiencies in knowledge among healthcare professionals regarding Ramadan fasting can lead to people with diabetes choosing not to inform their healthcare team that they will fast, particularly in Muslim minority countries.[62]

Depending on where the adolescents live, they often attend school for the whole day, and partake in after-school activities, including sports, during Ramadan, even though they experience sleep disturbances and changes to routines, with late-breaking of the fast and waking early to have the pre-dawn *Suhoor*. For adolescents with T1D, fasting adds more challenges, especially for those living in Muslim minority societies, where there may not be adjustments made to school and sports schedules, particularly when the hours of fasting are longer (summers).

The psychological effects of fasting during Ramadan can vary. Both healthy individuals and people with diabetes can experience opposing psychological outcomes for different reasons, including the changes that accompany the practice of fasting.[63] Further research is needed to assess the psychological effects of fasting during Ramadan in adults as well as adolescents with T1D or T2D.

11 | FASTING: POTENTIAL COMPLICATIONS AND SAFETY

Potential risks associated with fasting are hyperglycemia, hypoglycemia, DKA, thrombotic episodes, and dehydration.[5–7] Although most of the available data are based on adult studies, an individualized approach, close monitoring of BGLs and weekly follow-up with the medical team is the best approach to prevent acute complications in both adults and young people with diabetes.[64]

12 | IMPACT ON GLYCEMIC OUTCOMES

Data on the impact of Ramadan fasting on glycemic outcomes are based on few small studies with inconsistent results. Some studies in children with diabetes demonstrated a significant improvement in fructosamine levels, whereas others showed no changes, or even an increase in HbA1c levels.[57,61,65–68]

Some studies[3,68] have shown that Ramadan fasting in individuals with T1D might predispose to acute complications, although this has not been confirmed by others. Overall, fasting can be considered a safe practice if people with diabetes monitor BGLs frequently and break the fast when hypoglycemia or marked hyperglycemia occur[18,58,64,69,70] Besides, Ramadan fasting has been found safe when pre-fasting medical assessment, focused education, appropriately adjusted insulin regimens, diet control, and management of daily activities have been implemented in individuals with stable diabetes control and no comorbidities[57,68,70] Studies have shown that adolescents are able to fast for several days during the Ramadan month,[71,72] but unplanned fasting may predispose to hypoglycemia and hyperglycemia with or without ketosis.[28,59]

13 | ACUTE COMPLICATIONS

13.1 | Hypoglycemia

Hypoglycemia is a major complication of fasting. The EPIDIAR study of 1070 adults with T1D reported that fasting during Ramadan increased the risk of severe hypoglycemia by 7.5-fold. During Ramadan, 2% of people with diabetes experienced at least one episode of severe hypoglycemia requiring hospitalization.[3] In a pediatric study symptomatic hypoglycemia resulted in breaking the fast on 15% of the days.[72]

In addition, CGM data have shown wide BGL fluctuations during fasting and eating hours and episodes of unreported hypoglycemia.[72] The frequency and duration of hypoglycemia, hyperglycemia, and severe hyperglycemia were significantly higher in adolescents with T1D who had pre-Ramadan suboptimal than those with good glycemic control.[73] In a retrospective study of 50 children and adolescents with T1D (age 12.7 ± 2.1 years), those with HbA1c >8.5% had more frequent episodes of hypoglycemia than those with HbA1c ≤8.5%.[74]

Hypoglycemia has been typically encountered during the hours preceding *Iftar*.[75] Young adults with suboptimal management of T1D experienced wide fluctuations in glucose levels between the fasting and eating hours, with a greater tendency toward hyperglycemia.[76]

13.2 | Breaking the fast due to hypoglycemia

Monitoring BGLs during fasting is essential to predict, prevent, and treat hypoglycemia. It is of paramount importance that BGL is checked if any symptoms suggestive of hypoglycemia are experienced, so that the fast is interrupted promptly. However, some young people may not be willing to break their fast, particularly if hypoglycemia occurs close to sunset (time to end the fast for the day), and this may predispose them to a severe hypoglycemia. A study of 33 children with T1D in Bangladesh showed that only 3 out of 13 children broke their fasting following onset of symptoms of hypoglycemia.[77] However, in another study[61] most children and adolescents were willing to terminate their fasting when hypoglycemia occurred, regardless of the time of the day. Education might persuade young people with diabetes to break the fast when hypoglycemia occurs.

13.3 | Diabetic ketoacidosis

Fasting increases glucagon levels and accelerates lipolysis and ketosis. These pathophysiological changes, in conjunction with fasting itself, may lead to metabolic decompensation in people with diabetes. Episodes of DKA have been reported during Ramadan fasting.[78,79] Detection of euglycemic ketosis during fasting requires evaluation of acid–base state, blood glucose and ketone values (ideally blood ketone measurements, if available) to differentiate DKA from ketosis due to prolonged fasting.[80] See ISPAD 2022 Consensus Guidelines Chapter 12 on Sick Day Management in Diabetes for further details on ketosis monitoring.

14 | INSULIN MANAGEMENT DURING FASTING

Knowledge of insulin action, interpreting glucose values and adjusting insulin doses for *Iftar* and *Suhoor* meals, is a prerequisite for safe Ramadan fasting. Based on clinical experience, different recommendations on how to adjust the type, dose, and timing of insulin in adults have been suggested.[69,81,82] However, clear evidence-based guidelines on insulin adjustment for adolescents with T1D are lacking.

Current recommendations for people on multiple daily injections (MDI) include a reduction of the total daily dose (TDD) of insulin to 70%–85% of the pre-fasting TDD[27,82] or 60%–70% of the pre-fasting dose of basal insulin.[7] For people on continuous subcutaneous insulin (CSII), a reduction of the basal rate of insulin infusion by 20%–40% in the last 3–4 h of fasting is recommended.[7] The South Asian Guidelines for Management of Endocrine Disorders in Ramadan recommend reducing basal insulin by 10%–20% during the fast days.[79,80] However, these recommendations are not based on data from large cohort studies or randomized controlled studies. Some studies have not shown a reduction in frequency of hypoglycemia with reduction of basal insulin in MDI and CSII regimens, although this has not been confirmed by all studies.[83,84] A suggested guide for adjustment of insulin dosages is given in Figure 1.

15 | INSULIN REGIMENS FOR ADOLESCENTS WITH T1D

Management of diabetes during fasting should be discussed on an individual basis, depending on access to different insulins and technology. Once fasting has started, insulin dosing should be regularly adjusted based on the results of glucose monitoring. Frequent BGL measurement is essential. MDI and CSII are the preferred regimens in young people with T1D during Ramadan.[85] In some regions, treatment with two or three daily injections with NPH and short-acting insulin may be used. Use of premixed insulin regimens require fixed intake of carbohydrates at set times and is not advised.

16 | BASAL-BOLUS INSULIN TREATMENT

16.1 | Basal insulin

16.1.1 | Long-acting insulin analogs

Insulin analogs have been safe for the management of well-controlled young people with diabetes during a fasting period of 17–19 h. A significant decline in glucose levels, with periods of hypoglycemia, is seen mostly near the end of the fasting period, although no episodes of severe hypoglycemia have been reported.[7,57,65,69,72,86,87] It is recommended that during Ramadan, the pre-Ramadan basal insulin dose should be reduced by 20%, when given in the evening.[5,27,57,68–71,87] When taken at *Iftar*, a further reduction may be needed—up to 40% of the pre-Ramadan basal dose.[7,88] Further individualized adjustment of the dose needs to be considered.

16.1.2 | NPH insulin

Based on the pharmacodynamic profile of NPH, there is a considerable risk of mid-day hypoglycemia and end-of-the-day hyperglycemia. Reduction of the dose is needed to prevent hypoglycemia, at the possible expense of higher BGLs at the end of the day.

16.2 | Bolus insulin

In most studies, the pre-*Iftar* and pre-*Suhoor* rapid-acting insulin doses are equal to the pre-Ramadan lunch and dinner doses, respectively. In some reports, the pre-dawn dose is reduced by 25%–50%,[7] depending on the carbohydrate content of the meal and the pre-meal BGL. In an adult study, the use of rapid-acting insulin analogs was associated with fewer hypoglycemic events and an improvement in postprandial glycemia compared with regular insulin.[89] Higher BGLs may require

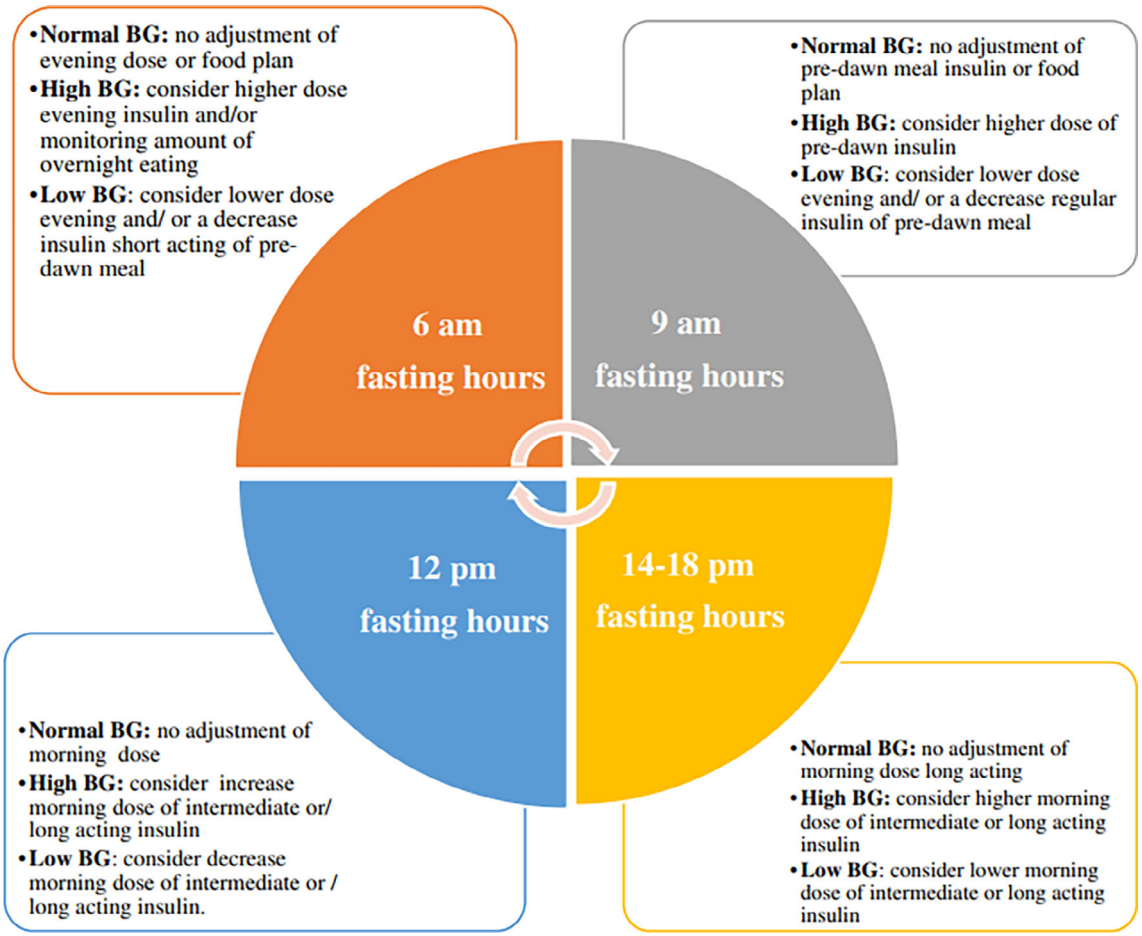

FIGURE 1 Schematic adjustments of insulin dose and/or food considerations during fasting hours

an additional dose of insulin administered as a correction dose, which is usually based on the pre-Ramadan correction factor.

16.3 | Twice daily insulin treatment

Two daily injections of NPH and regular insulin allow less flexibility in lifestyle and nutrition with more risk of hyperglycemia and hypoglycemia; therefore, their use is strongly discouraged. Owing to the NPH peak effect, dose adjustment for a 12–16 h period of fasting is more challenging.[84] Children on a twice-daily insulin regimen are much more prone to experience hyperglycemia with/without ketones than those on a basal-bolus regimen.[84] Using twice-daily insulin regimens during Ramadan requires more dose adjustments, taking the usual morning dose before the sunset meal and only short-acting insulin at the time of their dawn meal.

16.4 | Premixed insulin

Premixed insulin is not recommended in people with T1D. Premixed insulin given twice daily requires fixed intake of carbohydrates to coincide with the peaks of insulin activity. During fasting, it is difficult to properly adjust carbohydrate intake in *Suhoor* and *Iftar*; therefore the use of premixed insulin is not advised.[9] However, many individuals with T1D, especially in regions where basal-bolus insulin is not prescribed or available, use premixed insulin. These individuals can either refrain from fasting, but those who still want to participate in Ramadan fasting, should discuss with their physicians before Ramadan starts, regarding the safety of using premixed insulin while fasting and the importance of blood glucose monitoring to detect hypoglycemia.

17 | INSULIN PUMP THERAPY

The use of insulin pumps can facilitate insulin adjustment and decrease the risk of hypoglycemia and hyperglycemia during fasting.

17.1 | Basal rate

Lowering the basal insulin infusion rate temporarily or suspending it, can help people with T1D to avoid major hypoglycemic events and

TABLE 1 List of commonly eaten food during the month of Ramadan

Food	Serving size	Carbohydrate (g)
Fruits and vegetables		
Dried figs	2 figures (28 g)	16
Fresh dates	1 date (19 g)	6
	3 dates (57 g)	18
Dried dates	1 date (6 g)	4
	3 dates (18 g)	12
Dried apricot	1 half (6 g)	2
	8 halves (48 g)	17
Sultanas	Snack pack (40 g)	30
Dried barberries	1/4 cup (37 g)	20
Cakes, pastries, and sweets		
Chocodate Arabian delights (chocolate-coated dates with nut inside)	1 piece (11 g)	7
Mouhalabieh (milk flans)	1 cup (200 g)	30
Galactobureko (filo custard pastry, syrup soaked)	1 piece	28
Baklava	1 piece (50 g)	26
Turkish delight	1 piece (18 g)	15
Kanafeh	1 square, 6 tablespoons (120 g)	40
Halva (nut butter-based, e.g., tahini)	2 tablespoons, (50 g)	22
Ghraybeh (butter cookies)	1 cookie (15 g)	7
Ma'mool/maamoul/ma'moul (cookies stuffed with walnuts/dates)	1 cookie (35 g)	23
Basbousa (sweet semolina cake soaked in syrup)	1 slice (30 g, 3 cm × 3 cm)	14
Sekerpare (butter cookie soaked in syrup)	1 piece (18 g)	16
Tulumba (fried dough soaked in syrup)	1 piece (35 g)	37
Lokma (sweet fried dough)	1 ball (13 g, 2 cm diameter)	10

improve glycemic control during fasting.[64,68,70] In most studies, the basal insulin rate is reduced by 10%–15% during the hours of fasting; with some suggesting a reduction up to 40% toward the end of the day.[70,72,73,90] However, one study did not show any difference in hypoglycemia frequency if the basal rate is reduced.[83]

17.2 | Bolus

Insulin boluses covering the predawn and sunset meals have been either increased[70] or unchanged as per the pre-Ramadan insulin-to-carbohydrate ratio and insulin sensitivity factor.[72,75,90] In studies in young people on CSII, none developed severe hypoglycemia or DKA during Ramadan fasting.[64,70,72,75,83,90]

The benefits and risks of CSII or MDI during Ramadan were recently assessed by two systematic reviews and meta-analyses.[53,91] Loh et al.[53] pooled data from 17 observational studies involving 1699 persons treated with either CSII or non-CSII regimens and concluded that the CSII regimen was associated with lower rates of severe hypoglycemia and hyperglycemia, but higher rates of non-severe hyperglycemia than MDI regimens. These findings suggest that appropriate selection of individuals, with regular adjustments of the basal insulin rate and intensive glucose monitoring, might mitigate the hypoglycemia risk during Ramadan. However, analysis of observational studies[91] using CSII versus MDI during Ramadan did not show any differences in weight, HbA1c or lipid levels.

17.3 | Sensor-augmented pumps

Fasting during Ramadan is feasible with sensor-augmented pumps (SAP), with adequate counseling and support.[65,84] Significantly, fewer episodes of hypoglycemia have been observed with use of the predictive low-glucose insulin suspend algorithm in 60 adolescents with T1D.[90]

18 | THE ROLE OF NEWER INSULINS

Although some experience with newer insulins in adults with diabetes has been reported, further data are needed in the pediatric population to establish clear guidance around their use. These include more concentrated insulin formulations (insulin glargine U300) and the newer basal insulin degludec, with flatter pharmacodynamic profiles.[92]

Insulin degludec is approved for clinical use from the first year of age and is associated with lower rates of nocturnal hypoglycemia,

more flexibility in timing of insulin administration and better quality of life compared to other basal insulins.[93–95] These advantages might be of utmost importance especially during fasting.

The ORION study,[96] a prospective, observational, international multicenter study, evaluated the safety and effectiveness of Glargine 300 units/ml in insulin-treated adults with T2D before, during and after Ramadan in a real-world setting, found a low risk of severe/symptomatic hypoglycemia and improved glycemic control.

Hassanein et al.[97] showed that in adults with T2D during fasting, insulin degludec/insulin aspart (IDegAsp) is effective, safe and well tolerated.

19 | NUTRITION MANAGEMENT DURING RELIGIOUS FASTING

19.1 | Pre-fasting nutrition education

Pre-fasting nutrition assessment and education is essential to ensure the safety of young people planning for Ramadan or other fasting. An individualized meal plan is required, based on energy requirements, commonly eaten/permitted foods during the fast, timing of *Suhoor* and *Iftar* meals, insulin regimen, and exercise pattern. Ongoing monitoring of BGLs with appropriate insulin adjustment is necessary to prevent hypo- and hyperglycemia. It is recommended that fluids, such as water or non-sweetened fluids, be consumed at regular intervals in the non-fasting hours to prevent dehydration.

19.2 | Meal-time routines during Ramadan

Ramadan fasting represents a major shift in meal timing and content and daily lifestyle and exercise patterns. The two main meals are *Iftar* (usually eaten 6–7:30 p.m.), and *Suhoor* (usually consumed between 3 and 5.30 a.m.). Mealtimes depend on the time of sunrise and sunset. The predawn meal should be eaten as close to dawn as possible, to minimize the fasting period. In addition, a late evening meal or supper is commonly eaten before bed (about 10 p.m.). This usually contains traditional sweets. A snack such as milk and dates or juice may initially be taken before *Iftar* to break the fast.

19.3 | Guidelines for nutritional care and meal planning

The nutritional composition of food eaten during Ramadan is different from the rest of the year. Commonly eaten foods are shown in Table 1.

Significant changes in nutrient intake, with higher fat and sugar intake, during Ramadan is reported in adolescents with T1D.[98] It is recommended that adolescents with T1D should lower saturated fat and sugar. Low glycemic index (GI) carbohydrates should be the basis of foods consumed at *Iftar* and *Suhoor*. Lean protein and low GI carbohydrates are particularly important at *Suhoor* to enhance satiety during the day. Moderation in traditional sweet intake and fried foods is strongly recommended, particularly at *Iftar*. The *Iftar*, *Suhoor* and other nighttime snacks and meals should be covered by prandial rapid-acting insulin to prevent postprandial glycemic excursions, with education on carbohydrate counting to allow adjustment of the insulin dose to match carbohydrate intake. Daily consistency in carbohydrate intake is necessary for those not familiar with carbohydrate counting. Continuous snacking after *Iftar* should be discouraged. The insulin bolus should be given before the meal; administration during or after the meal is not advisable.[99]

The use of an extended bolus delivered by an insulin pump, where some of the insulin is delivered promptly and the remainder over 2–6 h, enables the insulin bolus to match the glycemic effect of the meal. This is particularly useful for the high-fat meals consumed at *Iftar*.

19.4 | Maintaining healthy weight and lowering of cardiovascular risk factors during Ramadan

It is important to prevent dyslipidemia and excessive weight gain during Ramadan.[66] A diet rich in fruit, vegetables, low-fat dairy products, legumes, and whole grains should be encouraged to reduce adverse changes in lipid profiles and to prevent excessive weight gain.

In children and adolescents with T1D, both weight gain and weight loss have been reported during Ramadan.[69,77] Therefore, an individualized plan with appropriate energy intake to maintain growth and development is required, as well as regular follow-up to monitor and prevent rapid weight changes.

20 | FASTING AND PHYSICAL ACTIVITY

Exercise patterns in adolescents are different from adults, varying from unpredictable play to planned sports. It is recommended that a reasonable level of activity should be maintained during Ramadan fasting, with avoidance of strenuous activities in the hours before sunset, when hypoglycemia is most likely. Exercise patterns vary depending on the geographic region and the need for school attendance. Differences in sleep patterns coupled with fasting in the daylight hours impact the amount and type of physical activity youth participate in. Adolescents without diabetes have been reported to reduce physical activity during Ramadan fasting.[100]

Studies on nutrition and sports management during Ramadan focusing on adolescents are limited. Typically, outside of fasting periods, additional carbohydrate is advised for spontaneous activities to avoid hypoglycemia.[100] During fasting, careful attention to insulin adjustment is required to enable normal levels of physical activity without hypo- or hyperglycemia. Pre-fasting diabetes education should discuss physical activity with a plan for appropriate insulin adjustment, hydration and hypoglycemia treatment as part of individualized care.

A review of studies in healthy adult athletes who participated in Ramadan fasting concluded that changes in training, fluid intake, diet, and sleep patterns can be managed to minimize, but not fully mitigate, the impact on athletic performance.[101] The review concluded that athletes with T1D should consider medical exemption from fasting; however, if an athlete with T1D chooses to fast, an individual plan to optimize performance and ensure safety is needed. Principles of nutritional management for athletic performance in T1D during fasting have been proposed,[102] however, they require adaptation in meal timing for fuel and recovery.

21 | MONITORING OF BLOOD GLUCOSE DURING FASTING

Optimizing glycemic control pre-Ramadan or other religious fasting is an essential measure to ensure safe fasting. Frequent BGL measurements are needed for safe fasting, and this does not violate the observance of Ramadan. The concept among Muslim communities that pricking the skin for BGLs invalidates Ramadan fasting is an incorrect interpretation.[8] This should be strongly emphasized in educational programs. SMBG remains the most widely used method of monitoring, but the use of CGM can greatly facilitate insulin adjustments.

BGL monitoring during fasting is based on the same principles of monitoring outside of fasting, with the times being related to meals, medications and symptoms. To assess adequacy of postprandial BGLs, readings are recommended 2 h after the main evening meal (*Iftar*) and before the predawn meal. A measurement on waking up is essential to enable individuals to judge their basal dose as well as the *Suhoor* meal insulin dose. Testing in the last 2 h of the fasting period is recommended, as there is an increased likelihood of hypoglycemia at this time.[73,75] Additional midday BG monitoring is useful if morning readings are in the low-normal range. Testing is essential when symptoms of hypoglycemia are experienced or suspected.

22 | CONTINUOUS GLUCOSE MONITORING

The use of CGM is becoming the standard of care for people with T1D, but unfortunately these devices are still inaccessible in many parts of the world due to their high cost and lack of national insurance coverage. In a study of 14 adolescents with T1D using CGM, no difference in mean BGLs or duration of hypoglycemia, hyperglycemia, and severe hyperglycemia were found between the Ramadan and non-Ramadan period.[103] Adults and adolescents with T1D show wide glucose fluctuations during Ramadan, with a slow fall during fasting hours followed by a rapid rise in glucose levels after the sunset meal (*Iftar*)[104] These data suggest that efforts should be made to decrease glycemic excursions following *Iftar*, including administering insulin 15 to 20 min before the meal and replacing high GI for healthier, low GI foods.[105]

Beshyah et al.[106] provided a comprehensive demonstration of glucose changes during Ramadan fasting using isCGM in eight individuals with different glucose tolerance status, showing high glucose exposure, wide variation and marked glucose instability after both *Suhoor* and *Iftar*. In a prospective pilot study on 51 children with diabetes, isCGM revealed hypoglycemia in 33% of the days, without episodes of severe hypoglycemia or DKA.[67] In another study in adolescents with diabetes, the use of isCGM showed the daily pattern of hypoglycemia with an incidence of episodes of 0% between 7 and 11 p.m., which increased to 69% from 11 a.m. to 7 p.m.; 65% of these episodes were mild (between 61 and 70 mg/dl), and 8% were lower than 50 mg/dl.[75] These studies suggest that adolescents with T1D could use CGM to fast without any risk of life-threatening severe hypoglycemia or DKA. Multiple devices linked with remote connections are now available, and have a role in remote monitoring, detecting and reducing potential complications during fasting.

23 | FASTING IN YOUNG PEOPLE WITH T2D

There is a global rise in the prevalence of T2D in young people that is associated with the increased incidence of obesity and sedentary lifestyle.[107,108] In 2018 a dramatic rise in the prevalence of T2D was reported in Indonesia, the largest Muslim population in the world.[109] In parallel to this, interest has grown on the impact of Ramadan fasting on the prevention and/or improvement of T2D.

Intermittent fasting is a form of fasting where a person cycles between periods of eating and fasting for religious or non-religious reasons. It has become a popular pattern of eating for weight loss and control of T2D in adults.[110]

Individuals with medical conditions such as T2D are exempted from Ramadan and other fasting in different religions. However, as discussed earlier, the EPIDIAR survey showed that 79% of Muslim people with T2D fast regardless of the possible risk of complications such as hypoglycemia, hyperglycemia, dehydration and thrombosis.[3]

Overall, current evidence suggests safety and a positive impact of intermittent fasting on glycemic and metabolic control of people with T2D, supporting this practice, especially in the low and medium risk groups.[111] When followed under medical supervision, intermittent fasting may reduce body weight, central adiposity and HbA1c.[112] It can also improve insulin sensitivity and markers of cardiovascular disease. However, intermittent fasting can be associated with hypoglycemia in people with diabetes treated with sulfonylureas and insulin.[113] Different conditions in different regions such as weather, duration of fasting and cultural eating habits may contribute to different effects on the metabolic profile of people with T2D who adopt intermittent fasting.[112]

It should be noted that unlike most forms of intermittent fasting, Ramadan fasting involves no intake of water or other fluids during the fasting period. Previous studies suggested that Ramadan fasting may affect metabolic profile by decreasing the frequency and amount of calorie intake, decreased physical activity, fluid restriction and

TABLE 2 Risk groups of people with T2D plan to observe fasting

Very high risk: fasting not recommended
- Severe hypoglycemia within the 3 months prior to Ramadan.
- Severe hyperglycemia with average fasting or premeal plasma glucose >16.7 mmol/L (300 mg/dl) or glycated hemoglobin (HbA1c) >86 mmol/mol (10%).
- A history of recurrent hypoglycemia or hypoglycemia unawareness.
- DKA/hyperosmolar hyperglycemic state within the 3 months prior to Ramadan.
- Acute illness.
- Performing intense physical labor.
- Chronic dialysis.

High risk: may choose not to fast
- Moderate hyperglycemia (average BGL 8.3–16.7 mmol/L [150–300 mg/dl] or HbA1c 64–86 mmol/mol [8%–10%]).
- Significant microvascular or macrovascular complications.
- Living alone and treated with insulin or sulfonylureas.
- Individuals with comorbid conditions that present additional risk factors such as heart failure, malignancy, renal impairment.

Moderate risk: may choose to fast with caution

People with T2D with no complications and HbA1c <64 mmol/mol (8%) treated with lifestyle intervention, metformin, thiazolidinedione (TZD), incretin-based therapies, sodium-glucose cotransporter-2 inhibitors and/or short-acting insulin secretagogues.

Low risk: may choose to fast

People with T2D with no complications and HbA1c < 53 mmol/mol (7%) treated with lifestyle intervention, metformin, TZD and/or incretin-based therapies.

With encouragement on adequate hydration during non-fasting hours, especially in hot humid environments, to reduce the risk of dehydration and postural hypotension

Source: Adapted from Ibrahim et al 2020.[111]

changes in sleep pattern.[111,112,114–116] Ramadan fasting was found to reduce Fetuin-A levels, a glycoprotein associated with insulin resistance.[117] A recent meta-analysis reported a general reduction in body weight and waist circumference and an overall improvement of metabolic profile markers such as BGLs, HbA1c and lipid levels after Ramadan fasting.[112] In a study in the United Arab Emirates in individuals with T2D not treated with insulin, fasting was not associated with any significant short-term changes in metabolic control, glucose fluctuation or time in hypoglycemia, apart from an initial increase in glucose variability, compared with the non-fasting pre-Ramadan period.[118]

Although adolescents practice Ramadan fasting and other forms of intermittent fasting, the impact of such fasting on glucose biomarkers in this age group has not been adequately studied.[108] However, it has been hypothesized that adolescents with T2D will probably benefit from intermittent fasting similar to adults, given a similar pathogenesis of the disease.[108] Several studies reported that intensive education programs before and during Ramadan could significantly improve and prevent the complications of diabetes such as hypoglycemia.[36,119] However, this kind of support may not always be feasible for Muslim adolescents in Western countries.[120]

23.1 | Recommendations on management of fasting in people with T2D

Successful management of adolescents with T2D during intermittent fasting should aim at achieving the general goals of control of symptoms, reasonable glycemic targets and prevention of acute complications such as hypoglycemia, which is the most common concern for people with T2D.[112] Structured diabetes education can improve glycemic and metabolic outcomes.[36,121] Health care providers should screen individuals with T2D before Ramadan, to assess risks and educate them to improve safe fasting practices.[121]

The American Diabetes Association/ European Association for the Study of Diabetes (ADA/EASD) consensus recommendations provide comprehensive guidance for person-centred glycemic management in individuals with T2D who observe Ramadan fasting.[111] Pre-Ramadan counseling and clinical assessment should include review of areas such as key characteristics such as age, lifestyle, cultural and socioeconomic factors and presence of comorbidities, with risk stratification.[111] The categories of risk for individuals with T2D who fast during Ramadan range from very high to low-risk individuals, as reported in Table 1.[111]

Management plan during Ramadan can be summarized as follows:

- Identification of the individual's risk category and other risk factors, such a sub-optimal adherence to medications, fear of hypoglycemia, medication side effects and lack of access to medications.
- Regular and more frequent monitoring of BGLs during fasting (especially for those on insulin, insulin secretagogues and high-risk groups), although CGM is *currently not routinely* recommended for individuals with T2D.[111]

The therapeutic options for fasting for people with T2D include: lifestyle management, weight management and adjustment of medications.[111] Guidance on the first two options can be referred to in other parts of this document, in relation to dietary changes and different intensity of exercise, including Taraweeh prayer, where they are encouraged to increase physical activity that improves insulin resistance. However, the recommendations on non-insulin lowering medications can be referred to in the most recent ADA/EASD consensus updated 2019 guidance.[122] The most common non-insulin lowering medication approved for adolescents with T2D is metformin. No dose change for metformin is advised during Ramadan and this drug is generally not associated with risk of hypoglycemia.[111]

23.2 | Future perspectives for management of T2D during fasting

Technology can be used where available to aid in adjusting therapy and improve care and support for adolescents with T2D who intend to fast during Ramadan. Nowadays, food intake, BGL monitoring, medication dosages and exercise time can all be digitalized and accessed remotely.[111] Based on the currently available literature

among young adults, it might be safer to implement fasting programs among well controlled young people with T2D under close observation and medical supervision.[108] Intermittent fasting non-religious programs might be cost-effective, with the potential to minimize the incidence of T2D, preventing young people from developing T2D and protecting them from complications linked to disease and infection.[108] However, there is need for further research to assess how intermittent fasting might impact the health of children and adolescents with T2D (Table 2).

24 | LIMITATIONS OF STUDIES ON RELIGIOUS IN YOUNG PEOPLE WITH DIABETES

Studies on fasting during Ramadan in children and adolescents have several limitations, such as small sample size and retrospective designs, which influence the interpretation of the results. Country-specific differences in physical exercise and schooling demands may also impact study outcomes. As the season when Ramadan occurs changes, conclusions are not universally applicable. The impact of physicians' and diabetes educators' knowledge, attitudes, beliefs, and practices in relation to Ramadan fasting highly influence the education and management of young people with diabetes. In addition, there are limited data on other religious fasting practices in young people with diabetes. Further multicenter studies are needed to increase the understanding of the safe management of Ramadan and other religious fasting in young people with diabetes. However, obtaining the approval of ethics committees to undertake such studies in adolescents and young adults can be difficult. This is particularly challenging because cultural and religion-sensitive issues might arise from such research.

25 | CONCLUSIONS

The management of young people with diabetes during Ramadan and other religious fasting is challenging, due to limited high-quality data in this specific population. Well-designed, randomized controlled trials are needed to determine optimal insulin regimens to minimize glucose fluctuations throughout the fasting and eating hours. Recent developments, such as the use of new insulin analogues, insulin pumps, advanced glucose monitoring devices and telemonitoring might enhance safe fasting in the future. However, these innovations are not universally accessible. At the present time, careful individual assessment and structured diabetes education remain the mainstay of ensuring safe fasting.

AUTHOR CONTRIBUTIONS

AB, DZ, MK and KG contributed to the section of the 'General rules of fasting in different religions'. SS and SA put a draft on the section of 'pre-Ramadan education'. Telemedicine and digital health section were written by SS and AEA. UIU wrote the 'physiology of fasting' section. ABP and SA put a draft for 'psychology offasting section'. UIU and MK drafted the 'impact on metabolic control' section. SS and KG worked on the 'complications of diabetes'. AP and DZ wrote the 'insulin regimens' section while AEA wrote the section of 'insulin pumps'. SA and MK put a draft on the 'nutrition management in Ramadan'. Physical activity in fasting was written by SK and ZK. AEA wrote the section of 'Blood glucose monitoring' and AB wrote the type 2 diabetes section. MLM guided authors on the proper writing of the chapter and revised the final version. AD liaised between authors, divided the tasks, arranged and chaired chapter meetings, put the drafts together and edited each part. All co-authors revised and approved the final version.

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CONFLICT OF INTEREST

None of the authors declared any conflicts of interest that may jeopardize the impartiality of these guidelines.

DATA AVAILABILITY STATEMENT

Data used for chapter writing is available on request.

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