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Recommendations for management of diabetes and its complications during Hajj (Muslim pilgrimage)

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ABSTRACT

Hajj is one of the five pillars of Islam and is a must-do for all adult Muslims once in their life provided they are able to do it. Considering the 8.8% global prevalence of diabetes, coupled with the number of Muslims performing Hajj (~2.5 million adult Muslims), it could be estimated that Muslims with diabetes performing Hajj may exceed 220 000 per year. According to Islamic rules, Hajj should not cause severe difficulties for Muslims. The Holy Qur'an specifically exempts from this duty Muslims who are unable physically or financially if it might lead to harmful consequences for the individual. This should be applicable to subjects with diabetes considering its severe and chronic complications. During the Hajj, diet, amount of fluid intake and physical activity may be altered significantly. This exemption from the duty is usually not considered a simple permission; Muhammad the Prophet of Islam mentioned, 'God likes his permission to be fulfilled, as he likes his will to be executed'. However, most Muslims with diabetes prefer to do the Hajj duty, and this may cause major medical challenges for Muslims with diabetes and their healthcare providers. So it is very important that healthcare providers are aware of the possible risks that could happen during the Hajj. People with diabetes may face many health hazards during the Hajj, including but not limited to the 'killer triad': hypoglycemia, foot injury and infections. Many precautions are necessary in the prevention and treatment of possible serious complications. Risk stratification, medication adjustments, proper clinical assessment, and education before doing the Hajj are crucial.

INTRODUCTION

It is estimated that the global Muslim population is expected to jump; the population in 2010 was almost 1.6 billion and it is projected to be about 2.8 billion by 2050.[1]

Hajj is one of the five pillars of Islam and is a must-do for all adult Muslims once in their life provided they are able to do it. Considering the 8.8% global prevalence of diabetes,[2] coupled with the number of Muslims performing the Hajj (~2.5 million adults), it is estimated that Muslims with diabetes performing the Hajj may exceed 220 000 per year. The prevalence of diabetes in the Arab and Muslim countries is above the global prevalence in non-Muslim countries. Moreover, a large number of people over 60 years of age are performing the Hajj, and it is known that the prevalence of diabetes increases with age. Hence, the number of people with diabetes during the Hajj could be considerably higher.[3]

Hajj is one among the five mandatory pillars of Islam:

- Faith confession (Shahada).
- Praying five times a day (Salat).
- Fasting during the month of Ramadan (Saum).
- Alms-giving to the needy (Zakat).
- Pilgrimage to Mecca (Hajj).[4]

With the exception of the confession of faith, any other pillar may sometimes or at all times exempt some people; for example, women should not practice the daily prayer during the menstrual period; poor Muslims may be exempted from alms-giving; fasting during the Ramadan may not be practiced by those who are sick or traveling; lastly, the pilgrimage is limited to the financial and physical ability of an individual.

According to Islamic rules, Hajj should not cause severe complications for Muslims. The Holy Qur'an specifically exempts from this duty Muslims who are unable physically or financially if it might lead to harmful consequences for the individual.[5]This should be applicable to individuals with acute or chronic complications of diabetes, which could put Muslims at high risk for multiple complications. During the Hajj, diet, amount of fluid intake and physical activity may be altered significantly. This exemption from the duty is

usually not considered a simple permission; Muhammad the Prophet of Islam mentioned, 'God likes his permission to be fulfilled, as he likes his will to be executed'.[6] However, most Muslims with diabetes, similar to non-diabetic Muslims, prefer to do the Hajj duty, causing major medical challenges for patients with diabetes and their healthcare providers. So it is very important that healthcare providers are aware of the possible risks that could happen during the Hajj. The rules on medical decisions before and during the Hajj among people with diabetes are largely unknown. This was mainly due to lack of evidence from prospective and/or retrospective studies on the effects of Hajj. A group of diabetologists from a large number of Muslim and non-Muslim countries took the initiative to exchange knowledge and perspectives in order to suggest clear recommendations aiming to optimize the outcome during and after the Hajj duty.

In this statement, the authors avoided the use of the terms 'indicated' or 'not indicated' for Hajj because it is a religious duty that Muslims decide to do after ample discussions with religious opinion leaders, family and healthcare providers. The authors emphasize that Hajj for people with diabetes, especially those with poor glycemic control, may result in multiple risks. In this document, the authors clearly addressed most of these potential risks, as well as provided advice for the optimal management of diabetes before and during the Hajj.

HAJJ DUTY

The Hajj duty (pilgrimage to Mecca to visit the sacred house of Allah (Kaaba)) includes the intention to do it and travel to the holy places in Mecca and Medina.

This duty includes significant physical activity, including circumambulation (Tawaf) and walking (Saay), and both are integral parts of the Hajj; the total walking distance can exceed 64 kilometres depending on the ability of the individual. Staying on Mount Arafat at daytime is mandatory, which usually has a very high temperature. The full description of the Hajj duty can be found in the Book of Hajj by Sahih Al-Bukhari (https://sunnah.com/bukhari/25).[7]

MAGNITUDE OF THE PROBLEM

Pilgrims may be subjected to specific illnesses due to many factors, which could be unique to the Hajj duty. These include but not limited to carrying infections already existing in their countries, overcrowding, inadequate nutrition, poor access to drinking water, hot weather and physical exertion. People with diabetes are at a greater risk of illness due to the nature of the disease and also the altered daily routine, which may affect diabetes control.

The health risks for pilgrims with diabetes include the following:

- Hypoglycemia.
- Dehydration.
- Foot injuries and infection.
- Hyperglycemia, diabetic ketoacidosis, and hyperosmolar state.
- Heat exhaustion and heat stroke.
- Infections, such as chest infections and diarrhea.
- Heart problems due to increased physical exertion.[8]

In an observational prospective study, it was found that 26% of those who were admitted to Makkah Hospital were patients with newly diagnosed diabetes and were not even aware of their diabetes, while 74% had pre-existing diabetes. On admission it was found that almost 77% of the participants had poor diabetes control, and about 55% received diabetes education sessions before going to the Hajj; it was found that approximately 37% did self-monitoring of blood glucose (SMBG) occasionally and only 22% knew that SMBG is needed more frequently during the Hajj. In the same study, it was found that 60% of those admitted on the big gathering during the Arafat Day (see duty description) did stop taking their diabetes medications. Many subjects were treating themselves using herbal remedies, aiming to control their blood glucose without using glucose-lowering medications. Also, many subjects were having misconceptions that while they are in Makkah, they do not have to take any medicines or regulate their blood glucose.[9] In another study, it was found that out of a total of 689 patients admitted to the emergency room, 31.9% had diabetes.[10] A large proportion of Muslims doing the Hajj are elderly and usually suffering from different chronic conditions, and a significant percentage of them also have diabetes complications including eye, kidney, coronary heart disease, and diabetic foot problems.[11]

The Hajj activities demand significant physical and mental exertion. Due to changes in the normal life of patients with diabetes during the Hajj (eg, geography, weather, diet and physical activities), they are subject to a real challenge to their physical abilities. Diabetes was reported to be a leading cause of morbidity and mortality during the Hajj.[12 13] In addition to severe heat, excessive exertion, long walking distances and direct health hazards, there are a number of logistics that pose a challenge to patients with diabetes, which include traveling and waiting for long hours in the sun for transport or buses, with the medications exposed to heat and with difficulties in finding cool places or fridges for insulin storage. Also, it is difficult to predict access to and the temperatures of different types of refrigerators available on buses and camping areas. Considering the huge diversity of people performing the Hajj, language barrier may complicate the management of acute complications and make access to specific medical services more difficult; learning a few vocabularies in Arabic or English or using mobile phone applications that offer instant translation may provide help in overcoming the language barrier during emergency situations.

MISCONCEPTIONS AND RELIGIOUS CONCESSIONS

Understanding some beliefs and religious concessions related to the Hajj may significantly help in improving patient outcome during the Hajj. For example, people

with diabetes believe that they can manage their diabetes as usual during the Hajj and do not seek medical advice before leaving for the Hajj. Also, SMBG may not be done assuming it could spoil the Hajj; others may also use herbal medications for control of blood glucose during the Hajj (see online supplementary appendix I).

RISK STRATIFICATION[i] (SEE THE ALGORITHM IN ONLINE SUPPLEMENTARY APPENDIX II)

Low risk

- Well-controlled diabetes treated with lifestyle intervention, and metformin, acarbose, thiazolidinediones or incretin-based therapies.
- A1C around 7%.

May choose to do the Hajj.

Moderate risk

- People with diabetes treated with short-acting insulin secretagogues, basal insulin, and newer generations of sulfonylureas (dose adjustment advised).
- A1C below 8.5%.
- People treated with sodium-glucose transporter-2 (SGLT-2) inhibitors; however, the risk of volume depletion during high-temperature weather should be considered.

May choose to do the Hajj with caution.

High risk

- Uncontrolled adult type 1 diabetes.
- Type 2 diabetes on basal-bolus insulin regimen or insulin pump therapy.
- Severe hypoglycemic episodes during the last 3 months prior to the Hajj.
- Uncontrolled hypertension and coronary heart disease.
- Sustained poor glycemic control.
- Pregnancy.
- Patients with a history of Diabetic Ketacidosis (DKA) or hyperosmolar hyperglycemic state.

Hajj is not recommended or is postponed.

Very high risk

- History of recurrent hypoglycemic episodes.
- Hypoglycemia unawareness.
- Patients with kidney disease stages 3–4 and 5 chronic kidney disease.
- Advanced macrovascular and microvascular complications.
- History of acute myocardial infarction in the last 6 months prior to the Hajj.
- Patients with unstable angina.
- Old age with ill-health status.
- Physically unfit who needs assistance on walking.
- Heart failure.
- Active or major foot problem.

Hajj is strongly not recommended.

[i]This risk stratification was based mainly on the expert's opinions and there is a need for evidence-based clinical trials.

FOOT PROBLEMS

In 2003 and 2004, diabetic foot lesions were the common causes of admission (16.3%) to two of the general hospitals in the Hajj places, Mina and Arafat.[14] Few studies have reported on diabetic foot lesions in people with diabetes doing the Hajj. However, Alfelali *et al*[15] did an observational study trying to describe the spectrum of foot lesions among people with diabetes and those without diabetes. The authors looked at Muslims who performed the Hajj in 2013 in the foot clinics in Mina during the peak days. Out of the 197 participants from 21 countries, it was found that 60 (31%) were people with diabetes. The most commonly observed injuries were blisters (34%) and erythema (25%) in both subjects with diabetes and non-diabetic subjects. Also, many of the participants with diabetes had callosities.[15] Another study included 129 Muslims from France doing the Hajj, with a mean age of 62. Of the participants, a total of 63.6% were older than 60 years of age. The prevalence of diabetes was 26.4%, and the total walking distance during the Hajj was about 58 km. Of the participants, a total of 31.8% had blisters; it was significantly higher in women and in those who were overweight and/or obese. Also, a total of 10.9% of the participants had sore legs and feet; two of them had tendonitis and edema of the legs while performing the Hajj.[16]

16 steps to keep the foot healthy before, during and after the Hajj[15 17–19]

1. Daily inspection of the feet for lesions such as blisters and bleeding between toes. Using a mirror will help to inspect the bottom of the foot and the heel.
2. If unable to do it, you may seek the help of a relative or a friend.
3. Foot examination by a specialist in diabetic foot care is a must before the Hajj.
4. Socks or stocking should fit well in the shoe; padded hosiery could help in reducing the pressure and offer more protection.
5. Both the soles and the shoes or sandals should be inspected for any foreign objects before use every time.
6. Use shoes and/or sandals with proper measurements; they should be comfortable and easy to use.
7. Always choose leather shoes with good space for the toes. Athletic and/or running shoes are good choices for walking.
8. Try to change footwear whenever possible.
9. NEVER walk barefoot.
10. Avoid soaking your feet in hot water; check the temperature in advance.

11. A daily wash of the feet is required, and keep your feet dry especially between the toes. You can use moisturizing creams but not between the toes.
12. When taking a bath, check the temperature in advance. You can use a thermometer or even your elbow. The hot water should not drip onto the toes.
13. Seek immediate help if you notice any new lesion or swelling of the feet. Redness and pain are also alarming. If so stay off your feet until proper advice is sought.
14. Education before going to the Hajj on how the feet may be affected.
15. Ensure optimal glycemic control and do not smoke (smoking is forbidden in Mecca during the Hajj).
16. Brand-new shoes are not preferred, as new shoes may rub unduly on the feet. Concessions (Rukhus) to patients with diabetes included an arrangement that protects the feet from any injury or prevent unfelt slipping of some footwear.

HYPERGLYCEMIC EMERGENCIES

Hyperglycemic emergencies were addressed in the Saudi health check directives in 2007. In a study that looked at all cases of diabetic ketoacidosis admitted to one hospital, there were 18 episodes; only one case happened during the Hajj. Uncontrolled blood glucose was the main precipitating factor in almost 94% of cases, and the mortality rate was 5.6%.[20]

Concomitant illnesses and inadequate use of insulin and oral antidiabetic agents precipitated diabetes complications such as ketoacidosis or hyperglycemic hyperosmolar state.[20] In cases with hyperglycemia, persons with diabetes should drink enough water and are required to continue taking insulin as prescribed. Also they need to ask for immediate medical help if they experience symptoms or signs of ketoacidosis.[20] In another study that looked at cases with diabetic ketoacidosis admitted to one of the Madinah hospitals, it was found that respiratory infections could significantly precipitate hyperglycemic emergencies.[21]

As for those with type 2 diabetes treated with oral medications, they may need insulin injections at least on a temporary basis during acute illness (see the algorithm in online supplementary appendix II).

HYPOGLYCEMIA DURING THE HAJJ

Hypoglycemia is one of the major concerns during the Hajj. Hypoglycemia usually results from excessive physical activities and prolonged walking; it could also result from significant changes in the quality and time of eating. Khan *et al*[22] reported that hypoglycemic episodes were common during the Hajj. They highlighted the importance of the differences in the concentration of insulin preparations between Saudi Arabia (100 U/mL) and some other countries (eg, 40 U/mL) that may cause episodes of hypoglycemia. The authors also believe that the use of higher doses of soluble insulin twice daily without intermediate insulin may cause hypoglycemia derived from physical activity and/or skipped meals. Insulin doses during normal life should be reduced during the Hajj due to the significant increase in physical activity.[22]

A study looked at 169 Omanis with diabetes during the Hajj. The data were analyzed in a diabetes clinic in 1996. It was found that almost 86% of the participants were on oral diabetes medications. Those with type 1 diabetes and 96% of those with type 2 diabetes got diabetes medications when they traveled to the Hajj. During the Hajj, 2.4% of them reported a random plasma glucose of <4.0mmol/L, 14% reported a random plasma glucose of 4.0–6.0mmol/L, while only 9.5% were trained to test their blood sugar.[23 24]

Another study by Alakkas[25] aimed to examine the readiness to do the Hajj and if there is any link to the type of care, education received and history of doing the Hajj before the study. They reported the type of diabetes care received, education and informing the caregivers about the trip. It was a cross-sectional study done on October 4–6, 2014. The study included 262 participants from different countries. They found that participants with diabetes were older, overweight and mostly with long duration of diabetes. Except for having the medications, most of the studies on the Hajj readiness were far below 50%, and this may show poor preparation for the Hajj and the need for proper pre-Hajj education. The previous performance of the Hajj did not impact the study's primary outcome.[25]

Some recommendations for the prevention of hypoglycemic episodes during the Hajj

- Monitoring of blood glucose levels. For those using insulin or sulfonylureas, they need more frequent measurements.
- Seek medical advice in adjusting medication doses especially if you are on insulin or sulfonylureas (see online supplementary appendix II).
- Do not skip meals.
- Adjust your physical activity, get rest in between and increase fluid intake during the Hajj walking.
- Reduce medication doses and get snacks if you have hypoglycemia (see the algorithm in online supplementary appendix II). Consider stopping the Hajj walking if there is severe or recurrent hypoglycemia.
- Always keep records of the blood glucose measurements to identify patterns that contribute to hypoglycemia.

RENAL AND CARDIOVASCULAR DISEASE

Due to this mass gathering, there is an expected high risk of communicable diseases and cross-infections; it was initially indicated that contracting different types of infections, especially respiratory and kidney infections, was very common, along with other renal disorders.[26 27]

The strenuous exercise is a challenge to Muslims during the Hajj. However in a survey by Gautret *et al*,[28] they did not find a remarkable number of people with diabetes with cardiovascular problems. It was also observed that women were more prone to have cardiac problems.[28] In another survey done in a tertiary hospital, 31.9% of the studied population had diabetes mellitus and 31.8% suffered from cardiovascular diseases (CVDs).[29]

There seems to be a difference in the prevalence of diabetes and cardiac diseases, probably due to the different cultures and populations that come to the Hajj. In a study by Meysamie *et al*,[30] the prevalence of CVD, among the Iranian pilgrims studied, was lower in 2005 than in the previous year.

In 2004, Madani *et al*[31] found that 63.6% of pilgrims admitted to the intensive care unit had CVD and 23% had myocardial infarction. In a survey by Tariq *et al*,[32] 2.4% of admissions were for renal causes, mainly renal colic and renal failure.

Many patients with diabetes may have coronary artery disease. Electrocardiogram (EKG) may be of help before traveling to do the Hajj, with clear instructions to attend health facilities as soon as possible if chest pain, shortness of breath or palpitation arises.

EYE DISEASES

People with diabetes are more prone to the diseases of the eye; some practices during the Hajj may put them at greater risk. They may have transient changes in their visual acuity due to large blood glucose fluctuations. Also, poor vision may increase the risk of falls or accidents.

Infections

People with diabetes are more susceptible to infections, and this also involves infections of several eye structures.

Lid and lashes

Recurrent styes and blepharoconjunctivitis are common in people with diabetes; several studies also reported that *Demodex folliculorum* is more frequent in patients with diabetes than in healthy volunteers.[33 34]

Conjunctiva

Conjunctivitis is recorded more frequently in people with diabetes.[35]

Cornea

Abnormalities of the corneal epithelium can be seen more in people with diabetes, leading to corneal erosion, persistent epithelial defect or corneal ulcers.[36]

Dry eye

Dry eye is a common problem in older people, and diabetes is also suggested a risk factor. The symptoms and signs of dry eye syndrome are similar to other ocular surface diseases such as ocular discomfort, irritation, dry or foreign body sensation in the eye, redness, mucous discharge, blurry vision, itching, contact lens intolerance, increased frequency of blinking, and so on. Patients with dry eye are more prone to infections, and in severe cases it may lead to corneal infiltration or ulceration, leading to visual impairment.[37 38]

Diabetic retinopathy

Proliferative retinopathy is characterized by glial proliferation and new vessels, which are more fragile than normal vessels and are prone to leakage and hemorrhages. In the presence of severe non-proliferative or proliferative retinopathy, vigorous aerobic or resistance exercise has the potential risk of triggering vitreous hemorrhage or retinal detachment.[39 40]

Recommendations

Patients who did not have an eye check for more than 1 year should have one when planning to go to the Hajj. Those with severe non-proliferative and proliferative retinopathy should consult their ophthalmologist before deciding to go to the Hajj. Extreme care should be taken of sanitation and to immediately consult their doctors in case of any irritation, redness and foreign body sensation. Patients with dry eye syndrome should continue their medications and consult before the Hajj and consider intensifying the treatment. Extra care should be taken in people with poor visual acuity. Patients who wear contact lenses must take extra hygiene care.

NUTRITION AND HYDRATION

Hydration during the Hajj

Fluid requirements are dependent on several factors: amount and frequency of perspiration, type of activity, intensity and duration of the activity, and individual needs. Prolonged aerobic activity can contribute to various levels of dehydration, and exposure to higher temperatures will exacerbate it. Hydration status varies during the day, but any amount of physical activity will increase loss of fluid and subsequent needs. The general recommendation for daily fluid intake is approximately 3.7 L for men and 2.7 L for women.[41] Proactively hydrating with non-caffeinated beverages at least several hours before participation in the Hajj will aid in fluid absorption and normal urine output.[42]

Key recommendations for maintaining hydration during the Hajj

- The goal for adequate hydration throughout the 6-day journey should be at least 0.4–0.8 L per hour.
- Glucose-containing fluids can be used to treat and reduce the risk of hypoglycemia.

Food safety during the Hajj

Food that has been improperly prepared and stored is at high risk of containing bacteria, viruses, parasites and chemical substances. This alone causes more than 200 different illnesses, ranging from diarrhea to certain cancers. It is estimated that 600 million—almost 1 in 10 people in the world—become ill from contaminated food.[43]

Key bacteria that lead to foodborne illnesses include *Salmonella*, *Campylobacter* and enterohemorrhagic *Escherichia coli*. Raw milk, raw or undercooked poultry and drinking water contaminated by animals tend to cause *Campylobacter* infection. Unpasteurized milk, undercooked meat and unwashed fresh fruits and vegetables can be associated with enterohemorrhagic *E. coli*. *Vibrio cholerae* is found in contaminated water and food cooked in contaminated water. Symptoms of these foodborne illnesses can include abdominal pain, diarrhea, fever, headache and vomiting, which may lead to severe dehydration and possibly death.[44] During the Hajj, it is important to choose foods that are not at the highest risk for foodborne illnesses. In temperatures above 30°C, food should never sit out for more than 1 hour, and if it does it must be discarded. A good rule of thumb is to eat foods that are at the highest risk for foodborne illnesses within the first day, but to reduce the risk of illnesses, relying on shelf-stable items during the journey will reduce the incidence. While canned goods are a safe option, their mere weight will be a hindrance.[45]

Key recommendations for food safety during the Hajj

- Verify the expiration date of all shelf-stable items before you buy them.
- Always wash hands with soap and clean water before and after preparing the food.
- Always wash hands with soap and clean water before and after eating.
- Wash fruits and vegetables well before eating.
- Cooked food must be consumed immediately after preparing; if it will be used for another meal, it must be stored cold.
- Do not eat food that has been left at room temperature for more than 1 hour.
- Avoid storing cooked food in vehicles unless placed in a storage that will keep it cold.

MEDICATION ADJUSTMENT

The ideal drugs for the Hajj are those associated with low risk of hypoglycemic episodes, especially during the walking period (like Tawaf); unfortunately, there have been few publications studying the safety and efficacy of the commonly used and newer antidiabetic drugs.

The rates of hypoglycemia with metformin have been shown to be low.[46 47] The low rate of hypoglycemia makes metformin an attractive therapy during the Hajj.

Sulfonylureas are widely used for antidiabetic drugs. Most of the studies showed that sulfonylureas carry a high risk of hypoglycemia. The risk of hypoglycemia is usually more in the elderly with diabetes and those with renal impairment and medical illnesses.[48] Sulfonylureas should be avoided or used with caution. Also the dose may be adjusted before doing the Hajj physical activity, and newer generations are preferred.

Alpha-glucosidase inhibitors have been used successfully in many countries, with the most common side effect being gastrointestinal symptoms, which may be inconvenient during the performance of the duties. To date, no prospective studies have addressed the safety and efficacy of these agents during the Hajj specifically.[49]

Thiazolidinediones, such as pioglitazone, have lower glucose, but with low risk of hypoglycemia. Thiazolidinediones have been thought of as a potentially useful agent during the Hajj because of fewer hypoglycemic episodes; however, studies are needed to determine its safety.[50]

Dipeptidyl peptidase-4 (DPP4) inhibitors seem to be a good choice during the Hajj because of the low rates of hypoglycemia and there is no need for adjusting the doses.[51]

Glucagon-like peptide-1 (GLP-1) receptor agonists are likewise very attractive either used alone or in combination with metformin and/or insulin, and are associated with very low rates of hypoglycemia with metformin, lowest glucose variability and hypoglycemia when combined with basal insulin.[52 53]

SGLT-2 inhibitors are novel and approved drugs for the treatment of type 2 diabetes. SGLT-2 drugs tend to have low rates of hypoglycemia, although with an increased risk of mild volume contraction and dehydration. The decreased rates of hypoglycemia make SGLT-2 inhibitors a good choice during the Hajj; however, volume contraction and dehydration may be of concern during the Hajj, especially in warm or hot climates. Randomized controlled studies are needed to determine the risks and benefits of using SGLT-2 inhibitors during the Hajj.[54]

Insulin treatment is usually linked to increased risk of hypoglycemia, especially during the Hajj and its prolonged walking. Insulin doses usually need to be reduced during the Hajj in patients with type 1 and type 2 diabetes. The combination of basal (glargine, detemir or degludec) and rapid-acting insulin analogs (lispro, aspart and glulisine) proved to be superior to human insulin formulations (isophane insulin (NPH) and regular) during the Hajj as this regimen may reduce the risk of hypoglycemia. The main advantage of a basal-bolus regimen is that it is a close match to the body release of insulin. The second advantage of a basal-bolus regimen is the flexibility as to when meals are taken.[55]

Insulin pump therapy has been shown effective in optimizing glycemic control and in reducing the risk of hypoglycemia in patients with type 1 diabetes, so it could be a good choice during the Hajj. In addition, insulin pump allows more flexibility around meal times, as well as lowers the basal dose, minimizing the risk of developing hypoglycemia as a result of exercise (Hajj walking).[56]

GENERAL RECOMMENDATIONS

Before travel

- See your physician 1–2 months before the Hajj for good control of diabetes mellitus and associated morbidities.
- Make sure you attend a medical education session on the logistics involved.

- Inform the camp manager and/or physician about your disease and medications.
- Prepare a checklist of mandatory requirements (see Diabetes Hajj Checklist Box in online supplementary appendix III).
- Complete your recommended vaccinations, including influenza and pneumococcal vaccines.
- Prepare enough medications, cool pack to store insulin, glucose meters, and ketone dipsticks.
- It is preferable to pack diabetes medications in carry-on bags, not in the checked luggage. This simply will protect the medicines from being misplaced, and also because luggage may be stored in cargoes and subject to extreme temperature changes, which may affect the potency of insulin and other medications.
- Choose shoes, sandals, and flip-flops with appropriate shapes and sizes (wide-front shoe to avoid extra pressure on the feet and the toes during long walking).

During travel and the Hajj

- Always carry some carbohydrates to be used in the event of hypoglycemia (juice, candy and so on).
- Try to adhere to a healthy balanced diet containing adequate, but not excess, carbohydrates, with appropriate protein and fiber but minimal (monounsaturated) fat. Use vegetables as desired and two units of fresh fruits per day but avoid fruit juice and syrups.
- Drink at least 3 L of water daily and carry enough water supply with yourself.
- If using insulin before Ihram, check your blood glucose using glucometer and urine ketone using dipstick (for type 1). If needed, use a small dose of insulin to cover for hyperglycemia and/or some bread for hypoglycemia.
- If using insulin before and during long walking, decrease the dose of short and intermediate insulin about 20% or more depending on the distance and effort. For patients on sulfonylurea drugs, this adjustment of daily dose (up to 50% decrease in the corresponding drug dose) can be applied.
- Before Tawaf (circumambulation around Ka'bah) and Saay (walking between Safa and Marwah), consume some additional carbohydrates (bread is preferred).
- Walk slowly during the Tawaf and Saay, and try to protect your feet from damaged ground tiles or other pilgrims.
- In case of fever, diarrhea, vomiting or any acute medical condition, consult your medical team promptly instead of waiting in your residence.
- Always have an umbrella and try to stay in shaded areas.
- Wetting the head and body with water many times during the day is another way to keep the body cool.
- When there is a need to get Zamzam water, ensure the hygienic condition of the bottles and/or containers.
- People with diabetes should always carry their diabetic identifications and cubes of sugar, candy or juices to be used in case of hypoglycemia.
- Do not share personal items with others, and always wash hands more with water and antiseptic soap.

CALL TO ACTION

Healthcare providers

The statements here target only the healthcare providers, and they may read these carefully and implement what they believe suit their community and their patients with diabetes.

- Encourage patients to do a clinic visit at least 1 month before the Hajj.
- Arrange for education sessions, either individual or group sessions, at least 1 month before the Hajj.
- Do proper medication adjustments a few weeks before the Hajj after full clinical assessment.
- Work closely with the religious leaders to advise people with diabetes to follow the recommendations of their healthcare providers.
- Do the same communications with non-government organizations, media, and patients' relatives and friends.
- Pay much attention to the killer triad which might occur during the Hajj: hypoglycemia, foot injury and infections.
- Encourage prospective studies that look at the use of various medications during the Hajj, especially newer drugs with low rates of hypoglycemia.

Saudi Hajj authorities

- If possible ask for brief medical records as a required document for doing the Hajj.
- For people with diabetes, they should be offered enough daily water bottles and sugary food items to be used in case of hypoglycemia.
- If possible offer a suitable shoe either for free or at a nominal cost. Also allow people with diabetes to walk and do Tawaf and Sayy using their shoes, assuming they are clean.
- Try to ease the Tawaf and Sayy for people with diabetes.
- Provide diabetes healthcare providers (medical doctors and nurses) very close to the Hajj practices areas.

SUMMARY

Hajj is one of the five pillars of Islam and is a must-do for all adult Muslims once in their life provided they are able to do it. According to Islamic rules, the Hajj should not cause severe difficulties for Muslims. The Holy Qur'an specifically exempts from this duty Muslims who are unable physically or financially if it might lead to harmful consequences. This should be applicable to subjects with diabetes with severe or multiple chronic complications. During the Hajj, diet, amount of fluid intake and physical activity may be altered significantly. So it is very important that patients and healthcare providers are aware of the possible risks that could happen during the Hajj. People

with diabetes face many health hazards during the Hajj, including but not limited to hypoglycemia, foot injury and infections. Education and precautions are necessary in the prevention and treatment of possible serious complications. Risk stratification, medication adjustments, proper clinical assessment, and education before doing the Hajj are crucial.

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REFERENCES

1. The Future of World Religions: Population Growth Projections, 2010-2050. www.pewresearch.org. http://www.pewforum.org/2015/04/02/muslimswww.pewresearch.org.
2. IDF Diabetes Atlas - 8th Edition. 2017. http://www.diabetesatlas.org/across-the-globe.html.
3. Siavash M, Haghighi S. Recommendations for patients with diabetes mellitus during hajj pilgrimage. *J Res Med Sci* 2012;17:988–9.
4. Hadith Nawawi 40, 3. https://sunnah.com/nawawi40
5. King Fahd Complex for the printing of the Holy Qur'an. The noble Qur'an, surah3 Al-Imran verse 97, page 86.
6. Al-Albani Sahih al-Jaam page 383. https://archive.org/details/muhamad_afia_hotmail_20170317_1212.
7. Al-Bukhari S. The book of Hajj, hadith from 780 to 856. https://sunnah.com/bukhari/25.
8. Madani TA, Ghabrah TM, Al-Hedaithy MA, *et al*. Causes of hospitalization of pilgrims in the Hajj season of the Islamic year 1423 (2003). *Ann Saudi Med* 2006;26:346–51.
9. Hasan G, Moabber H, Alyamani A, *et al*. Study on risk factors (predisposing factors) for poor diabetes control during Hajj (1436/2015) in people with diabetes. *Pak J Med Sci* 2016;32:1092–6.
10. Khan NA, Ishag AM, Ahmad MS, *et al*. Pattern of medical diseases and determinants of prognosis of hospitalization during 2005 Muslim pilgrimage Hajj in a tertiary care hospital. A prospective cohort study. *Saudi Med J* 2006;27:1373–80.
11. Al-Ghamdi SM, Akbar HO, Qari YA, *et al*. Pattern of admission to hospitals during muslim pilgrimage (Hajj). *Saudi Med J* 2003;24:1073–6.
12. Beshyah S, Sherif I. Care for People with Diabetes during The Moslem Pilgrimage (Haj) An Overview. *Libyan J Med* 2008;3:39–41.
13. Valerio L, Arranz Y, Hurtado B, *et al*. [Epidemiology and risk factors associated with religious pilgrimage to Saudi Arabia. Results of a prospective cohort 2008-2009]. *Gac Sanit* 2012;26:251–4.
14. Al-Salamah SM. General surgical problems encountered in the Hajj pilgrims. *Saudi Med J* 2005;26:1055–7.
15. Alfelali M, Barasheed O, Alshehri J, *et al*. Foot injuries among hajj pilgrims with and without diabetes mellitus: implications for infection management. *Infect Disord Drug Targets* 2014;14:140–7.
16. Sridhar S, Benkouiten S, Belhouchat K, *et al*. Foot ailments during Hajj: A short report. *J Epidemiol Glob Health* 2015;5:291–.
17. Miller JD, Carter E, Shih J, *et al*. How to do a 3-minute diabetic foot exam. *J Fam Pract* 2014;63:646–56.
18. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and Their Recurrence. *N Engl J Med* 2017;376:2367–75.
19. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. *JAMA* 2005;293:217–28.
20. Alsafadi H, Goodwin W, Syed A. Diabetes care during Hajj. *Clin Med* 2011;11:218–21.
21. Yusuf M, Chaudhry S. Diabetic ketoacidosis in pilgrims visiting Madinah Al-Munawarah, Saudi Arabia. *International Diabetes Digest* 1998;8:14–16.
22. Khan SA, Bhat AR, Khan LA. Hypoglycemia in diabetics during Hajj. *Saudi Med J* 2002;23:1548.
23. Baomer AA, el bushra HE. Profile of diabetic Omani pilgrims to Mecca. *East Afr Med J* 1998;75:211–4.
24. Beshyah S, Sherif I, Beshyah, IH Sherif SA. Care for people with diabetes during the moslem pilgrimage (haj) an overview. *Libyan J Med* 2008;3:39–41.
25. Alakkas Z. International Journal of Clinical Endocrinology and Metabolism, 2015.
26. Alzahrani AG, Choudhry AJ, Al Mazroa MA, *et al*. Pattern of diseases among visitors to Mina health centers during the Hajj season, 1429 H (2008 G). *J Infect Public Health* 2012;5:22–.
27. Al-Ghamdi SM, Akbar HO, Qari YA, *et al*. Pattern of admission to hospitals during muslim pilgrimage (Hajj). *Saudi Med J* 2003;24:1073–6.
28. Gautret P, Soula G, Delmont J, *et al*. Common health hazards in French pilgrims during the Hajj of 2007: a prospective cohort study. *J Travel Med* 2009;16:377–81.
29. Khan NA, Ishag AM, Ahmad MS, *et al*. Pattern of medical diseases and determinants of prognosis of hospitalization during 2005 Muslim pilgrimage Hajj in a tertiary care hospital. A prospective cohort study. *Saudi Med J* 2006;27:1373–80.
30. Meysamie A, Ardakani HZ, Razavi SM, *et al*. Comparison of mortality and morbidity rates among Iranian pilgrims in Hajj 2004 and 2005. *Saudi Med J* 2006;27:1049–53.
31. Madani TA, Ghabrah TM, Albarrak AM, *et al*. Causes of admission to intensive care units in the Hajj period of the Islamic year 1424 (2004). *Ann Saudi Med* 2007;27:101–5.
32. Madani TA, Ghabrah TM, Al-Hedaithy MA, *et al*. Causes of hospitalization of pilgrims in the Hajj season of the Islamic year 1423 (2003). *Ann Saudi Med* 2006;26:346–51.
33. Yamashita LS, Cariello AJ, Geha NM, *et al*. Demodex folliculorum on the eyelash follicle of diabetic patients. *Arq Bras Oftalmol* 2011;74:422–4.
34. Clifford CW, Fulk GW. Association of diabetes, lash loss, and Staphylococcus aureus with infestation of eyelids by Demodex folliculorum (Acari: Demodicidae). *J Med Entomol* 1990;27:467–70.
35. Ansari AS, de Lusignan S, Hinton W, *et al*. The association between diabetes, level of glycaemic control and eye infection: Cohort database study. *Prim Care Diabetes* 2017;11:421–9.
36. Jeganathan VS, Wang JJ, Wong TY. Ocular associations of diabetes other than diabetic retinopathy. *Diabetes Care* 2008;31:1905–12.
37. American academy of ophthalmology cornea/external disease panel. Preferred practice pattern guidelines. *Dry eye syndrome*. San Fransisco, CA: American Academy of Ophthalmology, 2013. www.aao.org/ppp
38. Zhang X, Zhao L, Deng S, *et al*. Dry eye syndrome in patients with Diabetes Mellitus: Prevalence, etiology, and clinical characteristics. *J Ophthalmol* 2016;2016:1–.
39. Sigal RJ, Kenny GP, Wasserman DH, *et al*. Physical activity/exercise and type 2 diabetes: a consensus statement from the American Diabetes Association. *Diabetes Care* 2006;29:1433–8.
40. Colberg SR, Sigal RJ, Fernhall B, *et al*. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement. *Diabetes Care* 2010;33:e147–e167.
41. Kenefick RW, Cheuvront SN. Hydration for recreational sport and physical activity. *Nutr Rev* 2012;70(Suppl 2):S137–S142.

42. American College of Sports Medicine, Sawka MN, Burke LM, *et al*. American College of Sports Medicine position stand. Exercise and fluid replacement. *Med Sci Sports Exerc* 2007;39:377-90.
43. World Health Organization. 2018. Food safety. http://www.who.int/en/news-room/fact-sheets/detail/food-safety (accessed 27 Apr 2018).
44. World Health Organization. 2018. Food safety. http://www.who.int/en/news-room/fact-sheets/detail/food-safety (accessed 27 Apr 2018).
45. United States Department of Agriculture Food Safety and Inspection Service. Food safety while hiking, camping & boating. www.fsis.usda.gov (accessed 26 Apr 2018).
46. Bailey CJ. Metformin: historical overview. *Diabetologia* 2017;60:1566–76.
47. Wright AD, Cull CA, Macleod KM, *et al*. Hypoglycemia in Type 2 diabetic patients randomized to and maintained on monotherapy with diet, sulfonylurea, metformin, or insulin for 6 years from diagnosis: UKPDS73. *J Diabetes Complications* 2006;20:395–401.
48. International Hypoglycaemia Study Group. Minimizing Hypoglycemia in Diabetes. *Diabetes Care* 2015;38:1583–91.
49. Hanefeld M, Josse RG, Chiasson JL. Alpha-glucosidase inhibitors for patients with type 2 diabetes: response to van de Laar et al. *Diabetes Care* 2005;28:1840.
50. Schernthaner G, Matthews DR, Charbonnel B, *et al*. Efficacy and safety of pioglitazone versus metformin in patients with type 2 diabetes mellitus: a double-blind, randomized trial. *J Clin Endocrinol Metab* 2004;89:6068–76.
51. Mishriky BM, Cummings DM, Tanenberg RJ. The efficacy and safety of DPP4 inhibitors compared to sulfonylureas as add-on therapy to metformin in patients with Type 2 diabetes: A systematic review and meta-analysis. *Diabetes Res Clin Pract* 2015;109:378–88.
52. Bowering K, Bain SC, Seufert J, *et al*. Liraglutide + metformin combination therapy in type 2 Diabetes: clinical benefits associated with early use of liraglutide and with switching a sulfonylurea for liraglutide. *Can J Diabetes* 2012;36:S46.
53. Bajaj HS, Venn K, Ye C, *et al*. Lowest Glucose Variability and Hypoglycemia Are Observed With the Combination of a GLP-1 Receptor Agonist and Basal Insulin (VARIATION Study). *Diabetes Care* 2017;40:194–200.
54. Sodium-glucose Cotransporter-2 (SGLT2) Inhibitors. 2016. Administration USFD. https://www.fda.gov/Drugs/DrugSafety/ucm446852.htm (cited May 2018).
55. https://www.diabetes.co.uk/insulin/basal-bolus.html.
56. https://www.diabetes.co.uk/insulin-pumps/pros-cons-of-insulin-pumps.html.
57. Al-Arouj M, Bouguerra R, Buse J, *et al*. Recommendations for management of diabetes during Ramadan. *Diabetes Care* 2005;28:2305–11.