

Self-Monitoring of Blood Glucose and Hypoglycemia Association During Fasting in Ramadan Among Patients with Diabetes

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Purpose: The study aims to assess current practices of patients with diabetes to control blood glucose levels during Ramadan.

Patients and Methods: A cross-sectional approach has been used for collecting data through a structured and interview-based questionnaire to assess the association between self-monitoring of blood glucose (SMBG) and hypoglycemia. The questionnaire has recorded information about demographics, duration of diabetes, and treatment of diabetes, and hypoglycemia complications faced during Ramadan. The primary outcomes of this study include frequency of SMBG during fasting in Ramadan and association of SMBG and hypoglycemia and break of fasting. However, the secondary outcomes include medications, glycemic control, and other influencing factors. The data was analyzed using Statistical Package of Social Sciences (SPSS) version 20.

Results: The findings have shown that the majority of the patients used a combination of metformin+sulphonylurea (23.02%) following metformin+insulin (20.86%), insulin (12.94%), and metformin (8.63%). Whereas diet control, high or low blood sugar, insulin dose adjustment in fasting conditions were the most influential factors during Ramadan when the blood sugar levels were tested. Majority of the patients monitored their blood glucose level during pre-iftar (56.8%) following to hypoglycemia (30.2%), post-iftar (29.4%), and rarely monitored in afternoon (3.5%) despite that only 10.1% monitored their blood glucose on a daily basis. Patients who had symptoms of hypoglycemia and had to break their fasting at least once were 41% and 27.2%, respectively. There is a significant association between age and gender with symptoms of low blood sugar level. Additionally, a significant association between blood sugar monitoring and high blood sugar level has been shown ($p=0.041$), indicating that lack in daily blood sugar monitoring can increase the blood sugar level of a patient during Ramadan.

Conclusion: The present study has helped in providing better understanding about the self-monitoring of blood glucose level and hypoglycemia. Furthermore, it also emphasizes the pre-Ramadan education about when to break their fasting along with frequency and timing of SMBG.

Keywords: glycemic control, insulin, medication, metformin, sulphonylurea

Introduction

The prevalence of diabetes has increased in recent decades at a massive rate, regardless of age groups. Developing countries have seen an increase in the prevalence of diabetes due to a variety of reasons; some of which are a sedentary lifestyle and poor-quality nutrition. It is expected to rise from about 415 million, to a burgeoning 642 million patients with

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diabetes in the year 2040.¹ In 2015, there were three Muslim-majority countries, Bangladesh, Indonesia, and Egypt, amongst the top 10 countries having adults suffering from diabetes.² There is a widespread prevalence of obesity due to increasing wealth and westernization in the Arabian Gulf. Moreover, there is also an increase in the dietary consumption and energy-dense food. In addition, the adoption of a sedentary lifestyle with the least amount of exercise and physical activity have worsened the problem.

Patients on a glucose control plan either for medical reasons or for religious reasons; like fasting in Ramadan, undergo a risk of suffering from hypoglycemia. Patients with diabetes must be very cautious when fasting during Ramadan as fasting can lead to low blood sugar; a condition known as hypoglycemia. Patients who insist on fasting, despite the risks associated with it, pose a medical challenge for the health-care professionals and for themselves.³ Delayed or missed meals and limited or no consumption of fluids vastly contribute to cause hypoglycemia. There are many other causes of hypoglycemia like, renal dysfunction, cognitive dysfunction, concomitant medications, old age, and long duration of diabetes.⁴ The main cause of hypoglycemia is the use of glucose-lowering medications that are used to increase the circulating insulin. The treatment of patients with type 2 diabetes with antihyperglycemic medications vastly increases the risk of hypoglycemia.⁵

Patients with diabetes who are at a high risk of major complications during fasting in Ramadan may face severe hypoglycemia. Moreover, patients undergoing dialysis treatment, performing intense physical labor, pregnant women, and patients with advanced macrovascular complications of the brain, heart, or peripheral vessels are recommended against fasting in Ramadan. Patients who are at moderate risk of complications during fasting, and insist on fasting, must adhere to dietary advice given by their physicians. Furthermore, efficient meal planning and a balanced diet will ensure more safety. A low glycemic index diet consists of moderate consumption of carbohydrates and proteins, lower fat, higher fiber, and fresh vegetables and fruits.⁶ Besides these dietary modifications, self-monitoring of blood glucose (SMBG) is another effective method in efficient management of hypoglycemic conditions in patients with diabetes.

Islam exempts a person from fasting when it may significantly affect the health of the faster or when an individual is sick. However, use of a glucose meter is one measure of precaution employed by patients with diabetes during Ramadan. Diabetes management with medications and consistent monitoring is an effective

strategy to prevent long-term complications of diabetes. SMBG is an essential requirement for patients with diabetes, who need to adjust their insulin doses on a regular basis. Therefore, the advantages of SMBG cannot be overstated; although it requires adequate handling and storage and proper performance of the quantifying process.⁷ The use of SMBG is widely recommended by health-care professionals and diabetes specialists. It is effective to prevent hypoglycemia and to achieve a safe level of glycemic control. In SMBG, the patient collects detailed information about blood glucose levels at different points of time throughout the day. It enables the physician to provide the patient with the precise amount of medication to maintain constant glucose levels. Subsequently, the patient can also adjust physical activity and dietary routine to improve their glycemic control on a regular basis.⁸

One of the standard methods to monitor the glycemia level is through glycosylated hemoglobin test, which is done at three-month intervals. Patients suffering from type 2 diabetes must try to keep their HbA1c measurements at 6.5%, but a physician can best customize the ideal level of HbA1c according to patient's history and other parameters. The HbA1c does not monitor patients on a regular basis. The patients need to discuss the dietary regimen during fasting, their medication schedules and other aspects related to diabetes. However, SMBG is a boon for patients with diabetes. This test can be done at any time of the day, before or after a physical activity, or between meals. It is handy and can be personally used by patients.⁹ Besides, it is very affordable and advisable that all patients with diabetes have a blood sugar monitor at home. This is because Muslims usually go for very high calorie food, they sleep and work for fewer hours, and they do not exercise during Ramadan. Moreover, there is limited data on controlling diabetes in Ramadan, despite the large number of Muslim populations globally. Therefore, the present study aims to assess current practices of diabetic patients to control blood glucose levels during Ramadan.

Materials and Methods

Ethical Approval: MoH in Saudi Arabia approved this study. It was a face to face interview after getting verbal consent from the participants. The study was in accordance with the Declaration of Helsinki.

This cross-sectional study was conducted through an interview-based questionnaire. The study subjects were a representative group of patients with diabetes, among which 139 patients were selected, who attended clinic during the second

and third week following completion of fasting in Ramadan. All the patients with diabetes attending the participating clinic at the time of the study, practicing SMBG, and fasting most of Ramadan (more than 15 days) were included in the study. The exclusion criteria for this study were patients with diabetes who were under 18 years of age.

During the second and third week following completion of fasting in Ramadan, all patients with diabetes attending participating clinics were requested to be interviewed using the questionnaire. Consent was obtained from all study participants before introducing the questionnaire. A close-ended questionnaire was used to assess knowledge and awareness about Ramadan fasting of the study population. Frequency of SMBG during fasting in Ramadan and association of SMBG and hypoglycemia and break of fasting were primary outcomes of this study. Medications, glycemic control, and influencing factors were secondary outcomes. The obtained data was entered into Microsoft Excel and then transferred to SPSS version 20 (IBM Corporation, Armonk, NY, USA) for conducting further analysis. The data is presented in form of frequencies and percentages since it is descriptive.

Results

Table 1 depicts the demographic details of the patients. A total of 66.9% male and 33.1% female patients participated in the study. Mostly patients were treated with metformin + sulphonylurea (23.02%), metformin + insulin (20.86%), and insulin (12.94%). **Table 2** presents influential factors contributing toward the hypoglycemia and break of fasting.

Table 3 presents the types of medicines used by patients during Ramadan. Most of the patients used a combination of metformin+sulphonylurea (23.02%) following metformin+insulin (20.86%), insulin (12.94%), metformin (8.63%), and metformin+sulphonylurea+glitazones (7.194%). Metformin alone was taken by 8.63% of the patients, whereas metformin in combination to other drugs was taken by 72.66% of the patients.

Table 4 presents blood glucose level monitored by patients during Ramadan at different times. Most of the patients monitored their blood glucose level during pre-iftar (14.3%) following hypoglycemic condition (10.07%), post-iftar (7.913%), pre-iftar + pre-sahoor (7.194%), and pre-iftar + pre-sahoor + hypoglycemic (6.748%). Findings of **Table 5** show that 56.83% and 29.49% patients mon-

Table 1 Demographic Details

Measure	Items	Frequency	Percentage (%)
Gender	Male	93	66.9
	Female	46	33.1
New medicine	Yes	44	32.1
	No	94	67.9
Information about testing	Yes	65	47.1
	No	72	52.8
Days a week	1 day	48	34.5
	2 days	29	20.9
	3 days	27	19.4
	4 days	8	5.8
	5 days	3	2.2
	6 days	1	0.7
	7 days	14	10.1
Times a day	Once	78	56.1
	Twice	36	25.9
	3 times	10	7.2
	4 times	4	2.9
	5 times	1	0.7
	6 times	1	0.7
	7 times	1	0.7
Feeling of symptoms	Yes	59	42.4
	No	80	57.6
Breaking fasts	Once	23	16.5
	Twice	7	5
	3 times	6	4.3
	4 times	1	0.7
	More than 6 times	1	0.7
	Total number of breaking fast	38	
Episodes of low blood level	Once	16	11.5
	Twice	15	10.8
	3 times	14	10.1
	4 times	4	2.9
	5 times	1	0.7
	6 times	6	4.3
	More than 6 times	1	0.7
	Total number of low blood level episodes	57	
HbA1c reading	Under 6.5%	12	8.6
	6.6–7.5%	20	14.4
	7.6–8.5%	29	20.9
	8.6–9.5%	9	6.5
	9.6–10.5%	6	4.3
	Over 10.5%	8	5.8

Table 2 Table Depicting the Influential Factors

Factors	Not at All Influential N (%)	Low Influential N (%)	Slightly Influential N (%)	Neutral N (%)	Moderately Influential N (%)	Very Influential N (%)	Extremely Influential N (%)
Low blood sugar	53 (38.1)	13 (9.4)	8 (5.8)	4 (2.9)	16 (11.5)	19 (13.7)	26 (18.7)
High blood sugar	48 (34.5)	16 (11.5)	14 (10.1)	13 (9.4)	3 (2.2)	16 (11.5)	29 (20.9)
Advice of health-care professional	13 (9.4)	14 (10.1)	10 (7.2)	29 (20.9)	31 (22.3)	18 (12.9)	24 (17.3)
Controlling diet	23 (16.5)	18 (12.9)	12 (8.6)	17 (12.2)	24 (17.3)	19 (13.7)	26 (18.7)
Adjusting insulin dose	7 (5)	5 (3.6)	5 (3.6)	17 (12.2)	13 (9.4)	13 (9.4)	16 (11.5)
Keeping an eye on blood sugar	20 (14.4)	17 (12.2)	15 (10.8)	20 (14.4)	17 (12.2)	24 (17.3)	22 (15.8)
Starting change therapy	27 (19.4)	11 (7.9)	10 (7.2)	23 (16.5)	21 (15.1)	20 (14.4)	25 (18)
Fasting condition	37 (26.6)	9 (6.5)	5 (3.6)	31 (22.3)	25 (18)	15 (10.8)	17 (12.2)
Stabilizing blood sugar	38 (27.3)	14 (10.1)	10 (7.2)	28 (20.1)	16 (11.5)	16 (11.5)	15 (10.8)
Regular hypoglycemic attacks	51 (36.7)	11 (7.9)	7 (5)	12 (8.6)	9 (6.5)	24 (17.3)	23 (16.5)
Severe hypoglycemic Attack	57 (41)	8 (5.8)	4 (2.9)	11 (7.9)	9 (6.5)	16 (11.5)	33 (23.7)

Table 3 Types of Medicine

Items	N	%
Metformin	12	8.63
DPP4i	0	0
Sulphonylurea	0	0
Glitazones	0	0
Insulin	18	12.94
Metformin+insulin	29	20.86
Metformin+sulphonylurea	32	23.02
Metformin+DPP4i	4	2.877
Metformin+glitazones	2	1.438
Metformin+others	5	3.597
DPP4i+glitazones+insulin	1	0.719
DPP4i+sulphonylurea	2	1.438
Sulphonylurea+glitazones	1	0.719
Sulphonylurea+insulin	1	0.719
Sulphonylurea+others	1	0.719
Metformin+DPP4i+insulin	3	2.158
Metformin+sulphonylurea+insulin	6	4.316
Metformin+sulphonylurea+glitazones	10	7.194
Metformin+sulphonylurea+DPP4i	8	5.755
Metformin+DPP4i+insulin+sulphonylurea	2	1.438
Missing	1	0.719
Others	1	0.719
Total	139	100

itored blood glucose level at pre-iftar and post-iftar, respectively. Moreover, 22.30% of participants monitored their blood glucose level at pre-sahoor.

Table 6 shows the factors influencing patients during Ramadan as they test their blood sugar. The results indicate that low/high

Table 4 Blood Glucose Level Monitoring

Items	N	%
Afternoon	3	2.158
Pre-iftar	20	14.388
Post-iftar	11	7.913
Pre-sahoor	5	3.59
When unwell	7	5.035
Hypoglycemic	14	10.07
Post-iftar+pre-sahoor	3	2.158
Post-iftar+hypoglycemic	2	1.438
Pre-iftar+hypoglycemic	8	5.755
Pre-iftar+pre-sahoor	10	7.194
Pre-iftar+when unwell	6	4.316
Post-iftar+unwell	2	1.438
Pre-iftar+post-iftar	10	7.194
Pre-iftar+post-iftar+unwell	1	0.719
Afternoon+pre-iftar+unwell	1	0.719
Pre-iftar+post-iftar+pre-sahoor	3	2.158
Pre-iftar+post-iftar+pre-sahoor+hypoglycemic	1	0.719
Pre-iftar+post-iftar+others	1	0.719
Afternoon+pre-iftar+post-iftar	1	0.719
Pre-iftar+when unwell+hypoglycemic	2	1.438
Pre-iftar+pre-sahoor+ypoglycemic	9	6.748
Pre-iftar+post-iftar+when unwell+hypoglycemic	6	4.316
Others	6	6.748
Missing	8	5.755
Total	139	100

blood sugar, diet control, insulin dose, and adjustment in fasting conditions were the most influential factors. Table 7 shows significant association of age and gender with symptoms of low blood

Table 5 Blood Glucose Level Monitoring Timing

Items	N	%
Afternoon	5	3.59
Pre-iftar	79	56.8
Post-iftar	41	29.49
Pre-sahoor	31	22.30
When unwell	25	17.98
Hypoglycemia	42	30.21
Random	7	5.03

sugar level. Moreover, gender was significantly associated with SMBG level, which indicates that there is significant variation in SMBG level with respect to both genders. In the context of breaking fast, there was no significant association of self-monitoring indicators, which shows no influence on breaking fast during Ramadan.

Discussion

The present study provided a better emphasis toward the SMBG regimen education during fasting. These findings are supported by Ko et al,¹⁰ who investigated the importance of patient education as part of care of patients with diabetes. The results depicted that HbA1c of the control group was found to be higher than the patients who had undergone the SIDEPE education program. It was also discovered that the patients who underwent the SIDEPE were taking better care of themselves through the SMBG regimen. Conversely, the control group patients were lacking in self-care. It was concluded that a professional and thorough patient education program proved indispensable for patients suffering from diabetes.¹⁰

The present study showed that self-monitoring behavior of the patients during fasting was influenced by low/high blood sugar, diet control, insulin dose, and adjustment

Table 6 Controlling Blood Glucose Level Among the Diabetic Patients

	Not at All Influential N (%)	Low Influential N (%)	Slightly Influential N (%)	Neutral N (%)	Moderately Influential N (%)	Very Influential N (%)	Extremely Influential N (%)
Low blood sugar	53 (38.1)	13 (9.4)	8 (5.8)	4 (2.9)	16 (11.5)	19 (13.7)	26 (18.7)
High blood sugar	48 (34.5)	16 (11.5)	14 (10.1)	13 (9.4)	3 (2.2)	16 (11.5)	29 (20.9)
Healthcare professional advice	13 (9.4)	14 (10.1)	10 (7.2)	29 (20.9)	31 (22.3)	18 (12.9)	24 (17.3)
Diet control	23 (16.5)	18 (12.9)	12 (8.6)	17 (12.2)	24 (17.3)	19 (13.7)	26 (18.7)
Insulin dose adjustment	7 (5)	5 (3.6)	5 (3.6)	17 (12.2)	13 (9.4)	13 (9.4)	16 (11.5)
Fasting condition	37 (26.6)	9 (6.5)	5 (3.6)	31 (22.3)	25 (18)	15 (10.8)	17 (12.2)

Table 7 Blood Glucose Level Monitoring Either Alone or in Combination

	Symptoms of Low Blood Sugar Level		Episode of Low Blood Sugar		Break Fasting	
	Correlation Value (r)	Significance Value (p)	Correlation Value (r)	Significance Value (p)	Correlation Value (r)	Significance Value (p)
Age	-0.175	0.040	0.082	0.545	-0.241	0.145
Gender	0.262	0.002	0.374	0.004	0.163	0.328
Diabetes	0.075	0.388	-0.204	0.128	-0.99	0.556
Types of medicines	-0.123	0.151	-0.044	0.749	0.127	0.455
New medicine	0.139	0.103	0.105	0.443	0.012	0.942
Testing blood sugar level	0.103	0.229	0.218	0.106	-0.119	0.484
Days a week	-0.013	0.881	-0.11	0.936	0.037	0.827
Times a day	0.007	0.941	0.020	0.883	0.168	0.314
Blood glucose monitoring	-0.001	0.991	0.028	0.836	0.033	0.844

in fasting conditions. A similar study conducted by Farmer et al¹¹ found that increased frequency of SMBG was associated with increased frequency of self-reported episodes of low blood glucose, even among patients not taking insulin or sulfonylureas.¹¹ The present study also showed that most of the patients during fasting monitored their blood sugar levels at pre-iftar and when experiencing hypoglycemic symptoms despite that only 10.1% monitored their blood glucose on a daily basis. However, Mansouri et al¹² showed that 28.2% of the patients monitored their blood glucose on a daily basis, while 10.6% monitored it more than once daily.

The present study has highlighted the importance of using SMBG among the patients with diabetes during Ramadan. This was confirmed by Alamoudi et al¹³ who stated that use of SMBG might help the patients with diabetes to have fewer episodes of hypoglycemia, lower weight, and better glucose control compared with usual care. Another study examining the impact of customized type 2 diabetes education program on clinical consequences during Ramadan showed that patients with type 2 diabetes were more likely to modify their diabetes treatment plan (97% vs 88%), reduce their body mass index and glycated hemoglobin.¹⁴

The present study is informative as it also highlights the significance of clinically important data of patients with diabetes during Ramadan fasting. However, the results are limited because it has focused on a small sample and it has limited statistical power as it is an exploratory study. The study lacks analysis of other potentially confounding factors such as age, parity, BMI, personal, and family history.

Conclusion

The study has assessed the association between SMBG and managing the hypoglycemic condition among patients with diabetes. The study results depicted that low blood sugar level differs with respect to age and gender. The study has provided better understanding about the SMBG level and hypoglycemia frequencies during fasting in Ramadan. It shows that self-monitoring of blood sugar level differs with respect to gender of the patients. Moreover, none of the self-monitoring indicators were influential in breaking fast of the patients during the Ramadan. Considering the study results, the use of SMBG is emphasized during Ramadan as recommended by health-care professionals and diabetes specialists.

Moreover, the study recommends that diabetic patients need to be encouraged and guided for changing their

lifestyle during Ramadan to minimize the risk of developing acute complications. It also recommends continuous glucose monitoring to be studied for understanding the blood glucose changes in patients with diabetes during Ramadan. In the similar context, public health programs also need to be developed and implemented before Ramadan to address the diabetes management that would promote safe fasting practices and avoid any complications.

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Disclosure

The authors report no conflicts of interest in this work.

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