



Culturally based pre-Ramadan education increased benefits and reduced hazards of Ramadan fasting for type 2 diabetic patients

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Abstract

Objectives In the current study, we aimed at evaluating the effect of a culturally-based pre-Ramadan education program (PREP) on glycemic control, weight, adherence to post-sunset physical activity, perception of hypoglycemia, and anti-diabetic medication dose adjustment during Ramadan fasting in type 2 diabetics.

Study design A total of 1008 type 2 Diabetes patients were offered a culturally-based PREP in addition to the standard of care, two months before Ramadan. A retrospective interview one month after Ramadan compared the fasting experience of PREP attendees (470 patients) with those who merely received standard of care (538 patients) (Non-PREP).

Results Ramadan fasting improved glycemic control with a correlation between HbA1c percent reduction and the number of fasting days ($r = -0.290$, $p = 0.007$). More HbA1c and weight percent reduction were observed in PREP attendees compared to the Non-PREP group ($-14.8\% \pm 9.3$ vs. $-5.4\% \pm 5.4$; $p < 0.001$; and $-1.96\% \pm 5.4$ vs. $-0.39\% \pm 2.8$; $p < 0.001$, respectively). More commitment to night prayers in the PREP attendees compared to the Non-PREP group, (85.5% prayed >20 nights vs 28.4%; $p < 0.001$) with more HbA1c and weight percent reduction in the those who performed the prayers more than 20 nights compared to those who performed no prayers ($-11.69\% \pm 8.8$ vs $-6.28\% \pm 6.4$, $p < 0.001$; and $-2.76\% \pm 5.1$ vs $1.35\% \pm 1.8$, $p < 0.001$, respectively). More perception of true hypoglycemia was associated with PREP attendance ($p0.046$), insulin treatment ($p0.000$), and reduction of antidiabetic medication dosage ($p0.004$). Repeated lowering of antidiabetic medications doses with sequential downsizing of meals' portions, and appetite was reported.

Conclusion Ramadan fasting was beneficial for people with type 2 diabetes with reduction of HbA1c in correlation with the number of fasting days. Contrasting PREP with Non-PREP participants discovered better HbA1c and weight reduction in the former group even with equal number of fasting days. PREP participants performed more Taraweeh night prayers. The more the prayer nights the more decline of HbA1c and weight was observed. PREP improved perception and response to hypoglycemia with low-dosing of antidiabetic medications, especially insulin.

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Introduction

From puberty onwards, Muslims must perform intermittent daytime fasting for 30 successive days during the lunar month of Ramadan from pre-dawn to sunset. Dietary restriction by intermittent fasting or chronic caloric reduction has been claimed to increase longevity by reducing oxidative stress [1, 2]. Moreover, During fasting, not merely do animal and human cells produce glycerol instead of ethanol produced in yeast cells, but with the former supplying carbon for energy production without activation of pro-aging nutrient-induced signaling pathways, which is accelerated by the latter, to boot [3, 4]. Time-limited 12 to 20 hours of fasting has been associated with an increase of basal energy expenditure [5], and reduction of energy intake, into the bargain [6]. Improvement of muscle glucose disposal after the first subsequent meal could be another plus [7]. This suggested a beneficial effect of Ramadan intermittent daytime fasting on glucose metabolism in both people with type 2 diabetes as well as healthy ones. This benefit might be blunted by improper feeding habits, inadequate self-management knowledge, and lack of physical activity, where education is of utmost importance.

To be useful and easily applicable, Pre-Ramadan Education programs should convey simple, clear information [8] and take advantage of the Islamic cultural background [9, 10]. Favorable reduction of HbA1c, weight, hypo- and hyperglycemic events has been recorded in previous Ramadan focused education studies, which unfortunately included a limited number of participants [11, 12] and fasting days [12]. On the other hand, non-adherence of patients with diabetes to Ramadan education programs, which has been suggested to increase their vulnerability to complications [13], might be reasoned by inapplicability of these programs, not taking the patients' keenness to fast into consideration. One of the weakness points in education programs could be lack of action plan to prevent hypoglycemia by adjusting antidiabetic medication dosage, due to scarce information of the patients about the basics of their mode of action. Another point might be the recommendations about physical activity during Ramadan. Exercise has been prohibited during fasting hours and encouraged after breakfasting at sunset [14]. However, the regular exercise might be inconvenient to most of the patients during Ramadan and inappropriate to the high spiritualities unique to the month of fasting.

Indulging the patients in their own management plan during Ramadan, using interactive education sessions, discussing healthy alternatives of food choices, meal timing, clear cutoff

blood glucose readings for breaking the fast, pre-emptive action plans to avoid hypoglycemia, proper hydration after sunset, and Ramadan-compatible physical activity, were hardly needed.

Objectives of the study

Our objectives were to evaluate the effect of a culturally-based pre-Ramadan education program (PREP) on fasting associated changes in HbA1c and weight, commitment to the non-obligatory night prayers, detection of hypoglycemia, and dose adjustment of anti-diabetic medications during Ramadan in people with type 2 diabetes.

Study design

In the year 1437 Hijri, 2016 Gregorian, 1008 patients with type 2 diabetes who wished to fast during Ramadan were offered only the standard of care (538 patients) during their regular pre-Ramadan visits or PREP in addition (470 patients), two months preceding Ramadan. PREP was a two-hour interactive session held daily for a new group of 10–20 patients with type 2 diabetes, referred from private clinics, in the Arabic Association for the Study of Diabetes and Metabolism (AASD) Education center. PREP aimed to improve patients' knowledge about diabetes and Ramadan fasting [Supplementary 1]. Aided by a common investigators-prepared presentation, PREP was delivered. It included the following:

- General knowledge about pathogenesis and treatment of type 2 diabetes
- Risk stratification for Ramadan fasting
- Advice about food planning and proper hydration during Ramadan
- A suggested schedule for self-monitoring of blood glucose SMBG (4 points related to prayer or meal times for simplicity, or on demand when feeling unwell)
- Clear cutoff levels for breaking the fast [≤ 3.9 mmol/L (70 mg/dl) and ≥ 16.6 mmol/L (300 mg/dl)]
- Counseling to seek medical advice and/ or permission to reduce insulin secretagogues or insulin dosage if mid-day blood glucose readings were ≤ 5.6 mmol/L (100 mg/dl) in two successive days, meanwhile arranging for diabetes clinic appointment.
- Emphasizing the importance of physical activity incorporated in the postprandial Muslim non-obligatory night prayers i.e. Taraweeh prayers

One month after Ramadan, we retrospectively analyzed the fasting experience of 1008 patients with type 2 diabetes, known to have a stable treatment regimen at least three months before Ramadan and conducted no fasting in the two lunar months preceding Ramadan [47% were PREP participants and 53% received standard of care only (Non-PREP)] who volunteered to answer an interview questionnaire about their fasting in comparison to regular days [supplementary 2]. The study was approved by the local ethical committee, and written consents were obtained from the participants before being interviewed in the AASD Education center. Pregnant women, type 1 diabetes, and very high-risk type 2 patients were excluded.

Statistical analysis

Data of PREP and Non-PREP were statistically described in terms of mean \pm standard deviation (\pm SD), frequencies (number of cases), and percentages when appropriate. Numerical variables between the study groups were juxtaposed using a Student *t*-test for independent samples in collocating two groups of normally distributed data and Mann Whitney *U* test for independent samples for comparing data, which were not normally distributed. A comparison of normally distributed numerical variables between more than two groups was made using a one-way analysis of variance ANOVA test with post-hoc multiple 2-group comparisons, while abnormal numerical variables were compared using the Kruskal Wallis test. For comparing categorical data, Chi-square (χ^2) test was used. The exact test was performed instead when the expected frequency is less than 5. Correlation between the various variables was done using the Spearman rank correlation equation. Univariate and multivariate analysis models were used to test for the preferential effect of the independent variable(s) on the dependent variable(s). A *p* value of less than 0.05 was considered statistically significant. All statistical calculations were done using computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) release 15 for Microsoft Windows (2006).

Results

Patients' characteristics were presented in Table 1. There was a significant reduction in HbA1c after Ramadan fasting compared to baseline ($p = 0.001$), with a significant correlation between HbA1c percent reduction and the number of days fasted ($r = -0.290$, $p = 0.007$) (Fig. 1).

Percent reduction in HbA1c ($p < 0.001$) and weight ($p < 0.001$) was significantly higher in PREP compared to non-PREP participants, despite the number of fasting days being comparable ($p = 0.914$) (Table 2).

Table 1 Participants and Study Characteristics

Patients (n)	PREP	Non-PREP
1008	470	538
Men	280 (59.5%)	270 (50.2%)
	Mean \pm SD	Mean \pm SD
Age (years)	51 \pm 11	50 \pm 12
Number of Fasting Days	29.5 \pm 1	29.7 \pm 0.6
Weight before fasting (Kg)	90.45 \pm 11.13	91.21 \pm 11.13
Weight after fasting (Kg)	89.53 \pm 11.53	90.43 \pm 12.42
HbA1c before Ramadan	9.55 \pm 1.97%	9.60 \pm 2.5%
HbA1c after Ramadan	8.57 \pm 1.81%	9.0 \pm 2.1%
Patients on OAD (n)	217	276
Patients on insulin (n)	163	168
Patients on both (n)	90	94
[OAD+ basal insulin]		
Breakfasting Events	50	137
Hypoglycemia caused breakfasting	49	40

PREP: Pre-Ramadan Education Program Participants

Non-PREP: Pre-Ramadan Education Program Non-participants = Standard of Care Participants

OAD: Oral Anti-diabetic Medications

SD: Standard Deviation

Compliance with more nights of non-obligatory prayers, i.e. Taraweeh prayers, showed a significant correlation to PREP (Fig. 2). Taraweeh prayers were undertaken for more than 20 nights during the month of Ramadan in 85.5% of PREP participants compared to 28.45% of the non-PREP group ($p < 0.001$) (Fig. 2). ANOVA across four groups according to the number of prayer performance nights (none, 10, 20, > 20 nights) showed a significantly higher percent reduction in HbA1c ($p < 0.001$) and weight ($p < 0.001$) with increased number of prayer nights (Table 3).

Hypoglycemia compelling to break the fast was noticed only by 10% of PREP group (49 events in 470 patients) and 7% of non-PREP participants (40 events in 538 patients), with nobody reporting more than one event during Ramadan (Table 1). However it was the main cause of breaking the fast in the former group 98% (49 out of 50 breakfasting events), while representing only 29% in the non-PREP group (40 out of 137 breakfasting events) (Table 1). More perception of hypoglycemia and documented self-monitored hypoglycemia showed significant association with insulin treatment, attending PREP, and dose adjustment of anti-diabetic medications (Table 4).

Discussion

Ramadan fasting was associated with improvement of the overall glycemic control (HbA1c) and weight reduction, with more significant effects in PREP participants.

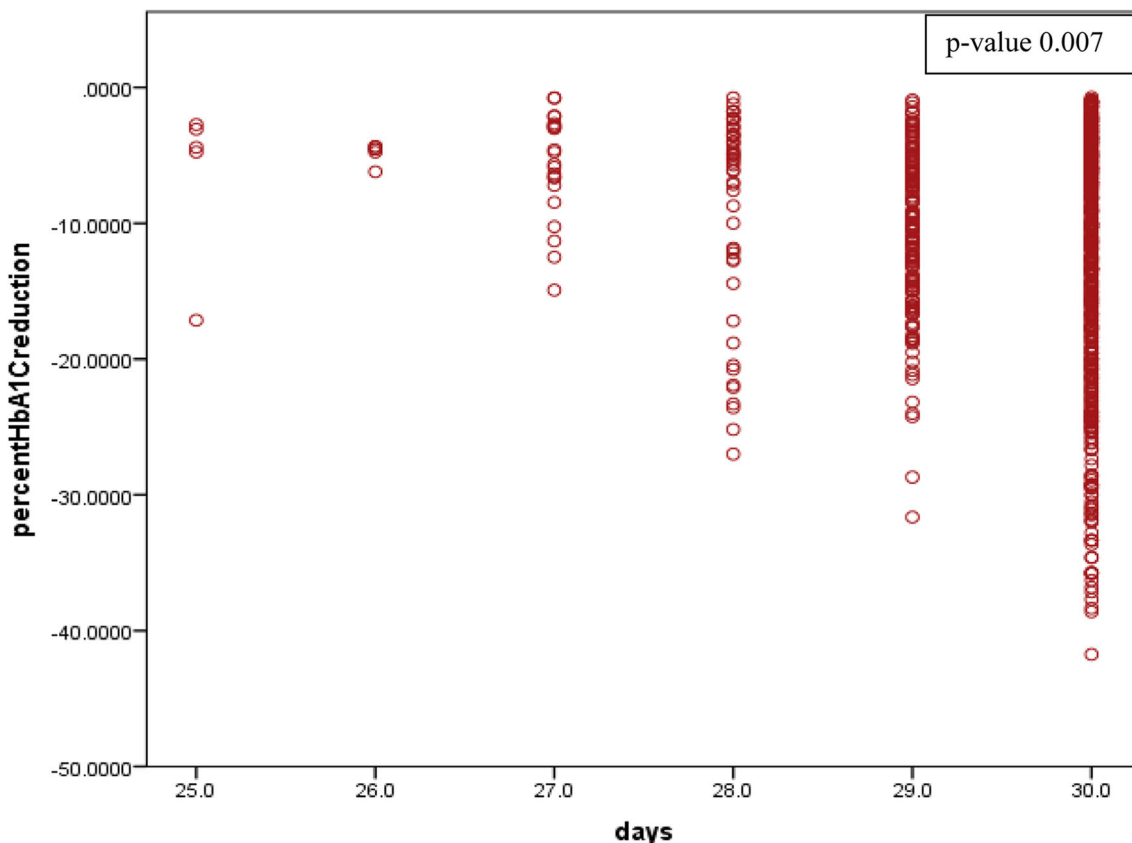


Fig. 1 Correlation between percent HbA1c reduction and the number of fasting days in Ramadan for all participants

In the current study HbA1c values one month before and one month after Ramadan were set against one another, which agreed with most of the recommendations accepting HbA1c as a measure for overall glycemic control over the prior three months [15, 16]. PREP sessions were held two months before Ramadan, so expected to show their impact on the subsequent months, including the fasting experience of Ramadan just in the middle. A significant positive correlation was detected between the percent reduction in HbA1c and the number of fasting days, despite the diversity of the initial HbA1c values of various participants at the commencement of fasting.

Table 2 Comparison between PREP and Non-PREP

	PREP		p- value
	Non-PREP Mean ± SD	PREP Mean ± SD	
Percent HbA1C Change	-5.3882% ±5.4	-14.8087% ±9.3	<0.001
Percent Weight Change	-0.393% ±2.8	-1.966% ±5.4	<0.001
Fasting Days	29.5 ± 1	29.7 ± 0.6	0.914

SD: Standard Deviation

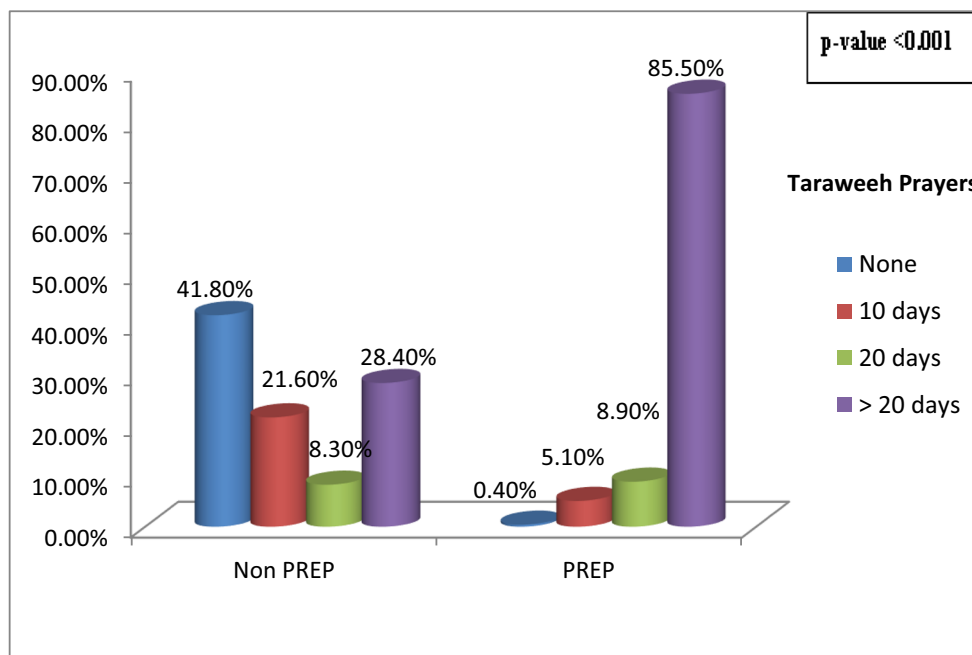
PREP: Pre-Ramadan Education Program Participants

Non-PREP: Pre-Ramadan Education Program Non-participants = Standard of Care Participants

There has been contradictory data about the effect of Ramadan fasting on glycemic control, as some studies showed improvement [17], while others showed deterioration [18]. Being an intermittent daytime fasting with allowance of food and drink after sunset each day, there has been a high vulnerability for hyperglycemia during Ramadan, each night. Significant lowering of HbA1c one month after Ramadan in our study might be indicative of the extended effect of PREP on the patients’ attitude despite the feasting time during and after Ramadan. Similarly prolonged favorable effects of Ramadan education programs have been suggested by other researchers [19], while apparent contradiction between our conclusions and those of a prospective study which showed elevation of fasting blood glucose and HbA1c recorded immediately after Ramadan [20] could be questionable, as the same study group reported significant lowering of HbA1c one month after Ramadan. In addition, it was conducted on fewer participants, who fasted an average of only ten days [20], which could be claimed to be insufficient to assess the actual effect of Ramadan fasting. On the contrary, the current study included more participants who fasted most of the days of Ramadan, taking into consideration that the more the number of fasting days, the more was the HbA1c percent reduction.

Cross-cultural barriers between patients and physicians or educators have been suggested to interfere with proper pre-

Fig. 2 Percent of Participants committed to night Taraweeh Prayers in PREP and Non-PREP groups



PREP: Pre-Ramadan Education Program Participants

Non-PREP: Pre-Ramadan Education Program Non-participants = Standard of Care Participants

Ramadan education [18, 21], deteriorating glycemic control. Comparing these data with the current results emphasized the role of effective culturally-based PREP in maximizing the metabolic benefits of Ramadan fasting among people with diabetes.

Weight has been reported to increase [22], decrease [23] or remain unchanged after Ramadan fasting in people with diabetes, as well as healthy individuals. Increased carbohydrates and fat consumption, on one hand, and limited physical activity, on the other hand, have been claimed as the main causes of weight gain [22]. In the present study, putting examples of culturally-derived healthy recipes, low in carbohydrates and fat, rich in fibers and low in total caloric content could partially explain significant weight reduction in PREP participants compared to the non-PREP group. Motivating patients to be engaged in regular night physical activity was an added bonus.

During Ramadan, there are non-obligatory night prayers referred to as Taraweeh prayers, which comprise repetitive

standing, kneeling, and prostration, combining aerobic and resistance exercise [24], providing moderate-intensity physical activity for an average of 40 min. Encouraging the PREP participants to join these prayers significantly upgraded their commitment for more nights. The timing of these prayers in the postprandial period after the main sunset meal, concomitant with increased muscle glucose uptake [7], has been suggested to blunt postprandial glycemic excursion [2], contributing to reduction of HbA1c [25, 26] and oxidative stress [2]. This might explain the more significant percent reduction in HbA1c and weight in the PREP group compared to the non-PREP in the current study. This also stressed on the importance of improving the knowledge of physicians, nurses, and educators about Islamic cultural backgrounds before delivering PREP, to implement them properly, when needed most.

Hypoglycemia has been claimed to increase by 7.5 folds in type2 diabetes patients during Ramadan in the EPIDIAR study [27]. Bravis et al. have related a four-fold increase and 0.44 reductions of hypoglycemic events during Ramadan to

Table 3 Comparison between Participants according to Partaking at Taraweeh Night Prayers

Mean ± SD	Taraweeh Prayers				p value
	None	10 days	20 days	> 20 days	
Percent HbA1C Change	-6.2765% ±6.4	-7.621% ±9.4	-10.5546% ±9.9	-11.6872% ±8.8	<0.001
Percent Weight Change	1.345% ±1.8	0.512% ±1.3	0.222% ±0.7	-2.757% ±5.1	<0.001
Number of Fasting Days	29.5 ± 0.9	29.5 ± 1.2	29.2 ± 1.1	29.7 ± 0.6	0.891

SD: Standard Deviation

Table 4 Association between Perception of More Hypoglycemic Events with Pre-Ramadan education, Different Anti-diabetic Medications, and Dose Adjustment

Perception of more frequent hypoglycemic events compared to regular days	Hypoglycemia	True Hypoglycemia ≤ 3.9 mmol/L (70 mg/dl)
In association with	Significance p value	Significance p value
Pre-Ramadan education	0.027	0.046
Sulfonylurea	0.000	0.745
Metformin	0.227	0.094
DPP4 Inhibitors	0.000	0.401
Insulin	0.000	0.000
Dose Adjustment	0.038	0.004

the lack versus presence of education, respectively, in a cohort mainly treated with sulfonylureas [19]. A Malaysian study has shown 1.6 fold relative risk increase of hypoglycemia during Ramadan, mainly related to tight glycemic control and old age, rather than a specific antidiabetic agent [28]. Moreover authors reported that compliance to the pre-dawn meal (Suhur meal) reduced relative risk of hypoglycemia by 50% [28]. On the contrary a recent Saudi study by AlKhaldi et al., has detected high incidence of hypoglycemia during Ramadan, where at least one attack has been reported by half of the studied cohort. Type1 diabetes, young age, long diabetes duration and insulin treatment have been deemed risk factors for occurrence of hypoglycemia, while pre-Ramadan education has been claimed to augment patients' noting of it [29]. In comparison hypoglycemia in the current study was much less common, whether in PREP or non-PREP groups, which could be interpreted by exclusion of type1 diabetics, sticking to the pre-dawn Suhur meal by the majority [28], as well as stable doses of anti-diabetic medications before Ramadan [27]. Increased perception of hypoglycemia was reported by those treated with sulfonylureas, DPP4 Inhibitors, and insulin, but was only true documented hypoglycemia in insulin-treated patients, in raw with the Saudi study [29]. This might be explained by awareness of physicians about the necessity of dose reduction of sulfonylureas during Ramadan [30], being glucose independent insulin secretagogues [31, 32], and low probability of hypoglycemia with DDP4 inhibitors, having glucose-dependent action [33]. However, hypoglycemia perception was associated with PREP attendance also agreeing with the findings of AlKhaldi et al. [29], and reduction of insulin and oral anti-diabetic medications OAD dosage, which might reflect better hypoglycemia awareness and pre-emptive self-management skills in the PREP group, as most of them reported seeking medical advice when several readings of SMBG showed lower trends, or lowering of the dose by their own, till arranging for a visit to the diabetes clinic. This could also explain the apparent opposition between the general low incidences of

hypoglycemia, while being the most common cause for breaking the fast in the PREP group. Despite adherence of most of the physicians to initial redistribution and dose lowering of OAD and insulin [30], reducing treatment doses several times during Ramadan was essential to avoid hypoglycemia. This suggested that the total number of fasting days might exert a cumulative effect on increasing both insulin sensitivity [34, 35] and energy expenditure [5] mandating physician-guided or self-managed successive dose reduction.

Moreover, patients reported progressive appetite suppression and portion size reduction throughout the month, compared to previous studies, which investigated eating behaviors in rather shorter periods of fasting, showing increased food liking and wanting [36]. This could be reasoned by acquiring new repetitive daytime food suppression behavior for 30 consecutive days during the month of Ramadan, increasing personal capacity to delay reward of food intake [36], reducing attention to food [37], and improving insulin sensitivity [35]. In the remaining limited time of post-sunset food and drink allowance, the role of proper culturally-based PREP was distinct in promoting healthier food choices and encouraging moderate-intensity physical activity in prolonged Taraweeh night prayers.

Both intermittent daytime fasting and Taraweeh-associated moderate-intensity physical activity during night were suggested to improve insulin sensitivity. An inverse correlation has been found between improved insulin sensitivity and the dopamine-dependent rewarding effect of hedonic food intake [38]. Moreover, these prolonged night prayers, unique to Ramadan, could be considered an eudaimonic behavior that might replace pleasure attaining hedonic food intake in improving the sense of well-being [39]. Increased dopamine with eudaimonic behavior has been deemed to play a vital role in having a positive mood, which has been suggested to influence cognition and creative problem solving [40], needed most in the flexible, healthy food choices, self-dependent or physician-aided anti-diabetic medication dose adjustment, and adherence to glycemic targets.

Study limitations

Being a retrospective interview study, recall bias, and drop-outs in response to some questions, could be considered study limitations. However, every effort was exerted to reduce them by limiting the time interval between Ramadan and the questionnaire. Interviewing the participants was used instead of just asking them to write down the answers to have an acceptable real-life fasting experience evaluation.

Conclusion

Ramadan fasting improved the overall glycemic control in type 2 diabetics, with the number of fasting days being influential to the percent reduction of HbA1c. However, much better glycemic control and weight reduction were detected in the PREP versus the Non- PREP group, in spite of comparable number of fasting days. PREP increased interest in Taraweeh night prayers, representing a more culturally-fitting moderate-intensity physical activity than regular exercise, with a favorable impact on HbA1c and weight, more noticeable with increasing prayer nights. PREP improved perception and response to hypoglycemia by anti-diabetic medications dose adjustment and lowering. Repeated reduction of OAD and insulin dosage throughout Ramadan to avoid hypoglycemia, hinted at a proactive attitude of the PREP participants and could possibly be caused by synergism between the appetite suppressing effect of 30 successive days of daytime fasting and physical activity in night prayers in enhancing insulin sensitivity. Ameliorating knowledge of physicians and educators about Islamic cultural backgrounds could amend their efficiency in delivering practical pre-Ramadan education.

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Compliance with ethical standards

Conflict of interest None

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