LAPORAN AKHIR PENYELIDIKAN

TAJUK:

The impact of Ramadan fasting on metabolic control and biochemical profile of type 2 diabetic patients in Kubang Kerian, Kelantan

By
Dr. Nor Azwany Yaacob

1877 X

Semua laporan kemajuan dan laporan akhir yang dikemukakan kepada Bahagian Penyelidikan dan Pembangunan perlu terlebih dahulu disampaikan untuk penelitian dan perakuan Jawatankuasa Penyelidikan di Pusat Pengajian.

USM R&D/JP-04

LAPORAN AKHIR PROJEK PENYELIDIKAN R&D JANGKA PENDEK

A. MAKLUMAT AM

Tajuk Projek: The impact of Ramadan fasting on metabolic control and biochemical profile of Type 2 diabetes patients in Kubang Kerian, Kelantan.

Tarikh Mula: 1 April 2002

Nama Penyelidik Utama: Dr. Nor Azwany bt. Yaacob (681222-03-5038)
(*berserta No. K/P*)

Nama Penyelidik Lain: Profesor Wan Mohamad bin Wan Bebakar (540121-03-5099)
(*berserta No. K/P*) Prof. Madya Abdul Aziz Al-Safi bin Ismail (571104-03-5419)

B. PENCAPAIAN PROJEK:

(*Sila tandakan* [/] *pada kotak yang bersesuaian dan terangkan secara ringkas di dalam ruang di bawah ini. Sekiranya perlu, sila gunakan kertas yang berasingan*)

☐ Penemuan asli/peningkatan pengetahuan

Dapat mengenal pasti tahap pengetahuan, sikap dan amalan pesakit diabetes terhadap puasa Ramadan. Pengetahuan pesakit adalah rendah mengenai tanda-tanda hipoglisemia, amalan yang betul semasa berpuasa dan masaalah yang mungkin dihadapi jika mereka berpuasa Ramadan. Pada amnya sikap pesakit terhadap puasa Ramadan adalah positif. Pesakit diabetes di Kubang Kerian masih mengambil makanan manis semasa berbuka dan kebanyakkannya tidak mengamalkan makan lewat malam didalam bulan puasa.

Berpuasa Ramadan dikalangan pesakit diabetes di Kubang Kerian tidak memberi kesan signifikan kepada berat jisim tubuh, tekanan darah, tahap glukos darah, dan profil lipid. Terdapat peningkatan yang signifikan terhadap kawalan diabetes berdasarkan serum fruktosamin dan peningkatan signifikan dalam osmolaliti urin. Pada kesimpulannya, manfaat puasa Ramadan dapat dicapai bukan hanya melalui peningkatan pengetahuan tetapi juga memerlukan kawalan penyakit secara keseluruhan dari awal.

☐ **Rekaan atau perkembangan produk baru,**
(*Sila beri penjelasan/makluman agar mudah dikomputerkan*)

(1) _____

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(2) _____

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(3) _____

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☐ **Mengembangkan proses atau teknik baru,**
(*Sila beri penjelasan/makluman agar mudah dikomputerkan*)

(1) _____

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☐ **Memperbaiki/meningkatkan produk/proses/teknik yang <u>sedia ada</u>**
(*Sila beri penjelasan/makluman agar mudah dikomputerkan*)

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C. PEMINDAHAN TEKNOLOGI

☐ Berjaya memindahkan teknologi.

Nama Klien: (1) _____
(Nyatakan nama penerima pemindahan teknologi ini dan sama ada daripada pihak swasta ataupun sektor awam)
(2) _____
(3) _____

☐ Berpotensi untuk pemindahan teknologi.
(Nyatakan jenis klien yang mungkin berminat)

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D. KOMERSIALISASI

☐ Berjaya dikomersialkan.

Nama Klien: (1) _____

(2) _____

(3) _____

☐ Berpotensi untuk dikomersialkan.
(Nyatakan jenis klien yang mungkin berminat)

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E. **PERKHIDMATAN PERUNDINGAN BERBANGKIT DARIPADA PROJEK**

(*Klien dan jenis perundingan*)

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(2) _____

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(4) _____

F. **PATEN/SIJIL INOVASI UTILITI**

(*Nyatakan nombor dan tarikh pendaftaran paten. Sekiranya paten/sijil inovasi utiliti telah dipohon tetapi masih belum didaftarkan, sila berikan nombor dan tarikh fail paten*).

(1) _____

(2) _____

(3) _____

G. **PENERBITAN HASIL DARIPADA PROJEK**

(i) LAPORAN/KERTAS PERSIDANGAN ATAU SEMINAR

(1) Free paper presentation at 4th International Scientific Meeting FIMA IMAM 2002. Topic: Knowledge, attitude and practice of Type 2 diabetic patients on Ramadan fasting at Kubang Kerian, Kelantan, 4-7 July 2002

(2)Free paper presentation at Kolokium Kebangsaan Kesihatan Masyarakat ke IX 24-25 September 2002. Topic: The impact of Ramadan fasting on glycemic control of Type 2 diabetic patients in HUSM, Kelantan.

(3) _____

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(4) _____

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(5) _____

(ii) **PENERBITAN SAINTIFIK**

(1) Effect of Ramadan fasting on glycemic status of type 2 diabetic patients in Northern Malaysia – sent to Southeast Asian Journal of Tropical Medicine and Public Health. Status: Awaiting reply.

(2) Effect of Ramadan fasting on hydration status of type 2 diabetic patients in Northern Malaysia – sent to The International Journal of Ramadan Fasting Research. Status: Awaiting reply.

(3) Knowledge, attitude and practice of type 2 diabetes mellitus patients on Ramadan fasting in Hospital Universiti Sains Malaysia, Kubang Kerian, Kelantan. Sent to The Medical Journal of Malaysia. Status: Awaiting reply

(4) _____

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(5) _____

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(6) _____

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H. HUBUNGAN DENGAN PENYELIDIK LAIN
(*sama ada dengan institusi tempatan ataupun di luar negara*)

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(4) _____

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I. **SUMBANGAN KEWANGAN DARI PIHAK LUAR**
(Nyatakan nama agensi dan nilai atau peralatan yang telah diberi)

(1) _____

(2) _____

(3) _____

J. **PELAJAR IJAZAH LANJUTAN**
(Nyatakan jumlah yang telah dilatih di dalam bidang berkaitan dan sama ada diperingkat sarjana atau Ph.D).

	Nama Pelajar
Sarjana	Dr. Nor Azwany bt. Yaacob (Sarjana Perubatan Masyarakat)
	_____
	_____
Ph.D	_____
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	_____

K. **MAKLUMAT LAIN YANG BERKAITAN**

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15/9/03

Tarikh

Tandatangan

TANDATANGAN PENGERUSI
JAWATANKUASA PENYELIDIKAN
PUSAT PENGAJIAN

Laporan akhir penyelidikan

Topic: The impact of Ramadan fasting on metabolic control and biochemical profiles of type 2 diabetic patients in Kubang Kerian, Kelantan.

Introduction:

Malaysia is an Islamic country with majority of the population is Muslim. Every year in Ramadan, the ninth month of Muslim calendar, a Muslim is required to fast everyday from the beginning of dawn until sunset. The average duration of fasting in Malaysia is 13.5 hours and during this period, a person is required to abstain from any oral intake including medications. Islam recommends that fasting Muslims eat a meal before dawn, called "sahur". Individuals are exempt from Ramadan fasting if they are suffering from an illness that could be adversely affected by fasting. They are allowed to restrain from fasting for one day to all 30 days, depending on the condition of their illness. People diagnosed with diabetes fall into this category and may be exempted from the fasting requirement.

Earlier commentaries on the effect of fasting diabetics were mostly letters to editors reporting care reports and experience (Barber *et al*, 1979; Davidson, 1979; Aslam and Wilson, 1989). Barber *et al* (1979) reported half of the interviewed patients practice Ramadan fasting. The other half claimed exemption on medical grounds but insulin therapy is not an obvious reason. The insulin-treated patients noticed less glycosuria. They also did not notice any significant increased in hospital admission among those patients who choose to fast.

In 1990, a local study by Mafauzy *et al*, shows significant difference between the means of body weight, serum fructosamine, total calorie intake, total carbohydrate intake and percentage of simple carbohydrate intake before and during Ramadan fasting. The significant fall in the serum fructosamine level implied that the overall glycemic control was significantly better during the fasting month than before. None of the patient had symptoms to suggest worsening of glycemic control. This study concluded that for non-insulin dependent diabetic patients, Ramadan fasting is possible and related to an improvement in the diabetic control.

Rasheed (1992), in his overview on the fast of Ramadan, quoted two studies showing very little problems encountered by diabetics in Ramadan. Omar and Motala, 1997; recommended all diabetics to be evaluated before the month of Ramadan to assess their physical well being, metabolic control, and ability to keep fast. They added that a Muslim diabetic should be educated about special problems that may occur during fasting, as well as any therapeutic adjustments that may become necessary. Laajam, 1990, reported a study on overweight non-insulin diabetic patients, found no significant change in body weight, blood glucose

Study Impact

At local level, there is no information on what proportion of our diabetic patients that continue to fast, and what is their level of knowledge that they have for them to practice Ramadan fasting safely. We also lack of information on how they carry on with Ramadan fasting in terms of adjustment on drug regimen and alteration in dietary intake. Currently, there is no specific health education program for fasting diabetic.

There is limited information on the impact of Ramadan fasting on biochemical profiles of type 2 diabetic patients. As discussed above, studies had shown that there is an improvement in diabetic control and body weight during Ramadan if they follow the prescribed diet. Information on these issues, as well as the impact of the one-month fasting in diabetics is essential to guide patients and medical professional regarding their safety and benefits of this practice. This study hopes to provide important informations for health care providers in educating and planning the management of diabetic patient during fasting month of Ramadan.

Objective

General Objective : To study the impact of Ramadan fasting on metabolic control and biochemical profile in Type 2 Diabetes Mellitus.

Specific Objectives:

1. To identify the knowledge of, attitude towards and practice of type 2 diabetics in relation to Ramadan fasting.
2. To determine the effect of Ramadan fasting on Body Mass Index (BMI) according to gender.
3. To determine the effect of Ramadan fasting on blood pressure according to hypertension status (hypertensive and unknown hypertensive) and BMI categories (ideal BMI and overweight).
4. To determine the effect of Ramadan fasting on fasting blood glucose (FBG).
5. To determine the effect of Ramadan fasting on serum fructosamine level according to BMI categories (ideal BMI and overweight).
6. To determine the effect of Ramadan fasting on urine osmolality according to gender.
7. To determine the effect of Ramadan fasting on lipid profile according to BMI categories (ideal BMI and overweight).
8. To determine the effect of Ramadan fasting on blood urea, serum creatinine and uric acid.

Methodology

This study was divided into two parts. Part 1 is the Knowledge, Attitude and Practice (KAP) study and part 2 is the study on the effect of Ramadan fasting on BMI, blood pressure, glycemic control and hydration status.

KAP study was a cross sectional study done on type 2 diabetic patients attending Diabetic Medical Clinic and Family Medicine Clinic Hospital Universiti Sains Malaysia in November to December 2001. The sample size was calculated using single proportion formua based on pilot study done at Klinik Kesihatan Bandar Kuala Krai. The calculated sample size was 227 subjects. Data collection was done using a validated questionnaire set. The study criteria was:

Inclusion criteria

i. Muslim patients.
ii. Confirmed cases of type 2 diabetes mellitus based on the World Health Organization (WHO) 1998 criteria (Alberti and Zimmet, 1998). The criteria is fasting plasma glucose more or equal to 7.0 mmol/l and 2 hours glucose reading of more or equal to 11.1 mmol/l or if they are reported as currently using an oral hypoglycemic agent.
iii. Diabetic patients on oral hypoglycemic agents.

Exclusion criteria

i. Patients on diet therapy alone or insulin therapy.
ii. Newly diagnosed diabetic patients who are practicing Ramadan fasting for the first time since being diagnosed.

243 type 2 diabetic patients on oral medication had been interviewed. The outcome measures were the mean score of knowledge subdomain, proportion of patients who had right attitude and practice correctly in relation to Ramadan fasting.

The study of the effect of Ramadan fasting was a prospective study. Sample size was calculated with Power and Sample size (PS software) version 1.0.13 for t-test paired (dependent) sample size, at 95% confidence interval with power of 80%. Significant mean difference of each variable was based on clinical significance and standard deviation of difference was based on other diabetic study findings. The biggest calculated sample was 29. Considering the drop out of 20% the minimum sample size required was 35 subjects.

Inclusion criteria

i. Muslim patients.
ii. Confirmed cases of type 2 diabetes mellitus based on World Health Organization (WHO) 1998 criteria. The criteria is fasting plasma glucose more or equal to 7.0 mmol/l and 2 hours glucose reading of more or equal to 11.1 mmol/l or if they are reported as currently use of oral hypoglycemic agent.
iii. Diabetic patients who were on oral hypoglycemic agents.

iv. Patient plan to fast the whole month of Ramadan.

Exclusion criteria

i. Diabetic patients not willing to fast or advised not to fast by attending physician.
ii. Pregnant diabetic patients.
iii. Patients on diet therapy alone or insulin therapy.
iv. Newly diagnosed diabetic patients where responds to therapy are yet to established.
v. Patients known to have renal failure (serum creatinine > 2mg/dl (176 μmol/l) or on dialysis.
vi. Patient known to have underlying renal disease.
vii. Patients with liver failure due to alcohol abuse, hepatitis and cirrhosis.
viii. Patients with left or right ventricular failure or a combination of both. Left ventricular failure characterized by symptoms of exertional dyspnea, cough, fatigue, orthopnea and paroxysmal nocturnal dyspnea; and has signs of cardiac enlargement, rales, gallop rhythm and pulmonary venus congestion. Right ventricular failure characterised by elevated venus pressure, hepatomegaly and dependent edema (Massie, 1996).
ix. Patients who had to break the fast for more than 20% of Ramadan period (6 days).

Data were collected on four time series (Flow Chart attached). 43 patients completed the data collection. Data were analysed using Repeated Measure ANOVA and presented as changes in mean and time effect.

Results

KAP Study

Relative higher mean score was noted for question on general health, diabetic complication and symptoms of hyperglycemia. The mean score was relatively lower for questions regarding symptoms of hypoglycemia (1.7±1.26), correct practice during fasting (1.9±0.65) and problems that may arise from fasting (1.9±0.72).

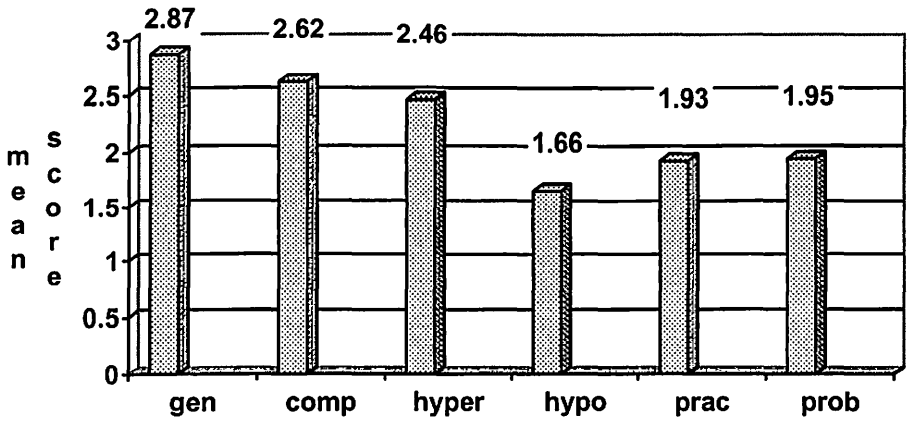

Figure 1: Mean score of knowledge subdomains
*gen=general health, comp=complication, hyper=hyperglycemia symptoms, hypo=hypoglycemia symptoms, prac=correct practice, prob=problem that may arise.

Positive attitude was shown by high proportion of responders who agree on their responsibility on control of disease (Question 1 and 2). Similarly, positive attitude was shown on their willingness and ability to carry out Ramadan fasting and attitude towards physical activity (Question 3, 5 and 6). There were still 11.5% of responders who were not convinced that fasting could help diabetes control (Table 1).

Table 1: Percentage of respond for attitude questions.

	Agree	Not sure	Disagree
Q1. Should know blood glucose level	98.4	0.4	1.2
Q2. Able to control disease	92.2	7.0	0.8
Q3. Unable to fast because need to take medications	2.1	1.2	96.7
Q4. Fasting can help disease control	84.0	11.5	4.5
Q5. Ability to fast the whole month	93.8	1.2	4.9
Q6. Unable to do usual daily activity if fasting	5.8	0.8	93.4

Majority of responders discuss medication schedule adjustment with doctor (83.1%) and take pre-dawn meal or sahur (98.8%), however there were still high proportion of responders who take sugary food on breaking fast (41.5%), 28.8% sometimes and 29.6% always. There was high proportion of those who did not take supper (66.2%) (Table 2).

Table 2: Percentage of respond for practice questions

Question	Never & seldom	Sometimes	Often & always
Change medication schedule based on doctor advice	10.7	6.2	83.1
Reduced frequency of medication	53.5	4.5	42.0
Make sure take sahur (pre dawn meal)	0.4	0.8	98.8
Take sugary food on breaking fast	41.5	28.8	29.6
Take supper	66.2	18.1	15.6

Study of the effect of Ramadan fasting

i. Body Mass Index (BMI)

There was a reduction in mean BMI on fourth week of Ramadan but increased again after four weeks of Ramadan (Figure 2)

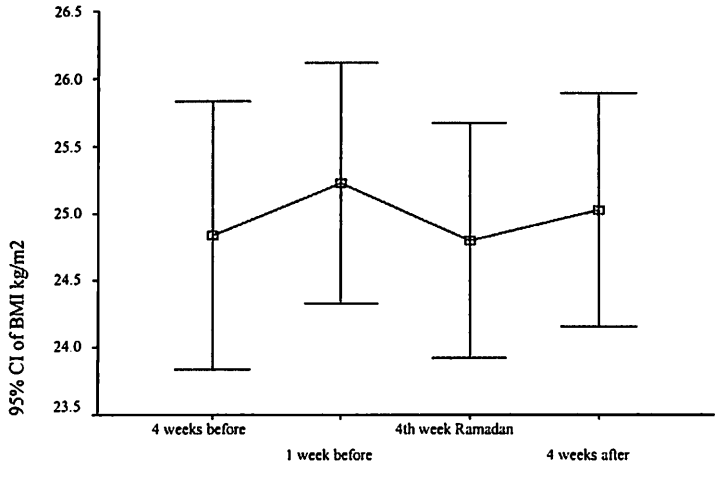

Figure 2: Error bars of mean BMI (kg/m^2) in 43 subjects by week in relation to Ramadan

Repeated Measure ANOVA showed no significant difference of mean BMI across the time period (F=3.24, p=0.06) after considering the effect of gender in the model. There was a significant interaction between time and gender.

ii. Blood Pressure

The changes in mean systolic BP was not significant across time after considering the effect of hypertension (HPT) status and BMI categories in the model (F=0.30,p=0.82). There was no significant interaction between time and hypertension status as well as BMI categories (Figure 3).

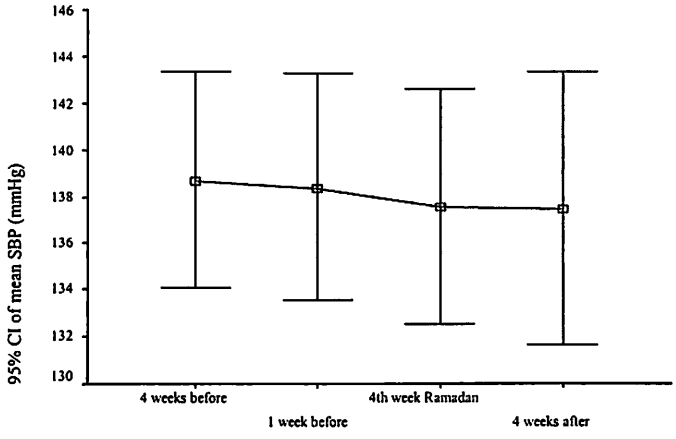

Figure 3: Error bars of mean systolic BP (mmHg) in 43 subjects by week in relation to Ramadan.

Mean diastolic BP showed an increase on fourth week of Ramadan but reduced back to similar level after four weeks of Ramadan (Figure 4). These changes were not significant across time (F=0.36, p=0.78) after considering the effect of hypertension status and BMI categories in the model. There is no significant interaction between time and bypertension status as well as BMI categories

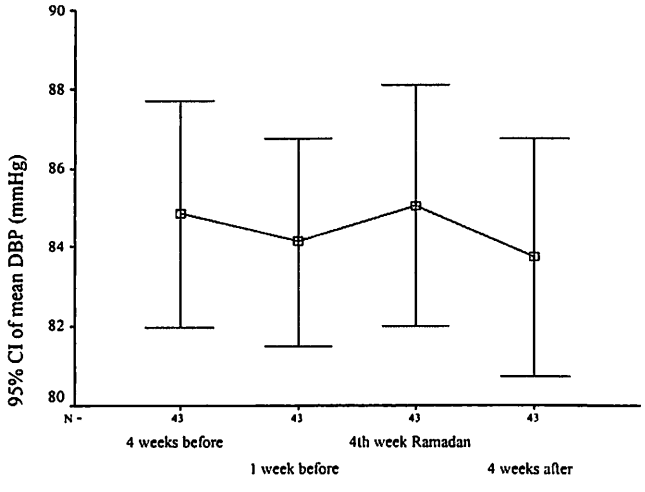

Figure 4: Error bars of mean diastolic BP (mmHg) in 43 subjects by week in relation to Ramadan

iii. Fasting Blood Glucose

There was a reduction of mean FBG during Ramadan. The mean FBG increased again after four weeks of Ramadan.

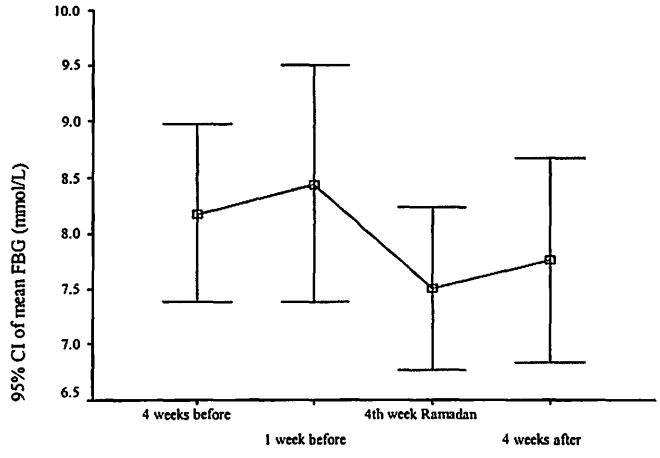

Figure 5: Error bars of mean FBG (mmol/L) in 43 subjects by week in relation to Ramadan

Repeated measure ANOVA found no significant difference of mean FBG across the four time series ($F=2.00$, $p=0.12$).

iv. Serum Fructosamine

All four mean serum fructosamine levels were above 350 μmol/L indicating poor control of diabetics (McGhee, 1994) before Ramadan and even worse on fourth week of Ramadan and four weeks after Ramadan as shown in Figure 6.

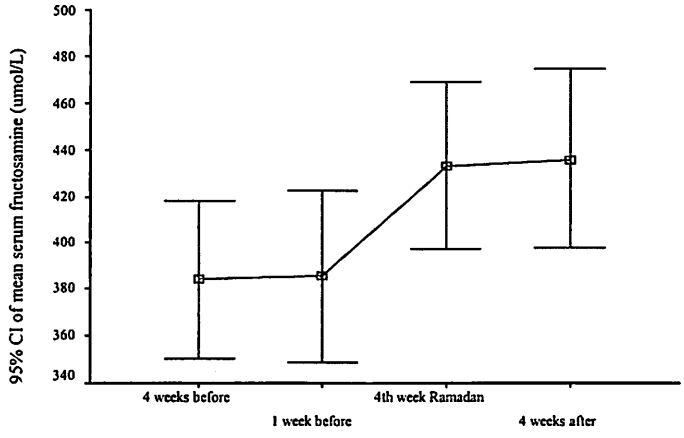

Figure 6: Error bars of mean serum fructosamine level (μmol/L) in 43 subjects by week in relation to Ramadan.

Repeated Measure ANOVA was done considering the effect of BMI categories in the model. The changes in serum fructosamine level were significant across the four time series ($F=8.996.p<0.01$). The significant mean difference were between fourth week of Ramadan with four weeks and one week before Ramadan.

v. Urine Osmolality

All four mean serum fructosamine levels were above 350 μmol/L indicating poor control of diabetics (McGhee, 1994) before Ramadan and even worse on fourth week of Ramadan and four weeks after Ramadan as shown in Figure 7.

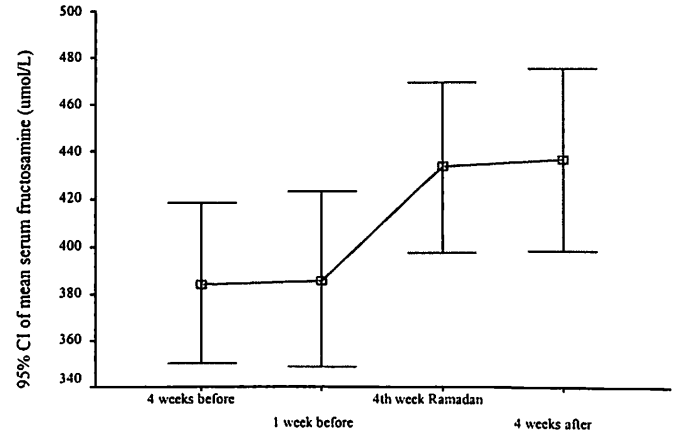

Figure 7: Error bars of mean serum fructosamine level (μmol/L) in 43 subjects by week in relation to Ramadan.

Repeated Measure ANOVA was done considering the effect of BMI categories in the model. The changes in serum fructosamine level were significant across the four time series ($F=8.996.p<0.01$). The significant mean difference were between fourth week of Ramadan with four weeks and one week before Ramadan.

vi. Blood Urea

There was no significant changes in mean blood urea level ($F=0.897$, $p=0.445$) after considering the effect of hypertension, ACE inhitor treatment, gender and illness duration.

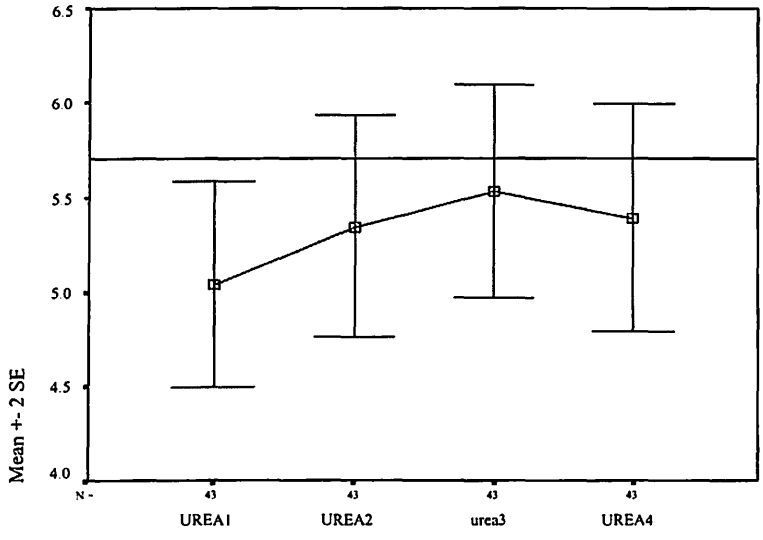

Figure 8: Error bars of mean urea (mmol/L) in 43 subjects by week in relation to Ramadan.

vii. Serum creatinine

There was no significant changes of serum creatinine level by the time series.

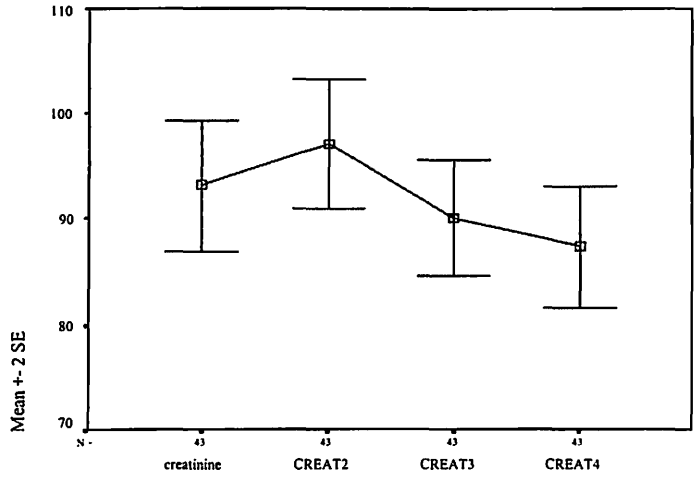

Figure 9: Error bar of mean serum creatinine (μmol/L) by time series.

viii. Uric acid

There was no significant changes in mean uric acid level by time series.

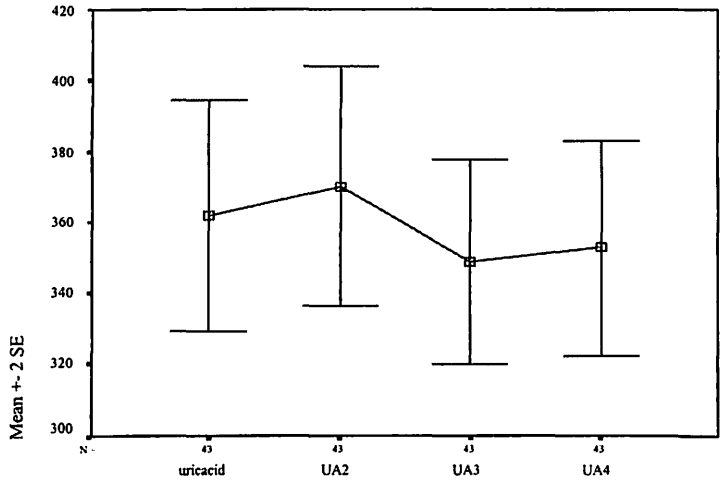

Figure 10: Error bars of uric acid levels (μmol/L) by time series

ix. Lipid profiles (Fasting Triglyceride, Cholesterol, High Density Lipoprotein)

There were no significant changes in mean cholesterol and HDL by time series. However there were significant changes in FTG levels (F=2.764, p=0.045) after considering the effect of gender and BMI categories.

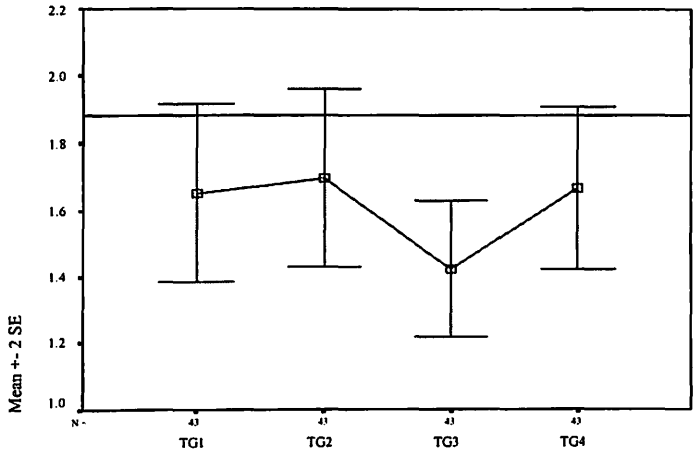

Figure 11: Error Bars of mean FTG (mmol/L) by time series.

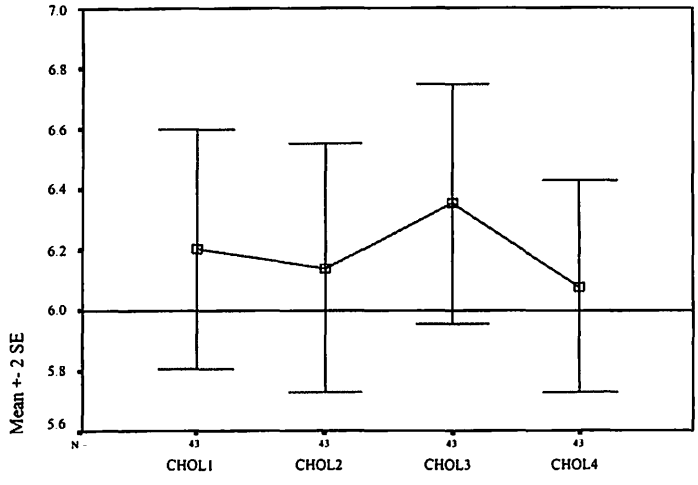

Figure 12: Error bars of mean Cholesterol (mmol/L) by time series

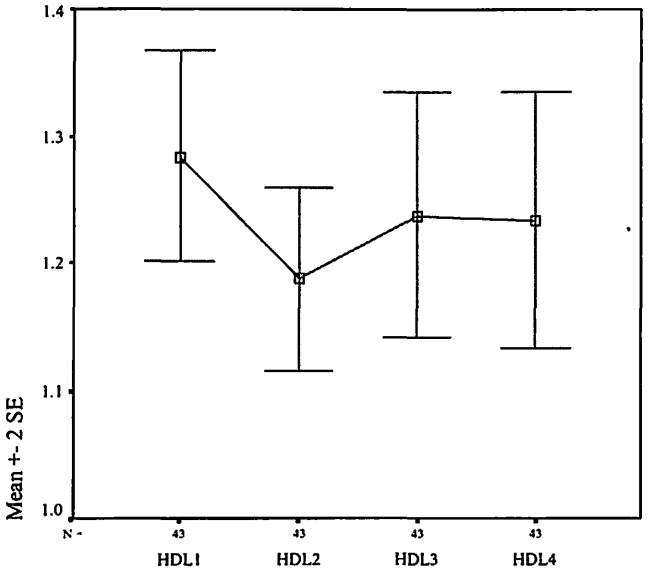

Figure 13: Error bars of mean HDL (mmol/L) by time series

Discussion

KAP Study

This study showed higher mean score of knowledge in term of general health knowledge (ideal body weight, physical exercise and dietary control) and diabetic complications on renal, heart and eye. This indicates the effect of the health education received. This finding was also supported by Norsiah *et al.*(2002). DCDCP on diabetes health education profile in Malaysia reported 77% of patients in East Malaysia received health education on healthy eating, 12% on diabetic complication and 13% on hypoglycemia (National action plan and strategies, 1998). There was also a high mean score on diabetic complication although the DCDCP report showed only a low percentage of health education received. This may be due to self-experience and sharing disease experience with other patients increase their knowledge. Discussion with attending doctor on blood investigation results such as renal function test and referral to Ophthalmologist also play a role in enhancing the knowledge of diabetic complications.

Relatively higher mean score of knowledge for hyperglycemia symptoms may be due to the fact that the patients had experienced it and presented with the symptoms on diagnosis. The patients also had experienced the symptoms when they were in poor

controlled state. This is online with the DCDCP report that showed 87.6% of East Coast West Malaysia diabetic patients were having FBG of more than 7.8 mmol/L and 92% were having HbA_{1c} of more than 7.5% (poor controlled). Knowing to recognize the hyperglycemia symptoms can help patients to motivate themselves to avoid compensatory eating and taking sugary local foods which were available in abundance during Ramadan in this region. Avoidance of compensatory eating and abstention from high-calorie and highly refined foods had been recommended during Ramadan fasting in order to optimize control (Azizi and Siahkolah, 1998).

Knowledge score were noted to be relatively lower on hypoglycemia symptoms compared to mean score on hyperglycemia symptoms. Patients may have experienced the symptoms but did not aware that it is a warning sign of hypoglycemia. This finding was very alarming and indicates the need of more health education, since patients who want to carry out Ramadan fasting need to know how to recognized warning signs of hypoglycemia. They must know how to recognized this condition in order to decide to break the fast earlier and thus, prevent further complication and problems (Shahid, 2001).

Knowledge on dietary practice during Ramadan was also relatively poor. Many study subjects (81.9%) answered that they must take heavy meal with rice or bread during pre-dawn meal or sahur. There were also 18.9% of the study subjects noted that they must take sugary food on breaking fast to compensate the fasting glucose level. This finding were noted despite good knowledge on the importance of dietary control, which suggest that current knowledge was not adequate for the patients to practice Ramadan fasting appropriately.

In term of Ramadan fasting helps to control diabetes, there were still 16.0% who did not know this fact. Previous studies had shown that fasting Ramadan associated with improvement in diabetic control instead of making it worsen (Mafauzy *et al*, 1990; Azizi and Siahkolah, 1998 and Laajam, 1990). This fact is important to be highlighted so that patients will be more motivated to control their diet and drug intake during Ramadan instead of accusing the fasting practice if they want to maintain good disease control.

Poorly controlled diabetics may lose excessive water because of high blood glucose. When the kidneys cannot conserve water the patient will suffer from dehydration and more so if the patient continues to fast (Malaysian Diabetes Association, 1993). Knowledge about possible risk of dehydration is important for the patients so that they will take adequate water during the non-fasting period of the day along with maintaining good diabetic control. Only small proportion of study subjects (36.2%) were aware of this risk which should alarmed doctors to emphasized on adequate water intake especially in the elderly patients and those who are actively working outdoors during the daytime.

There were quite a high proportion of study subjects (24.7%) who thought that fasting could increase the risk of them getting infections. Patients should be educated that infection risk is associated with glucose control (Leibovici *et al*, 1996; Rayfield *et al*, 1982) and not directly from fasting practice. This point should be emphasized together with the importance of maintaining good diabetic control during the month.

Majority of study subjects had positive attitude towards their own responsibility to control and monitor their disease and their willingness and ability to carry out fasting Ramadan. This correlates well to the fact that many of diabetic patients practice Ramadan fasting. The positive attitude on disease control and monitoring can be a good start to encouraged more patients to do home blood glucose monitoring. DCDCP had reported only 0.4% of patients in East Coast West Malaysia who do self-blood glucose monitoring (National action plan and strategies, 1998). Self- monitoring of their blood glucose will safeguard from serious disturbance of the blood glucose level during the day especially in the first week of Ramadan (Malaysian Diabetes Association, 1993).

Proper adjustment in the dosage of hypoglycemic agents will lower the risk of hypoglycemia and hyperglycemia in fasting diabetic patients. Although many study subjects discussed with their doctor, there were portions of them who adjust the schedule without doctor consultation. Those who reduced their medication frequency are either advised by doctor, adjusted for convenience of taking medication during the non-fasting period or reduced it when developed hypoglycemic symptoms. Those who did not reduce

their drug frequency schedule were mainly those who were on twice daily or once daily dose of medication. Even though study subjects adjusted medication regime after discussing it with their doctor, patients should be encouraged to do home monitoring to ensure control of diabetic state. These facts on drug adjustment once again highlighted the need of health education on how to recognized hypoglycemic and hyperglycemic symptoms.

Taking pre-dawn meal and supper had been advice to help prevent possible attack of hypoglycemia. Many of the study subjects aware of the need of taking pre-dawn meal to avoid them break their fast earlier. They also practice pre dawn meal because they were taking their morning dose of medication at dawn, which must be taken with meal. However only 33.8% of the study subjects practiced taking supper, mainly because they were still feeling full and it was not their usual habit. Thus, emphasis on this should be made especially for those who take their second dose of drug before going to bed.

More than half of them still take sugary food on breaking fast. This finding was similar to other study in HUSM which reported a significant increased in the intake of refined sugars contained in local delicacies among HUSM diabetic patients during Ramadan (Mafauzy *et al,* 1990) and a study in Riyadh which reported tendency to over-eating throughout the non- fasting periods among the study participants (Laajam, 1990). This inappropriate dietary intake was also online with the knowledge deficits found in proper dietary practice during Ramadan as mention above.

Study of the effect of Ramadan fasting

i. Body Mass Index (BMI)

The changes of mean BMI were not significant across time. Although it was reduced from one week before Ramadan, the mean BMI increased again after four weeks of resuming non-fasting state. This finding was similar to studies in healthy subjects with same time interval measurements (Fedail *et al.,* 1982; El Ati *et al.*, 1995; Maislos *et al.*, 1998). Similarly, a local study by Mafauzy *et al.* (1990), reported similar reduction in

body weight of diabetic patients compared to just before and end of Ramadan. Laajam (1990) in Riyadh also noted no significant reduction of body weight in overweight diabetic patients just before and after Ramadan. The reduction on fourth week of Ramadan was probably due to reduction in total daily calorie intake and carbohydrate content of food during Ramadan as reported by studies on diet intake both in healthy and diabetic subjects (Husain *et al.*, 1987; Mafauzy *et al.*, 1990; Maislos *et al.*, 1998). Thus, once the subject resumed their usual food habit after Ramadan the measurements increased again to almost similar level than before Ramadan measurements.

This finding indicates that the food restriction during Ramadan was only able to produce a small reduction over a short duration. Thus, this reduction does not benefit the overall diabetic management in controlling body weight specifically, and also in reducing risk of developing syndrome X. However, Ramadan can be the first step to motivate patients to reduce their weight through behavior modification in diet intake.

ii. Blood Pressure.

There were no significant changes of mean systolic and diastolic BP across time. The changes were small ranging 0.27 to 1.45 mmHg for systolic BP and 0.04 to 1.09 mmHg for diastolic BP. The fluctuation reflected a short interval effect of Ramadan fasting on BP. It also reflected that dietary and drug changes during Ramadan did not significantly affect the BP control or harm the diabetics even if they were also hypertensives. The reduced diet intake may also be accompanied by reduced sodium and other electrolyte intake, thus reducing of the blood pressure slightly. This is consistent with findings by Husain *et al.* (1987) where a decrease in sodium urinary excretion during Ramadan is likely to be due to reduced electrolyte intake. The slight reduction in systolic BP during Ramadan may also be due to the psychological effect of inner peace and tranquility as described by Soliman (2002). Hypertensive patients may also benefit from their body

weight reduction during Ramadan, as even a 5% reduction in weight will result in significant lowering of blood pressure (Ministry of Health Malaysia, 1998).

iii. Fasting Blood Glucose (FBG)

The mean FBG changes across time were not significant. FBG had been found to have seasonal and individual variation (Nattrass, 1996; Yudkin and Stratton, 1996). The reduction in FBG from one week before to fourth week of Ramadan with mean difference of 0.94 mmol/L may be due to the fluctuation of FBG by time and thus reflected glucose blood level at the time of blood taking. The FBG samples during the non-Ramadan period were taken in the morning after an overnight fast but the Ramadan samples were taken in the afternoon to have similar interval of blood taking from the last meal. Afternoon samples may be affected by physical activity before the blood taking resulting in lower level. The difference in total calorie and carbohydrate intake during Ramadan as reported by Mafauzy *et al.*, (1990), also can influence the FBG level. The difference may also be due to variations in the amount or type of food consumed, regularities and compliance with prescribed medications, and differences in physical activities.This finding was similar with local study finding by Mafauzy *et al.*, (1990), as well as study finding in overweight patients in Riyadh (Laajam, 1990) which reported non-significant change of FBG just before and at the end of Ramadan.

iv. Serum fructosamine

The high fructosamine levels found in this study illustrate similar status of glycemic control among local diabetic patients as reported by DCDCP based on HbA1c. DCDCP reported 73% of Malaysia diabetic patients and 92% of East Coast West Malaysia diabetic patients were having HbA1c of more than 7.5% (National action plan and strategies, 1998). Fructosamine levels increased significantly on fourth week of Ramadan and did not change significantly after four weeks of Ramadan. This finding differs from Mafauzy *et al.* (1990), which reported a significant decreased in fructosamine levels. This difference may be explained by the study method whereby dietician consultation to assess dietary intake of the subjects may influence subjects to be more compliance to the

prescribed diet resulting in better glycemic control. However, review of literatures by Azizi and Siahkolah noted no significant change before and during Ramadan fasting. Other studies using HbA1c values reported no change or improvement in glycemic control during Ramadan (Laajam, 1990; Azizi and Siahkolah, 1998; Soewondo, 2002). The variation in these study findings for fructosamine may be also be due to variation in the amount or type of food consumed, regularities and compliance with prescribed medications, overeating after the fast is broken or differences in physical activities as in FBG findings.

v. Urine osmolality, blood urea and serum creatinine

The significant increase in the mean urine osmolality during Ramadan was not beyond the normal limit suggesting that water deprivation during fasting was not sufficient to cause dehydration. This reflects the ability of the kidneys to excrete relatively high concentrated urine in the daytime and thus, showed that the body adapted adequately to water deprivation during the day. It does also indicate that the concentrating ability of the kidneys remained unimpaired during Ramadan. The reduction of the mean back to similar level after Ramadan further suggests the body adaptive ability and the changes were related to amount of fluid intake.

The non significant changes in blood urea and serum creatinine also indicates good renal adaptation ability to the changes in water intake. Thus, Ramadan fasting does not sufficient to cause derangement in renal function.The significant change in the urine osmolality level across the time was mainly due to the reduced fluid intake during the fasting month. Possible cause of dehydration due to over-exertion (Malaysia Diabetes Association, 1993) in the study subjects can be excluded since subjects reported no strenuous exercise during fasting although they continue their daily routine physical activity. Exposure to the hot sun may also predisposed diabetic patients to dehydration (Malaysia Diabetes Association, 1993). However, Ramadan month on year 2001 was more in the rainy season rather than hot season.

Diet therapy is an essential tool in diabetic management. The dietary management by giving advice and prescribed individual diet plan was stressed on to help control of glucose levels in the blood, to achieve satisfactory body weight and to ensure sufficient calories for normal activities. Water on the other hand, is not a nutrient and provides no calories. It is however, essential as the medium in which all body processes take place. Adequate water intake tended to be forgotten in giving advice to diabetic patients, and therefore the need for health education program in Ramadan fasting should be emphasized.

vi. Uric acid

Serum uric acid had been noted to be very labile with day to day and seasonal variation (Wallach 2000). The non significant reduction during Ramadan and increased again after one month of Ramadan were most likely due to reduced protein intake and high fat diet as found by Nomani *et al*,1990.

vii. Lipid profiles

The findings correspond to other findings where studies reported different impact of Ramadan on lipid profiles as drug regimens, diet and daily activity need to be taken into consideration (Azizi and Siahkolah, 1998). Similar finding in cholesterol by Mafauzy *et al*, 1990 suggested that these changes were due to diet intake related to environment factors surrounding the patients.

Limitations

The pre-test study to evaluate the KAP questionnaire set was best done during Ramadan since it will be used during Ramadan. This was not possible because of time constraint to start this study in Ramadan month in order to reduce recall bias particularly questions on dietary and drug practice. There was possibly a selection bias of subjects by taking patients who attended clinics during the month. Selection of subjects from HUSM Diabetes register was tried but most of the patients were reluctant to come during Ramadan for various reasons especially those who depended on other family members. However, those patients who attended the clinics were given appointment date during their last visit before Ramadan or they came to continue medication. The bias may be in attitude whereby those who came to the clinics were more motivated with regards to

fasting Ramadan. The KAP study was unable to describe appropriateness of drug practice during Ramadan due to lack of questions specification based on treatment received and reason of drug adjustment.

The study of the effect of Ramadan fasting does not include control group. It was not possible to find Muslim diabetics without acute complication who does not practice Ramadan fasting in this locality. Taking baseline parameter reading four weeks and one week before Ramadan can help illustrating the baseline of the subjects and act as control of their own changes in term of time effect.

The study of the effect of Ramadan fasting was also subjected to selection bias. Those who were willing to come on four consecutive visits may be more motivated in terms of compliance and disease control. Adjusting the follow-up date according to their appointment dates to the specialist clinic, work and personal schedule minimized this bias in helping them to come for the visits. Observer bias was handled by appointing only one research assistant to take body weight readings and one researcher to take blood pressure readings.

This study does not include dietary information to explain the changes in BMI, FBG and fructosamine levels. The dietary history if taken by hospital dietician may influence the dietary habit and indirectly the glycemic control of the subjects and thus obscure the effect of Ramadan fasting with the usual current practice among patients who does not have specific guide on diet adjustment during Ramadan. Blood pressure and FBG measurements were also subjected to the regression to the mean effect since these parameters were known to fluctuate within an individual. Taking two measurements before the intervention can avoid this effect. The second measurement acts as the baseline to assess the intervention effect (Yudkin and Stratton, 1996). In this study, even though not assigned by investigator, Ramadan fasting can be taken as intervention. Taking measurements several time in a day or everyday during Ramadan was not practicable in this study and may also not be ethically accepted. Using Repeated Measure ANOVA analysis can also handle the regression to mean effect of repeated measurements.

Conclusion

Type 2 diabetic management is aimed for glycemic control and preventing further complications. This study noted high score of knowledge and attitude as well as diet practice. Ramadan fasting was found to have no harmful effect of on BP and does not sufficient to cause hypoglycemia and dehydration. Ramadan fasting also does not seem to benefit BMI and glycemic control. These findings suggest that safety and benefits of Ramadan fasting among type 2 diabetics without acute complication is not dependent on KAP on Ramadan fasting per se but depends on the good management of diabetics even during the non-Ramadan period. Therefore, the whole diabetes care and pre-Ramadan considerations of the monitoring and metabolic control are essential in advising diabetics on Ramadan fasting.

Recommendations

i. Further studies need to be precise in term of medication schedule, adjustment done and reason of the adjustment to identify practice on drug adjustment during Ramadan in further detail.

ii. Matched comparative study with non-diabetic subjects of the impact of Ramadan fasting in type 2 diabetics on physical and biochemical profiles, such as BP, renal and liver function will illustrate the safety of Ramadan fasting in diabetic patients.

iii. Other factors such as dietary habits, food composition, calorie control and measurements during each week of Ramadan should be taken into consideration in research on diabetics during Ramadan.

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