Glycaemic Control, Lipid Profile, Blood Pressure and Body Weight Status Among Diabetics in Rural Malaysia

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ABSTRACT

Introduction: *Diabetes is associated with a high risk of cardiovascular disease. The management of blood glucose, dyslipidaemia and other modifiable risk factor, is a key element in the multifactorial approach to prevent complications of type 2 diabetes.* **Materials and Methods:** *A cross sectional study was conducted to determine the level of glycaemic control, lipid profile, blood pressure and body weight status among type 2 diabetics in rural Malaysia. A total of 237 diabetic subjects participated in this study. Physical examination was carried out, including measurements of height, weight, waist and hip circumferences, and systolic and diastolic blood pressure. Fasting venous blood samples were collected to determine the glucose level and lipid profile.* **Results:** *About 70% of the subjects had a high body mass index (BMI), equal to or above 25 kg/m2. More than 60% of the subjects had systolic blood pressure ≥ 140 mmHg and/or diastolic ≥ 90 mmHg. Mean fasting blood glucose was 9.84±4.54 mmol/L. Mean total cholesterol was 5.18±1.35 mmol/L. High density lipoprotein cholesterol (HDLC) and triglyceride (TG) and glucose levels were higher in male than in female, but not statistically significant (p>0.05). However, low density lipoprotein cholesterol (LDLC) was higher in females than males (p<0.05). Mean HDLC was below 1.0 mmol/L in all subjects.* **Conclusion:** *Glycaemic control, lipid profile, blood pressure and body weight status were not satisfactory and may increase the risk of microvascular and macrovascular complications among these subjects. Appropriate intervention programs should be implemented for better diabetes control among rural subjects.*

KEYWORDS: Diabetic control, Diabetes, Rural, Malaysia

INTRODUCTION

Diabetes mellitus in Malaysia has increased in prevalence since 1960. In 1960, the prevalence of diabetes was 0.6% of the population, in 1982, 2.1%, in 1986, 6.3%, and in 1996, it had risen to 8.3%.[1] The prevalence is highest among Indians (3.5% to 16%), followed by Chinese and Malays.[2] Among Malays in Malaysia, the prevalence is highest among urban Malays (8.2%), followed by settlers (6.7%) and Malays in rural areas (2.8%).[3]

Diabetes is associated with a high risk of cardiovascular disease (CVD). The management of diabetic dyslipidaemia, a well recognised and modifiable risk factor, is a key element in the multifactorial approach to prevent CVD in individuals with type 2 diabetes.[4] Tight control of blood glucose and blood pressure has been shown in the United Kingdom Prospective Diabetes Study (UKPDS) to reduce the risk of developing macrovascular and microvascular complications in diabetes mellitus type 2 patients.[5] Therefore, the only course for diabetics at present is to ensure perfect control of the status of their diabetes so that the complications may be prevented or delayed.

The American Diabetes Association in its Position Statement, has recommended that patients with diabetes should maintain a systolic blood pressure of <130 mmHg and a diastolic blood pressure of <80 mmHg.6,7 In addition, the primary goals of therapy for an adult should be to maintain low density lipoprotein cholesterol (LDLC) below 2.6 mmol/L and triglycerides (TG) below 1.7 mmol/L, while raising high density lipoprotein cholesterol (HDLC) above 1.15 mmol/L for men and possibly another 10 mg/dl higher still for women.[6]

The Asia Pacific Type 2 Diabetes Policy Group, supported by the International Diabetes Foundation (IDF) Western Pacific (WP) Region, has produced the fourth edition of Type 2 Diabetes Practical Targets and Treatments. In the report, the IDF has recommended that patients with diabetes maintain their systolic blood pressure below 130 mmHg and diastolic blood pressure below 80 mmHg; total cholesterol should be lower than 4.5 mmol/L, with LDL cholesterol lower than 2.5 mmol/L. TG should be below 1.5 mmol/L, HDL cholesterol should exceed 1.0 mmol/L and fasting glucose should be maintained between 4.4 and 6.1 mmol/L.8

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The combination of hyperglycaemia, obesity, dyslipidaemia and hypertension has been labelled metabolic syndrome, dysmetabolic syndrome or insulin resistance syndrome. This combination indicates common underlying aetiological factors; it is not surprising that the clinical importance of metabolic syndrome is the high cardiovascular risk associated with it. [8] Sustained improvement in health is recognised as an important goal in diabetes care.[9]

As Malaysia proceeds rapidly towards a developed economy status, the population's lifestyle will continue to change. The escalation of nutrition-related chronic degenerative diseases, once an urban phenomenon, has now spread to the rural population at an alarming rate.[10] Therefore, the objective of this study was to determine the level of glycaemic control, lipid profile, blood pressure and body weight status among subjects with type 2 diabetes mellitus, specifically at Felda Gugusan Palong, Gemas Negeri Sembilan, Malaysia.

MATERIALS AND METHODS

A cross-sectional study was conducted at Felda Gugusan Palong, Gemas Negeri Sembilan. Subjects were selected using cluster sampling, wherein 1184 settlers were sampled and a total of 237 diabetic subjects were recruited for this study. Informed consent was obtained and:

1. Subjects were interviewed using pre-tested questionnaires.
2. Subjects were examined to determine height, weight, waist and hip circumferences, and systolic and diastolic blood pressure.

Inclusion criteria included selected settlers (husband and wife) identified in the sampling frame and their agreement to participate in this study, attend blood collection centres and be interviewed during data collection. Exclusion criteria included subjects with mental disorders, AIDS or HIV positive status.
Sample size calculation

The formula used for calculating sample size was: $n = Z(1-\alpha/2)^2 \times p \times (1-p) / d^2$, where $Z(1-\alpha/2)$ indicates 95% confidence level, p is the prevalence of FPG < 6.1 mmol/L /good glycaemic control (according to Mafauzy, 18%), and d is the desired accuracy level for estimating prevalence of good glycaemic control (set at ± 0.10).[11,12] Given these parameters, we required a sample size of at least 56 subjects for this study.

Weight was measured with a Tanita digital weighing scale (Japan), and height was measured using a SECA bodymeter (Germany). Each measurement was recorded to the nearest 0.1kg and 0.1cm, respectively. Body mass index (BMI) was computed using the ratio of weight (kg) per height2 (m2), and following the classification of the World Health Organization.[13] Waist and hip circumferences were measured using an inelastic measuring tape to the nearest 0.1cm. Waist circumference was obtained by measuring the distance around the smallest area below the rib cage and above the umbilicus and was analysed using the National Institute of Health's classification.[14] Hip circumference was measured at the point yielding the maximum circumference over the buttocks with the tape held in a horizontal plane. Blood pressure was measured using Omron digital blood pressure monitor (Japan).

Fasting blood samples were collected to determine glucose levels and lipid profile (TC, HDLC, LDLC and TG). Biochemical analyses were done using the Hitachi Chemical Analyser (Japan). Total LDLC was calculated using Friedewald formula.[15]

Statistical analysis was done using SPSS version 12.0. All the variables were coded, and appropriate statistical analyses were performed, including determining the mean and standard deviation, and utilising the chi square test for association and the t-test for difference. Statistical significance was assessed at a level of less than 0.05.

The objective of this study was to determine the level of glycaemic control, lipid profile, blood pressure and body weight status among subjects with type 2 diabetes mellitus specifically at Felda Gugusan Palong, Gemas Negeri Sembilan, Malaysia. Data on the glycaemic control, lipid profile, blood pressure and body weight status among type 2 diabetes mellitus, especially in rural Malaysia, are limited. In the present study, we assess the level of glycaemic control, lipid profile, blood pressure and body weight status among subjects with type 2 diabetes mellitus at Felda Gugusan Palong, Gemas Negeri Sembilan, Malaysia.

RESULTS

Socio-demography

Table I presents the socio-demographic data of subjects by gender. The study group consisted of 237 subjects, of which 42.6% were male and 57.4% were female. The majority of the subjects (91.5%) were 40-59 years old; 72.2% of all subjects were Malay and 27.8% were Indian. About 95% of the subjects were married, and 5.1% were widowed or divorced. Only 13.1% of the subjects had never acquired any formal education, while the majority of the subjects (75.9%) had a primary school education. A higher percentage of males had a secondary level of education, and the difference in education level between male and female subjects was statistically significantly ($p<0.05$). The mean monthly income was RM 656.24 ± RM 520.41, and while males had a higher monthly income than females, this did not prove to be statistically significant ($p>0.05$). The mean household size was 4.52 ± 2.09 and was higher among male subjects ($p<0.05$).

Table I. Socio-demography data of subjects by gender

	Male	Female	Total	χ^2	p value
n	101 (42.6%)	136 (57.4%)	237 (100%)		
Age (years)	52.86 ± 5.83	48.89 ± 5.73	50.58 ± 6.09		
30-39	3 (3.0)	6 (4.4)	9 (3.8)		#
40-49	25 (24.8)	77 (56.6)	102 (43.0)		
50-59	66 (65.3)	49 (36.0)	115 (48.5)		
≥ 60	7 (6.9)	4 (3.0)	11 (4.7)		
Ethnic					
Malay	66 (65.3)	105 (77.2)	171 (72.2)	4.06	0.06
Indian	35 (34.7)	31 (22.8)	66 (27.8)		
Marital status					
Married	100 (99.0)	125 (91.9)	225 (94.9)	6.08	0.02
Widow/ Widower/ Divorced	1 (1.0)	11 (8.1)	12 (5.1)		
Education level					
No formal education	8 (7.9)	23 (16.9)	31 (13.1)	6.04	0.04
Primary	78 (77.2)	102 (75.0)	180 (75.9)		
Secondary	15 (14.9)	11 (8.1)	26 (11.0)		
Occupation					
Settlers	95(94.1)	129(94.9)	224(94.5)	0.07	0.5
Other	6(5.9)	7(5.1)	13(5.5)		
Monthly income (RM)	753.47 ± 616.66	584.04± 423.59	656.24± 520.41	0.67	0.5
Household size	4.62± 2.28	4.44± 1.93	4.52 ± 2.09	2.51	0.02

Chi squared could not performed because more than 20% of the cells have expected values less than 5

Anthropometric Measurements

Table II shows the anthropometric measurements and blood pressure levels by gender. The mean BMI of all subjects was 27.47±5.00kg/m2, with females possessing a higher BMI (28.15± 5.60 kg/m2) than males (26.55±3.89 kg/m2; p<0.05). The difference in height, weight and BMI between males and females was statistically significant (p<0.05). Waist circumference was not significantly different between males and females (p>0.05). Waist to hip ratio was higher among males than females (p<0.05), but hip circumference showed the opposite trend (p<0.05).

The classifications of body mass index, central obesity and waist to hip ratio of the subjects by gender are presented in Table III. Overall, less than 30% of the subjects were classified as at a normal BMI, with more males (37.6%) than females (23.5%) in this category. Furthermore, 47.3% of subjects were classified as overweight, while 22.4% were obese. Nearly 63% of the subjects were classified as having a waist to hip ratio (WHR) ≥ 0.95 for males or ≥ 0.85 for females. Based on waist circumference, 18.8% of males were at high risk of co-morbidities compared to the almost threefold increase of high risk among females (61%). Gender differences in waist circumference and waist to hip ratio were statistically significant (p<0.05), with a higher percentage of female subjects categorised as having abdominal obesity and at high risk of comorbidity.

Blood pressure

Table IV presents the blood pressure categories of the subjects by gender. Based on the systolic blood pressure, 46.8% of the subjects were classified as having a systolic blood pressure ≥140mmHg, and 54.4% of the subjects were identified as having a diastolic blood pressure ≥90mmHg. In total, more than 60% of the subjects were identified as having a systolic blood pressure ≥140 mmHg and/or a diastolic blood pressure ≥90 mmHg. The results of this study showed no gender differences in term of blood pressure classification (p>0.05).

Fasting Blood Glucose and Lipid Profile

Means ± standard deviations for lipid profile and for glucose by gender are presented in Table V. Mean total cholesterol for males was 5.04±1.40 mmol/L and 5.29±1.31 mmol/L for females. HDLC and glucose were higher in males than in females, but the differences were not statistically significant (p>0.05). LDLC was higher in females than males (p<0.05), while triglyceride levels showed an opposite trend.

Results from this study were compared to targeted lipid profiles, blood pressure and BMI for diabetics. The mean for systolic and diastolic blood pressure was above 140/90mmHg. The majority of subjects (64.1%) had a blood pressure ≥140/90mmHg, and only 15.2% had a blood pressure in the optimal range (<130/80mmHg). Fasting blood glucose was at an optimal level for only 14.8% of the subjects, and a majority of the subjects (64.1%) had fasting blood glucose of more than 7.0 mmol/L. Only 24.9% of the subjects had a total cholesterol ≥6.0 mmol/L, while 30.4% of the subjects were in the optimal range. LDL-cholesterol measurements showed that 39.2% of subjects had a level >4.0 mmol/L, while only 15.6% had an LDLC <2.5 mmol/L. As for HDL-cholesterol measurements, only 16.5% of the subjects had HDL-cholesterol levels >1.1 mmol/L, while 71.3% had a level < 0.9 mmol/L. For triglycerides, the majority of the subjects (57.5%) were at an optimal level, and only 13.5% of the subjects had triglycerides > 2.2 mmol/L. The majority of the subjects (56.5%) had a high BMI (≥27 kg/m2 for males & ≥26 kg/m2 for females), while less than 27% of the subjects had a BMI in the optimal range.

Table II. Mean ▫ standard deviation for anthropometric measurements and blood pressure by gender

	Male n=101	Female n=136	Total n=237	t	p value
Height (cm)	164.65± 5.81	150.94±6.64	156.78 ± 9.26	16.58	0
Weight (kg)	71.96± 10.89	63.98 ±11.87	67.38 ± 12.10	5.3	0
BMI (kg/m^2)	26.55 ±3.89	28.15 ±5.60	27.47± 5.00	-2.47	0.01
Diastolic (mmHg)	91.21± 11.93	92.43 ±12.69	91.91 ± 12.75	-0.73	0.47
Systolic (mmHg)	141.80± 24.52	139.29± 20.81	140.36 ± 2.45	0.83	0.4
Waist circumference (cm)	92.96± 12.90	90.25± 82.26	100.37± 10.41	1.76	0.08
Hip circumference (cm)	97.38 ±7.89	102.58 ±11.48	91.41± 11.31	-3.92	0
Waist to Hip Ratio (WHR)	0.96 ±0.11	0.88 ±0.08	0.91± 0.10	5.77	0

Table III. Classification of body mass index, central obesity and waist to hip ratio of the subjects by gender

		Male n=101 n(%)	Female n=136 n(%)	Total n=237 n(%)	χ^2	p value
BMI (kg/m^2)	Underweight (<18.5 kg/m^2)	0	2(1.5)	2(0.8)		#
	Normal (18.5-24.9 kg/m^2)	38(37.6)	32(23.5)	70(29.5)		
	Overweight (25.0-29.9 kg/m^2)	43(42.6)	69(50.7)	112(47.3)		
	Obese (≥30 kg/m^2)	20(19.8)	33(24.3)	53(22.4)		
Central obesity	Normal	48(47.5)	40(29.4)	88(37.1)	8.14	0
	Android obesity (WHR≥0.95 ♂ and WHR≥0.85 ♀)	53(52.5)	96(70.6)	149(62.9)		
Waist circumference	Normal (♂ ≤102 cm, ♀≤88 cm)	82(81.2)	53(39.0)	135(57.0)	42.14	0
	High risk (♂ >102 cm, ♀>88 cm)	19(18.8)	83(61.0)	102(43.0)		
Waist circumference*	Normal (♂ ≤90 cm, ♀≤80 cm)	35 (34.7)	18 (13.2)	53 (22.4)	15.31	0
	High risk (♂ >90 cm, ♀>80 cm)	66 (65.3)	118 (86.8)	184 (77.6)		

* According to the Asia-Pacific regional guidelines, abdominal obesity was defined as a WC >90 cm for men and >80 cm for women.

Source: Steering Committee of the WHO Western Pacific Region, IASO & IOTF. The Asia-Pacific perspective: Redefining obesity and its treatment. Australia : WHO Western Pacific Region, 2000.

Table IV. Blood pressure categories by gender

		Male n=101 n(%)	Female n=136 n(%)	Total n=237 n(%)	χ^2	p value
Systolic blood pressure	Normal	54(53.5)	72(52.9)	126(53.2)	0	1
	≥140mmHg	47(46.5)	64(47.1)	111(46.8)		
Diastolic blood pressure	Normal	47(46.5)	61(44.9)	108(45.6)	0.07	0.9
	≥90 mmHg	54(53.5)	75(55.1)	129(54.4)		
Blood pressure	Normal	40(39.6)	52(38.2)	92(38.8)	0.05	0.89
	High blood pressure (Systolic ≥140 mmHg and/or diastolic ≥90 mmHg.)	61(60.4)	84(61.8)	145(61.2)		

Table V. Lipid profile and glucose levels (mean ± standard deviation) by gender

	Male n=101	Female n=136	Total n=237	t	p value
Total cholesterol (mmol/L)	5.04±1.40	5.29±1.31	5.18±1.35	-1.14	0.16
HDLC (mmol/L)	0.77±0.51	0.76±0.43	0.76±0.47	tu0.19	0.85
Triglyceride (mmol/L)	1.68±0.95	1.47±0.72	1.56±0.83	1.94	0.05
LDLC (mmol/L)	3.51±1.20	3.87±1.19	3.71±1.21	-2.29	0.02
Glucose level (mmol/L)	10.37±5.32	9.44±3.84	9.84±4.54	1.57	0.12

Table VI. Status of lipid profile, glucose level, blood pressure and BMI among the subjects

	Good %	Moderate %	Poor %
Blood Pressure (mmHg)	15.2 (<130/80 mmHg)	20.7 (≥130/80-<140/90 mmHg)	64.1 (≥140/90 mmHg)
Glucose Level* (mmol/L)	14.8 (4.4-6.1 mmol/L)	19.8 (6.2-7.0 mmol/L)	64.1 (>7.0 mmol/L)
Triglyceride (mmol/L)	57.4 (<1.5 mmol/L)	29.1 (1.5-2.1 mmol/L)	13.5 (≥2.2 mmol/L)
LDLC (mmol/L)	15.6 (<2.5 mmol/L)	45.2 (2.5-4.0 mmol/L)	39.2 (>4.0 mmol/L)
HDLC (mmol/L)	16.5 (>1.1 mmol/L)	12.2 (1.1-0.9 mmol/L)	71.3 (<0.9 mmol/L)
Total Cholesterol (mmol/L)	30.4 (<4.5 mmol/L)	44.7 (4.5-5.9 mmol/L)	24.9 (≥6.0 mmol/L)
BMI (kg/m^2)	26.2 (<25 kg/m^2♂, <24 kg/m^2♀)	17.3 (25-26.9 kg/m^2♂, 24-25.9 kg/m^2♀)	56.5 (≥27 kg/m^2♂, ≥26 kg/m^2♀)

* Total less than 100% because another 1.3% could not fitted to any categories, their blood glucose was less than 4.4 mmol/L.

DISCUSSION

The Diabetes Control and Complications Trial (DCCT) and other European studies have demonstrated the efficacy of intensive insulin treatment in preventing the onset and/or progression of microvascular complications such as retinopathy, nephropathy, and neuropathy.[16-19] The results from this study showed that the majority (64.1%) of the subjects have fasting blood glucose levels above 7.0 mmol/L. Other studies in Malaysia showed similar results, where diabetic subjects had fasting blood glucose levels beyond the optimum level. Studies by Eid et al, Suhaiza et al and Mafauzy et al showed 60%, 85.7% and 89% of their diabetic subjects, respectively, had fasting glucose levels above 6.7 mmol/L.[20-22] These figures indicate the urgency of controlling and preventing microvascular complications among diabetics in rural areas. The majority of the subjects in this study would also require intervention and ongoing monitoring to ensure that targeted glucose levels are reached and maintained.

The Action in Diabetes and Vascular Disease: Preterex and Diamicron Modified Release Controlled Evaluation (ADVANCE) showed that an intensive glucose control strategy significantly reduced the primarily composite outcome of major macrovascular events, mainly as a consequence of a reduction in nephropathy.[23] Other prospective studies have shown continuous associations of blood glucose and glycated haemoglobin levels with the risks of major vascular events.[24,25]

A positive relationship between glycaemic control and the concentration of TC, LDLC and triglycerides has been reported by The Diabetes Control and Complications Trial (DCCT).[26] The data from The SEARCH diabetes study show that the association between poor diabetes control and high concentration of TC, LDLC and triglycerides also extends to those between 10 and 22 years old in all major ethnic/racial groups.[27] Similar results were obtained in this study, namely, a positive and significant correlation between fasting blood sugar and TC ($r=0.197$; $p<0.01$), and between fasting blood sugar and triglycerides ($r=0.391$; $p<0.01$), but not between fasting blood sugar and LDLC ($p>0.05$).

In this study, about one-fourth of the subjects exceeded the targeted level of total cholesterol, and about 40% of the subjects had LDL cholesterol levels above 4.0 mmol/L. Studies by Mafauzy et al showed that 87.7% of diabetic subjects had total cholesterol levels above 4.8 mmol/L, while those of Ismail et al found that 73.2% of their subjects had levels above 5.2 mmol/L.22,28 Results from the present study showed that 39.2% of the subjects had LDL cholesterol above 4.0 mmol/L. This percentage is lower than that in studies by Eid et al, in which 62% of their subjects were classified as having high LDLC.20 Studies by Ismail et al found that 90.9% of diabetics analysed had LDLC levels above 2.6 mmol/L.[28]

The NCEP ATP (III) recommends aggressive LDL reduction for patients with diabetes, and the ADA recommends that LDLC be maintained below 2.6 mmol/L.6 This targeted value is achievable, as results of this study showed that only 15.6% of the subjects had LDLC levels less than 2.5 mmol/L. With regard to HDLC, this study showed that more than 70% of the subjects had HDLC levels below 0.9 mmol/L, even though they were medicated. Therefore, intervention programs targeted to physical activity are suggested to increase HDLC levels in this community.

The mean systolic and diastolic blood pressure was above 140/90mmHg. The majority of the subjects (64.1%) had blood pressure measurements ≥140/90mmHg, and only 15.2% had blood pressure measurements in the optimum range (<130/80mmHg). Studies by Mafauzy showed that 40.9% of his subjects had high blood pressure.[22] Chuang et al reported that, among diabetics in Asia, 27% had diastolic blood pressure levels above 140mmHg, while 10% had systolic blood pressure levels above 90mmHg.[29] Control of blood pressure is important in preventing cardiovascular complications among diabetics.

Being overweight constitutes a health risk as it is associated with several co-morbidities, including type 2 diabetes mellitus, cardiovascular diseases, hypertension, dyslipidaemia, hyperuricaemia, respiratory diseases, osteo-arthritis and depression.[30,31] The majority of the subjects in this study (56.5%) had a BMI at or above 27 kg/m2 for males and at or above 26 kg/m2 for females. Only 26.9% of the subjects' BMI measurements were in the optimal range. Similar findings have also been reported by Mafauzy, 81.4% of their subjects had BMI >23 kg/m2.22 According to Ford et al, for every kilogram of weight gain, the risk of diabetes increases between 4.5% and 9%.[32] The relationship between obesity and diabetes is of such interdependence that the term 'diabesity' has been coined.[33] According to Kahn et al, in obese individuals, adipose tissue releases increased amounts of non-esterified fatty acids, glycerol, hormones, pro-inflammatory cytokines and other components of insulin resistance.[34] When insulin resistance is accompanied by dysfunction of pancreatic islet -cells — the cells that release insulin — failure to control blood glucose levels results.

This study has shown similar results to other studies involving diabetics in Malaysia. The prevalence of dyslipidaemia, high blood pressure, obesity and poor glycaemic control (as evidenced by fasting blood glucose levels) are alarming in rural areas and highlight the need for lifestyle intervention programs to control diabetes.

CONCLUSION

Glycaemic control, lipid profile, blood pressure and body weight status among diabetics in rural areas are unsatisfactory and should be controlled to prevent diabetes complications, including those of a microvascular and macrovascular nature, among these subjects. Appropriate intervention programs should be implemented for better diabetes control among these subjects.

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