IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e-ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 2, Issue 1 (Sep. – Oct. 2013), PP 14-21
www.iosrjournals.org

The Effectiveness of Lifestyle Intervention among Pre-Diabetes Patients in Melaka, Malaysia.

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Abstract: Introduction: *The aim of this study is to evaluate the effectiveness of lifestyle intervention on physical (weight, body mass index (BMI), blood pressure, waist circumference) and biochemical (fasting blood sugar (FBS), 2 hours postprandial (2HPP), and lipid profile) parameters among individuals with pre-diabetes.* ***Methods:*** *This study involved 185 pre-diabetics patients from fourteen selected health clinics in Melaka. The patients were divided into three groups based on the intervention that they received namely lifestyle intervention (n=62), pharmacological intervention (n=60), and control group (n=63). Each clinic applied only one type of intervention. The control group received only the conventional education. the lifestyle intervention group underwent group and individual dietary counseling together with exercise programme, and the pharmacological intervention group were given the oral Metformin (500 mg b.i.d).* ***Results:*** *Both blood glucose profiles included FBS and 2HPP with the mean difference of 0.24 ± 0.94 mmol/L were significantly reduced in the lifestyle intervention group. Waist circumference and LDL-cholesterol were significantly reduced while HDL-cholesterol was significantly elevated in both lifestyle and pharmacological intervention groups. The greatest reduction of body weight and BMI were seen in pharmacological intervention group with the mean difference of 2.06 ± 2.68 kg and 0.89 ± 1.17 kg/m^2 respectively as compared to the lifestyle intervention and the control group with the mean difference of 1.49 ± 2.98 kg, 0.46 ± 2.02 kg/m^2; 0.61 ± 1.16 kg, 0.10 ± 1.03 kg/m^2 respectively. The lifestyle intervention showed significant reduction in weight (p=0.004), BMI (p=0.023) and waist circumference (p=0.005) as compared to the control group. Multivariable analysis, the lifestyle intervention still had an effect on fasting blood sugar (FBS), 2 hours postprandial (2HPP), and body mass index (BMI) after all the baseline differences were controlled. The lifestyle intervention showed the greater decreased in FBS (0.279 mmol/L) than pharmacological intervention (0.245 mmol/L).* ***Conclusion:*** *Lifestyle intervention was effective in reducing blood sugar profile of pre-diabetic patients as compared to the pharmacological intervention and the control group.*

Keywords*: Prevention T2DM, primary intervention, impaired glucose tolerance, pre-diabetes.*

I. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a major health problem associated with excess morbidity and mortality, and is on increasing prevalence worldwide[1]. It is a widespread health problem and may be life-threatening from associated complications such as coronary artery, cerebrovascular, retinal, neurological, and renal diseases[2-4]. The rise in diabetes mellitus is largely attributed to the epidemic of obesity together with sedentary lifestyle as well as unhealthy dietary habit. Therefore, efforts are needed to determine the possible ways to early intervene those who are at high risk of T2DM. Diabetes is a lifestyle disease and preceded by pre-diabetes for years before manifests as overt hyperglycaemia. The symptoms, however, can be managed by a healthy lifestyle. Pre-diabetes is a condition of people who were diagnosed with impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG) [4]. They have increased risk of developing T2DM[5] and cardiovascular disease[6,7]. It is estimated that approximately 25% of people diagnosed with IGT or IFG progress to diabetes mellitus over a 3 to 5 year period[8] (Nathan, 2007). Patients with both IGT and IFG, older age, overweight, or other diabetic risk factors are more likely to progress to diabetes. Other risk factors for diabetes include family history of diabetes, sedentary lifestyle, hypertension, dyslipidemia, history of gestational diabetes or large for gestational age infant, and polycystic ovarian syndrome. The primary prevention of diabetes mellitus is based on knowledge of the natural history of the development of IGT and its risk factors.This is an important to identify an intervention targeted on individuals who are at highest risk of developing the disease[9]. Patients who have impaired glucose tolerance (IGT) or impaired fasting glucose (IFG) have the potential to become diabetes[10]. Patient in these conditions has not showed the normal blood sugar level, but he also has not yet

reached the level of diabetes. This condition represents an intermediate stage in the development of T2DM. Then, the effective treatment is an urgent need for diabetes prevention. The type of intervention can either be pharmacological or non-pharmacological. The pharmacological intervention includes the diabetic medications and weight loss medication. Meanwhile, the life style modification or behavioral modification is classified under the non-pharmacological intervention. The effectiveness of lifestyle modification includes the increasing of increased in physical activity, dietary intervention, and reduction of body weight in the prevention and management among pre-diabetic patients. It has been proven by US Diabetes Prevention Programme result which is showed that a diet and exercise intervention resulted in reducing the body weight and sugar profile in 2.8 years compared in placebo and pharmacological group [11]. Similarly, the Finnish Diabetes Prevention Study also found that diet and exercise intervention resulted in weight and blood glucose in the intervention group between one and three years compared to the control group [12]. Therefore, the purpose of this study is to evaluate the effectiveness of lifestyle intervention on physical (weight, BMI, blood pressure, and waist circumference) and biochemical (blood sugar and lipid profile) parameters among people with pre-diabetes.

II. MATERIALS AND METHODS

2.1 Study design: The study was a six months non randomized intervention study or also known as quasi experimental study. The subjects were divided into three groups based on the interventions type: control group (n=63), lifestyle intervention group (n=62), and pharmacological intervention group (n=60). The framework of this study is shown in Fig: I.

2.2 Sample and recruitment: A total of 185 pre-diabetic patients using World Health Organization criteria[13]. IGT was defined as 2 hours post glucose load plasma glucose $\geq$ 7.8 and < 11.1 mmol/L[13]. IFG was defined as fasting blood sugar $\geq$ 6.1 and < 7.1 mmol/L[13]. Diabetes and normal glucose tolerance were defined as 2 hours plasma glucose $\geq$ 11.1 and 7.8 mmol/L, respectively[13]. Subjects with IGT and IFG were recruited from outpatient health clinics in Melaka. The inclusion criteria were BMI $\geq$ 23 kg/m^2 and aged between 25 to 65 years old. Physical (body weight, BMI, blood pressure, and waist circumference) and metabolic (blood sugar and lipid profile) parameters were measured. The patients were followed up for six months and assessments were made before and after intervention. Food intake and physical activity were quantified at pre and post intervention using standardized forms and interviews. For dietary intake, quantity of food per day for the past 1 month was ascertained for major food/beverage items. They were then converted to major food constituents using a food nutrition database (Nutritionist Pro)[14]. Physical activity was assessed in a standardized way using GPAQ version 2.0[15].

2.3 Intervention

2.3.1 Lifestyle intervention group: Subjects who were assigned to this group received instructions and counseling for both diet and exercise interventions. Participants were encouraged to consume more vegetables, and reduce their intake of simple sugars. They were also encouraged to reduce their calorie intake so as to gradually lose weight at a rate of 0.5-1.0 kg per month. In addition, they were taught and encouraged to increase the amount of their leisure physical exercise. Counseling sessions were conducted monthly for 6 months.

2.3.2 Pharmacotherapy intervention group: Subjects who were assigned to this group were given general information about diabetes and pre-diabetes. They were also given informational brochures with general instructions on diet and/or leisure physical activities. The subjects were prescribed tab metformin 500 mg twice a day.

2.3.3 Control group: Subjects who were assigned to the control group were given general information about diabetes and pre-diabetes. Diabetic educator also dispensed informational brochures with general instructions on diet and/or leisure physical activities to the control group subjects, but no individual instruction or formal group counseling sessions were carried out.

2.4 Statistical analysis: The SPSS statistical programme version 19 (SPSS, Inc, Chicago, USA) was used. All data are presented as mean ± SD. A two-tailed paired t-test or the chi-square test was used to analyze differences within groups between the baseline and post intervention. Differences over time between study groups were tested by two-way analysis of variance with time as repeated measure. A p-value of less than 0.05 was considered statistically significant.

2.5 Study ethics: Ethical approval was obtained from the Research Committee, Universiti Kebangsaan Malaysia Medical Centre (FF-131-2011) and National Medical Research and Ethics Committee, Ministry of Health, Malaysia (NMRR-11-114-8318).

III. RESULTS

A total of 185 (92.5%) study subjects completed the 6 months intervention. A total of 20 subjects who did not attend the six month visit or terminated early, were defined as dropout. The base-line characteristics of subjects from all the groups were shown in TABLE 1 and 2. There were significant differences in some the physical and biochemical parameters at baseline. At baseline visit, the subjects had mean age 50.23 ± 11.85 years with body mass index (BMI) of 29.94 ± 5.45 kg/m^2 , fasting blood sugar (FBS) of 5.96 ± 0.63 mmol/L, and 2 hours post-prandial (2HPP) of 8.96 ± 1.11 mmol/L. Multiple linear regression analyses were performed to control baseline differences between groups. TABLE 3 showed the outcome variables calculated as differences between values at follow-up and baseline. After six months, reduction of body weight and body mass index (BMI) was largest seen in the pharmacological group mean difference 2.06 ± 2.68 kg, 0.89 ± 1.17 kg/m^2 respectively compared to the lifestyle and the control group mean difference were 1.49 ± 2.98 kg, 0.61 kg/m^2, 0.46 ± 2.02 kg, 0.10 ± 1.03 kg/m^2 respectively. The largest reductions were seen in the fasting blood sugar and 2 hours post-prandial (2HPP) in the lifestyle intervention group and both mean difference were 0.24 ± 0.94 mmol/L. The pharmacological group, showed significant reduction only in fasting blood sugar (mean difference 0.21 ± 0.8 mmol/L). Other favorable significant changes found in both the lifestyle and the pharmacological intervention groups were reduction in waist circumference, LDL-cholesterol, and HDL-cholesterol. The serum triglyceride, however, was only reduced in the pharmacological group by 0.18 mmol/L. There were no significant changes observed in systolic and diastolic blood pressure in all the three groups. Further analysis with Bonferroni post hoc test showed that subjects in the lifestyle intervention group had a significant reduction in mean body weight (p=0.004), body mass index (BMI) (p=0.023), and waist circumference (p=0.005) as compared to the control group. However, the pharmacological group showed a significant reduction in the mean of triglyceride (p=0.022) as compared to the control group. The energy intake showed a more prominent decrease in the life style intervention group (TABLE 4) as compared to the control and the pharmacological intervention group. There was no significant difference in the physical activity before the intervention among all subjects. But, there was a higher percentage of physically active in the lifestyle intervention group than the other groups during the post intervention (TABLE 5). The physical activity had significantly increased in both lifestyle and pharmacotherapy intervention groups. Multivariable analysis (TABLE 6,7 and 8), has proven that after all the baseline differences were controlled, the pharmacotherapy intervention still had an effect on fasting blood sugar (FBS) and body mass index (BMI). But the lifestyle intervention had an effect on fasting blood sugar (FBS), 2 hours postprandial (2HPP), and body mass index (BMI) after all the baseline differences were controlled. The lifestyle intervention has reduced fasting blood sugar (FBS) greater (0.279 mmol/L) than the pharmacological intervention (0.245 mmol/L). The pharmacological intervention, however, showed a greater reduction in body mass index (BMI) which is (0.268 kg/m²) than the lifestyle intervention (0.167 kg/m²).

IV. FIGURES AND TABLES

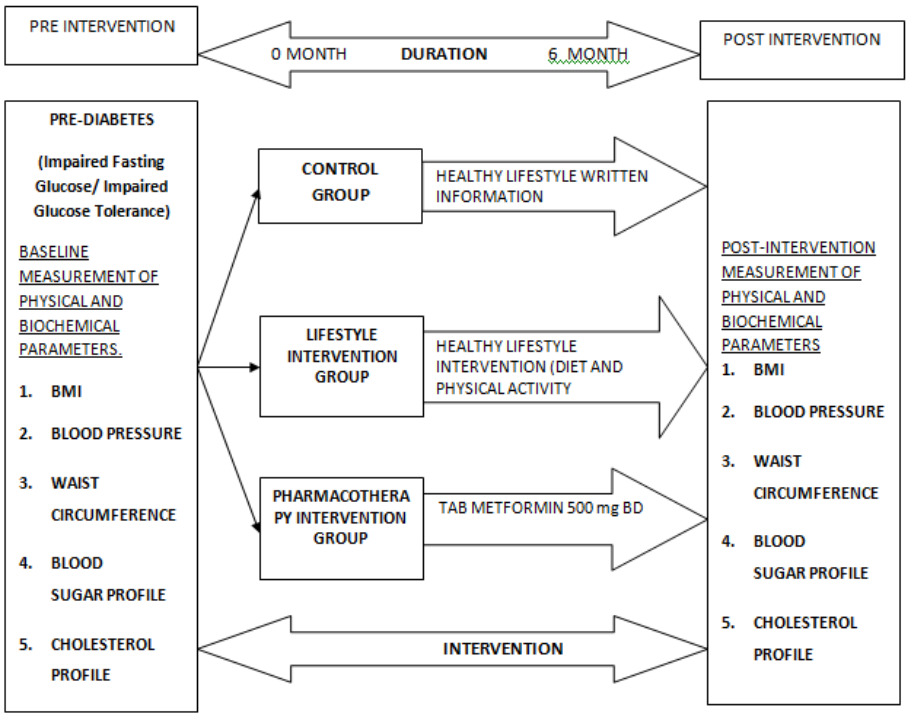

Table 1: Baseline demographic characteristics of the intervention group

Variables	All	Control group	Lifestyle intervention group	Pharmacotherapy intervention group	χ^2	p value
	N= 185	N= 63	N = 62	N = 60		
Sex (%)						
Male	55 (29.7)	19 (30.2)	21 (33.9)	15 (25.0)	1.157	0.561
Female	130 (70.3)	44 (69.8)	41 (66.1)	45 (75.0)		
Ethnicity (%)						
Malay	149 (80.5)	51 (81.0)	50 (80.6)	48 (80.0)	4.243	0.374
Chinese	20 (10.8)	9 (14.3)	4 (6.5)	7 (11.7)		
Indian	16 (8.6)	3 (4.8)	8 (12.9)	5 (8.3)		
Age (year)[a,x]	50.23 ± 11.85	51.03 ± 12.36	45.52 ± 11.11	54.25 ± 10.46	9.268[β]	<0.001***

[a] Data are means ± SDs. *** significant at p < 0.001, [β] value of t-statistic
[x] significant difference between lifestyle intervention group and control group (post hoc analysis p< 0.05).

Table 2: Baseline physical and metabolic characteristics of the intervention groups

Outcome variables	All	Control group	Lifestyle intervention group	Pharmacotherapy intervention group	p value
	N= 185	N= 63	N = 62	N= 60	
Body weight (kg)[x]	72.79 ± 14.96	68.59 ± 11.88	75.55 ± 14.88	74.36 ± 17.07	0.013**
Body mass index (kg/m^2)[x,z]	29.94 ± 5.45	28.10 ± 4.20	30.94 ± 5.85	30.80 ± 5.80	0.002**
Waist circumference (cm)[x,z]	95.51 ± 12.19	90.48 ± 10.58	98.46 ± 11.23	97.70 ± 13.2	<0.001***
Systolic BP (mmHg)	133.26 ± 17.57	133.52 ± 17.10	131.40 ± 18.80	134.92 ± 16.83	0.469
Diastolic BP (mmHg)	79.91 ± 9.75	80.08 ± 8.56	80.32 ± 10.67	79.32 ± 10.07	0.763
FBS (mmol/L)[y,z]	5.96 ± 0.63	5.85 ± 0.69	5.88 ± 0.60	6.17 ± 0.55	0.012**
2HPP (mmol/L)	8.96 ± 1.11	8.91 ± 1.05	8.83 ± 1.09	9.15 ± 1.17	0.247
Total Cholesterol (mmol/L)	5.48 ± 0.98	5.29 ± 0.89	5.33 ± 1.00	5.48 ± 0.99	0.564
Triglyceride (mmol/L)[y,z]	1.58 ± 0.63	1.45 ± 0.56	1.51 ± 0.58	1.82 ± 0.70	0.009**
LDL- Cholesterol (mmol/L)	3.28 ± 1.04	3.22 ± 0.98	3.22 ± 1.11	3.39 ± 1.02	0.558
HDL- Cholesterol (mmol/L)	1.36 ± 0.51	1.41 ± 0.51	1.42 ± 0.51	1.25 ± 0.49	0.238

All data are means ± SDs. ** significant at p< 0.01, *** significant at p<0.001
[X] - significant difference between lifestyle intervention group and control group (post hoc analysis p< 0.05).
[Z] - significant difference between pharmacology intervention group and control group (post hoc analysis p< 0.05).
[Y] - significant difference between lifestyle intervention group and pharmacology intervention group (post hoc analysis p< 0.05).

Table 3: Changes in physical and metabolic characteristics during pre and post intervention (repeated measure ANOVA)

Outcome variables		Control group (N = 63)	Lifestyle intervention Group (N= 62)	Pharmacotherapy intervention group (N= 60)	F-statistic (df=2)	p value
Body weight (kg)[x]	0 month	68.59 ± 11.88	75.55 ± 14.88	74.36 ± 17.07		
	6 month	68.14 ± 11.62	74.05 ± 14.65	72.30 ± 17.13		
	Difference[x]	0.46 ± 2.02	1.49 ± 2.98	2.06 ± 2.68	3.33	0.038*
Body mass index (kg/m^2)[x,z] 0month		28.10 ± 4.20	30.94 ± 5.85	30.80 ± 5.80		
	6 month	28.05 ± 4.26	30.31 ± 5.74	29.9 ±5.69		
	Difference[x]	0.10 ± 1.03	0.61 ± 1.16	0.89 ± 1.17	4.34	0.014*
Waist circumference(cm)[x] 0 month		90.48 ± 10.58	98.46 ± 11.23	97.70 ± 13.2		
	6 month	90.57 ± 9.92	95.63 ± 11.63	95.0 ± 13.53		
	Difference[x]	- 0.09 ± 3.18	2.83 ± 4.17	2.65 ± 7.78	6.18	0.003**
Systolic blood pressure (mmHg)	0 month	133.52 ± 17.10	131.40 ± 18.80	134.92 ± 16.83		
	6 month	134.29 ± 15.33	130.45 ± 17.71	135.88 ± 20.83		
	Difference	- 0.76 ± 16.59	0.95 ± 16.14	- 0.96 ± 20.1	1.32	0.269
Diastolic blood pressure (mmHg)	0 month	80.08 ± 8.56	80.32 ± 10.67	79.32 ± 10.07		
	6	81.20 ± 11.87	80.26 ± 8.84	80.38 ± 9.93		

	month					
	Difference	- 1.11 ± 13.79	0.06 ± 10.55	- 1.07 ± 9.21	0.14	0.871
FBS (mmol/L) [y,]	0 month	5.85 ± 0.69	5.88 ± 0.60	6.17 ± 0.55		
	6 month	6.39 ± 2.16	5.63 ± 1.00	5.95 ± 0.87		
	Difference	- 0.53 ± 2.28	0.24 ± 0.94	0.21 ± 0.80	3.34	0.038*
2HPP (mmol/L)	0 month	8.91 ± 1.05	8.83 ± 1.09	9.15 ± 1.17		
	6 month	9.26 ± 4.08	7.96 ± 2.19	9.02 ± 2.09		
	Difference	- 0.35 ± 4.07	0.24 ± 0.94	0.13 ± 2.19	3.72	0.026*
Total cholesterol	0 month	5.29 ± 0.89	5.33 ± 1.00	5.48 ± 0.99		
(mmol/L)	6 month	5.13 ± 0.90	5.28 ± 0.79	5.28 ± 0.79		
	Difference	0.15 ± 0.81	0.55 ± 0.69	0.64 ± 0.75	1.27	0.284
Trigliceride [y,]	0 month	1.45 ± 0.56	1.51 ± 0.58	1.82 ± 0.70		
(mmol/L)	6 month	1.49 ± 0.64	1.59 ± 0.68	1.64 ± 0.57		
	Difference	- 0.04 ± 0.54	- 0.09 ± 0.79	0.18 ± 0.69	3.85	0.023*
LDL- cholesterol	0 month	3.22 ± 0.98	3.22 ± 1.11	3.39 ± 1.02		
(mmol/L)	6 month	3.12 ± 0.92	2.82 ± 1.06	3.09 ± 0.65		
	Difference	0.09 ± 0.90	0.41 ± 0.99	0.30 ± 0.91	0.35	0.011*
HDL-cholesterol	0 month	1.41 ± 0.51	1.42 ± 0.51	1.25 ± 0.49		
(mmol/L)	6 month	1.32 ± 0.42	1.73 ± 0.64	1.57 ± 0.65		
	Difference	0.08 ± 0.45	- 0.31 ± 0.84	- 0.32 ± 0.74	4.42	0.013*

All data are means ± SDs. * significant at p < 0.01, ** significant at p< 0.01***, significant at p<0.001, [X] significant difference between lifestyle intervention group and control group, [y] no significant difference between the intervention group (p>0.05), [z] significant difference between pharmacology intervention group and control group (post-hoc analysis).

Table 4- Changes in nutrient intake during pre and post intervention

Outcome variables	Control group N=63	Life style intervention group N = 62	Pharmacotherapy Intervention group N= 60	F-statistic[a] (df=2)	p value
Energy (kcal)[x]					
0 month	2535.43 ± 475.89	2887.87 ± 419.68	2668.37 ± 510.37		
6 month	2449.49 ± 443.09	2592.16 ± 526.06	2473.13 ± 506.76		
Difference	85.94 ± 294.25	295.71 ± 414.12	195.24 ± 320.72	4.95	0.008*
Protein (%)#					
0 month	17.57 ± 2.85	17.41 ± 2.21	17.39 ± 2.27		
6 month	17.53 ± 2.63	17.90 ± 2.24	17.97 ±2.32		
Difference	0.04 ± 1.35	-0.48 ± 1.55	-0.57 ± 1.14	0.05	0.962
CHO (%)#					
0 month	55.48 ± 7.54	55.61 ± 6.46	56.82 ± 5.95		
6 month	55.95 ± 6.94	54.66 ± 8.20	54.77 ± 6.93		
Difference	- 0.469 ± 4.39	0.95 ± 4.72	2.05 ± 5.38	0.18	0.834
Fat (%)#					
0 month	26.61 ± 5.36	26.97 ± 5.80	25.73 ± 4.59		
6 month	26.30 ± 5.38	27.74 ±6.87	26.48 ± 4.45		
Difference	0.31 ± 4.13	-0.77 ± 3.9	-0.75 ± 2.99	0.95	0.387

All data are means ± SDs
#percentage from total energy, * significant at p < 0.01
p values for differences between group were tested by two-way analysis of variance with time as a repeated measure.
[X] significant difference between lifestyle intervention group and control group

Table 5- Rates of changes (in percentage) for physical activity based on GPAQ category during pre and post intervention

Group/ Physical activity category		0 month	6 month	p value$^{\beta}$
		Low/Inactive n (%)	High/Active n (%)	
Control group	Low/Inactive	26 (41.3)	5 (7.9)	0.063
	High/Active	0 (0)	32 (50.8)	
Lifestyle intervention group	Low/Inactive	15 (24.2)	12 (19.3)	0.0001
	High/Active	0 (0)	35 (56.5)	
Pharmacotherapy Intervention group	Low/Inactive	28 (46.7)	9 (15.0)	0.004
	High/Active	0 (0)	23 (38.33)	

Pearson Chi-square test- pre intervention (χ^2 =4.183, p=0.124)
$^{\beta}$ p value from McNemar test.
Low/Inactive: Physical activity less than 600 MET-min/week.
High/Active: Physical activity at least 600 MET-min/week.

Table 6 Factors affecting differences pre and post body mass index (BMI) among all subjects in study groups..

Independent variables/ Constant	**$^{\beta}$**	**SE**	**95 % CI**	**t-stat**	**p value**
Constant	-0.432	1.052	(-2.059,1.645)	-0.411	0.662
Pharmacotherapy intervention	-0.312	0.225	(-1.112, -0.298)	-3.418	**0.001***
Lifestyle intervention	-0.176	0.216	(-0.816, -0.007)	-2.007	**0.045***
Pre body mass index	-0.328	0.032	(-0.133, 0.008)	-2.210	**0.028***
Age	0.017	0.008	(-0.015, 0.018)	0.195	0.846
Pre body weight	0.120	0.012	(-0.015, 0.033)	0.764	0.446
Pre waist circumference	0.089	0.012	(-0.016, 0.033)	0.697	0.487
Pre fasting blood sugar	0.061	0.142	(-0.165, 0 394)	0.806	0.421
Pre triglyceride	0.053	0.140	(-0.178, 0.374)	0.698	0.486

* significant at $p < 0.05$
CI – confident interval

Table 7: Factors affecting differences pre and post fasting blood sugar (FBS) among all subjects in study groups..

Independent variables/ Constant	**$^{\beta}$**	**SE**	**95 % CI**	**t-stat**	**p value**
Constant	2.862	1.335	(0.228,5.496)	2.145	**0.033***
Pre Fasting Blood Sugar	-0.291	0.180	(-1.079, -0.369)	-4.081	**<0.001*****
Pre triglyceride	0.187	0.177	(0.810, 0.110)	2.594	**0.012***
Lifestyle intervention	-0.245	0.274	(-1.336, -0.256)	-2.908	**0.004****
Pharmacotherapy intervention	-0.243	0.285	(-1.360, -0.233)	-2.789	**0.006****
Age	0.147	0.011	(-0.002, 0.040)	1.810	0.072
Pre body weight	0.103	0.015	(-0.020, 0.,0.41)	0.690	0.491
Pre body mass index	0.204	0.040	(-0.022, 0.137)	1.438	0.152
Pre waist circumference	-0.172	0.015	(-0.052, 0.009)	-1.405	0.162

* significant at $p < 0.05$,
** significant at $p<0.01$,
*** significant at $p < 0.001$
CI = confident interval

Table 8: Factors affecting differences pre and post 2 hours post prandial (2HPP) among all subjects in study groups..

Independent variables/ Constant	β	SE	95 % CI		t-stat	p value
Constant	-5.874	2.831	(-11.462,	-0.287)	-2.075	0.039
Pharmacotherapy intervention	-1.037	0.606	(-2.233,	0.158)	-1.713	0.088
Lifestyle intervention	-1.548	0.580	(-2.694,	-0.403)	-2.668	**0.008****
Age	0.002	0.023	(-0.042,	0.047)	0.110	0.912
Pre body weight	-0.026	0.033	(-0.091,	0.039)	-0.783	0.435
Pre Body Mass Index	0.082	0.085	(-0.087,	0.250)	0.957	0.340
Pre waist circumference	0.024	0.033	(-0.041,	0.089)	0.730	0.466
Pre fasting blood Sugar	0.449	0.381	(-0.304,	1.201)	1.177	0.241
Pre triglyceride	0.650	0.376	(-0.093,	1.392)	1.727	0.086

** significant at $p<0.01$,
CI = confident interval

V. DISCUSSION AND CONCLUSION

Discussion: The lifestyle intervention had induced the reduction in body weight, body mass (BMI), waist circumference, fasting blood sugar (FBS), 2 hours post-prandial (2HPP) and LDL- cholesterol were showed significant reduction. The Finnish study showed the intervention group participants' loss weight and reduced their waist circumference and the changes were significant compared to the control group [16]. In this study the reduction in FBS and 2HPP in the lifestyle intervention group could be due to the weight loss, increased physical activity and reduction in caloric intake. These findings seemed promising as the Finnish Study had reported that diet and physical activity are both important in maintaining healthy normal blood glucose level and preventing the T2DM[12]. The benefit of increased physical activity and reduced dietary intake in reducing diabetes incidence has been confirmed in the Diabetes Prevention Programme and the Da Qing Study in China [17,18]. Better glycemic control in the subjects of the lifestyle intervention group was probably due to their greater contact with diabetic educators and greater attention to diet and physical activity. This will encourage subjects to equip themselves with necessary knowledge and skills, and to increase their overall physical activity and decrease caloric intake. Improved glucose metabolism in subjects with type 2 diabetes in a result of weight loss and caloric restriction[19,20]. Lowering of fasting blood sugar also occurred in the pharmacological intervention group, however, the reduction was significantly greater in the lifestyle intervention. Health care providers should continue to evaluate the risks and/or presence of T2DM and to offer lifestyle interventions, including diet and physical activity therapies. Body weight reduction in the pharmacological intervention group appeared not to be a pharmacologic effect, since there was significant difference between the groups in term of the caloric intake and physical activity. The subjects in the pharmacotherapy intervention group also showed reduction in their caloric intake, and this may not representative with respect to their usual diet. In this study there was significant increased in physical activity which is indicated that physical activity had an effect on parameters measured among subject in pharmacotherapy group probably due to subjects who had reduced in weight they will increase their physical activity. The limitations of this study are the relatively small sample size and short duration of intervention, which may limit the ability to detect clinically meaningful differences. However the multivariable analysis was done as to account for the parameters differences at baseline. Future studies should be carried out on a larger population and over a longer period of time to ensure a more effective intervention. In addition, such study should receive a higher priority following the rapid increase in diabetes. **CONCLUSION:** In summary, the lifestyle intervention showed significant reduction in body mass index (BMI), fasting blood sugar (FBS) and 2 hours postprandial (2HPP) on subjects with pre-diabetes. Lifestyle interventions are more effective compare to the pharmacotherapy, and should be the first choice in treating those with pre-diabetes. Patients with pre-diabetes should be advised on the benefits of modest weight loss, good dietary habits and regular physical activity. The healthier lifestyle can modify other risk factors for cardiovascular disease such as hypertension, dyslipidemia and obesity. The lifestyle intervention programme in this study is practical and can be recommended in the health care system..

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