CHAPTER 4

RESULTS AND DISCUSSION

The purpose of this study was to examine the effect of the Diabetes Self-Management program on knowledge of diabetes, glycemic control, cardiovascular risk, and quality of life among people with diabetes mellitus. The research findings are presented as following:

Part I Demographic characteristics of the samples

Part II The comparison of knowledge of diabetes, glycemic control, cardiovascular risk, and quality of life between baseline and post-test of the experimental and control groups

Part III The comparison of knowledge of diabetes, glycemic control, cardiovascular risk, and quality of life at post-test between the experimental and control groups

Part I: Demographic Characteristics of the Sample

Three hundred and fifty one people with type 2 diabetes mellitus were reported uncontrolled diabetes. Two hundred and nine people met the research criteria and were asked to participate. One hundred and fifty seven agreed and were enrolled in the study (75.12% participation), and 147 participants completed the study

(93.63% retention). The final sample for analysis included 147 subjects, with 75 in the experimental group and 72 in the control group.

Of the 10 subjects not retained, 6 were in the control group and 4 were in the experimental group. The reasons for dropping out from the control group were: 1 died from sepsis, 2 were admitted to the hospital for a major cerebrovascular event and myocardial infarction, 1 changed the treatment from oral hypoglycemic drug to use insulin therapy, and 2 switched to a new health care service not covered by the approving institutional review board. The reason for dropping out from the experimental group included: 1 was admitted to the hospital for breast cancer and had surgery, and 3 did not complete in all intervention sessions (2 missed one session because of traveling to other province, 1 missed one session because of sickness) (see Figure 3).

Diabetes self-management program design

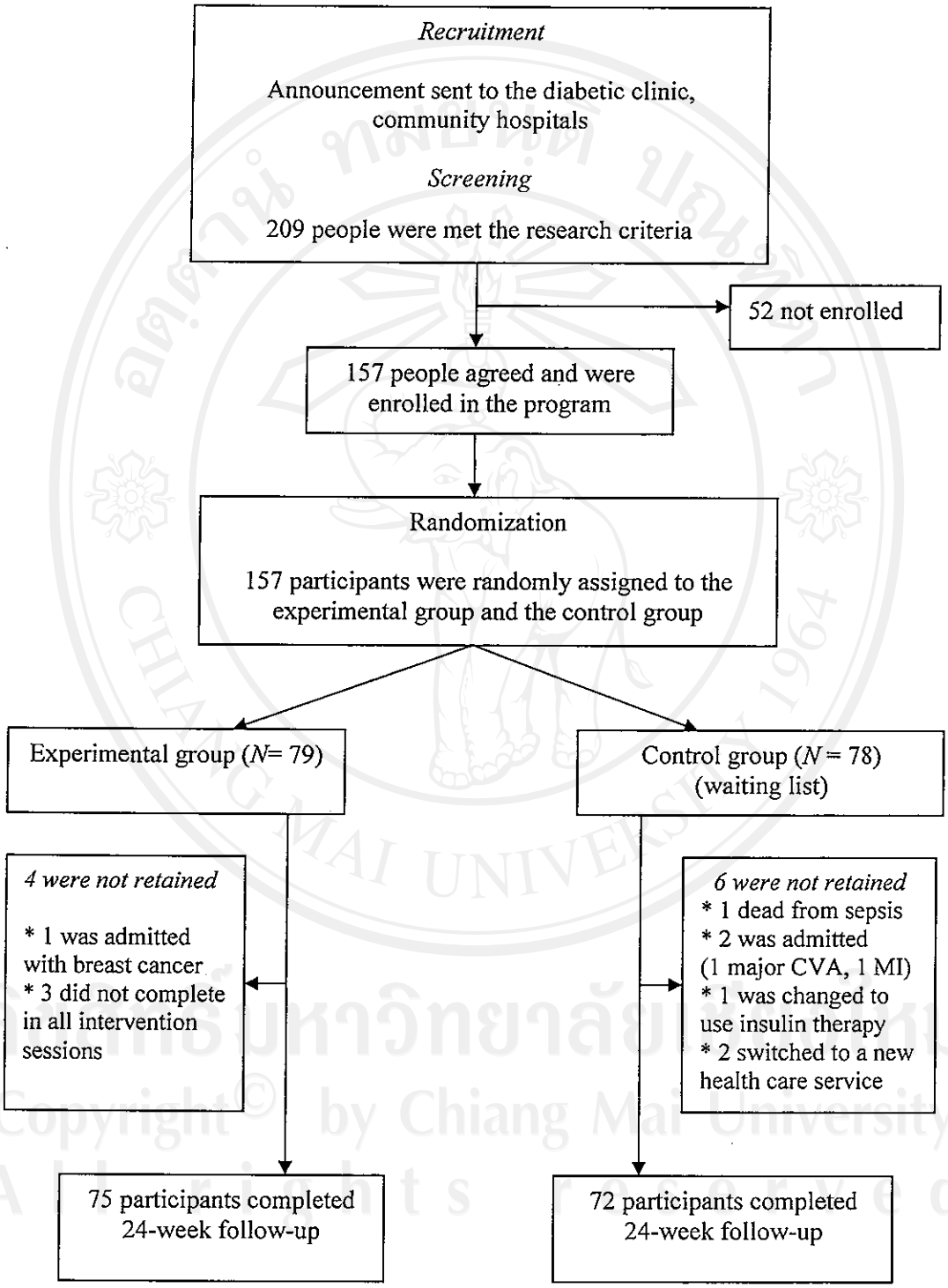

Figure 3. Study flow for diabetes self- management program

A larger percentages of participants were female (76.20%), and overweight (BMI > 23 Kg/m^2, 80.95%). The participants had an average age of 56.80 years (SD = 10.23 years), about two-thirds were married, and resided in a rural area. Of all participants, 92.50% had at least some level of primary school education and 53% had physically intensive work. A hundred and thirteen participants (76.87%) reported monthly household income of less than 5,000 Baht. Health care coverage was from a variety of sources. Most of the participants (76.19%) had national health care insurance. Participants had been diagnosed as type 2 diabetes mellitus for an average of 6.18 years (*SD* = 5.01 years), and had HbA_{1c} level of 8.09% (*SD* = 1.91%, ADA 2004 recommended < 7%). Compared to the control group, the experimental group was similar in all demographic data at baseline, only age showed borderline difference (p = .053) (see Table 4.1).

Table 4.1

Demographic Variables of the Control and Experimental Groups

Demographic characteristics	Control (*N* = 72) *n*	%	Experimental (*N* = 75) *n*	%	Statistic test value	*p-value*
Age (year)						
M ± *SD*	55.14 ± 10.22		58.40 ± 10.05		1.951[t]	.053
(Range)	(37-75)		(35-79)			
35-50	29	40.28	15	20.00		
51-65	29	40.28	43	57.33		
> 65	14	19.44	17	22.67		
Gender						
Male	20	27.78	15	20.22	1.225[a]	.268
Female	52	72.22	60	80.00		

Note. [t] = *t*-test; [a] = Chi-square test; [b] = Fisher's Exact test.

Table 4.1 *(continued)*

Demographic characteristics	Control ($N = 72$)		Experimental ($N = 75$)		Statistic test value	*p-value*
	n	%	*n*	%		
Marital status						
Single	4	5.55	11	14.67	4.447[a]	.108
Married	50	69.44	52	69.33		
Widowed/ Separated	18	25.00	12	16.00		
Educational level						
Primary school	67	93.06	69	92.00	.059[a]	.808
Secondary school	5	6.94	6	8.00		
Occupation						
Non-physically intensive work (unemployed, self-employed, household, merchant, fisher)	34	23.10	35	23.80	.005[a]	.946
Physically intensive work (gardener, employment)	38	25.90	40	27.20		
Household income (Baht/month)						
< 5,000	41	56.94	42	56.00	.284[a]	.868
5,000-10,000	26	36.11	26	34.67		
>10,000	5	6.95	7	9.33		
Health insurance						
National health care	55	76.39	57	76.00	1.700[b]	.637
Government benefit	10	13.89	13	17.33		
Social insurance	6	8.33	3	4.00		
Self-payment	1	1.39	2	2.67		

Note. [t] = *t*-test; [a] = Chi-square test; [b] = Fisher's Exact test.

Table 4.1 *(continued)*

Demographic characteristics	Control ($N = 72$)		Experimental ($N = 75$)		Statistic test value	*p-value*
	n	%	*n*	%		
Alcohol-consumption						
Never consumed	52	72.22	60	80.00	1.311[a]	.519
Consumed in the past	11	15.28	9	12.00		
Currently consumed	9	1.25	6	8.00		
Smoking						
Never smoked	58	80.56	66	88.00	1.926[b]	.382
Smoked in the past	11	15.28	6	8.00		
Currently smoked	3	4.16	3	4.00		

Note. [t] = *t*-test; [a] = Chi-square test; [b] = Fisher's Exact test.

Participants' history of having complication of diabetes and other co-morbidities were obtained. Most participants had co-morbid diseases including hypertension (65.30%), eye problems (cataract, blur vision; 4.70%), both eye problems and kidney diseases (7.4%), and 89.8% were taking combined drug for diabetes mellitus (Sulfonylurea group and Metformin). Compared to the control group, the experimental group was similar in all clinical measures at baseline (Table 4.2).

Table 4.2

Clinical Characteristics of the Participants in the Control and Experimental Groups at Baseline

Demographic characteristics	Control ($N = 72$)		Experimental ($N = 77$)		Statistic test value	*p-value*
	n	%	*n*	%		
Comorbid diseases						
None	23	31.94	19	25.33	.787[a]	.375
Hypertension	38	52.78	33	44.00	1.133[a]	.287
Cardiomegaly	1	1.39	0	0	1.049[b]	.490
Eye problems (cataract, blur vision)	3	4.17	4	5.33	.110[b]	.740
Kidney disease (proteinuria)	0	0	2	2.67	1.946[b]	.259
Previous stroke (recovery)	1	1.39	2	2.67	.300[b]	1.00
Eye and kidney disease	6	8.33	13	17.33	2.644[b]	.104
Hypertension and cardiomegaly	0	0	1	1.33	.967[b]	1.00
Hypertension and kidney disease	0	0	1	1.33	.967[b]	1.00
Current medication						
Oral hypoglycemic drugs						
None	1	1.39	0	0	3.540[b]	.117
One drug						
Sulfonylurea	1	1.39	6	8.00	.110[b]	1.00
Metformin	3	4.17	4	5.33		
Combined drugs (Metformin and Sulfonylurea)	67	93.06	65	86.70	3.540	.170

Note. [t] = *t*-test; [a] = Chi-square test; [b] = Fisher's Exact test, [z] = rank sum Mann-Whitney-U

Table 4.2 *(continued)*

Demographic characteristics	Control ($N = 72$)		Experimental ($N = 77$)		Statistic test value	*p-value*
	n	%	*n*	%		
Other drugs						
Antihypertensive	18	25.00	26	34.67	1.637 [a]	.201
Lipid-lowering	7	9.72	10	13.33	.468 [a]	.494
Anticoagulant	0	0	2	2.7	1.946 [b]	.497
Antihypertensive and lipid-lowering	19	26.39	12	16.00	2.832 [a]	.123
Antihypertensive and anticoagulant	0	0	4	5.33	3.947 [b]	.120
Anticoagulant and lipid-lowering	2	2.78	2	2.67	.002 [b]	1.000
Antihypertensive, anticoagulant, and lipid-lowering	3	4.17	2	2.67	.252 [b]	.677
Duration of having diabetes mellitus (year)	5.82 ± 5.32 (1-20)		6.52 ± 4.71 (1-26)		-1.710 [z]	.087
Body mass index (Kg/m^2) (range)	26.89 ± 4.45 (18.46- 47.67)		26.28 ± 4.31 (18.05-38.95)		.852 [t]	.396
Systolic blood pressure (mmHg) (range)	130.97 ± 15.67 (80-170)		128.67 ± 15.36 (90-160)		.90 [t]	.369
Diastolic blood pressure (mmHg) (range)	104.44 ± 23.07 (60-150)		104.53 ± 20.02 (70-160)		.025 [t]	.980

Note. [t] = *t*-test; [a] = Chi-square test; [b] = Fisher's Exact test; [z] = rank sum Mann-Whitney-U

Difference in Knowledge of Diabetes, Glycemic Control, Cardiovascular Risk, and Quality of Life of People with Diabetes Mellitus between the Experimental and Control Groups at Baseline

Prior to conducting data analysis, the differences between experimental and control groups at baseline in diabetes knowledge score, glycemic control level, cardiovascular risk score, and quality of life were examined using independent sample t-test. Results showed that there were slight difference of mean between the experimental and control groups among all these variables but not statistically significant.

Regarding knowledge of diabetes, results showed that both experimental and control groups had moderate level of knowledge. The diabetic knowledge score of the experimental group was similar to that of the control group (M = 13.47, SD = 2.92 and M = 12.99, SD = 3.16, respectively) (see Table 5).

In this study, glycemic control was assessed by FPG and HbA_{1c}. The mean FPG in both experimental group and control groups were higher than normal limits by falling into a fair level (M = 147.33, SD = 41.44 mg % VS M = 140.34, SD = 46.12 mg %, respectively). Compared to the goal of glycemic control (FPG 90-130 mg %) recommended by the American Diabetes Association (ADA, 2004), the number of participants in the control group who reached the goal at baseline was 40.28%, while in the experimental group was 38.67%. The number of participants who had poorly controlled blood glucose (FBG > 180 mg %) in both groups was also similar (Table 5).

Based on HbA_{1c} level, most participants in both experimental and control groups (40.00% VS 48.61%, respectively) showed poor diabetic control (HbA_{1c} > 8%) at

baseline. According to ADA (2004), the glycemic control goal is HbA_{1c} level of < 7%. The number of participants in the experimental group who could control diabetes mellitus was higher than that in the control group (33.30% VS 27.78%). However, the means of HbA_{1c} of the experimental group (M = 8.08, SD = 1.87) and the control group (M = 8.09, SD =1.98) at baseline were similar (see Table 5).

In this study, the cardiovascular risk or the risk for coronary heart disease (CHD) over the next ten years (Framingham Heart Study, 1991) was examined. At baseline, the mean of CHD risk of participants in the experimental group (M = 25.41, SD = 12.76) was slightly higher than the control group (M = 22.04, SD = 11.7), but was not statistically significant (p= .098). The mean risk scores of both groups were high. With regards to the severity of CHD risk, the number of participants in the control group with low CHD risk (< 10%) was higher than those in the experimental group (16.67% VS 6.67%). However, the participants in the experimental group who had high CHD risk (> 20%) were similar to those in the control group (56.00% VS 55.55%) at baseline (see Table 5).

In terms of quality of life (QOL), the mean QOL score of the control group was slightly higher than the experimental group (M = 62.38, SD = 15.22 VS M = 60.61, SD = 15.27) at baseline, but the difference was not statistically significant (p > .05). Most participants in both experimental and control groups had a moderate QOL score (38.67% VS 44.44%, respectively) (see table 5).

Table 5

Difference of the Knowledge of Diabetes, Glycemic Control, Cardiovascular Risk, and Quality of Life of People with Diabetes Mellitus between the Experimental and Control Groups at Baseline (N=147)

Dependent Variable	Possible score	Control group ($N = 72$)	Experimental group ($N = 75$	Statistic test-value	*p-value*
Knowledge of diabetes	0-20	12.99 ± 3.16	13.47 ± 2.92	.958 [t]	.340
Low	0.00 - 6.67	17 (23.61%)	15 (20.00%)		
Moderate	6.67 - 13.35	26 (36.11%)	26 (34.67%)		
High	13.36 - 20.00	29 (40.28%)	34 (45.33%)		
FPG (mg %)	90-130	140.34 ± 46.12	147.33 ± 41.44	.967 [t]	.335
	< 90.00	7 (9.72%)	3 (4.00%)		
Good	90.00 - 130.00	29 (40.28%)	29 (38.67%)		
Fair	130.01-180.00	23 (31.94%)	29 (38.67%)		
Poor	> 180.00	13 (18.06%)	14 (18.67%)		
HbA_{1c} (%)	(goal < 7)	8.09 ± 1.98	8.08 ± 1.87	-.029 [t]	.977
Good	< 7	20 (27.78%)	25 (33.33%)		
Fair	7 - 8	17 (23.61%)	20 (26.67%)		
Poor	> 8	35 (48.61%)	30 (40.00%)		
CHD risk (%)	0-100	22.04 ± 11.71	25.41 ± 12.76	1.664 [t]	.098
Low	< 10	12 (16.67%)	5 (6.67%)		
Intermediate	10 - 20	20 (27.78%)	28 (37.33%)		
High	>20	40 (55.55%)	42 (56.00%)		
Quality of life	0 -100	62.38 ± 15.22	60.61 ± 15.27	.704 [t]	.482
Low	0.00 - 33.33	32 (44.44%)	36 (48.00%)		
Moderate	33.33 - 66.66	32 (44.44%)	29 (38.67%)		
High	66.67 - 100.00	8 (11.11%)	10 (13.33%)		

Note. [t] = *t*-test

Part II The Comparison of Knowledge of Diabetes, Glycemic control, Cardiovascular Risk, and Quality of Life between Baseline and 24 Weeks after Entering the Program of the Experimental and Control Groups

One hypothesis of this study was that the program stimulated a positive improvement in knowledge of diabetes score, glycemic control, cardiovascular risk, and quality of life compared to before entering the program. To examine the difference of all variables between baseline and post-test between the experimental group and the control group, the paired t-test was performed.

Prior to data analysis, all assumptions of the t-test were checked. The Kolmogorov-Smirnof test showed normal distribution. The Levene's test indicated homogeneity of variances of knowledge of diabetes, fasting plasma glucose, CHD risk, and QOL among groups. However, the null hypothesis test showed an error of equal variance of HbA_{1c}, (p = .007). Therefore, data transformation using inverse ln(x) to produce normal distribution and equal variance were performed (Mertler & Vannatta, 2002). Then, the same tests for distributions and homoscedasticity of HbA_{1c} were done. Result of the Kolmogorov-Smirnof test after data transformation indicated normal distribution of HbA_{1c}, and the Levene's test showed homogeneity of variance of both groups. Therefore, the results of assumptions testing allowed the use of paired *t*-test for this study.

Comparison of Knowledge of Diabetes between Baseline and 24 weeks after Entering the Program of the Experimental and Control Groups

At 24 weeks after entering the program, the mean scores of knowledge of diabetes in both experimental group (M = 16.25, SD = 2.41), and control group (M = 13.78, SD = 3.06) had significantly increased ($p < .001$, $p < .05$, respectively) compared to baseline (M = 13.47, SD = 2.92, M = 12.99, SD = 3.16, respectively). A significant improvement was observed. That is the participants in the experimental group had increased mean score of knowledge (D = 2.79), whereas those in the control group had slightly increased score by a half as much (D = 0.79) (see Table 6).

Table 6

Comparison of Knowledge of Diabetes between Baseline and 24 Weeks after Entering the Program of the Experimental (N = 75) and Control groups (N = 72)

Knowledge of diabetes	Baseline $M \pm SD$	24 weeks $M \pm SD$	*D*	*t*	*p-value*
Experimental group	13.47 ± 2.92	16.25 ± 2.41	2.79	7.459	.000
Control group	12.99 ± 3.16	13.78 ± 3.06	0.79	3.14	.036

Comparison of Glycemic Control between Baseline and 24 Weeks after Entering the Program of the Experimental and Control Groups

To evaluate the effects of the program on glycemic control, this study focused on fasting plasma glucose (FPG) and HbA_{1c} scores. Results showed there

was a greater significant reduction in FPG of participants in the experimental group ($D = 25.85$, $p < .001$) at 24 weeks after entering the program compared to the baseline (see Table 7). In the control group, the mean of FPG at 24 weeks after entering the program was slightly higher than that of the baseline but was not statistically significant ($D = 0.79$, $p = .473$) (see Table 7).

With regards to the change in HbA_{1c} in the original data (before data transformation), it was found that participants in the experimental group significantly showed a positive improvement of glycemic control by decreasing the mean score of HbA_{1c} ($D = 0.68\%$, $p <. 001$) from poor control ($M = 8.08$, $SD = 1.87$) to fair control at 24 weeks follow-up ($M = 7.40$, $SD = 1.2$). For the control group, there was a slight change in the mean HbA_{1c} from baseline ($M = 8.09$, $SD = 1.98$) compared to the mean at 24 weeks after entering the program ($M = 8.02$, $SD = 1.75$), but it was not statistically significant ($p = .380$) (see Table 7).

However, after analyzing transformed data, the results were still similar to that from the original data (see Table 7). These results showed that the experimental group had a significant decrease in their mean score of HbA_{1c} at 24 weeks after entering the program ($p < .001$) compared to baseline, whereas the control group did not ($p = .413$) as presented in Table 7.

Table 7

Comparison of Fasting Plasma Glucose and HbA_{1c} between Baseline and 24 Weeks after Entering the Program of the Experimental (N = 75) and Control Groups (N = 72)

Glycemic control	Baseline $M \pm$ SD	24 weeks $M \pm$ SD	*D*	*t*	*p-value*
Fasting plasma glucose (FPG)					
Experimental group	147.33 ± 41.44	121.48 ± 31.82	25.85	5.23	.000
Control group	140.34 ± 46.12	140.57 ± 36.98	-0.79	-.07	.473
HbA_{1c}					
Experimental group	8.08 ± 1.87	7.40 ± 1.25	0.68	4.19	.000
Control group	8.09 ± 1.98	8.02 ± 1.75	0.07	.31	.380
$HbA_{1c}{}^{a}$					
Experimental group	0.13 ± 0.02^{a}	0.14 ± 0.02^{a}	0.01^{a}	4.19	.000
Control group	0.13 ± 0.03^{a}	0.13 ± 0.03^{a}	0.00^{a}	-.220	.413

Note. ^{a} = data transformation

Comparison of Cardiovascular Risk between Baseline and 24 Weeks after Entering the Program of the Experimental and Control Groups

As mentioned previously, the cardiovascular risk in this study was assessed by the CHD risk (Framingham Heart Study, 1991). It was found that the mean of CHD risk in the experimental group at 24 weeks after entering the program (M = 20.58, SD = 10.98) had significantly decreased from baseline (M = 25.41, SD = 12.76)

($p < .001$). For the control group, results showed that there was a slight decrease in CHD at the 24 weeks follow-up ($M = 20.50$, $SD = 9.91$) compared to baseline ($M = 22.04$, $SD = 11.71$) but not statistically significant (p = .061) (see Table 8).

Table 8

Comparison of Cardiovascular Risk between Baseline and 24 Weeks after Entering the Program of the Experimental (N = 75) and Control Groups (N = 72)

CHD risk	Baseline $M \pm SD$	24 weeks $M \pm SD$	*D*	*t*	*p-value*
Experimental group	25.41 ± 12.76	20.58 ± 10.98	4.83	4.90	.000
Control group	22.04 ± 11.71	20.50 ± 9.91	1.54	1.55	.061

Comparison of Quality of Life between Baseline and 24 Weeks after Entering the Program of the Experimental and Control Groups

Results appeared to show that with regard to QOL, participants in the experimental group had significantly improved their QOL ($p < .001$). Comparing the change occurring over time, results revealed that the mean of QOL score increased from moderate level at baseline ($M = 60.61$, $SD = 15.27$) to high level at 24 weeks after entering the program ($M = 70.43$, $SD = 14.70$) (see Table 9). On the other hand, the control group participants had a slight decrease in their mean QOL score from 62.38 ($SD = 15.22$) at baseline to 61.71 ($SD = 14.73$) at 24 weeks (see Table 9).

Table 9

Comparison of Quality of Life between Baseline and 24 Weeks after Entering the Program of the Experimental (N = 75) and Control Groups (N = 72)

Quality of life	Baseline $M \pm SD$	24 weeks $M \pm SD$	*D*	*t*	*p-value*
Experimental group	60.61 ± 15.27	70.43 ± 14.70	-9.82	-5.90	.000
Control group	62.38 ± 15.22	61.71 ± 14.73	0.67	.475	.637

Part III The Comparison of Knowledge of Diabetes, Glycemic Control, Cardiovascular Risk, and Quality of Life between the Experimental and Control Groups at 24 Weeks after Entering the Program

Another hypothesis of this study was that the program stimulated a significant positive improvement in knowledge of diabetes, glycemic control, CHD risk, and QOL for participants in the experimental group compared to the control group at 24 weeks after entering the program. To explore further how the experimental group and the control group were affected by the treatments in terms of mean difference among knowledge of diabetes, glycemic control, CHD risk, and QOL as mentioned earlier, an analysis of covariance (ANCOVA) on post-test scores, with pre-test as the covariate was conducted to determine any difference between both groups. As a result of borderline differences of age between the experimental and control groups found at baseline (p = .053) (see Table 4.1), covariance analyses of the differences were carried out.

The assumptions of ANCOVA were tested to ensure that the requirements were fulfilled for the present study. The Kolmogorov-Smirnof test showed that data from the experimental group and the control group were normally distributed. The assumption of homogeneity of variances was tested using Box's test and Levene's test. Results showed the homogeneity of variance-covariance from Box's test. The Levene's test indicated homogeneity of variances of knowledge of diabetes, FPG, CHD risk, and QOL among groups, except for HbA_{1c}. Therefore, data transformation by using In (X) to produce normal distribution and equal variance was performed for HbA_{1c} (Mertler & Vannatta, 2002). The results of Kolmogorov-Smirnof test, and the Levene's test were not violated after data transformation. Then, the relationship existing between the dependent variables and the covariate was tested to see if it was linear. Results indicated a strong linear relationship between the covariates and dependent variables. In addition, the assumption of homogeneity of regression for covariates and the dependent variables was also tested. Results indicated that the assumption of homogeneous regression slopes were tenable. Therefore, results of assumptions testing allowed use of ANCOVA for this study.

Comparison of Knowledge of Diabetes between Participants in the Experimental and Control Groups at 24 Weeks after Entering the Program

The differences of diabetic knowledge between groups were analyzed. Pretest scores of knowledge and age was entered as covariates. The result from ANCOVA analysis revealed that after controlling for baseline levels of diabetic knowledge and age, there was significant difference in knowledge of diabetes at 24 weeks follow-up, with the experimental group participants achieving a greater

increased knowledge than those who were in the control group with small effect, $F(1,143) = 36.84, p < .001, \eta^2 = .114$ (see Table 10).

Table 10

Comparison of Knowledge of Diabetes between Participants in the Experimental and Control Groups at 24 Weeks after Entering the Program (N=147)

Source	*SS*	*df*	*MS*	*F*	*p-value*	η^2
Between group	219.25	1	219.25	36.84	.000	.114
Covariate						
pre-knowledge	109.97	1	109.97	18.48	.000	
age	41.57	1	41.57	6.99	.009	
Residual	851.05	143	5.95			
Total	1294.83	146				

Comparison of Glycemic Control between Participants in the Experimental and Control Groups at 24 weeks after Entering the Program

As mentioned earlier, in this study, the glycemic control was assessed by level of FPG and HbA_{1c}. ANCOVA, controlling for baseline values and age, indicated a statistically significant difference in FPG and HbA_{1c} between people in the experimental group and the control group. Compared to the participants in the control group, the FPG in the experimental group was significantly lower than control participants with small effect, $F(1,143) = 16.23, p < .001, \eta^2 = .104$ (see Table 11).

With regards to the HbA_{1c}, results of ANCOVA revealed that the experimental group had a greater significant decrease in original HbA_{1c} than the control group with small effect, F (1,143) = 7.43, $p < .01$, $\eta^2 = .049$ at 24 weeks after entering the program (see Table 11). Additionally, after data were transformed, the HbA_{1c} in the experimental group was also significantly lower than control subjects with small effect, F (1,143) = 6.19, $p < .05$, $\eta^2 = .041$, respectively at post-test. The results obtained revealed that the program produced significantly positive effect on glycemic control assessed by fasting plasma glucose and HbA_{1c} level (see Table 11).

Table 11

Comparison of Glycemic Control between Participants in the Experimental and Control Groups at 24 weeks after Entering the Program (N=147)

Source	*SS*	*df*	*MS*	*F*	*p-value*	η^2
FPG	14949.04	1	14949.04	16.23	.000	.102
Between group						
Covariate						
pre-FPG	34231.92	1	34231.92	37.16	.000	
age	1677.84	1	1677.84	1.82	.179	
Residual	131733.10	143	921.21			
Total	185520.52	146				

Table 11 *(Continued)*

Source	*SS*	*df*	*MS*	*F*	*p-value*	η^2
HbA_{1c}						
Between group	12.797	1	12.797	7.426	.007	.049
Covariate						
pre- HbA_{1c}	80.939	1	80.939	49.965	.000	
age	.362	1	.362	.210	.647	
Residual	246.444	143	246.444			
Total	9071.710	146				
HbA_{1c} transformation						
Between group[a]	.003[a]	1	.003[a]	6.19[a]	.014	.041
Covariate						
pre-HbA_{1c}	154.22	1	154.22	39.47	.000	
age	0	1	0	0.73	.395	
Residual	562.45	143	0			
Total	752.95	146				

Note. [a] = data transformation

Comparison of Cardiovascular Risk between Participants in the Experimental and Control Groups at 24 weeks after Entering the Program

To compare the difference of CHD risk between the control group and experimental group at post-test, the pre-tested CHD risk and age were analysed as covariates. Results of ANCOVA showed a statistically significant difference in CHD risk between the experimental group and the control group, with the experimental group participants achieving a greater decrease than those who were control groups

with small effect, $F(1,143) = 6.17$, $P < .05$, $\eta^2 = .041$. These data showed that the program produced a significant positive effect on decreasing CHD risk as showed in Table 12

Table 12

Comparison of Cardiovascular Risk between Participants in the Experimental and Control Groups at 24 Weeks after Entering the Program (N=147)

Source	*SS*	*df*	*MS*	*F*	*p-value*	η^2
Between group	243.95	1	243.95	6.17	.014	.041
Covariate						
pre CHD risk	3716.52	1	3716.52	93.99	.000	
age	868.59	1	868.59	21.97	.000	
Residual	5654.51	143	39.54			
Total	15893.24	146				

Comparison of Quality of Life between Participants in the Experimental and Control Groups at 24 weeks after Entering the Program

Results of the ANCOVA on the score of QOL using the pre-test QOL and age as covariates presented that people who participated in the experimental group show a significantly increase in their mean score than those who were control group with small effect, $F(1,143) = 24.05$, $p < .001$, $\eta^2 = .144$ as presented in Table 13.

Table 13

Comparison of Quality of Life between Participants in the Experimental and Control Groups at 24 Weeks after Entering the Program (N=147)

Source	*SS*	*df*	*MS*	*F*	*p-value*	η^2
Between group	3314.98	1	3314.98	24.05	.000	.144
Covariate						
pre-QOL	11285.01	1	11285.01	81.85	.000	
age	28.10	1	28.10	0.20	.652	
Residual	19715.19	143	137.87			
Total	34178.23	146				

Discussion

The main purpose of this study was to evaluate the effectiveness of the diabetes self-management program on knowledge of diabetes, glycemic control, cardiovascular risk, and quality of life among adults 35 years of age and older with uncontrolled type 2 diabetes. Results from this study revealed that participants in the experimental group had greater significantly increase in knowledge of diabetes ($p < .001$), improvement of glycemic control (decreasing in FPG and HbA_{1c}; $p < .001$, $p < .001$, respectively), decrease in CHD risk ($p < .001$), and increase in QOL ($p < .001$) at 24 weeks after entering the program. In addition, participants in the experimental group had a greater significant increase in knowledge of diabetes, decrease in FPG, HbA_{1c}, CHD risk, and increase in QOL ($p < .001$, $p < .001$, $p < .05$, $p < .05$ and $p < .001$, respectively) at 24 weeks after entering the program than those in the control group.

With the aims of assessing the effectiveness of the diabetes self-management program, findings from an analysis of covariance confirmed the beneficial effects of this intervention program since it promoted significant change in different outcome variables as mentioned earlier. On the basis of the conceptual framework used in this study, the results proved that people with type 2 diabetes who received diabetes education and specific skill training stimulated by the program increased their knowledge of diabetes as well as the self-efficacy for realistic personal goal setting, actions to control illness, monitoring progress, and making adjustment to attain goals. Since the self-efficacy increased, appropriate self-management behaviors including goal setting, self-management to disease control, sign and symptom-monitoring,

decision making and problem-solving also increased. Therefore, the program promoted the success in improving glycemic control, decreasing CHD risk, and increasing QOL

The remarkably increased in knowledge of the experimental group participants may be due to well designed activities of the diabetes self-management program. The three specific program activities incorporated knowledge and skill practices including: one small group diabetes education class; four small group discussions and specific skill practicing on their own care; and two individual home visiting sessions. In addition, the researcher promoted regular contact during conducting the intervention, and was available for consultation by phone. Both group education and individual education were used in this study. Teaching people in groups has been seen as an effective intervention for diabetes education (Mensing & Norris, 2003). Individual education also showed effectiveness in improving patients' knowledge. Both group education and individual session are superior to other methods in increasing knowledge and are associated with a significant improvement in patients' level of activities (Wilson, 1993). Also small group discussion allows participants to ask questions they might have regarding their disease. Using group education, small group discussion, and individual sessions in this study, therefore, made the participants increase more knowledgeable.

Findings from the present study are congruent with a study of Brown et al. (2002), who conducted a health education program using instructional and support group for type 2 diabetic patients attending at diabetic clinic. Results reported that their intervention showed statistically significant increase in means of knowledge. Findings are also consistent with results from the education program of Rettig, Shrauger, Recker, Gallagher, and Wiltse (1986), which their program showed significantly greater

knowledge (p = .001) in the experimental group. The similar results support the benefit of group education, home visiting and individual health education.

However, it was found that findings from this study are incongruent with that of Raz, Soskolne, and Stein (1988), who conducted a small group education in patients with type 2 diabetes and the results failed to show significant increase in knowledge of diabetes. A possible reason to explain a different result is that the previous study use different method compared to the present study. The previous study used only a small group education, whereas the program in the present study carried out strategies that enhance learning including sharing experience in group discussion, use of written materials, practice sessions, modeling, and face to face discussion at home. Using a combination of variety of methods were well documented to enhance the amount of information the older people retain (Mensing & Norris, 2003). The finding, therefore, confirms the benefit of using multiple educational methods in this study.

Another finding regarding knowledge in this study was that the control group also significantly increased their knowledge compared to baseline. Knowledge gained in the control group may be due to the diabetes education routinely provided by physicians, nurses, dietitians, pharmacists, and other health care providers during waiting for treatment at the diabetic clinic. Another reason might be the dissemination of knowledge from the experimental participants to control participants. After randomizing the participants into the experimental and control groups, it was found that many of them were relatives. Although the random sampling divided them into different groups, some participants in the experimental group still shared new information they gained from classes to their relatives in the control group. In addition, normally people in rural area are always friendly and generous. Therefore,

sharing information and experience with other people is common, especially if the information is found to be beneficial to others. This fact may have increased the possibility of increasing knowledge in the control group in this study.

According to the glycemic control, results showed that the experimental group significantly decreased FPG and HbA_{1c} compared to baseline and the control group at 24 weeks after entering the program. Mechanisms underlying the improvements of FPG and HbA_{1c} in the present study could be due in part to the increased self-efficacy in self-management behaviors of the program. Many studies demonstrated strong relationship between self-efficacy and targeted behaviors (Anderson et al., 2000; Howells, 2002; Sturt, Whitlock, & Hearnshaw, 2005). The intervention used in this study was planned to promote self-efficacy in realistic personal goal setting, actions to control illness, monitoring progress, and making adjustment to goal attainment which are the major factors relating to disease control behaviors. As Bandura (1977, 1984, 1986) stated that sources of self-efficacy are formulating action plans, skill mastery, vicarious experience, persuasion, and physiological and emotional arousal, all sources were planned in the project intervention. The four small group discussions were designed to promote skill mastery. Participants were trained to undertake self-management skills and practice specific actions for controlling diabetes as mention earlier. In addition, the successes of other patients in performing appropriated self-management behaviors were used as role models to enhance self-efficacy. Those participants shared their experiences with the group and explained how they could modify their skilled behavior. Participants were also taught to make lifestyle change and trained how to monitor their signs and symptoms. They participated in practicing recording their blood glucose, blood pressure, blood lipids,

and problems that they found during changing their behaviors in their manual. Also, they were taught how to interpret the results and evaluate their disease control. Importantly, throughout the small group discussion, participants discussed barriers to change behaviors for attaining glycemic control goals. Group persuasion and reinforcement were promoted by the researcher to eliminate their barriers.

The individual home visit session allowed the researcher to contact each participant individually, and became more deeply focused on their problems. At the same time, participants had the opportunity to gain more self-awareness and also understanding of their problems and its management. Participants were encouraged to solve their own problems, anticipate their obstacles, and maintain new behaviors. These methods aimed to encourage and empower participants to have more confidence in their abilities to deal with their diabetes. Since the diabetes self-management intervention was promoted, it increased participants' belief in their ability to undertake new behaviors as mentioned previously. Diabetes self-management confidence included the belief in realistic personal goal setting, action to control illness and monitoring progress, and making adjustment to goal attainment. It resulted in increasing participant's abilities to follow proper diabetes control behaviors including managing their daily life with disease management and targeting initial behavior change, as well as persisting with change. These behaviors included goal setting behaviors, self-management behaviors to control illness, symptoms monitoring, and decision making which if they were performed regularly, it resulted in improving glycemic control by decreasing FPG and HbA_{1c}. These results confirmed that belief in one's ability to perform a behavior is an important link between knowing what to do and actually doing it that could lead to improve outcomes (Bandura, 1982).

Results from group discussion and home visits revealed that since the program was implemented, participants in the experimental group verbalized an intention to change their behaviors for attaining targeted disease control. *The tree of success in glycemic control* was created to guide goal setting and lead participants toward developing a personal action plan. The researcher informed participants to evaluate their level of blood glucose control by using the symbol as follow: *green leaf* indicated good control (FPG 90-130 mg%, or HbA_{1c}. < 7%), *yellow leaf* indicated not good and caution (FPG = 131-180 mg%, or HbA_{1c}.7-8%), and *red leaf* indicated poor control and a crisis that required regaining control (FPG >180 mg%, or HbA_{1c}. > 8%). It was found that participant correctly chose the leaf that presented his/her level of blood glucose and developed a plan for new behaviors as well as chose the desirable leaf for the next visit. Regarding self-management to control illness and monitoring, participants recorded what behaviors they have changed as well as signs and symptoms in the patient manual and shared with others in group discussion session. Also, participants made decision and adjusted their planned behaviors. The revised goal was written in the patient manual and shared in group discussion.

The increased self-efficacy of participants from the program was demonstrated by the qualitative data obtained during small group discussion. The open ended question, beginning with *" what do you think about your confidence that you can...?"* were used to gather data. Most participants (68 people, 90.67%) reported that they had more confidence to manage their diabetic control behaviors and to make decision about what they should do during having signs and symptoms of complications since they have been given diabetic education and participate in a small group discussion class. Only seven participants (9.33%) explained that they were still uncertain about

their ability to manage diabetes although they believed that they could achieve new behaviors because they concerned that their fasting plasma glucose still had not decreased to a normal level.

Although the behavioral change was not evaluated by quantitative tool in the present study, results from qualitative data showed that program underlying self-management education increased patients' knowledge, self-efficacy in self-management, and behavioral changes. Therefore, the findings confirmed the study conducted by Sturt, Whitlock, and Hearnshaw (2005) that promoting self-efficacy resulted in a mean reduction in participants' glycosylated hemoglobin for type 2 diabetic patients.

Findings in the present study are congruent with the study of Milenkovic, Gavrilovic, Percan, and Petrovski (2004), using group education method and interactive approach and the study of Karter et al. (2001), using self-monitoring of blood glucose. Their results showed significant reduction in mean of HbA_{1c}. The present study's results were also consistent with those of instructional education and group session conducted by Brown, Kouzekanami, Garcis, and Hanis (2002) that showed significant decrease in HbA_{1c} and FPG. These previous studies also focused on enhancing behavioral change as well as self-monitoring of blood glucose. Thus, findings support the notion that group education and self-monitoring of blood glucose significantly associated with better glycemic control (Guerci et al., 2003; Schwedes et al., 2002).

In this study, the results showed an inconsistency with other studies using self-management strategies in Thai samples, for example, Keeratiyutawong et al. (2006) who conducted a study on the effectiveness of a self-management program for Thai adults with type 2 diabetes by focusing on improving cognitive process and

skills in diabetes care and using variety methods of teaching education in a 6 months period. Also, they provided a telephone call to participants at three and five months. However, their results failed to show significant decrease in HbA_{1c}. Compared with the present study, Keeratiyutawong et al.'s study did not focus on self-efficacy enhancement while the present study did. Increased self-efficacy help participants initiate and maintain appropriate diabetic control behaviors, therefore, it can decrease HbA_{1c}.

An important point in the present study is that although findings showed significant difference in decreasing of HbA_{1c} in the experimental group after entering the program 24 weeks compared to baseline, the mean decrease of HbA_{1c} (0.68%) failed to show clinical significance in HbA_{1c} decrease recommended by the United Kingdom Prospective Diabetes Study (UKPDS) 35 (1% reduction, Stratton et al., 2000). A possible explanation for not achieving goal is the change of treatment during implementing the intervention program. There were some participants in the experimental group who were decreased the dosage of hypoglycemic agent (8 people, 5.44%), and four of them (40%) were decreased the dosage twice. The reason for decreasing the dose of hypoglycemic drugs is that after entering the program, their plasma glucose reached near normal limit. Two of them were changed the treatment of hypoglycemic agent from combined drugs to single drug. Furthermore, one of the participants had taken steroid because of another disease. Taking steroid made her blood sugar level getting higher than normal. These factors might affect the mean of HbA_{1c} at 24 weeks. Nevertheless, the mean decrease of HbA_{1c} in the present study was greater than that in the study of Keeratiyutawong et al. (2006) in which the average change of HbA_{1c} was 0.37% (S.D. = 2.17) at six months. It was also higher

than what reported by Norris et al. (2002), who conducted a meta-analysis on the effect of self-management education intervention for adults with type 2 diabetes. They reported an average decrease of HbA_{1c} of 0.26% (0.05-0.48%) at ≥ 4 months of follow-up interventions.

Another important finding is that a substantial reduction in CHD risk was achieved ($p < .05$) from application of the diabetes self-management program. Even in participants in the experimental group who had poor glycemic control (HbA_{1c} 8.09%) at baseline, there was a further significant reduction of CHD risk (4.83%, $p < .001$) after enrolling the program. Regarding CHD risk factors, it was found that most participants in the experimental group had decreased levels of total cholesterol, Triglyceride, LDL cholesterol, diastolic blood pressure, and BMI and had a greater increase in HDL cholesterol compared to the control group, although numbers of participants who were treated by lipid lowering drug in the control group were greater than those in the experimental group (31 people VS 24 people). Only systolic blood pressure showed less decrease than the control group (see in appendix G). In addition, results reported that the men in the experimental group who reached the goal of HDL > 40 mg/dl increased from 48.00% at baseline to 69.30% and women who reached the goal of HDL > 50 mg/dl increased from 17.30% to 28.00% after entering the program. Importantly, it was found that the participants in the experimental group who could reach the goal of total cholesterol < 200 mg/dl without treatment of lipid lowering drug increased from 21.80% at baseline to 25.20% at 24 weeks, whereas those in the control group showed a decrease from 25.20% to 23.10% (see Appendix G).

The promising result in this study demonstrated the effectiveness of self-management program in modifying risk factors for coronary heart disease. The

qualitative data from interviewing participants during individual discussion at home visits showed that most participants changed their diabetes management behaviors, especially dietary control and exercise in order to attain glycemic control goals since they participated in the intervention program. Thirty nine people (52.00%) reported that they had high confidence in making appropriate food choice. Eleven participants (14.67%) absolutely stopped eating dessert, 37 (49.33%) decreased the quantity of dessert consuming, 38 (50.67%) avoided eating a high lipid diet, 22 (29.33%) absolutely stoped eating a high lipid diet, and 22 (29.33%) avoided eating a salty diet. In addition, 24 participants (32%) reported that after participation in the program, they do exercise everyday. Twenty seven participants (34.62%), who occasionally exercised, increased exercise to at least 4-5 times a week. Some participants increased the frequency of exercise to 3 times a week (22, 29.33%) (see Appendix G). It can be concluded that the intervention program that promoted behavior changes by increasing appropriate food choice and proper physical activities can not only improve glycemic control, but also decrease CHD risk factors and CHD risk.

Findings showed inconsistent results from a prior study, a computer assisted diabetes self-management intervention conducted by Glasgow and Toobert (2000), in which the intervention could decrease total cholesterol, but not ratio of total cholesterol to HDL cholesterol in adults with type 2 diabetes. The present study also showed different results from the study of Schwedes et al. (2002) in which their program could not reduce total cholesterol and body mass index. It also differed from the study of Toobert et al. (2003) in which comprehensive lifestyle self-management intervention could not decrease triglyceride and increase HDL cholesterol in post menopausal woman with type 2 diabetes. Inconsistent findings may be due to the

different intervention used. The previous studies used a computer assisted program, structure education program, and comprehensive lifestyle program, whereas the present study used small group discussion and individual education which are effective in promoting positive health outcomes (Rickheim,Weaver, Flader, & Kendall, 2002).

Regarding QOL, it was found that the diabetes self-management program significantly improved the QOL of the participants ($p < .001$). In this study, QOL was assessed in terms of physical-psychosocial functioning that included physical activity, social activity, role activity, bodily pain, general mental health, usual role activity, vitality, and general health perception. These domains associated with participants' perception with regard to ability in diabetic control and their views about their health as well as how well they are able to do usual activities. As QOL could result from symptom control, the participants in this study increased their confidence in managing their illness and their abilities in diabetic control. From good controlling of blood glucose, the symptoms were reduced. The decrease of stress illness and symptom burden resulted in increasing QOL. In addition, the positive improvement of glycemic control, blood pressure control, CHD risk factors encouraged participants to have more confidence in performing all activities and roles like other healthy people did. As reported in previous study, Thai patients with diabetes who perceived diabetes as a serious disease which had higher impact on their lives perceived low level of life satisfaction (Puavilai, 1996). On the other hand, findings in the present study revealed that participants in the experimental group perceived positive outcomes in their health and functional status which resulted in satisfaction in daily life, therefore, their quality of life increased.

Findings in this study are congruent with other previous studies conducted by Kirk et al. (2001) using the exercise consultation program to enhance QOL of participants and Toobert et al. (2003)'s study using a comprehensive life style program including dietary habit, physical activity/ exercise, smoking cessation, and stress management in a sample of menopausal women with type 2 diabetes. However, the present study showed inconsistency with the study of Taylor et al. (2003) who conducted a randomized controlled trial to test the effectiveness of a nurse case management program in a group of diabetic patients with chronic complications. The researcher found that their program could not increase QOL of participants. The inconsistent findings may be due to the different treatment and intensiveness of the intervention.