Original Article

A Community-Based Lifestyle Modification for Prevention Diabetes in Pre-Diabetes: A Quasi-Experimental Study

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Objective: A quasi-experimental study, pretest-posttest design, was applied to assess the effects of the lifestyle modification programs [LMPs] on health behaviors, capillary plasma glucose [CPG], and nutritional status in pre-diabetes.

Materials and Methods: Eighty-one subjects with pre-diabetes meeting inclusion criteria during community survey by Diabetes Ambassador Youth Student were included in this study. The multi-sites study was conducted and allocated different LMPs specially exercise assignment to three communities, 28 subjects from Mahasawat Sub-district, 30 subjects from Khlongyong Sub-district, and 23 subjects from Khanonnae Sub-district. The demographic information, health behaviors factors, CPG, body mass index [BMI], and waist circumference were recorded, and analyzed using descriptive statistics, paired t-test and ANOVA.

Results: After the LMPs, participants from Mahasawat had statistically significant higher scores for food consumption and exercise behavior than before the program (p-value <0.05, and <0.01, respectively). Participants from Khlongyong Sub-district had statistically lower average CPG (p-value <0.05) and BMI (p-value <0.01) than before the program. Participants from Khanonnae Sub-district had statistically higher scores for food consumption (p-value <0.05) and exercise behavior (p-value <0.01), and lower BMI (p-value <0.05). When compared with before the program. The mean score of health behaviors, exercise aspect, stress management, and CPG were statistically significant different (F = 11.54, p-value <0.001; F = 11.34, p-value <0.001; F = 5.25, p-value <0.01; and F = 3.82, p-value <0.05, respectively). Thus, different activities in the LMPs had differently effects on health behaviors, CPG, and BMI.

Conclusion: The LMPs demonstrated improving of health behaviors, CPG, and BMI. It should be recommended to integrate with conventional method and education when pre-diabetes condition is recognized. It is a promising adjunct method to obviate pre-diabetes as well as diabetes and its complications in future.

Keywords: Lifestyle modification programs, Pre-diabetes, Health behaviors, Diabetes, Food consumption, Exercise behavior

J Med Assoc Thai 2018; 101 (3): 297-304
Website: http://www.jmatonline.com

Diabetes is not only a health crisis but also a global societal catastrophe in the twenty-first century being expected to continually rise in people aged 20 to 79 years, from 425 million in 2017 to 629 million in 2045, and have five million adults dying from diabetes. One in 11 adults has diabetes and one in two adults with diabetes is undiagnosed. Simultaneously, prevalence rate of diabetes in South East Asia is predicted to increase 84% from 82 million adults in 2017 to 151 million adults in 2045[1]. Similarly in Thailand, data from the fifth National Health Examination Survey indicated that the prevalence of diabetes in people aged 15 years and older was equal 8.9%[2]. The admission rate of patients with diabetes was found to increase from 795.04 per 100,000 people in 2007 to 1,233.35 per 100,000 people in 2015[3]. It has been projected that approximately 212.4 million people or half of people aged 20 to 79 years living with diabetes are undiagnosed, increasing the risk of developing diabetic complications[1].

Pre-diabetes is global and has affected approximated 212.4 million people or half of all people 20 to 79 years that have diabetes. It can damage all nerves and blood vessels, especially in vital organs, causing many complications such as cardiovascular diseases, neuropathy, retinopathy, and nephropathy[1]. This can lead to mental and socio-economic problems causing disability-adjusted life years [DALYs] loss. It also increases the mortality rate of diabetes from 12.21 per 100,000 population in 2007 to 17.83 per 100,000 population in 2015 in Thailand[4]. The mean

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How to cite this article: Terathongkum S, Wangpitipanit S, Kraithaworn P, Vallibhakara SA. A community-based lifestyle modification for prevention diabetes in pre-diabetes: a quasi-experimental Study. J Med Assoc Thai 2018;101:297-304.

expenditure spent on diabetes has been estimated to be 310 US dollars per person[1]. Therefore, it is essential to implement a prevention plan for the people with pre-diabetes to manage and control blood sugar to the normal range.

Numerous randomized controlled trials from different parts of the world have confirmed that lifestyle modification program [LMP] including physical activity and/or healthy diet is able to postpone or prevent the onset of type 2 diabetes[1]. It has been shown that nutritional control and performing exercise for at least 30 minutes a day leading to weight reduction by 6% decreased the incident rate of diabetes by 40% to 60%[5]. Thus, programs purposing to lessen the risk behaviors of pre-diabetes groups are necessary. Many studies have reported that after receiving the LMPs, including diabetic education, group discussion, and home visit or telephone follow-up, from eight weeks to one year, participants have shown a significant enhancement of health behavior, decrease in body mass index [BMI], waist circumference, and blood glucose levels when compared with before the program[6-8]. However, there are limited studies in persons with pre-diabetes including the lifestyle modification participation plan in their context and the use of only one group pre-posttest design. Therefore, it is essential to integrate the LMPs in pre-diabetes context.

Mahasawat Sub-district and Khlongyong Sub-district, Nakhon Pathom Province and Khanonnae Sub-district, Phra Nakhon Si Ayutthaya Province are rural-urban communities in the middle part of Thailand. Those communities have policy to prevent diabetes that is following the Ministry of Public Health recommendations. Unfortunately, most people still have high-risk behaviors including consuming sugars and fats as well as doing little exercise resulting in developing chronic diseases, especially diabetes. Therefore, it is important that the LMPs based on Bandura's self-efficacy Theory emphasizing community participation should be accomplished in persons with pre-diabetes. It believed that if people are mindful that they have the potential to manage and obtain the expected outcome, they will decide to perform healthy behaviors leading to the anticipated outcomes. Thus, if persons with pre-diabetes believe that they can do worthy health behaviors and expect to be successful in preventing diabetes, they will perform that health behaviors to prevent the disease. Perception of self-efficacy can be developed from four resources namely, 1) enactive mastery experience, 2) vicarious experience, 3) verbal persuasion, and 4) physiological and affective stages[9]. Thus, researchers are interested in studying the effects of the LMPs on health behaviors, capillary plasma glucose [CPG], and nutritional status (body mass index and waist circumference) in pre-diabetes using community participation via Diabetes Ambassador Youth (students practicing in Community Health Nursing Practicum, Bachelor of Science in Nursing, Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Thailand). To do this, they will built and provide the activities consisting of diabetes education, group discussion, and home visits and/or telephone follow-ups to inspire participatory problem-solving resulting in permanent behavioral changes and blood sugar control.

Material and Method

A quasi-experimental research design at three multisite pretest-posttest was conducted. The population of the study consisted of persons with pre-diabetes living in Mahasawat or Khlongyong Sub-district, Nakhon Pathom Province and Khanonnae Sub-district, Phra Nakhon Si Ayutthaya Province between October and November 2014. Those settings were initiated on the field study of the Diabetes Ambassador Youths as research assistances.

The inclusion criteria consisted of persons having diabetes risk score of 6 or more[10], aged 18 years up, able to perform exercise, able to communicate in Thai, giving permission for telephone visit or home visit, and signed the informed consent form. The exclusion criteria were subject who were being hospitalized during the study that affected the assigned intervention, or changing address and were unable to continue performing the intervention.

After the community survey, the persons that had a high-risk score of diabetes were classified as pre-diabetes. Thirty eligible participants with pre-diabetes in each community were enrolled into the study. During data collection, participants were withdrawn if they moved to another province, were admitted to the hospital, or were uncomfortable with the exercise. Thus, 81 eligible participants remained in the study, including 28 from Mahasawat Sub-district, 30 from Khlongyong Sub-district, and 23 from Khanonnae Sub-district.

The evaluation instruments used in the present study consisted of three LMPs integrated with the Bandura's self-efficacy for eight weeks and instruments for data collection. The intervention programs, developed by the researchers and their

research assistants, based on a review of literature integrating with Bandura's perceived self-efficacy theory, consisted of diabetic education and health behavior modification, exercise assignment at home for 30 minutes, three times a week, group discussions for sharing experience and solving their exercise problems at the fourth and eighth week, and home visits and telephone follow-ups at the second and sixth week. Those activities used different methods depending on the setting as shown in Figure 1.

The evaluation questionnaires for data collection were divided into six domains group. The demographic questionnaire consisted of age, gender, marital status, education, occupation, and average monthly income, family history for diabetes, personal illness, alcohol consumption, smoking habits, and diabetes risk score.

The diabetic risk score[10] consisting of age, BMI, waist circumference, blood pressure, and family history for diabetes. The score ranged between 0 and 17. Participants with a score of 6 or higher were in the high-risk group, stated as persons with pre-diabetes in this study.

The Health Behavior Questionnaire [BHQ] adopted from Winvat[11] consisted of 36 items divided into three aspects including food consumption (14 items), exercise (10 items), and stress management (12 items). Each item was assessed on a Likert-type scale from 0 to 4, where "0 = never/ no" and "4 = always" with the total possible score from 0 to 144 points. Higher scores indicated higher good health behavior for preventing diabetes, while a lower score meant lower health behavior for preventing diabetes. Sixty percent cut off point was used as a criterion for the total health behavior and its aspects. Cronbach's alpha demonstrated an acceptable reliability of 0.75, and 0.73 for this study.

The objective measurements CPG and nutritional status parameters including BMI and waist circumference were measured to objectively reflect the LMPs at baseline and eight weeks later.

Data collection

This study was approval by the Institutional Review Board [IRB], Faculty of Medicine Ramathibodi Hospital, Mahidol University, Thailand (IRB 2014/371) and participants, received written and verbal explanations, learnt of the objectives, methods, risks, benefits, and the right to withdraw from the study at any time throughout the study, signed the informed consent form. Data was collected by the assistant researchers (Diabetes Ambassador Youth). At baseline assessment

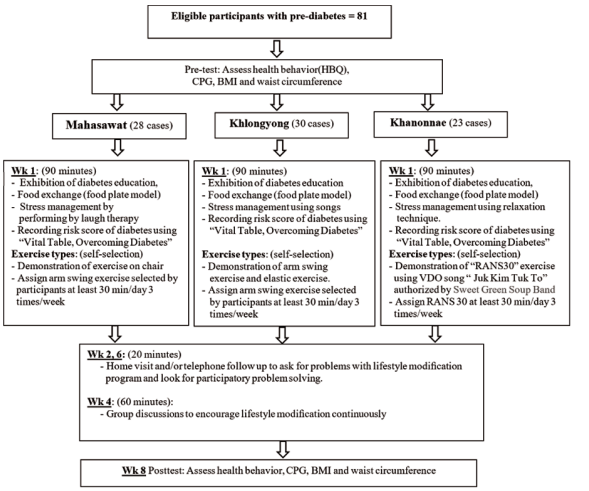

Figure 1. Flow of lifestyle modification programs integrated with the Bandura's self-efficacy among 3 multisite, Mahasawat Sub-district and Khlongyong Sub-district, Nakhon Pathom Province and Khanonnae Sub-district, Phra Nakhon Si Ayutthaya, Thailand.

at the first week, all participants were asked to provide the demographic information and the health behaviors by HBQ. The participants were also examined for CPG, BMI, and waist circumference. Next, the participants received the program for eight weeks depending on the setting (Figure 1). Data were obtained after finishing the program at the eighth weeks as at the baseline. The data was kept strictly confidential and only reported overall data.

Statistical analysis

The descriptive statistics, including means ± standard deviation [SD], frequency (n), and percent (%), were used to explain the demographic data and all dependent variables. Paired t-test or Wilcoxon matched signed-rank test was used to compare the health behavior scores depending on distribution of dependent variables such as CPG, BMI, and waist circumference before and after the program within group. The analysis of variance [ANOVA] and the least significant difference [LSD] were used to compare among groups. All Statistical analysis was performed using IBM SPSS Statistic 21 Software (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.).

Results

Eighty-one pre-diabetes persons were randomly enrolled and divided into three groups, 28 from Mahasawat Sub-district, 30 from Khlongyong Sub-

district, and 23 from Khanonnae Sub-district, mean age were 60.96 (SD 10.34), 64.73 (SD 8.59), and 50.74 years old (SD 9.53), respectively. Most of them were female (60.7%, 66.7%, 100%,) and married (75.0%, 63.3%, 87.0%).

Most participants from Mahasawat Sub-district and Khlongyong Sub-district completed primary school education (50.0% and 80.0%, respectively), while participants from Khanonnae Sub-district completed high school (52.2%). Most participants from Mahasawat Sub-district had no job (64.4%), whereas participants from Khlongyong and Khanonnae Sub-district were agriculture and employee (36.7% and 34.8%, respectively). The family income was approximately 14,156 baht (SD 10,481), 5,412 baht (SD 4,994), and 10,281 baht per month (SD 11,661). Most participants from Khlongyong and Khanonnae Sub-district had family history of diabetes (66.7% and 65.2%, respectively) and personal illness (73.3% and 56.5%) such as hypertension and dyslipidemia. Most participants had no alcohol consumption (71.4%, 96.7%, and 100%) and non-smoking (89.3%, 96.7%, and 100%, respectively). Besides, average diabetic risk score had closely 10 in Khlongyong and Khanonnae Sub-district (SD 2.53 and 2.27, respectively) (Table 1).

Before receiving the LMPs, the mean score of health behaviors were at high level among three communities (88.82±12.40, 85.50±13.94, and 86.91 ±11.57, respectively), while participants' mean score of nutrition aspect from Mahasawat and Khlongyong

Table 1. Baseline characteristic in persons with pre-diabetes (n = 81)

Items	Mahasawat (n = 28) (%)	Khlongyong (n = 30) (%)	Khanonnae (n = 23) (%)
Age (year), mean (SD)	60.96 (10.34)	64.73 (8.59)	50.74 (9.53)
Ranges (min to max)	43 to 85	46 to 85	22 to 68
Gender			
Male	39.3	33.3	-
Female	60.7	66.7	100
Marital status			
Single	10.7	10.0	13.0
Marriage	75.0	63.3	87.0
Widowed/divorced	14.3	26.7	-
Education			
No education	3.6	6.7	-
Primary school	50.0	80.0	39.1
High school	32.1	10.0	52.2
Bachelor's degree or higher	14.3	3.3	8.7
Occupation			
Unemployed	64.4	26.7	34.8
Government	7.1	10.0	8.7
Agriculture	7.1	36.7	8.7
Employee	14.3	10.0	34.8
Merchant	7.1	16.7	13.0
Family income (Baht per month), mean (SD)	14,156.52 (10,481.32)	5,412.67 (4,994.51)	10,281.25 (11,661.86)
Ranges (min to max)	600 to 38,800	600 to 20,000	2,000 to 48,000
Family history of diabetes			
Yes	57.1	33.3	34.8
No	42.9	66.7	65.2
Personal illness			
Yes	50.0	26.7	43.5
No	50.0	73.3	56.5
Alcohol consumption			
Yes	28.6	3.3	-
No	71.4	96.7	100
Smoking			
Yes	10.7	3.3	-
No	89.3	96.7	100
Diabetic risk score, mean (SD)	10.57 (2.99)	9.77 (2.53)	9.57 (2.27)
Ranges (min to max)	6 to 17	6 to 17	6 to 15

Sub-district were at low level (32.21±3.68 and 33.47 ±4.31, respectively) as well as mean score of stress management (28.07±5.96, 26.33±7.02, and 27.17±6.20, respectively). Besides, average CPG was higher stated as pre-diabetes (113.68±19.01, 109.70±14.43, 102.65 ±12.93 mg%, respectively), BMI was also higher than criteria (26.62±3.94, 25.76±3.89, and 27.47±4.28 Kg/m^2, respectively), and waist circumference were higher than height divided by two (91.68±7.01, 86.50±8.14, and 87.76±8.83 cm, respectively) (see Table 2).

After LMP participants from Mahasawat and, Khanonnae Sub-district had statistically significant higher scores for food consumption behavior (t = -2.56, *p*-value <0.05) and improved on exercise aspect t = -2.88, *p*-value <0.01) than before implement of intervention, respectively. Participants from Khlongyong Sub-district had statistically significant to lower average CPG (t = 2.11, *p*-value <0.05) and BMI (t = 2.86, *p*-value <0.01) when compared with before the applied LMPs. Participants from Khanonnae Sub-district also had statistically lower BMI (t = 2.65, *p*-value <0.05) when compared with before the program (Table 2).

After the LMP, both behavioral and objective goal were significantly changed, which consisted of the mean score of health behaviors, exercise aspect, stress management, and CPG, which were statistically significant different (F(2, 78) = 11.54, *p*-value <0.001; F(2, 78) = 11.34, *p*-value <0.001; F(2, 78) = 5.25, *p*-value <0.01, F(2, 78) = 3.82, *p*-value <0.05, respectively) (see Table 3, 4).

Discussion

The results revealed that after the LMPs the participants had statistically significant higher scores of food consumption behavior and exercise aspect as well as lower average of CPG and BMI when compared with before the program meaning that the LMPs aided to improve the health behaviors resulting in decreased risk among pre-diabetes subjects especially with CPG and BMI. These outcomes resulted from participants receiving the LMPs integrating with Bandura's Self-efficacy theory[9] in their context resulting in continuously performing exercise. Besides, Stanford, and Goodyear[12] stated that exercise acts as an insulin-like effect assisting to augment glucose uptake in skeletal muscle by moving glucose transporter 4 [GLUT4] from the intracellular location to the plasma membrane leading to improving insulin sensitivity and reducing insulin resistance.

Moreover, both exercise methods including the arm swing exercise and RANS30 in the LMPs were classified as moderate aerobic exercise assisting to use glucose and stimulate blood circulation resulting in sweating and stretching as well as relaxing tendon and muscle through the body. It was helping to enhance

Table 2. Comparisons of health behaviors, CPG, BMI, and waist circumference before and after lifestyle modification program of each pre-diabetes group using paired t-test (n = 81)

Variables	Subject group	Before intervention, mean±SD	After intervention, mean±SD	t	*p*-value
Health behaviors	Mahasawat	88.82±12.40	93.93±11.31	-1.69	0.103
	Khlongyong	85.50±13.94	81.33±10.80	1.54	0.134
	Khanonnae	86.91±11.57	91.35±9.00	-1.67	0.104
Food consumption	Mahasawat	32.21±3.68	34.75±4.40	-2.56	0.016*
	Khlongyong	33.47±4.31	32.33±3.65	1.14	0.264
	Khanonnae	34.22±4.59	34.65±4.66	-0.36	0.725
Exercise aspect	Mahasawat	28.54±6.74	28.46±4.17	0.06	0.953
	Khlongyong	25.70±7.25	24.07±4.61	1.40	0.173
	Khanonnae	25.52±6.58	29.35±4.49	-2.88	0.009*
Stress management	Mahasawat	28.07±5.96	30.71±7.46	-1.48	0.150
	Khlongyong	26.33±7.02	24.93±6.37	1.07	0.294
	Khanonnae	27.17±6.20	27.35±6.50	-1.05	0.917
CPG (mg%)	Mahasawat	113.68±19.01	110.93±20.83	0.47	0.640
	Khlongyong	109.70±14.43	102.63±13.09	2.11	0.044*
	Khanonnae	102.65±12.93	98.78±13.28	1.27	0.219
BMI (Kg/m^2)	Mahasawat	26.62±3.94	26.08±4.11	2.04	0.052
	Khlongyong	25.76±3.89	25.17±4.05	2.86	0.008*
	Khanonnae	27.47±4.28	27.13±4.45	2.65	0.015*
Waist circumference (cm)	Mahasawat	91.68±7.01	89.70±7.85	1.84	0.077
	Khlongyong	86.50±8.14	85.82±7.99	1.66	0.275
	Khanonnae	87.76±8.83	87.76±9.08	0.00	1.000

CPG = capillary plasma glucose; BMI = body mass index

* Statistically significant *p*<0.05

Table 3. Comparisons of health behaviors, capillary blood sugar, and nutritional status among pre-diabetes groups using ANOVA (n = 81)

Variance resource	SS	df	MS	F	*p*-value
Health behaviors					
Between group	2,552.43	2	1,276.22	11.54	0.000*
Within group	8,623.74	78	110.56		
Total	11,176.17	80			
Food consumption					
Between group	106.45	2	53.22	3.00	0.056
Within group	1,385.13	78	17.76		
Total	1,491.58	80			
Exercise aspect					
Between group	444.35	2	222.17	11.34	0.000*
Within group	1,528.05	78	19.59		
Total	1,972.40	80			
Stress management					
Between group	486.34	2	243.17	5.25	0.007*
Within group	3,610.80	78	46.29		
Total	4,097.14	80			
CPG (mg%)					
Between group	2,012.82	2	1,006.41	3.82	0.026*
Within group	20,562.74	78	263.63		
Total	22,575.56	80			
BMI (Kg/m^2)					
Between group	50.05	2	25.03	1.43	0.245
Within group	1,364.33	78	17.49		
Total	1,414.38	80			
Waist circumference (cm)					
Between group	218.09	2	109.04	1.60	0.209
Within group	5,331.35	78	68.35		
Total	5,549.43	80			

CPG = capillary plasma glucose; BMI = body mass index

* Statistically significant $p<0.05$

Table 4. Comparisons of health behaviors, capillary blood sugar and nutritional status among pre-diabetes groups using LSD (n = 88)

Subject group	Subject group	*p*-value
Health Behaviors		
Mahasawat	Khlongyong	0.000*
Mahasawat	Khanonnae	0.386
Khlongyong	Khanonnae	0.001*
Exercise aspect		
Mahasawat	Khlongyong	0.000*
Mahasawat	Khanonnae	0.480
Khlongyong	Khanonnae	0.000*
Stress management		
Mahasawat	Khlongyong	0.002*
Mahasawat	Khanonnae	0.083
Khlongyong	Khanonnae	0.204
CPG		
Mahasawat	Khlongyong	0.055
Mahasawat	Khanonnae	0.010*
Khlongyong	Khanonnae	0.395

LSD = least significant difference; CPG = capillary plasma glucose

* Statistically significant *p*-value <0.05

fat oxidation leading to decreased total fat mass and increase skeletal muscle[13-15]. These results were congruently with some studies helping to increase health behaviors[6-8,13,16], decrease blood sugar[7,8,13,16-22] and reduce BMI[6-8,16,19-21]. However, participants' food consumption behavior did not improve as well as exercise aspect except at Khanonnae community, which had more exercise than before the program resulting in non-significantly improvement of BMI and waist circumference. Thus, the study should add both more time exercise and suggestion to decrease food consumption and longer follow-up time for BMI and waist circumference assessment. The present study significantly demonstrates that different exercise types affect the exercise itself (p-value <0.009) and the BMI (p-value <0.015). It is because of RAN30, which was selected by Khanonnae group, was an exercise using VDO song "Juk Kim Tuk To" authorized by Sweet Green Soup Band Music. It was classified as moderate exercise and was strictly enforced by the group to practice as compared with the other exercise types used in this study. Mahasawat group selected only chair and arms swing exercise (mild to moderate exercise types). They preferred to receive only teaching and practice and engage more by themselves. Khlongyong group selected arm swing exercise (mild to moderate) but strictly implemented the hand practice on manner different from the Mahasawat group. That mean exercise intensity selected by the groups from high to low intensity were Khanonnae (RAN30), Khlongyong (arm swing exercise teaching and practice), and Mahasawat (chair and arm swing exercise teaching). Heinrich et al[23] recommend that high-intensity exercise options should be included and integrated in public health interventions. They explained that advantages of high-intensity exercise types were significantly less time exercising per week thus, capable to maintain exercise enjoyment and were more likely intend to continue.

When comparing three programs, the mean score of health behaviors, exercise aspect, stress management, and CPG were statistical significant difference at least a setting. Results revealed that health behaviors and exercise aspect in Khlongyong community were less than the other two setting, stress management at Mahasawat was better than the two setting, and CPG at Khanonnae was the lowest. This result might be from the exercise in the RANS30 using moderate intensity exercise consisting of music helping to encourage participants performing more exercise than different methods of other setting resulting in

lower CPG. Thus, the LMPs should integrate music in the exercise to encourage the participants.

Conclusion

The LMP is important, useful, and can be integrated with conventional method and education to improve the health behaviors of pre-diabetes condition. It can reduce the abnormal CPG in future. These programs should be adapted into communities to reduce blood sugar, BMI, and waist circumference resulting in diabetic prevention. A RAN30 is an example of the moderate exercise intensity. With enforced objective, it was more efficient than mild intensity exercise or an exercise with unenforced objective.

What is already known on this topic?

Persons with pre-diabetes that continuously perform a LMP that includes food consumption, exercise, and stress management at least 30 minutes a day, three days a week for eight weeks can help to reduce blood sugar and BMI resulting in prevention of diabetes.

What this study adds?

This study showed comparison of the three LMPs that help to increase health behaviors, reduce CPG, and decrease BMI. Besides, the study proposed that the more you exercise, the better the CPG and BMI. Thus, persons with pre-diabetes should continuously perform the LMP especially exercise.

Acknowledgement

Thanks are extended to the study participants for their involvement, Section for Clinical Epidemiology and Biostatistics for data management and statistical analyses, School of Nursing, Faculty of Medicine Ramathibodi Hospital, and Diabetes Association of Thailand under the Patronage of Her Royal Highness Princess Maha Chakri Sirindhorn for the funding for this research.

Potential conflicts of interest

The authors declare no conflict of interest.

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