

Effects of Arm Swing Exercise Program on HbA1c and Nutritional Status in Adults with Type 2 Diabetes in Community

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Abstract

OBJECTIVE: This experimental research design randomized two groups pre- and post- test, aimed at examining the effects of arm swing exercise program on hemoglobin A1c (HbA1c) and nutritional status in adults with type 2 diabetes mellitus (T2DM)

MATERIAL AND METHODS: Participants from Sub-district Health Promoting Hospital were randomly divided into two groups: an experimental group with 22 participants receiving arm swing exercise program for 12 weeks and a control group with 21 participants receiving routine nursing care. Data collection was done before and after the intervention using a demographic and a perceived self-efficacy in exercise questionnaire, HbA1c, waist circumference and body mass index (BMI). The data were analyzed by using descriptive statistics, Paired t-test and Independent t-test.

RESULTS: The findings showed that after the arm swing exercise program, the experimental group had significantly lower average of HbA1c, waist circumference and BMI compared with before the program ($p = 0.010$, $p = 0.000$, $p = 0.003$, respectively). The experimental group also had lower average of HbA1c compared with the control group ($p = 0.013$), but waist circumference and BMI were not significant.

CONCLUSION: The arm swing exercise program should be applied to adults with T2DM to control diabetes and its complications.

Keywords: arm swing exercise program, HbA1c, waist circumference, body mass index, adults with type 2 diabetes

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Diabetes mellitus is a significant global public health problem with annually rising trends. According to estimates from the International Diabetes Federation (IDF), there were 415 million diabetics worldwide in 2015. This number is expected to increase to 642 million diabetics in 2040.¹ Similarly, Thailand except Bangkok found increasing trends and the admission rate of patients with diabetes surged from 954.18 per hundred thousand people in 2010 to 1,233.46 per hundred thousand people in 2015.² Data from the fifth National Health Examination Survey indicated that prevalence rate of diabetes patients aged 15-59 years was equal to 61.79% and there were more females than males (9.8% and 7.9%) resulting in loss of DALY from 355,000 years and 236,000 years, respectively.³ Thus, uncontrolled diabetes may impact patients, families, society and the country.

Adults with T2DM may have acute complications such as hypoglycemia or hyperglycemia and common chronic complications consisting of renal failure (21.5%), diabetic retinopathy (7.4%) and cardiovascular disease (4.8%). This increased the mortality rate from 14.93 per hundred thousand population in 2013 to 17.53 per hundred thousand population in 2014.⁴ Some patients may have disabilities or complications requiring more care or treatment, causing stress from lifestyle modification, limited work ability, family role adaptation, and higher family expenses for care. Thailand is estimated to have expenses at approximately 17,500 – 70,000 baht per person per year.^{1,5} Thus, strategies for controlling blood sugar are necessary.

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To prevent complications from diabetes, glycemic control is essential and must be carried out simultaneously with pharmacological and non-pharmacological treatments or lifestyle modifications including controlling dietary intake and stress management especially regular exercise helping to secrete endorphins resulting in reduced stress^{1,6,7} and to increase cellular metabolism causing decreased blood sugar and free fatty acids resulting in reduced waist circumference and body mass index (BMI).⁸⁻¹¹

Nevertheless, most adults with diabetes cannot control dietary intake because diabetes medications especially sulfonylurea trigger hunger resulting in more calories intake. They also had less physical activity or exercise resulting in higher blood sugar levels and excessive weight.⁷⁻⁸ Thus, adults with diabetes need to have efficient exercise in order to reduce blood sugar levels and fat accumulation in the body in addition to reducing waist circumference and BMI.

Arm swing exercise (ASE) is a mild-moderate intensity aerobic exercise being cost-effective focused on physical energy and positions without causing impact to joints. This exercise is easy and convenient to perform in any place and at any time without equipment.^{12,13} In particular, adults with T2DM continuously perform ASE resulting in muscle contraction and relaxation. This makes more muscle flexibility and glucose energy use in the muscles by increasing glucose transporter-4 (GLUT-4) resulting in decreased insulin resistance, and increased insulin receptors and sensitivity in tissues, thereby reducing blood sugar. Moreover, liver produces glucose by

synthesizing substances such as lactates, ketones, amino acids and free fatty acids obtained from lipolysis of body parts resulting in reducing waist circumference and BMI.¹²⁻¹⁵

A number of limited research findings have revealed persons with diabetes to have significantly lower blood sugar after performing ASE for 30 minutes a day, three days a week for eight weeks.¹⁴⁻¹⁷ However, no statistically significant differences in reduced waist circumference and BMI were found among persons with diabetes¹⁸ and persons with pre-diabetes.¹⁹ Therefore, some studies proposed that ASE should be 30 minutes a day, more than three times a week over a period of eight weeks or no less than 150 minutes per week.¹³⁻¹⁶ Unfortunately, approximately 47% of persons with diabetes cannot continuously exercise as per recommendations.²⁰

Thus, it is necessary to build confidence in adults with diabetes to continuously perform ASE. Therefore, integration of Bandura's perceived self-efficacy theory affirming that a person must be assured to perform any activity successfully and expect beneficial outcomes from that activity.²¹ Similarly, adults with diabetes must be confident to accomplish ASE safely and expect decrease in blood sugar levels, waist circumference and BMI. Perceived self-efficacy comes from four resources, namely vicarious experience, enactive mastery experience, verbal persuasion and physiological and affective states. It is important to assimilate these resources in the ASE Program including other strategies such as sharing experience, home visiting or telephone follow-up (Figure 1) in order to motivate adults with diabetes to continuously practice ASE.

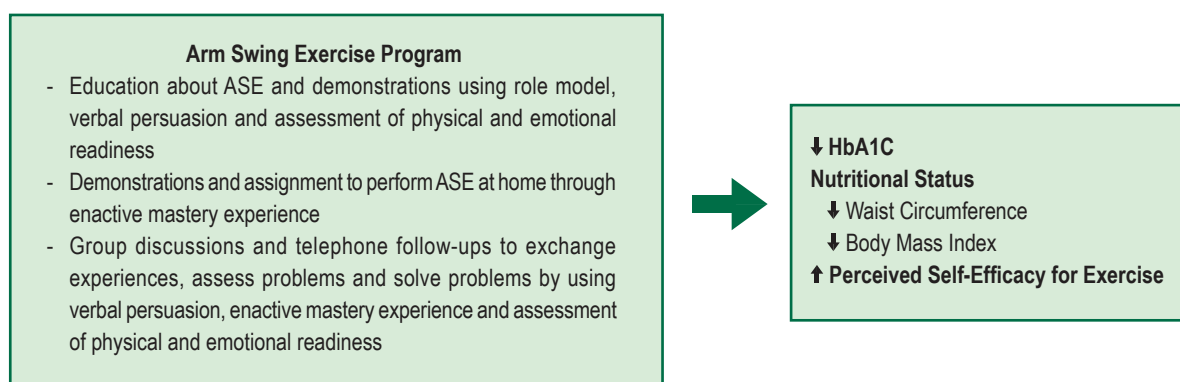


Figure 1: Conceptual framework of effects of the ASE Program on HbA1c and nutritional status in adults with T2DM

Rong Krachom and Bang Khu Rat Sub-district Health Promotion Hospitals (SHPH) are rural urban communities located in Bang Bua Thong, Nonthaburi, Thailand. Rong Krachom SHPH found an increasing prevalence rate of diabetes from 10.6 per thousand populations in 2012 to 43.7 per thousand populations in 2014.²² Meanwhile, Bang Khu Rat SHPH found the prevalence rate of diabetes in 2014 to be 17.77 per thousand populations.²³ Both SHPHs provided education and practices according to specific problems of persons with T2DM as well as casually performed home visits. Thus, this

study was aimed at examining the effects of the ASE Program on blood sugar level (HbA1c), nutritional status (waist circumference and BMI) and perceived self-efficacy for exercise in adults with controlled T2DM. The findings will assist to prevent complications in adults with T2DM.

Materials and Methods

This study is an experimental research design: two-group pretest-posttest design.

Population and sample

The population consisted of adults with T2DM at Rong Krachom SHPH and Bang Khu Rat SHPH, Bang Bua Thong, Nonthaburi. The samples comprised adults with T2DM receiving diabetic treatment at Rong Krachom SHPH and Bang Khu Rat SHPH, Bang Bua Thong, Nonthaburi from March-September 2016.

Participants were selected using the following:

Inclusion criteria:

- Diagnosed T2DM by physician
- Treated by oral antidiabetic drug
- Without complications such as retinopathy, nephropathy, neuropathy, heart disease and cerebrovascular disease
- Aged 20-59 years
- Able to perform ASE
- Willingly able to communicate in Thai language via telephone and having signed the informed consent form.

Termination criteria:

- Being hospitalized or complications
- Practicing ASE < 90 minutes/week

The sample size was calculated using Power Analysis through G * Power software program²⁴ based on the finding of Wongsricha's study having effect size equal 0.67.²⁵ A total of 21 participants obtained sufficiently statistical power (80%) in predicting the study outcomes with a statistically significant $p < 0.05$. Finally, researchers randomly enrolled 30 persons with T2DM to each group, Rong Krachom SHPH and Bang Khu Rat SHPH, to prevent sample lost.

Instrumentation

The instruments in this study were divided into two parts as follows: research instruments consisted of the ASE program and routine nursing care. The first one was created by the researcher from the literature review by integrating ASE¹⁶ and Bandura's perceived self-efficacy concept.²¹ This Program included knowledge, demonstration and return demonstration of ASE, ASE assignment at least 30 minutes a day, 5 days a week or at least 150 minutes/week for 12 weeks at home, telephone follow-up approximately 20 minutes/time at week 2, 3, 5, 6, 7, 9, 10 and 11, and group discussion for 60 minutes at week 4, 8, and 12. Furthermore, the participants were assigned to record food consumption and exercise. The Program was examined for content validity by a panel of three experts and obtained CVI at 1.0.

The ASE methods consisted of three periods as follows:^{12,16}

1. The warm-up period is a pre-exercise activity from head to toe for 5 minutes in order to prepare muscles and joints to prevent injuries and enhance body flexibility.
2. The exercise period composed of the following steps:
 - Stand straight and relaxed with both feet placed at the same width as the shoulders.
 - Relax the hands naturally with both palms facing backward and fingers placed closely together.

- Contract the abdomen, direct the waist, relax the head and neck, and naturally close the mouth.
 - Compress the feet on the ground until legs and abdomen are tense.
 - Look forward with the eyes focused on one point and maintain a peaceful mind with no distractions.
 - Move the arms forward naturally at no more than 90 degrees from the body with a smooth, fluid movement ("empty and light") and swing approximately 60 degrees backward with a force ("tight and heavy").
3. The cool-down period is performed in the same way as the warm-up period for 5 minutes in order to gradually bring the heart rate down to its pre-exercise level.

Lastly, the routine nursing care used a methodology entitled "Seven Color Life Traffic Ping Pong" to classify patients' diabetic severity by blood sugar and provide care for that group to control diabetes and its complications as follows:

- Normal group (white color) having FBS ≤ 100 mg/dl receives lifestyle modification;
- Pre-diabetes/ risk group (mild green) having FBS 100-125 mg/dl obtains as normal group and blood sugar added every 1-3 month;
- Diabetes group (green, yellow, orange or red) seen as risk group, taking diabetic medicine, complication practice, follow up with physician, and home visits; and
- Diabetes group with complications (black) consider referring to the province hospital for proper management and home visits.

Data collection instruments were divided as follows:

- The Demographic questionnaire built by the researchers consisted of gender, age, educational attainment, marital status, occupation, and mean monthly income, duration of diabetes, other chronic diseases, alcohol consumption and smoking.
- The Perceived Self-Efficacy for ASE Assessment questionnaire was adapted based on the exercise assessment form of Wongsricha's study.²⁵
- The questionnaire had ten items with 4-level rating scale from "Not Confident" to "Most Confident" with scores ranging from 1-4 points. Possible scores are 10-40 points and a high score means high levels of perceived self-efficacy to perform exercise. The content validity was obtained at 0.83. Cronbach's alpha tested for reliability was 0.88, and 0.82 for the present study.
- Glycated hemoglobin (HbA1c) and nutritional status, including waist circumference and BMI were measured at baseline and at the twelfth week.
- Finally, research regulating instruments consisted of the recording forms: ASE, nutritional status, telephone follow-up, and dietary consumption.

Data Collection Methods

This study was approved by the Institutional Review Board (IRB), Faculty of Medicine Ramathibodi Hospital, Mahidol

University, Thailand under the project titled “Effects of arm swing exercise program on blood sugar and nutritional status of persons with diabetes type 2 in community (ID 08-58-33)”. After participants signed the informed consent form, they were asked to answer demographic and the perceived self-efficacy for exercise questionnaires. The participants were also assessed

for HbA1c, waist circumference and BMI in the first week as a baseline assessment. Then, the participants in the experimental group received the ASE program for twelve weeks while the control group received routine nursing care. Data were achieved after the intervention at the twelfth week as at the baseline (Figure 2).

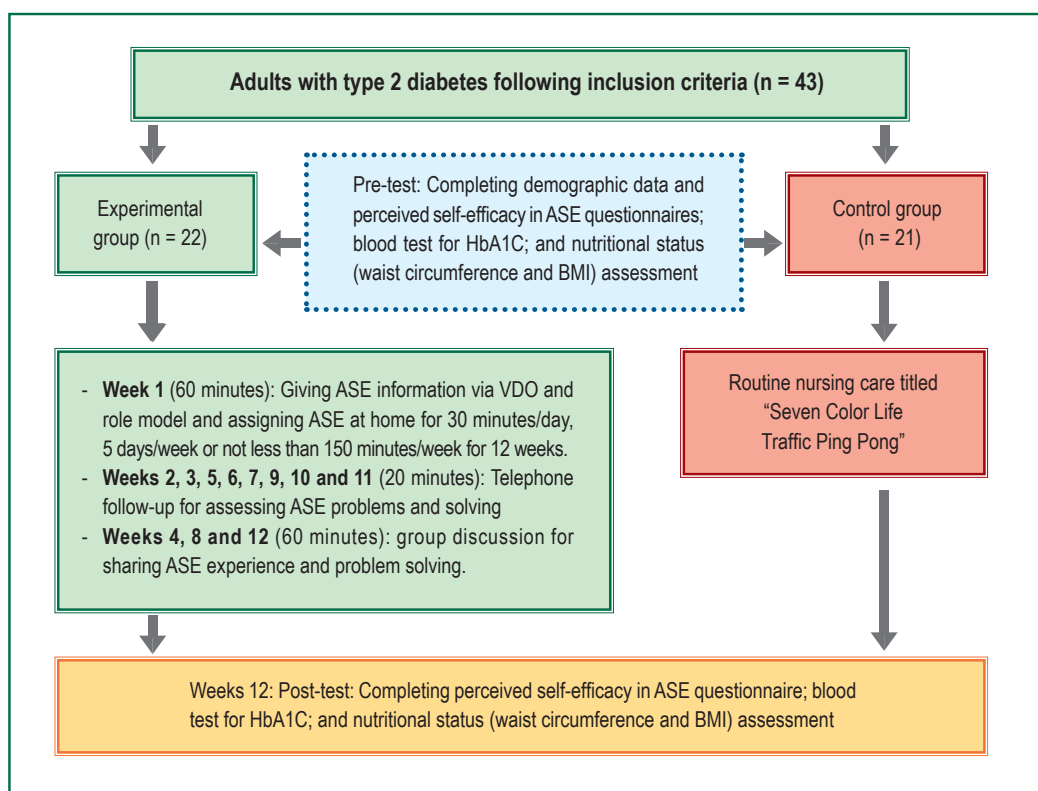


Figure 2: Data collection process

Data Analysis

All data were clean for integrity and accuracy along with using statistical programs to analyze demographic characteristics, perceived self-efficacy for ASE, HbA1c, waist circumference and BMI by using descriptive statistics and testing hypotheses with Pired t-test and Independent t-test.

Results

Sixty persons with T2DM were randomly divided into two groups with 30 participants in each group: an experimental group from Rong Krachom Sub-district Health Promotion Hospital and Bang Khu Rat SHPH. Eight participants from the experimental group and nine participants from the control group withdrew from the study because of being referring for proper management in a district hospital and moving back to their hometown. Thus, 43 subjects remained with 22 subjects in the experimental group and 21 subjects in the control group.

The findings revealed that most participants in the experimental group and control group were females (81.8%

and 85.7%, respectively). The experimental group and the control group had a similar mean age of 52.95 years (SD = 4.63) and 51.71 years (SD = 6.37), respectively and the highest education was elementary educational (68.2% and 76.2%). Most participants were married (81.8% and 71.4%, respectively) and were employed (72.7% and 52.4%, respectively). They had an average family income of 13,272.73 baht/month (SD = 8,929.25) and 14,190.48 baht/month (SD = 10,092.66), respectively. Both groups took oral anti-hyperglycemic drugs such as Metformin and Glipizide and had other diseases (95.6% and 85.7%, respectively), such as hypertension and hyperlipidemia. Approximately 10% of the experimental group consumed alcohol and were smoking cigarettes. All independent variables had no significant difference between the groups.

Before participation in the ASE program, the average of HbA1c, waist circumference, BMI and score of perceived self-efficacy for exercise between the experimental group and the control group were no different, as shown in Table 1. After participation in the ASE program, the experimental group had significantly lower mean HbA1c, waist circumference and

BMI when compared with before receiving the Program ($t = 2.82, p = 0.010$; $t = 6.18, p = 0.000$; $t = 3.43, p = 0.003$, respectively). Mean score of perceived self-efficacy for exercise was also significantly higher than before the ASE Program ($t = -2.59, p = 0.017$) as shown in Table 2. Mean HbA1c level

($t = -2.59, p = 0.013$) and perceived self-efficacy for exercise ($t = 3.37, p = 0.002$) of the experimental group were significantly better than the control group as shown in Table 3. Additionally, the experimental had a greater decrease in HbA1c (7.06%) after the ASE Program than the control group (3.10%).

Table 1: Comparison of average HbA1c, waist circumference, body mass index and perceived self-efficacy for exercise between the experimental and control groups before the program using Independent t-test ($n = 43$)

Variables	Experimental Group ($n = 22$)		Control Group ($n = 21$)		t	p
	Mean (SD)	min-max	Mean (SD)	min-max		
HbA1c	8.22 (1.42)	6.4 – 12.2	9.02 (1.87)	6.2 – 12.3	-1.59	0.120
Waist Circumference	91.32 (7.47)	79.0 – 106.0	91.86 (12.82)	68.0 – 129.0	-0.17	0.866
Body Mass Index	27.32 (3.64)	22.0 – 35.5	28.46 (6.60)	15.9 – 45.8	-0.71	0.484
Perceived Self-efficacy for Exercise	35.27 (4.21)	27.0 – 40.0	35.85 (4.44)	23.0 – 40.0	-0.44	0.660

Table 2: Comparison of average HbA1c, waist circumference, body mass index, and perceived self-efficacy for exercise before and after receiving the ASE Program in the experimental group by using Paired t-test ($n = 22$)

Variables	Pre-test		Post-test		t	p
	Mean	SD	Mean	SD		
HbA1c	8.22	1.42	7.65	1.18	2.82	0.010*
Waist Circumference	91.32	7.47	86.43	7.40	6.18	0.000***
Body Mass Index	27.32	3.64	27.00	3.58	3.43	0.003**
Perceived Self-efficacy for Exercise	35.27	4.21	38.36	2.93	-2.59	0.017*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Comparison of average HbA1c, waist circumference, body mass index, and perceived self-efficacy for exercise between the experimental group receiving the ASE Program and the control group receiving the routine nursing care using Independent t-test ($n = 43$)

Variables	Experimental Group ($n = 22$)		Control Group ($n = 21$)		t	p
	Mean	SD	Mean	SD		
HbA1c	7.65	1.18	8.74	1.58	-2.59	0.013*
Waist Circumference	86.43	7.40	91.19	13.37	-1.45	0.154
Body Mass Index	27.00	3.58	28.28	6.76	-0.78	0.437
Perceived Self-efficacy for Exercise	38.36	2.93	34.71	4.08	3.37	0.002**

Discussion

Adults with T2DM in the experimental group had significantly lower average HbA1c, waist circumference and BMI; and a higher mean score of perceived self-efficacy for exercise when compared to before receiving the program ($t = 2.82, p = 0.010$; $t = 6.18, p = 0.000$; $t = 3.43, p = 0.003$; $t = -2.59, p = 0.017$, respectively). Moreover, mean HbA1c level ($t = -2.59, p = 0.013$) and perceived self-efficacy for exercise ($t = 3.37, p = 0.002$) of the experimental group were significantly better than the control group. These outcomes occurred because participants received the ASE Program integrating with Bandura's Self-efficacy theory using four important resources to be mediator.²¹ The ASE program helped to motivate the experimental group to continually perform ASE acting as an insulin-like effect helping to increase glucose

uptake in skeletal muscle by translocation of glucose transporter 4 (GLUT4) from an intracellular location to the plasma membrane leading to improve insulin sensitivity and reduce insulin resistance.¹⁰ Consequently, skeletal muscle from visceral fat through the lipolysis process increased and HbA1c, waist circumference and BMI decreased.^{13-16,18,25}

Nevertheless, mean waist circumference and BMI in the experimental group were lower than the control group without statistically significant differences. This may be because the control group was reminded to exercise and control food by staff nurses and health care volunteers when the participants had follow-up at the Non-communicable Clinic. Unfortunately, most participants in the experimental group were assessed during Ramadan Ceremony. Thus, they consumed high-energy food increasingly, such as starch, fried food, sticky rice with

durian or mango, in the evening and had less physical activity or exercise and more sleeping instead in the daytime. This was different from the control group acting with the same behavior. Thus, a further study should control this confounding factor in order to achieve the excellent outcomes.

Conclusion

The ASE Program demonstrated improving blood sugar level, nutritional status, and perceived self-efficacy for exercise. It should be recommended to apply to persons with T2DM in order to control HbA1c, waist circumference and BMI. This will help to promote health and prevent complications of

diabetes. Moreover, further studies should be conducted by the ASE Program by clearly determining inclusion criteria, especially HbA1c or BMI to effectively obtain accurate findings; and comparing exercise duration integrating food control in 6-12 months' time for better health outcomes.

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