Original Article

Effects of Modified Arm Swing Exercise Program on Capillary Plasma Glucose and Body Composition in People with Uncontrolled Type 2 Diabetes

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Abstract

OBJECTIVES: A quasi-experimental research aimed at examining effects of Modified Arm Swing Exercise (MASE) Program on capillary plasma glucose (CPG) and body composition in people with uncontrolled type 2 diabetes (T2DM).

MATERIAL AND METHODS: Twenty-four people with uncontrolled T2DM from a Ban Phai Rong Wua Sub-district Health Promoting Hospital, Suphanburi province, Thailand who met the inclusion criteria were selected into the study and received the MASE Program for 12-week. Data were collected using a demographic questionnaire and measurements of CPG, body mass index (BMI), visceral fat and skeletal muscle at baseline, 8^{th}, and 12th week after MASE program, analyzed by descriptive statistics and repeated measure ANOVA.

RESULT: After the MASE Program, mean CPG, BMI and visceral fat tended to be decrease, and skeletal muscle was likely to have increased; however, all variables were not statistically significant different at the least interval (F (2, 46) = 1.80, $p > 0.05$; F (2, 46) = 0.31, $p > 0.05$; F (2, 46) = 0.32, $p > 0.05$; F (2, 46) = 3.12, $p > 0.05$, respectively).

CONCLUSION: The MASE Program should be recommended to people with uncontrolled T2DM for more than12 weeks for better outcomes.

Keywords: modified arm swing exercise program, capillary plasma glucose, body composition, people with uncontrolled type 2 diabetes

Diabetes is a major health problem worldwide, including in Thailand.[1] The prevalence rate has been increasingly rising from 8.3% in 2017 and is expected to reach 10.8 % in 2045. Similarly, approximately 4.2 million Thai people were diagnosed with type 2 diabetes (T2DM) in 2017. [1,2] About 79% of all people with diabetes are unable to control blood sugar leading to many complications including cardiovascular diseases, neuropathy, retinopathy, and nephropathy resulting in poor quality of life, high healthcare expenses, and approximately 30,000 people deaths annually.[2-4] Therefore, explicit managements of diabetes is needed.

To achieve glycemic control targets, people with diabetes should be taking medication and modifying lifestyle activities, especially controlling diet and ensuring adequate exercise.[3] However, these may be difficult to continuously perform since a study reported that Thai people with diabetes consumed an amount of carbohydrate per day that is more than the recommended amount causing obesity and hyperglycemia.[4] Moreover, lack of exercise can significantly accumulates abdominal fat and this is a predominant cause for developing insulin resistance leading to T2DM and its complications such as cardiovascular diseases.[5,6] Thus, people should be encouraged to exercise more in order to burn calorie intake as this is beneficial for improving glycemic control.[7] However, approximately 42% rural Thai people did not perform exercise and do have an inactive lifestyle[8] because of lack of time and poor exercise infrastructure.[9] Thus, a strategy promoting continuously exercise should be developed in a convenient and practicable approach.

Currently, an arm swing exercise (ASE) is recommended as a government policy and is a well-known and practical method to promote physical activity.[10] Performing ASE can encourage body movement integrated with meditation, and this has benefits for glucose expenditure in muscle and i ncreased insulin sensitivity. [10,11] The traditional arm swing exercise (TASE) has shown several advantages in numerous previous studies including reduced HbA1c level, waist circumference (WC), body mass index (BMI), and stress.[12-15] However, the TASE focuses on the upper part of the body. It should be more beneficial if researchers modify TASE to a modified arm swing exercise (MASE) using the lower part of the body simultaneously and it has been claimed that this stimulates lymph nodes leading to an increase in cytokine affecting insulin activity. This may assist in enhancing the level of glucose uptake in muscle to achieve glycemic control. [16]

Thus, MASE should be applied to promote hip and knee joint movement and muscle contraction including abdominal and quadriceps. However, a limited study revealed that MASE performed for 30 mins, 6 day/week for 12-week was able to reduce WC, but this exercise pattern could not improve fat mass and BMI in people with metabolic syndrome.[16] The MASE program should be further studied integrating Bandura's concept through four resources including: mastery experience, vicarious experience, verbal persuasion and physiological and effective states[17] in order to enhance continuously performing exercise in people with T2DM as shown in Figure 1. Therefore, this present study investigated the effects of the MASE program on CPG, BMI, visceral fat, and skeletal muscle in people with uncontrolled T2DM. The findings could assist to control blood sugar and prevent diabetic complications.

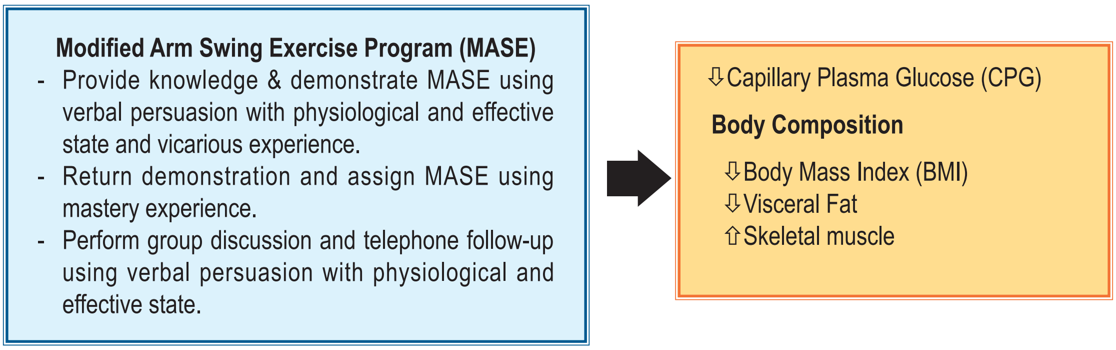

Figure 1: Conceptual framework of the MASE study

Materials and Methods

A quasi-experimental research: one-group pretest-posttest design conducted people with T2DM at the Ban Phai Rong Wua Sub-district Health Promoting Hospital, Suphanburi province, Thailand during December of 2016 to April of 2017.

Potential participants meeting the inclusion criteria:

1. Aged ≥ 20 years.
2. Diagnosed T2DM by a physician for more than a year and treated only with oral anti-hyperglycemic drug without diabetic complications.
3. HbA1c ≥ 7.0%
4. Had the ability to perform MASE.
5. Willing to participate in the program.

The exclusion criteria consisted of performed MASE < 90 minutes (mins)/week, missed appointments, referred to hospital or adjusted medication.

The sample size was determined based on Power Analysis using G*Power software sufficient for Repeated Measure ANOVA statistics with statistical power at 0.80, p at 0.05, effect size at 0.33 according to a previous study[18] obtaining 23 participants. Attrition rate 25% was added, so 30 people with T2DM were enrolled in the program.

The potential participants passing the inclusion criteria were randomly selected without replacement in the program. However, we lost six participants during the MASE program due to being referred to the district hospital and these were withdrawn at the 8th week of the project. Finally, we remained with 24 participants in predicting the study outcomes.

Research Instruments

The instruments used in this study were divided into two parts as follows:

The MASE program for 12-week was developed based on a literature review and Bandura's perceived self-efficacy theory.[17] The program included knowledge, demonstration and return demonstration of MASE consisting of warming-up, performing MASE by a little bending of the knees at the third MASE performance for 30 mins, and cooling down, MASE assignment at home for 30 mins/day 5 times/week for 12-week, group discussion for 60 mins at the 4th , 8th , and 12th week for sharing experience and solving their exercise problems; and telephone follow-up approximately 20 mins/time at the 2nd, 3rd, 5th, 6th, 7th, 9th ,10th, and 11th week. The content of the program was validated by three experts in the fields of nursing and general medicine equal to 1.

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The evaluation for data collection was divided into three domains as follow:

1. The demographic questionnaire included gender, age, level of education, marital status, occupation, duration of diabetes, diabetes medication, and co-morbidity domains.
2. CPG was assessed by Glucometer using the calibrated "ACCU-CHEK Performa" after fasting capillary blood at least 8 hours.
3. Body composition, consisted of BMI, visceral fat and skeletal muscle, was assessed by the Body Composition Monitor using the calibrated "OMROM-HBF375".

Data collection

The study received approval for ethical considerations from the Institutional Review Board (IRB), Faculty of Medicine Ramathibodi Hospital, Mahidol University, Thailand (ID 10-59-26). Participants received written and verbal explanations, learnt of the objectives, methods, risks, benefits, the right to withdraw from the study at any time throughout the study, and signed the informed consent form. Data were collected by the researcher at baseline assessment in the 1st week using the demographic characteristics, CPG, and body composition, including BMI, visceral fat, and skeletal muscle. Then, participants received the program for twelve weeks and data were obtained at 8th week and after the program as in the 1st week (Table 1). The data was kept strictly confidential and overall data was reported.

Statistical Analyses

Descriptive statistics were used to explain the demographic data. After study variables passing the assumptions, repeated measure analysis of variance (ANOVA) were used to examine the differences in the mean of CPG, BMI, visceral fat, and skeletal muscle with a statistically significant $p < 0.05$.

Results

Twenty-four participants with uncontrolled T2DM were completely participated in the MASE program for 12-week. The findings revealed that most participants were females (62.5%) with an average aged = 58.38 ± 8.87 years. Most participants were married (75 %), the highest educational attainment was primary school (91.7 %), and they worked as a farmer (41.7%) with a monthly family income 7,379.17 ± 5,894.35 bath. Mean duration of diabetes was to 6.83 ± 4.97 years with comorbidity (70.8%) consisting of hypertension (31.0%) and dyslipidemia (23.52%).

Before receiving the MASE Program, the means of CPG, BMI, and visceral fat were at the high level (156.00 ± 43.01, range = 93-258; 28.15 ± 5.31, range =17.39 - 37.83; 13.17 ± 6.62, range = 3-29, respectively); however, mean skeletal muscle was at the low level (24.47 ± 4.27, range =15.0 - 32.2). After receiving the Program, mean CPG, BMI and visceral fat tended to decrease, and skeletal muscle was likely to increase; however, all variables were not statistically significantly different at the least interval ($F(2, 46) = 1.80$, $p > 0.05$; $F(2, 46) = 0.31$, $p > 0.05$; $F(2, 46) = 0.32$, $p > 0.05$; $F(2, 46) = 3.12$, $p > 0.05$, respectively) as shown in Table 2 and Figure 2.

Table 1: Data collection procedure.

Week	Procedure
1	- Completion of demographic data - Assessment of CPG and body composition - Provide knowledge and demonstrate MASE - Return-demonstrate of MASE - Assign to perform MASE 30 mins/day, 5 times/week for 12-week at home
2 & 3	- Telephone follow-up
4	- Second visit at Health Care Center: Group discussion
5-7	- Telephone follow-up
8	- Third visit: Assessment of CPG and body composition and Group discussion
9-11	- Telephone follow-up
12	- Fourth visit: Assessment of CPG and bodycomposition and Group discussion

Table 2: Comparison of mean CPG, BMI, visceral fat, and skeletal muscle at the baseline, at the, 8th, and 12th week after receiving the MASE Program using repeated measures analysis of variances (n = 24)

Variable	Source of variance	SS	df	MS	F	*p*
CPG (mg/dl)	Time	3,412.03	2	1,706.01	1.80	0.177
	Variance		46			
BMI (kg/m2)	Time	0.67	2	0.34	0.31	0.738
	Variance		46			
Visceral fat (%)	Time	0.90	2	0.45	0.32	0.730
	Variance		46			
Skeletal muscle (%)	Time	8.01	2	4.01	3.12	0.054
	Variance		46			

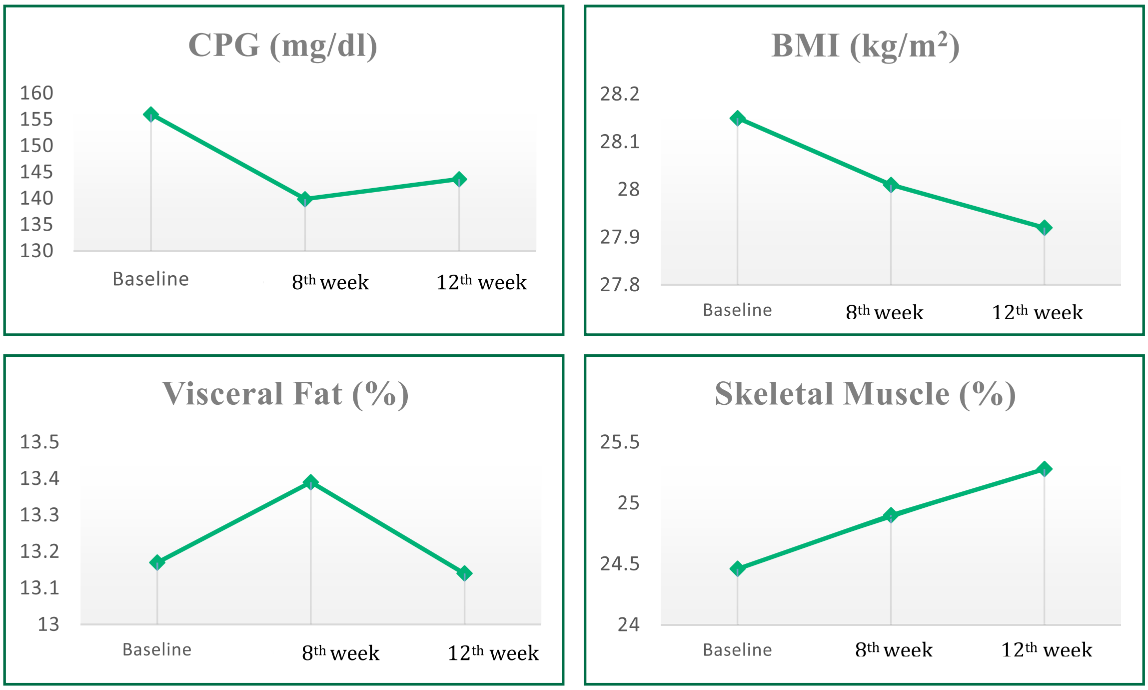

Figure 2: Comparison of mean CPG, BMI, visceral fat, and skeletal muscle at the baseline, at the 8^{th} and 12^{th} week after receiving the MASE Program

Discussion

The results showed that mean of CPG, BMI, and visceral fat have a tendency to decrease, and skeletal muscle showed a slight increase; however, after finishing the program, all variables were not a statistically significantly different. These findings were different from hypothesis outcomes, although participants continuously performed the MASE program integrating Bandura's Self-efficacy theory using four resources: mastery experience, vicarious experience, verbal persuasion, and physiological and effective states.[17] Unfortunately, approximately half of the participants in this study (41.7%) were older adults with a low level of skeletal muscle, and average BMI and visceral fat were at a high level resulting in insulin inactivity and insulin resistance leading to effectively decrease in glucose uptake in skeletal muscles.[19,20,21] Besides, the high level of visceral fat, especially around the abdomen, suppression of glucose transporter 4 (GLUT-4) resulted in high blood sugar. Therefore, achieving glycemic control in this study could be more difficult than in younger people with diabetes and a normal BMI.[22]

Moreover, visceral fat is determined as a major factor associated with the development of inflammation, vascular dysfunction, and atherosclerosis in the human body.[5] Excessive visceral fat can also strengthen inhibition of skeletal muscle glucose uptake[23] and insulin resistance leading to difficulty for controlling the disease.[24] The results in this study were contrasted to a previous study using TASE finding a significant decrease in HbA1C and BMI.[13,14] Possibly, the participants in both studies had more activities and lower BMI than participants in this study. However, this study was congruent with a study revealed that MASE 30 mins, 6 day/week for 12-week in people with metabolic syndrome could not significantly reduce fat mass and BMI.[16] Although, World Health Organization (WHO) suggests that people should continuously perform exercise at least 150 minutes per week[25], 12-week of MASE intervention is insufficient to yield changes both blood sugar level and body composition in people with T2DM, who have high BMI and visceral fat. Hence, people with diabetes should perform exercise for more than 12 weeks as recommended in a study for 6-months in order to reduce blood sugar level and improve body composition.[26]

Limitations

This study can be generalizable to people with uncontrolled T2DM being similar characteristics of the sample. However, the study lacks a control group. Thus, further study should use a randomized control trial to examine the effects of the MASE Program for a period of at least 6 months, especially in older adults who are overweight.

Conclusions

Based on these results, the MASE Program should be recommended to people with uncontrolled T2DM for more than 12 weeks since the outcomes are better than before the Program.

Conflicts of interest

The authors declare that they have no conflicts of interest

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