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ORIGINAL ARTICLE

A Walking Intervention for Enhancing Self-efficacy, Physical Activity, and Cardiovascular Endurance in Overweight Children: A Randomized Controlled Trial

[1]Napatsorn Suksong, [2]Raweewan Maphong, [1]Sonthaya Sriramatr*

[1]Department of Sport Science, Srinakharinwirot University, Bangkok, Thailand. [2]Faculty of Sports Science, Chulalongkorn University, Bangkok, Thailand.

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ABSTRACT

Background. Child obesity is an increasing trend in Thailand. Increasing physical activity is therefore necessary. **Objectives.** The purposes of this study were to investigate the effect of a walking intervention program on the self-efficacy, physical activity (PA), and physical fitness of obese children in Thailand and to examine whether self-efficacy mediated changes in PA and physical fitness. **Methods.** A total of 42 children aged 6-19 years were randomized into two parallel groups: a control group (n=21) and an intervention group (n=21) who participated in the walking physical activity enhancement program for 8 weeks. Self-efficacy, %body fat, cardiovascular endurance, sedentary behavior (SB), steps, metabolic equivalents (METs), light PA (LPA), and moderate to vigorous PA (MVPA) were measured at baseline and after the end of the intervention. Multivariate analysis of variance tests was performed. METs and steps scores were highly positive; a composite score was created (i.e., Mets-Steps). Path analysis was conducted for mediation testing. **Results.** Compared to the control group, the intervention group had a significant increase in self-efficacy ($p<0.05$), Mets-Steps ($p<0.01$), and the MVPA ($p<0.01$) at the end of the program, while % body fat ($p=0.41$), cardiovascular endurance ($p=0.11$), SB ($p=0.22$), and LPA ($p=0.31$) were unaffected. Self-efficacy did not significantly mediate the effect of the intervention on METs-Steps and MVPA. **Conclusion.** The intervention can increase self-efficacy, steps, METs, and MVPA, but the increase in steps, METs, and MVPA is not a result of the increase in self-efficacy.

KEYWORDS: ***Steps, Cardiovascular Endurance, Self-Efficacy, Physical Activity, Sedentary Behavior, Metabolic Equivalents.***

INTRODUCTION

The World Health Organization recommends that children and adolescents aged 5-17 engage in at least 60 minutes of moderate to vigorous physical activity (PA) per day and at least three musculoskeletal physical activities per week (1). In addition, Pal et al., (2011) recommended at least 30 minutes of continuous walking per day or 10,000 steps per day (2), which is considered moderate-intensity exercise (3). However, most Thai children do not have sufficient PA. Simultaneously, the incidence of obesity in children tends to increase (4). Encouraging PA for children, especially obese children, is therefore necessary. Adequate daily steps can help reduce body fat percentage and positively affect physical performance in overweight individuals (5).

Regular PA is essential for maintaining overall health and well-being, particularly in children.

*. Corresponding Author:
Sonthaya Sriramatr, Ph.D.
E-mail: sonthase@g.swu.ac.th

Among the various forms of exercise, walking stands out as a simple, accessible, and enjoyable activity. Moreover, walking is a good option for PA among overweight children and adolescents. This is because overweight children and adolescents tend to have more movement problems than normal-weight children and adolescents. Walking is an easy PA that can provide numerous health benefits. It can be done manually; no equipment is required; it is cost-effective, convenient, and safe; it does not require difficult skills, requires little energy, can burn excess fat well, and results in physical strength and improved cardiovascular health (6, 7).

Extensive research has consistently demonstrated the positive effects of walking interventions on various aspects of cardiovascular health in children. A systematic review of 12 studies involving over 1000 children conducted by Janssen and LeBlanc (2010) found compelling evidence supporting the positive effects of walking interventions on cardiovascular health. The review demonstrated that walking interventions significantly improved aerobic fitness and blood pressure levels in children. These findings highlight the effectiveness of walking as a cardiovascular health intervention in this age group (7). Further supporting evidence comes from the study by Chiu et al., (2023) emphasizes the beneficial effects of a 12-week walking intervention on circulating lipid profiles and adipokines in both normal-weight and abdominal obese female college students. These findings underscore the importance of promoting walking as an accessible and effective exercise intervention to improve cardiovascular health and metabolic function in this population. Further research in this area is warranted to explore the long-term effects and sustainability of walking interventions on these outcomes (8). Walking is a simple, effective, and enjoyable form of exercise that can significantly improve cardiovascular health in children. Implementing walking interventions into children's daily lives can contribute to their long-term health and well-being, reducing the risk of cardiovascular diseases later in life. Promoting walking empowers children to adopt healthy habits that can positively impact their cardiovascular health for years to come. Walking is a good option for PA among overweight children and adolescents. This is because overweight children and adolescents tend to have more movement problems than normal-weight children and adolescents. Walking is an easy PA, can be done manually; no equipment is required; cost-effective, convenient, and safe; and does not require difficult skills, requires little energy, can burn excess fat well, and results in physical strength (6).

However, it is well known that behavior change programs should be based on theory to produce expected results. Self-efficacy theory is a key indicator for achieving desired goals in a program that focuses on increasing PA. This suggests that the best way to increase PA levels is to increase self-efficacy (9), especially in obese children. Young et al., (2016) said that self-efficacy was the most important indicator of willingness to change physical behavior and lose weight (10).

Self-efficacy can be enhanced by increasing performance accomplishments (11). Children's experiences of success may improve their self-efficacy, while disappointments at an early stage may reduce it (11). In addition, goal-setting has been found to increase confidence in carrying out a desired behavior (12). Goals direct a child's attention, enhance concentration, and lead to new success strategies. If children set goals, they will motivate themselves to try to reach them, and if they can reach their goals regularly, their self-efficacy can increase (11). Additionally, making an individual's efforts and progress observable through the use of personal diaries is helpful (13). The second way to increase self-efficacy is through vicarious experience. Accordingly, a child's capacity is judged concerning other children's achievements (11). Seeing others succeed in the same task that a child plans to perform strengthens, the children's idea that they can do it themselves. The strength of this source of information on self-efficacy is that it is strongly influenced by the comparison of models (14). The comparison of models is based on two criteria: shared experiences and similar personal characteristics (12). Children, such as friends with a comparable lifestyle, may serve as models for specific behaviors and necessary skills (15). Choosing role models for the vicarious experience of regular PA among children may increase their self-efficacy. The third way of increasing self-efficacy is through verbal persuasion; adding feedback and rewards can increase motivation and task performance as well as self-efficacy (16). Specific feedback through comparison with others' or past performances has produced higher levels of PA self-efficacy (17). Fourth, information about the human body can influence self-efficacy. Therefore, self-efficacy can be increased by improving children's physical state, reducing stress, decreasing negative emotions, and correcting false interpretations (12).

In addition, self-monitoring is important for behavioral changes. Regular self-monitoring of PA (e.g., step counts) increases PA levels (18). Monitoring and recording of steps per day are important techniques for promoting walking (19). Increased self-monitoring also improves behavioral outcomes (20). Accordingly, the practical strategies for self-monitoring in this intervention were as follows: The children monitored and recorded their daily steps each week. Therefore, the purposes of this study were to study the results of a walking intervention program based on self-efficacy theory and self-monitoring that affects the level of PA and physical fitness of obese children in Thailand and to examine whether self-efficacy mediated changes in PA and physical fitness.

MATERIALS AND METHODS

Participants. A randomized controlled trial intervention was conducted using a pre-and post-test design. The sample consisted of 42 students classified as overweight according to the growth reference criterion for children aged 6-19 years. A child with a normal weight (WH-Z-score (WHZ) between -1.5 SD to 1.5 SD) has a weight that is proportionate to their height. A child with overweight (WHZ > 1.5 SD to 2 SD) is at risk of being overweight and developing obesity (21) with height criteria > +1.5 SD to > +3 SD of the standard deviation (Bureau of Nutrition, 2021) who walked less than 5,000 steps per day (22). The sample size was calculated using the G*Power program; the test power was 0.80 and the effect size was 0.4 (23) for a total of 42 subjects, divided into two groups of 21 subjects each, using simple random sampling. During participation in the program, nine subjects withdrew from the trial (six in the control group and three in the experimental group; see Figure 1). This study was approved by the Human Research Ethics Committee of Srinakharinwirot University, Bangkok, Thailand (research registration number SLUEC-G-159/2565). This study was conducted in compliance with international ethical principles, regulations, requirements, domestic and international laws, and the Declaration of Helsinki.

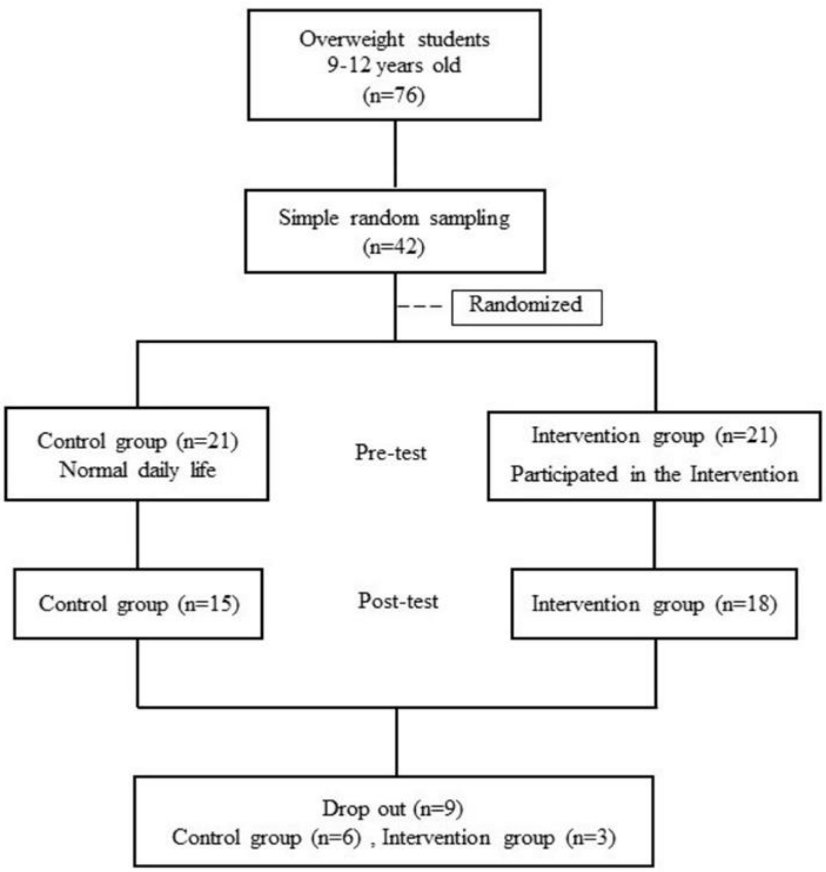

Figure 1. Flow diagram of participants in the trial.

Intervention Program. The intervention program was developed based on self-efficacy theory, including verbal persuasion, modeling (vicarious experience), performance accomplishments, emotional arousal, goal setting, and self-monitoring using a pedometer (11).

Self-efficacy theory. Practical strategies for performance accomplishment in this study included the following: 1) Children were provided with information about their steps; 2) Children started taking steps at minimum levels; 3) They set step goals, increasing such goals by 1000 steps every two weeks; 4) They recorded their steps every week; and 5) They receive positive feedback on their steps each week. The practical strategies for facilitating vicarious experiences in this intervention were as follows: 1) children received information about the steps of role models, and 2) students received information about their steps. The practical strategies for verbal persuasion in this intervention were as follows: Children received positive feedback about their steps every week. Practical strategies for improving physical and emotional states in this study were as follows: Stress and negative emotions were reduced by advising children to take steps at minimum levels and increasing the number of steps taken at a low rate each week. (11-17)

On Monday of the 1st and 2nd weeks, the researcher created motivation to change the health behavior of the intervention group by using verbal persuasion and live modeling to enhance knowledge about the methods and benefits of PA and playing games to classify the different types of PA.

In the 3rd and 4th week, the researcher used practices for performance accomplishments and desensitization, participant modeling, and emotional arousal to increase PA gradually so that the children could meet their goals (by themselves). These techniques were used to reflect the success of the child's changes. For example, self-efficacy increased from the experience of success in weeks 1 and 2 by having each child share his/her experience; a goal was set for each child to use his/her own PA in the previous two weeks to reflect the fact that they were aware of their successful performance. Researchers also used the method of emotional arousal by motivating interest and enthusiasm – through talking, conversing, exchanging problems, and providing encouragement by praising each other to give children the power to facilitate behavioral expression.

In the 5th and 6th weeks, the researchers used the same techniques as in the 3rd and 4th weeks, including the vicarious experience technique. The researchers mentioned that individuals participating in the intervention program who had taken the highest number of walking steps during weeks 1-4 could stimulate their self-efficacy and make other children perceive that they could succeed if they acted according to the live model. In addition, children were divided into groups of 3-4 people, and goals were set for the group to create mutual incentives within the group and to create motivation – by talking, discussing, sharing problems, and providing encouragement by praising each other – to give children the power to facilitate behavioral expressions. There was a competition for the combined number of steps taken by each group each week during weeks 5-8.

On Monday of the 7th and 8th weeks, the researchers used verbal persuasion and emotional arousal through gradual exposure to different stimuli (symbolic desensitization) for reinforcement by allowing members within the group to continuously stimulate their emotions by motivating interest and enthusiasm through talking, conversing, and exchanging problems with each other within the group to give members the power to facilitate behavioral expression continuously. The number of steps taken by each group was aggregated for each week. The group with the highest number of steps was identified, and they won and received a prize.

Goal setting. The students were asked to set the goal of walking 6000 steps in weeks 1 and 2 and increase it by 1000 steps every two weeks.

Self-monitoring. Each member of the intervention group received an SW-701 YAMAX DIGI-WALKER pedometer, Japan, and a personal diary, along with an explanation of how to use the pedometer and record the data. Children were asked to wear a pedometer only at the waist area, not throw it, shake it, or throw it away, and to be careful not to let the water hit it. The children wore a pedometer from 07:30 to 15:30 on Mondays, Wednesdays, and Fridays; recorded their daily steps after school time in a step diary; and reported the results to the researcher the next day. The children received the pedometer and tried it out for one week before participating in the program (23).

Measures. At baseline and after eight weeks, participants were assessed for self-efficacy, % body fat, cardiovascular endurance (i.e., the 3-minute up and down test), PA, and sedentary behavior (i.e., steps, metabolic equivalents (METs), light PA (LPA), and moderate to vigorous PA (MVPA)).

Demographic Characteristics. A demographic questionnaire was used to collect data on the age and sex of the participants. In addition, the research staff objectively measured weight and height. The body mass index (BMI) was calculated as weight (kg) divided by height (m) squared.

Self-efficacy. Participants completed a self-efficacy questionnaire. It contained questions about self-efficacy, which were divided into three behaviors: 1) Social cognitive theory (10 items), for example, "After school time, do you tend to allocate time for exercise or sports?" 2) Nutrition (11 items): "Do you tend to eat healthy foods?", and 3) PA and exercise (seven items), for example, "In your spare time, do you tend to take a walk or a run with your friend at school?" The responses were as follows: 1 (never), 2 (sometimes), and 3 (regular). A previous study reported good internal reliability (IOC=0.7-1.0). The questionnaire was administered as described by Sumalee Kiatchanog (24).

% Body fat mass. Body fat mass was measured using a body composition monitor (HBF-375; Omron, Tokyo, Japan). The children stood on a machine with their feet barely (8).

Cardiovascular endurance. Cardiovascular endurance was measured using the 3-minute up-and-down step test (reps) with the knee lift method; scores were recorded as 'number of times' and compared to the standard criteria for the 3-minute up-and-down step test, separated by age and sex. The test had a reliability value of 0.89 and a validity value of 0.88 (25).

Physical Activity and sedentary behavior. PA and SB were measured using the ActiGraph model wGT3X-BT version 3.2.1. (2013), China, and transcribed using ActiGraph GT3X software. The data included SB and PA levels (i.e., steps, LPA, MVPA, and METs). The ActiGraph device was attached to the right side of each participant's waist for three consecutive days (Tuesdays, Wednesdays, and Thursdays) from 07:30 to 15:30 (23).

Statistical analysis. To assess the interaction and main effects of the intervention, a series of 2 (intervention and control groups) × 2 (pre-test and post-test periods) between-group multivariate analysis of variance (MANOVA) tests were performed on all dependent variable scores. Since the correlations between METs and step scores were highly positive (r=0.97), a composite score (METs and step scores) was created (i.e., METs-Steps) for use in the MANOVA to avoid multicollinearity problems (26). Significant interaction effects were observed using Hotelling's T^2. The significance level was set at $p<0.05$. To aid the interpretation of the findings, Cohen's categorization of partial Eta-squared as small (0.01), medium (0.06), or large (0.16) effects was adopted. All analyses were performed using SPSS version 23.0 for Windows.

In addition, a path analysis was conducted for mediation testing. Path analysis is a type of structural equation modeling in which all the model's variables are observed, and all the paths are simultaneously estimated. The mediator variable (M) aims to clarify how the independent variable (X) and dependent variable (Y) interact, which allows the independent variable (X) to influence the mediator (M) and the resulting mediator variable (M) to influence the dependent variable (Y). Mediation occurs when variable X partially or completely influences variable Y through the intermediary variable M. This shows that the relationship between X and Y occurs via direct and mediated effects, indirectly causing X to affect Y through M (27).

The model was assessed using a chi-squared (χ^2) statistic, the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the Akaike information criterion (AIC). CFI and TLI values of 0.90 or greater indicated a good model fit. An RMSEA score from 0.05 to 0.08 was indicative of an acceptable fit, and values lower than .05 indicated a good fit. A lower AIC value for the model indicates a better fit than the other models. To evaluate the fit of the model, the following indices were considered: We considered a χ^2/df ratio <3, a CFI and TLI value >0.95, and an RMSEA value <0.05 as a good fit of the model (28). Path coefficients and correlations were reported as standardized estimates. All analyses were performed using Mplus version 5.0.

RESULTS

Descriptive Statistics. The average age, weight, height, and BMI of the participants in each group were approximately 10.38 years, 56.77 kg, 144.69 cm, and 27.18 kg/m^2, respectively. There were no significant differences between the intervention and control groups in any of the demographic and dependent variables in the pretest: Wilks' lambda F (12, 0.55)=1.11, p=0.42; see Tables 1 and 2 for means and standard deviations. The result of Box's M test was not significant, F (78, 184.67)=1.19, p=0.012. The univariate test also confirmed that there was no significant difference between the groups for every dependent variable in the pre-test (all, p>0.05). The mean number of steps taken by the experimental group from weeks 1 to 8 is shown in Figure 2.

Main effects of the intervention. The MANOVA using Pillai's trace showed that there was a significant interaction effect of intervention groups classified by testing period on all dependent variables (F (7, 0.97)=85.54, p<0.01, Eta=0.97). Hotelling's T^2 was used to follow up on the interaction effect of groups classified by testing period on all dependent variables. The test results using Pillai's trace showed that the main effects of the intervention on the dependent variables were significant (F (7, 0.03)=100.63, p<0.01, Eta=0.97). The results of Box's M test were significant (F (28, 57.00)=1.43, p<0.05). To assess which dependent variables contributed to significant difference, the univariate test using Pillai's Trace was used, and it showed that the main effects were observed on METs-Steps (p<0.01, Eta=0.93); MVPA (p<0.01, Eta=0.50); and self-efficacy (p<0.05, Eta=0.22), see Figure 3; however, no main effects of the intervention were observed on body fat (p=0.41), cardiovascular endurance (p=0.11), SB (p=0.22), or LPA (p=0.31), see Figure 4.

Mediation testing. A path analysis was conducted to test the linkages among self-efficacy, MET steps, and MVPA. Each model demonstrated an acceptable fit (Figure 5). For METs-Steps, path analysis showed that self-efficacy did not significantly mediate the effect of the intervention on METs-Steps, with an estimated standardized indirect effect of 0.04 (95% percentile bootstrap CI (-0.03, 0.10)), and a standardized direct effect of 0.93 (95% percentile bootstrap CI (0.85, 1.00)). The intervention explained 94 percent of the variance in METs-Steps. For MVPA, path analysis showed similar results, with an estimated standardized indirect effect of 0.11 (95% percentile bootstrap CI (-0.06, 0.28)) and a standardized direct effect of 0.60 (95% percentile bootstrap CI (0.32, 0.89)). The intervention also explained 57 percent of the variance in the MVPA.

Table 1. Participant's characteristics

Variables	Intervention group	Control group
	Mean±SD	**Mean±SD**
Sex (No.)	Male=9, Female=9	Male=10, Female=5
Age (Year)	10.50±1.043	10.27±.961
Weight (Kg.)	61.19±17.55	55.11±14.137
Height (Cm.)	145.22±22	145.13±9.576
BMI (Kg/m^2)	28.52±6.39	26.86±6.83

Table 2. Mean score of outcome variables

Variables	Intervention group Pre-test Mean±SD	Intervention group Post-test Mean±SD	Control group Pre-test Mean±SD	Control group Post-test Mean±SD
Body fat (%)	29.627±4.42	30.92±4.46	28.864±2.74	29.41±2.57
3S/D test (reps)	243.93±63.91	312.67±51.33	234.71±59.27	282.57±47.05
METs (kcal)	1.55±0.10	3.16±0.36	1.59±0.13	1.47±0.11
Steps (steps/day)	6465.00±1096.82	13632.07±932.22	7144.14±1572.74	5786.86±1383.89
SB (min/week)	308.34±18.87	327.32±39.17	290.45±43.73	337.76±37.33
LPA (min/week)	159.52±17.98	154.66±34.08	169.45±32.52	149.49±32.18
MVPA (min/week)	37.29±12.87	70.57±22.04	42.69±10.65	31.34±9.25
Self-efficacy (scores)	54.67±6.96	61.07±7.66	53.71±6.85	53.86±5.69

Data are shown as mean±standard deviation; 3S/D test: 3-min step up and down test; SB: sedentary behavior; LPA: light physical activity; MVPA: moderate to vigorous physical activity.

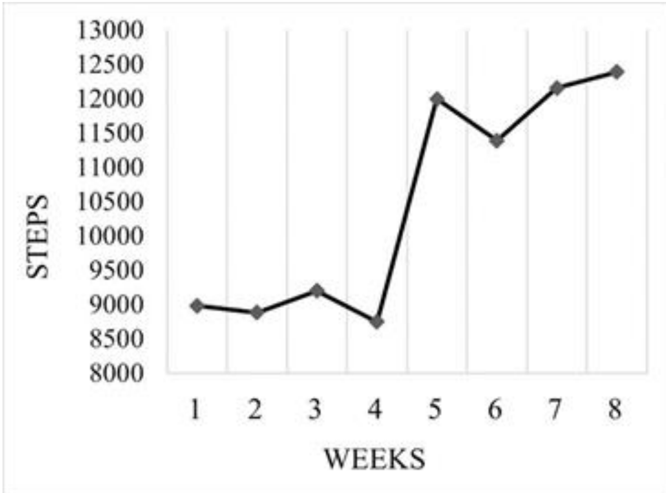

Figure 2. The average number of steps taken per week of the intervention group.

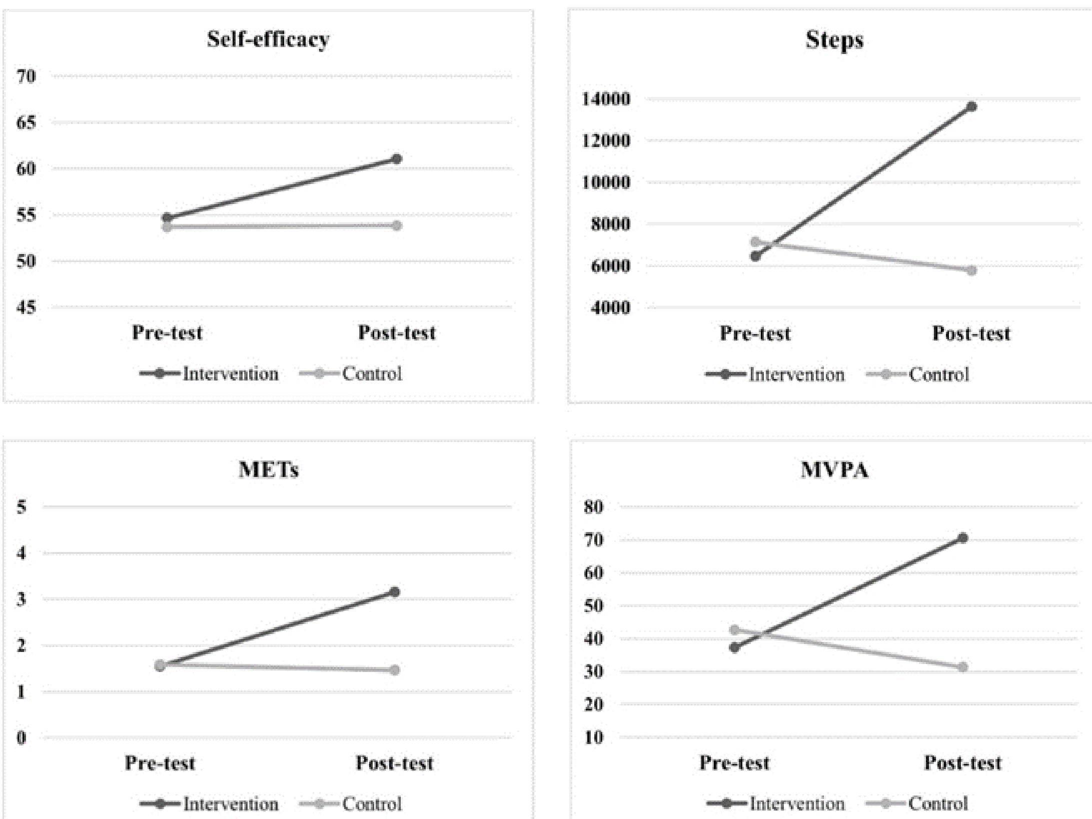

Figure 3. Self-efficacy, steps, METs, and MVPA values between groups were significantly different (all $p<0.05$).

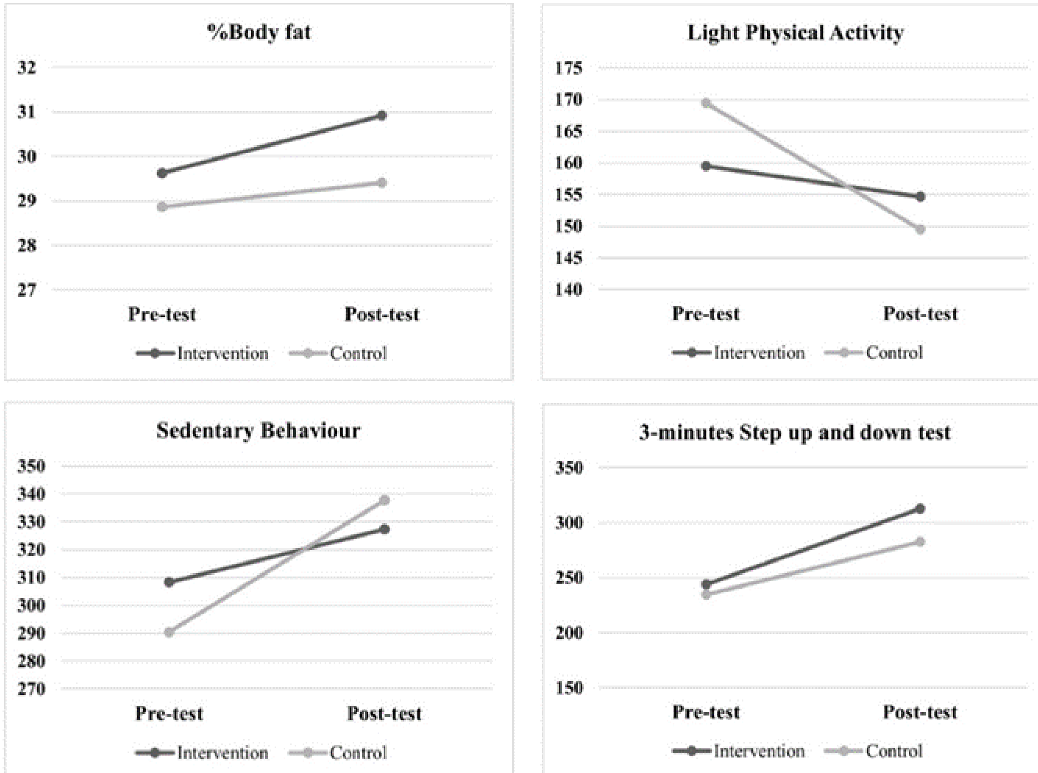

Figure 4. %body fat, LPA, SB, and cardiovascular endurance values between groups were not different (all, p>0.05).

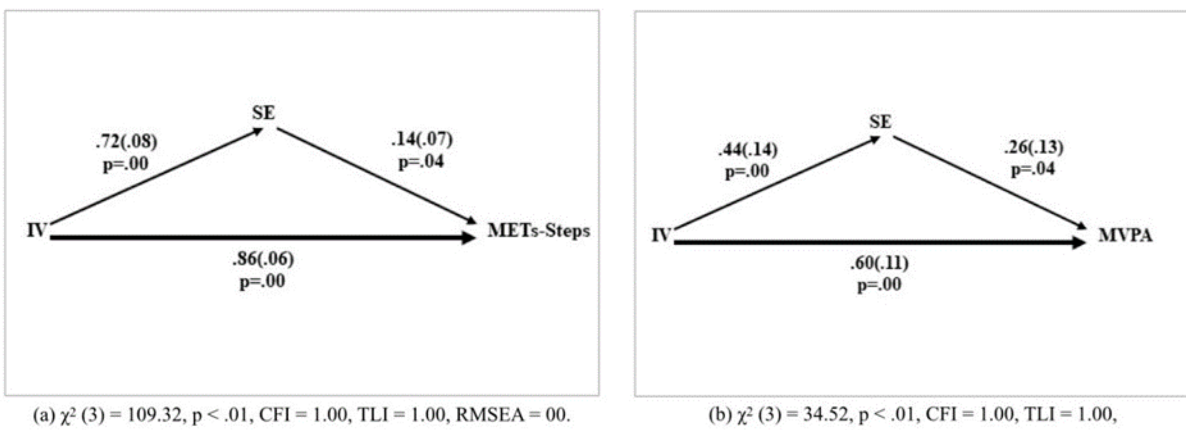

Figure 5. Path analyses demonstrating mediation effects of self-efficacy on METs-Steps (a) and MVPA (b). CFI: comparative-fit index; PA: physical activity; SE: self-efficacy; RMSEA: root mean square error of approximation; TLI: Tucker-Lewis index.

DISCUSSION

Self-efficacy-based walking interventions can increase self-efficacy, number of steps, METs, and the MVPA among overweight students. However, the intervention did not affect body fat percentage, cardiovascular endurance, SB, or LPA. The intervention was designed based on self-efficacy theory, goal setting, and self-monitoring. The researchers used practical strategies for performance accomplishment, vicarious experiences, verbal persuasion, and emotional arousal in the intervention, which included the following: children received information about their steps and the steps of role models, started taking steps at minimum levels, increased the number of steps at a low rate, recorded their steps every week, and received positive feedback about their steps each week. Accordingly, these strategies have a positive effect on PA (2).

Mediation testing revealed that the increase in PA (i.e., steps, METs, and MVPA) was the direct result of the intervention. The major contributing factor to the increase in PA may be the effect of the targeted intervention. Students were required to attach a pedometer and record the number of steps taken each week as they continued to increase their steps according to the goals set (see Figure 2). This indicates that the students set and achieved their goals. This allowed students to gradually change their behavior and increase their PA. According to Tully and Cupples (2011), setting a goal of walking or accumulating 10,000 steps per day results in increased PA levels (29). In addition, walking is easy and convenient and can be incorporated into a daily routine. This is consistent with the findings of Harrington, and Arena, who found that walking at least 10,000 steps per day was beneficial to health (5).

The intervention did not affect body fat percentage or cardiovascular endurance. While the intervention significantly increased PA levels, it did not reduce the percentage of body fat or increase cardiovascular endurance. These results are consistent with those of a previous study of university students that reported that the intervention could promote PA but did not change cardiovascular fitness (23). The intervention did not affect % body fat; this may be because there are physical environmental factors inside and outside the school that are not conducive to controlling student behavior. This is something that is difficult to control or may not change in the context of the surrounding school environment, such as the sale of inappropriate school meals or foods high in fat and energy. Accordingly, the increase in PA levels over eight weeks did not cause physiological changes in the body.

The effect of the walking intervention on the PA level is not influenced or explained by changes in self-efficacy. Even though the walking intervention may affect both PA level and self-efficacy separately, the changes in self-efficacy were unable to fully explain the observed differences in PA level brought on by the walking intervention. As a result, it indicates that the association between the walking intervention and PA level is a direct relationship rather than one that is mediated by self-efficacy. This may be because the program used stepwise goal setting and monitoring. The increase in self-efficacy did not result in an increase in PA levels, which is consistent with the findings of Schunk (1984), who found that knowledge influences behavior; however, knowledge alone cannot comprehensively explain the behavioral expressions of individuals (30).

CONCLUSION

Self-efficacy-based walking programs can improve several outcomes for overweight children. The student's confidence and motivation to participate in PA have been raised due to the intervention, which has increased steps, METs, and MVPA. The intervention did not, however, increase body fat percentage, cardiovascular endurance, SB, and LPA. The association between the walking intervention and PA level (i.e., MET-Steps and MVPA) is not mediated by self-efficacy. In other words, the walking intervention had a direct impact on the rise in PA levels.

However, some limitations should be mentioned. This research was conducted subject to environmental constraints within and outside the school that were not conducive to controlling the level of PA among students. For example, school-based teaching and learning activities may increase students' PA while participating in interventions. However, when considering the behavior of the control group, it was found that the PA of the control group had not increased. In addition, the distribution of food and drinks in schools, especially foods that are high in fat and energy, and sugar-containing soft drinks or other soft drinks, was not controlled for in this study. As a result, some students may have consumed these types of foods and drinks. Therefore, there was no decrease in body weight.

APPLICABLE REMARKS

- Children's levels of self-efficacy, steps, metabolic equivalents, and moderate to vigorous physical activity increased as a result of the walking intervention. Nonetheless, the influence of the intervention on steps, moderate-to-intense physical activity, and metabolic equivalents was not significantly mediated by self-efficacy. Children's levels of self-efficacy, steps, metabolic equivalents, and moderate to vigorous physical activity were increased as a result of the walking intervention.
- Walking is a basic activity of daily living and can be made simple. Teachers, parents, or other

relevant parties should set up a walking program to help obese youngsters become more active, use more energy, and feel more confident.

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AUTHORS' CONTRIBUTIONS

Study concept and design: Napatsorn Suksong. Acquisition of data: Napatsorn Suksong. Analysis and interpretation of data: Raweewan Maphong. Drafting the manuscript: Raweewan Maphong. Critical revision of the manuscript for important intellectual content: Sonthaya Sriramatr. Statistical analysis: Sonthaya Sriramatr. Administrative, technical, and material support: Napatsorn Suksong and Sonthaya Sriramatr. Study supervision: Raweewan Maphong and Sonthaya Sriramatr.

CONFLICT OF INTEREST

The authors mention that there is no "Conflict of Interest" in this study.

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