Original Article

Effects on Physical Fitness and Stress between Dance Exergame and Home-Based Dance Exercise with Videos in Female Youths with Sedentary Behavior: An Assessor-Blinded Randomized Controlled Trial

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ABSTRACT

Objectives: To compare the effects between dance exergame and home-based dance exercise with videos on physical fitness in female youths.

Study design: an assessor-blind randomized controlled trial.

Setting: Department of Physical Therapy, Faculty of Medicine, Prince of Songkla University, Songkhla, Thailand.

Subjects: Thirty female youths with sedentary behavior.

Methods: This study randomly divided the participants into the exergame group (n = 15), which received a dance exercise program with the Just Dance game, or the video group (n = 15), which received home-based dance exercise with videos. The exercise program for both groups started with 30 minutes, 5 times a week for two weeks then increased to 50 minutes, 3 times per week until the end of the program. Body mass index, percentage of body fat, muscle endurance, muscle strength, flexibility, agility and stress were measured at baseline, and then after 6 weeks of the exercise programs.

Results: After the 6-week program, the exergame group showed improvement in all physical fitness outcomes, while the video group showed no difference in body mass index, percentage of body fat or agility. When comparing between the exergame and the video groups, differences were found in arm and upper body muscle endurance and back muscle strength when compared to the video groups (11 vs 1, *p*-value = 0.012 and 27 vs 20, *p* = 0.032, respectively): but not in stress (3 vs 2, *p* = 0.102).

Conclusions: In female youths with sedentary behaviors, a 6-week program of exercise with dance exergame shows different effects on improving physical fitness when compared with home-based dance exercise with videos.

Keywords: dance exergame, home-based exercise, physical fitness, youth, sedentary behavior

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Introduction

Technology has made life more comfortable, but on the other hand, it has also resulted in reduced activity and energy consumption. This has led to a reduction in physical activity, and an escalation of sedentary behavior.[1] The World Health Organization (WHO) reported that 1 in 3 females had inadequate physical activity.[1] In Thailand, more than 1 in 5 female youths do not exercise or play sports; resulting in less physical activity than men.[2] Physical activity is important for both physical and mental health. A previous study found that most medical students lacked physical activity, and did not exercise.[3] This report reasoned that studying hard resulted in a lack of time and partners; wherein, the female students changed from positive to more negative health behaviors and lifestyles; resulting in decreased physical performance.[3]

There are many exercise programs for improving physical activity. Exercise motivation needs to be fun and interesting; hence, dancing is the most popular and widely used form of physical activity among young females; as it is more fun than traditional exercise.[4,5] Dance games involve both upper and lower body movements following the rhythm of the music, which contributes to body coordination while moving, and creates more energy than other exercises.[6,7] Exergames are an alternative exercise that uses body movements in conjunction with simulations from the game, which are effective in increasing physical activity in young people.[7,8] Using exergames can improve muscle endurance, muscle strength, cardiovascular fitness and psychological outcomes in healthy youths.[9] One study found that energy consumption, intensity and physical activity in dance games were similar to, or even greater than, standard exercises.[10] Just Dance is a popular dance game that requires interaction between the players and the game through feedback. The newer dance games

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focus on natural dancing using the player's own body as a controller. Players simply dance according to the characters in the game, and use their whole body to perform real dance movements.[11] Because of the synchronous movements to the tempo of music and animation players feel like they are playing a game, rather than exercising.[12,13]

Previous studies of dance games have focused on their effectiveness in energy expenditure and cardiovascular fitness.[6,7] However, it also has a positive impact on physical performance and mental status. Young people are interested in playing the exergame because it is fun, makes them feel as if they are playing a game rather than exercising, and also keeps their bodies moving more than traditional exercises.[14] Although, in Thailand, there are many different dances, a dance exergame has not been used to promote and prevent health problems. Therefore, the effect of a dance exergame on physical fitness and stress in female youths with a sedentary behavior needs to be further explored.

Methods

Study design

This prospective randomized controlled trial (RCT) was approved by the Human Research Ethics Committee (HREC), Faculty of Medicine, Prince of Songkla University (EC 60-422-30-2), and was registered at the Thai Clinical Trials Registry (TCTR20180420003) before the study commenced. The study was conducted at the Department of Physical Therapy, Faculty of Medicine, Prince of Songkla University; from January to May, 2018.

Participants

The participants in this study were recruited by posters and internet advertisements. Inclusion criteria were female youths (15-24 years) with a sedentary behavior (mostly sitting or lying in various activities during the day: excluding sleep for an average of at least 8 hours per day, and those exercising less than 150 minutes per week). The participants who had contraindications to exercise, according to the Physical Activity Readiness Questionnaire (PAR-Q), or vision problems that affected their visibility of seeing the animation were excluded from our study.

The sample size was calculated from a pilot study of 10 subjects using the following formula:[15]

$$N_{group} = \frac{\left(z_{1-\frac{\alpha}{2}} + z_{1-\beta}\right)^2 \left[\sigma^2{}_{exergame} + \sigma^2 \frac{video}{r}\right]}{\left(\mu_{exergame} - \mu_{video}\right)^2}$$

This study estimated the basis of arm and upper body muscle endurance of the 30 second, modified push-up test, at six weeks of program completion. The exergame group means = 2.74, SD = 5.50, while video group means = 0.70, SD = 2.90; and assuming 80.0% power and 5.0% significance, to detect any clinically meaningful difference between groups on arm and upper body muscle endurance. Based on this calculation, the sample size was 12 people per group, so when combined with a 20.0% dropout rate, a minimum sample size of 15 people in each group was required for this study.

Randomization and blinding

The participants were randomly divided into the exergame group or the video group by a computer, using block randomization with concealed allocation. Two physical therapists (TC, PP) who assessed were blinded to the exercise allocation.

Intervention

The exercise programs in both groups were divided into two phases: first and second week; the participants exercised five days a week, and in weeks three to six participants exercised three days a week. The programs consisted of 5 minutes of warm-up and 20 minutes of workout for the first two weeks; increasing to 40 minutes for the next four weeks until the end of the program, with a cool-down period at the end of the exercise session (Table 1).

For the selection of songs in the programs using a variety of rhythms with effort determined by sweat droplets specified for each song in game. The researcher determined that 2 sweat droplets were used as warm-up and cool-down sessions, while 3 sweat droplets were used for workout sessions (Table 1). The sequence of songs was switched according to the difficulty of the choreography.

Before starting the programs, the researchers instructed participants to assess themselves on the level of intensity during exercise by rating their perceived exertion. These were defined as a moderate (level 12-14) or by a verbal level. If they became too tired while dancing, the participants kept stomping their feet until their tiredness subsided and were able to continue dancing again. In compliance with the exercise program, the participants received a logbook to check and record other physical activities; via time in hours spent each day. In the home-based dance exercise with videos group, the participants were given a logbook to record their hours of dance and their level of exhausted after each session.

The exergame group exercised with the Just Dance game (Ubisoft, Montreuil, France) connected to an Xbox One X device with a Kinect camera and motion detection system, by copying the movements of characters displayed on the screen in the research room. The physical therapist (KJ) who is a trainer determined the participant's standing position before the exercise for a more comprehensive capture (Figure 1). The participants were instructed on how to play, and also watched a demonstration. After this, the trainer selected the music before four participants stood in the designated positions to start dancing (Figure 1). During and after playing the game, the participants received feedback and score levels.

Table 1. Exercise programs of the exergame and the video groups

Phase	Session	Effort	Week	Time (minutes)	Genre of song	Tempo (beats per minute)
First	Warm up	2 sweat droplets	Week 1-6	5	Country pop Dance pop	119-120
Second	Work out	3 sweat droplets	Week 1-2	20	Korean pop Tango Hip-hop Electronic dance	125-128
			Week 3-6	30	Dance pop Electronic dance Rhythm and blues	128-153
Third	Cool down	2 sweat droplets	Week 1-6	5	Latin pop Country pop	123-124

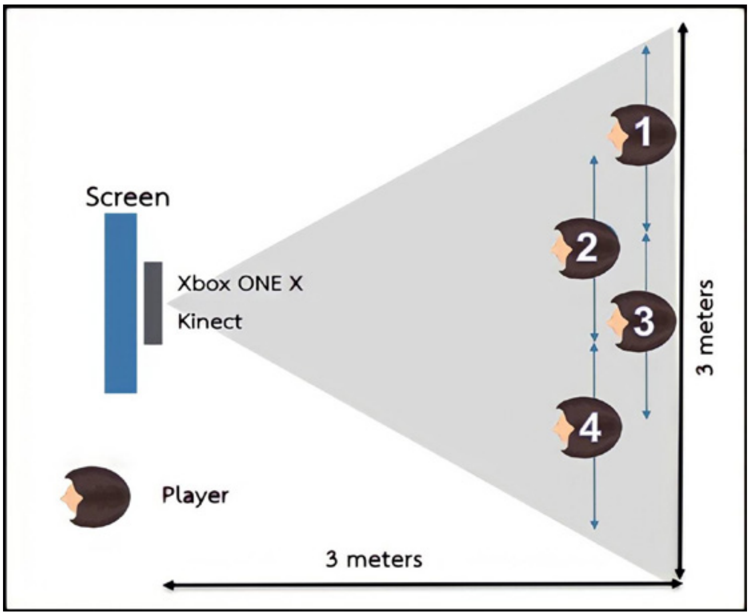

Figure 1. Device setting for motion detection and numbers representing the player's standing position

In the video group, the participants received home-based exercise with video files of dance containing images, songs and choreography, similar to the exergame group. To equalize the intensity and duration of exercise for both groups at different phases, another physical therapist (NT) who guided the video group gave video files to them two times; in the first and the third week (Table 1).

Outcome measurements

This study used the following outcome measures: arm and upper body muscle endurance were measured by using the 30 second modified push-up test; performed on a mat in a prone position on their hands and knees. When the participants heard the signal "start", they pushed up and down for as many repetitions as possible at their maximum speed within 30 seconds.[16] The test is to bend the elbows, lower the body until the chest touches the floor, try to keep the back straight all the time, the stomach does not touch the floor, then extend the elbows to push up to the starting position. Only the correct moves are counted.[16] Abdominal muscle endurance was performed on a mat in a supine position, with 90 degrees of knee flexion. The participants bent their bodies and scapular blades off the floor as much as possible within 60 seconds.[16] Leg muscle endurance was measured via the 60-second chair stand test. The participants sat in a chair, without a backrest, keeping both feet flat on the floor a shoulder-width apart, with crossed arms and both hands touching their shoulders. The participants stood up straight, legs stretched, and then sat back down into the starting position as many times as possible for 60 seconds.[16]

Back and leg muscle strength was measured using the back-leg-chest dynamometer test. This test required participants to stand on the base of a dynamometer, with their head and back straight, and both feet parallel and spread the width of their shoulders; with the chain adjusted to fit the participant. For back muscle strength, the participants bowed their heads slightly, stood with legs straight and held the handles. They pulled at full force while stretching their body up. In the leg muscle, strength test, the participants had to bend their knees at an angle of approximately 115 to 125 degrees, hold the handle slightly above the knee, and then exert full traction, while stretching both legs. Both tests were performed two times and the best value was recorded in kilograms (kg).[17] Muscle flexibility was measured using sit and reach tests. The participants sat in a long sitting position with their backs and legs straight. The soles of both feet were attached to the sit and reach box with toes pointing up, both arms were then raised straight in a forward position, with their palms on the sit and reach box. Then the participants leaned forward as far as possible and used their fingertips to push the sliding ruler on the sit and reach box. The test was repeated 2 times; recording the best value.[16] Agility was measured using the zig-zag run. The participants ran around six poles, without their bodies touching them, in a zigzag manner before returning to the starting point as quickly as possible; the time was then recorded (in seconds).[18]

The percentage of body fat was measured by using Omron HBF-306C Handheld (Omron Healthcare, Illinois, United States of America). The researcher filled out the participants' height, weight, age and gender and instructed the participant to stand straight, spread their legs as wide as their shoulders, hold the device on both sides of the control panel and raise it 90 degrees. After pressing the start button, the display showed the percentage of body fat and body mass index.[19]

The stress test used the five-items of stress questionnaire (ST-5); Thai version, which has good validity. It includes 5 items comprising of sleep problems, decrease in concentration, irritability, boredom and do not want to meet people. The cut off score is divided into 3 levels: no problem (score < 4), might have a problem (score 5-6) and have a problem (score > 7).[20] All variables were tested before and at the end of the study at 6 weeks.

Statistical analysis

The data was non normal distribution from Kolmogorov-Smirnov test; thus, presenting the data with median and interquartile range (IQR). The Wilcoxon-Signed rank test and the Mann-Whitney U test were used for non-parametric data. Statistical significance was determined two-tailed $p < 0.050$

Results

Thirty participants were successfully recruited, and enrolled into the study (Figure 2). Age range at the enrollment was 21-23 years of age (Table 2). There was no significant difference in age, participants in the exergame group had a median age of 21, and the control group was 22 years old.

After six weeks of exercise, the comparison between the two groups showed a significant difference in the primary outcome that is arm and upper body muscle endurance ($p = 0.012$) and back muscle strength ($p = 0.032$). The exergame group had a significant improvement in all variables ($p < 0.050$). Most of the participants in the exergame group reported they enjoyed exercising. However, in the video group, there were no significant differences in arm and upper body muscle endurance, agility, body mass index or body fat percentage (Table 3). Participants in the exergame group reported that they enjoyed exercising more with rhythm-based synchronous movements and in-game animations.

Discussion

This study compared the effects of dance exergame versus home-based dance exercise with videos on physical fitness and stress in female youths with a sedentary behavior. At the end of the program, dance exergame showed different improvements in arm and upper body muscle endurance and back muscle strength compared to the home-based dance exercise.

The increase in arm and upper body muscle endurance was consistent with the study of Vojciechowski et al, which found that exergame improves upper extremity muscle endurance in adolescents.[21] According to a study by Ambegaonkar et al, modern or contemporary dance requires vigorous movement and endurance of upper body muscles.[22] Similarly, this study used diverse and modern music; such as, electronic dance, rhythm and blues (R&B) at the highest tempo 153 beats per minute. According to this study, the participants in the exergame group enjoyed exercise and was encouraged to continue exercising. Additionally, they enjoyed

Table 2. Exercise programs of the exergame and the video groups

Variables	Exergame group (n = 15)	Video group (n = 15)	*p*-value
Body mass index (kg/m^2)[a]	21.0 (19.9, 23.1)	22.7 (19.1, 24.4)	0.836
Body fat percentage (%)[a]	28.6 (26.2, 31.1)	27.8 (22.8, 33.3)	0.678
Arm and upper body muscle endurance (time)[a]	7.0 (0.0, 9.0)	0.0 (0.0, 11.0)	0.502
Abdominal muscle endurance (time)[a]	13.0 (6.0, 25.0)	15.0 (0.0, 21.0)	0.519
Leg muscle endurance (time)[a]	39.0 (33.0, 44.0)	46.0 (40.0, 52.0)	0.051
Back muscle strength (Kg)[a]	48.0 (35.0, 58.0)	42.0 (38.0, 49.0)	0.329
Leg muscle strength (Kg)[a]	47.0 (36.0, 61.0)	50.0 (37.0, 58.0)	1.000
Flexibility (cm)[a]	5.0 (-1.0, 9.0)	9.5 (-2.0, 11.5)	0.340
Agility (sec)[a]	22.5 (20.8, 23.2)	22.2 (21.3, 22.8)	0.724
Stress (score)[a]	7.0 (4.0, 8.0)	4.0 (3.0, 7.0)	0.180

$p < 0.050$

[a]Median (Q1, Q3), test statistic by Mann-Whitney U test

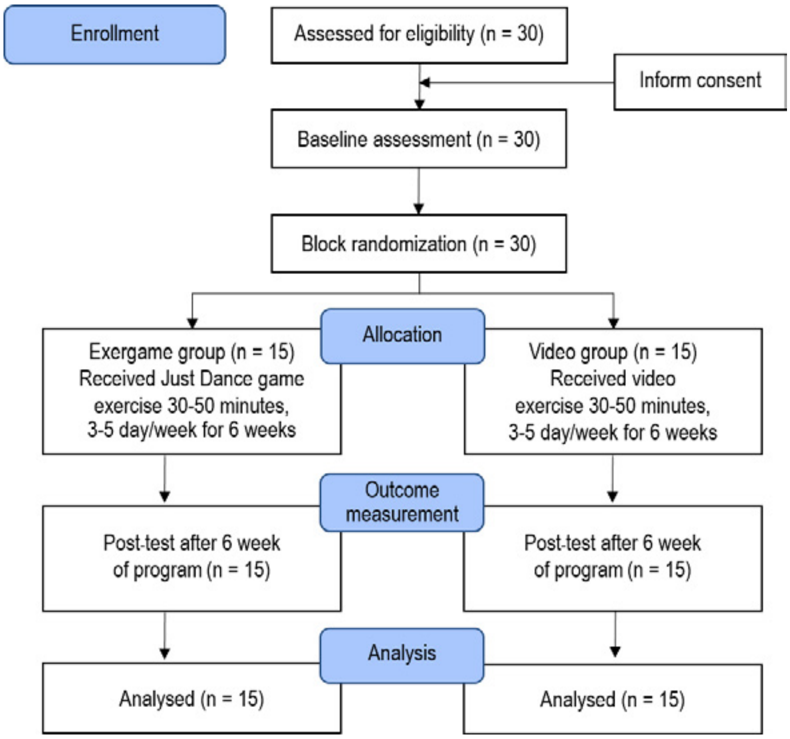

Figure 2. CONSORT flowchart showing participants' progress through the phases of a parallel randomized trial of two groups

Table 3. Comparison of the variables within groups and between groups at baseline and 6 weeks (n = 30)

Variables	Compare within group						Compare between group with post-test
	Exergame group (n = 15)			Video group (n = 15)			
	Pre-test	Post-test	*p*-value[a]	Pre-test	Post-test	*p*-value[a]	*p*-value[b]
Body mass index (kg/m^2)	21.0 (19.9, 23.1)	20.7 (19.5, 24.1)	0.041*	22.7 (19.1, 24.4)	21.9 (19.0, 25.2)	0.887	0.934
Body fat percentage (%)	28.6 (26.2, 31.1)	28.5 (25.1, 30.4)	0.006*	27.8 (22.8, 33.3)	28.0 (23.5, 34.5)	0.733	0.967
Arm and upper body muscle endurance (time)	7.0 (0.0, 9.0)	11.0 (6.0, 13.0)	0.001*	0.0 (0.0, 11.0)	1.0 (0.0, 7.0)	0.405	0.012*
Abdominal muscle endurance (time)	13.0 (6.0, 25.0)	27.0 (15.0, 35.0)	0.002*	15.0 (0.0, 21.0)	20.0 (0.0, 34.0)	0.005*	0.244
Leg muscle endurance (time)	39.0 (33.0, 44.0)	56.0 (50.0, 59.0)	0.001*	46.0 (40.0, 52.0)	54.0 (46.0, 60.0)	0.001*	0.633
Back muscle strength (kg)	48.0 (35.0, 58.0)	61.0 (52.0, 67.0)	0.008*	42.0 (38.0, 49.0)	51.0 (41.0, 56.0)	0.033*	0.032*
Leg muscle strength (kg)	47.0 (36.0, 61.0)	71.0 (57.0, 79.0)	0.001*	50.0 (37.0, 58.0)	64.0 (47.0, 68.0)	0.002*	0.097
Flexibility (cm)	5.0 (-1.0, 9.0)	8.5 (5.0, 12.0)	0.001*	9.5 (-2.0, 11.5)	11.0 (2.0, 13.0)	0.009*	0.648
Agility (sec)	22.5 (20.8, 23.2)	23.7 (21.1, 24.0)	0.009*	22.2 (21.3, 22.8)	22.8 (21.9, 23.1)	0.201	0.372
Stress (score)	7.0 (4.0, 8.0)	3.0 (2.0, 6.0)	0.028*	4.0 (3.0, 7.0)	2.0 (1.0, 4.0)	0.006*	0.102

Median (Q1, Q3), *$p < 0.050$
[a]Wilcoxon-Signed rank test; [b]Mann-Whitney U test

dancing with other players, and that it could be based on scores and feedback on the accuracy of their choreography. On the other hand, the participants in the video group had to dance alone at home; which was less fun and exertive. A previous study, by Jerrold et al, studied muscles contractions while dancing by electromyography (EMG), and found that the upper body muscles were active; particularly the biceps and triceps muscles.[23] When analyzing the choreography in this study, upper limb movements were mainly performed by the deltoid, pectoral, triceps, and biceps muscles. The reasons mentioned above concluded that the exergame group improved arm and upper body muscle endurance differently than the video group. Although there were no significant differences between the two groups in abdominal and leg endurance, both groups found significant differences before and after training. The muscle contractions during dance showed that the rectus abdominis, obliques, quadriceps and hamstrings muscle have a lot of contraction.[23]

In addition, this study found that after 6 weeks the dance exergame group had different strength of back muscle than the video group. Although no differences were found between groups in leg strength, both groups showed significant differences before and after training. The dance exergame has a positive effect on fast reaction times, coordination and strength.[24] Dancing can improve back muscle strength due to continuous isometric contractions with fast-twitch concentric and eccentric contractions to control balance from several movements.[25] As dance exergame has free dance games and creates fun from the characters in the game as well as from the feedback and scores; which reflect the dancers, as they move their bodies as one with the characters on the screen.[11] Dance exergame sets the level of energy exertion of medium or vigorous. The length of the song and the complexity of the choreography process can change the physical challenge.[26] The fast tempo of songs and choreography is bound to encourage more fast-twitch fiber muscle contraction, and result in improved muscle strength.[27] Dancing in the research room with other players to make it even more fun, resulted in constant and consistent full exertion. Providing real-time feedback so players can adjust their movements to correct them. The increased expertise made dancing better, moving more vigorously than home-based exercise with video. However, in the past, the effect of dance exergame on back muscle strength has not been investigated directly.

Other physical fitness variables were not significantly different between groups. but muscle flexibility differed significantly in both groups before and after training. This was consistent with the study on the effects of dance exercise programs in sedentary, female university students, which also showed a similar increase in muscle flexibility.[28] Moving their body to the rhythm of the music is dynamic stretching through the stretch reflex to prevent changes in muscle length and maintain muscle tension.[29] In contrast, this study showed that decreased agility, possibly caused by the breaks between each song, meant that the participants had to keep marching, which may hinder continued movement. Decreasing agility may be due to inconsistency between the choreography and zigzag testing skills. Therefore, practical skills from intervention cannot be transferred to outcome measurements. A study on the effects of active video games in adolescents explains that non-stop shuffles require sustained movements sufficient for motor and nervous system adaptation; resulting in improved agility,30 and that dancing continuously for 3 months can improve agility.[31] After 6 weeks of training, both body fat percentage and body mass index decreased in the exergame group, but increased in the video group. Dance exergame in adolescent girls were found to significantly reduce total body fat and subcutaneous adipose tissue in the abdomen and legs.[32] Therefore, the percentage of body fat also decreased in the exergame group.

The present study compared stress levels between groups and found that there were not significantly different, but they differed before and after training within group. This was consistent with a study of medical students in Thailand, in which dance exercise can decrease stress; especially severe stress or major depression.[33,34] At least 30 minutes of continuous exercise stimulates the hypothalamus and pituitary glands to release endorphins, which have stress-reducing properties. Additionally, the serotonin, dopamine, and norepinephrine produced, also helps control mood, stress and relieves depression.[35]

Dance exergame may be feasible and acceptable in youth. It should be promoted through school activities. If adapted to home activities, parents should be informed about the benefits of dance exergame and guide them in making future purchase decisions. In Thailand, there are still widespread restrictions on access to dance exergame. Finally, the researchers recommend that any exercise that is interesting, fun and motivating can encourage youths with a sedentary behavior to be more physically active.

The limitations of this study were that all the female youths were from one location. The home-based dance exercise with videos might have a design bias as the participants in this group had to exercise alone, no supervision or feedback like in the exergame group, and youths prefer a group exercise to an individual exercise. To reduce the design bias, the dance exercise with videos should be conducted in group. Moreover, the sample size was rather small to confirm statistical significances of all outcomes mentioned as the sample size calculation was based on the arm and upper body endurance only. Additionally, heart rate was not measured to determine exercise intensity; it was just a self-assessment by the Borg scale. Long-term follow-up of both exercise programs may show changes more clearly for other variables. This study also did not track whether the participants continued to use dance after the study ended. Further studies should include other populations, more intensity of exercise, and long-term follow-up.

Conclusions

After six-week of dance exergame and home-based dance exercise with videos can improve muscle endurance, muscle strength, muscle flexibility and decrease stress in female youths. However, dance exergame seems more effective in abdominal muscle endurance and back muscle strength. It is recommended that any exercise that is interesting and fun can motivate sedentary youth to get more exercise.

Disclosure

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