EFFECT OF GROUP SQUAT EXERCISES TO PERFORM ACTIVITY OF DAILY LIVING (ADL) IN ELDERLY PEOPLE

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ABSTRACT: The general objective of the study was to assess effects of group squat exercise on performance of activities of daily living and physical independence in elderly people in Health Centers in Bangkok. This was a quasi-experimental study, with pretest-posttest design in an intervention and a control group. The study used simple random sampling by lottery without replacement to select the participants in both groups. In the intervention group, out of 41 participants, 36 completed the program to the end. In the control group, out of 41 participants, 35 completed the program to the end. Data were collected by standardized interviewer-administered questionnaire, and analyzed by percentage, arithmetic mean, standard deviation, paired t-test, and independent t-test.

The results showed a trend for better performance of activities of daily living, as well as a trend for better performance on physical independence function, in the intervention group than the control group. The intervention group had lower (better) time-get-up-and-go test mean scores than the control group (P<.05), as well as a higher (better) chair stand test mean score (P<.05). There was no significant pre-post difference between groups in the standing balance test in right and left legs.

The results showed that the practice of specific squat exercises in groups, and on a regular basis, has benefits for elderly people, therefore playing an important role in mastering activities of daily living and keeping physical independence. Furthermore, the squat program was unanimously well accepted and appreciated, and no injuries were registered.

Keywords: Squat Exercises, Activity of Daily Living, Physical Independence and Elderly

INTRODUCTION

Regular physical activity is a key component of healthy aging. Of all groups, the elderly have the most to gain by being physically active [1]. The risk of physical independence and loss of the ability to perform activities of daily living (ADL) are decreased with regular physical activity [2]. For elderly people, it is especially important to maintain functional abilities and performing activity of daily living, with the assistance of appropriate physical activity. One type of exercise that may be beneficial in the elderly is squat exercises. The researcher studied the effects of a daily group squat exercise program on the ability to perform activities of daily living and physical independence in elderly who were 60 years of age and older. Also, researcher examined levels of perceived self-efficacy for exercise among those who regularly participated in group squat exercises or conventional exercises to determine whether there were differences between these groups. The researcher is unaware of any study to date that has investigated the effects of group squat exercises in a quasi-experimental study design on activity of daily living and physical independence among the elderly in Thailand. It is expected that the findings of the study would be alternative exercise programs to better perform activities of daily living among the elderly beyond the studied health centres. The findings may be used by physicians, therapists, and exercise specialists to design safe and efficient activity programs for the elderly Thai population. Furthermore it may become an interesting alternative exercise program for elderly people in all kinds of elderly clubs.

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MATERIALS AND METHODS

Sample and Sample size

This was a quasi-experimental study with pretest-posttest design in an intervention and a control group. The study population were elderly persons (both male and female), who were members of the Elderly Clubs of Health Centres 15 and 19, Bangkok Metropolis. The intervention group were elderly people from Health Center 19 whereas the control group were elderly people from Health Center 15. 245 and 284 elderly persons, respectively, were members of these Clubs at the time of study.

Inclusion criteria were as follows: a) the participants have to be 60 years or older, b) can walk independently, c) have the ability to understand basic motor command, and d) agree to participate in the

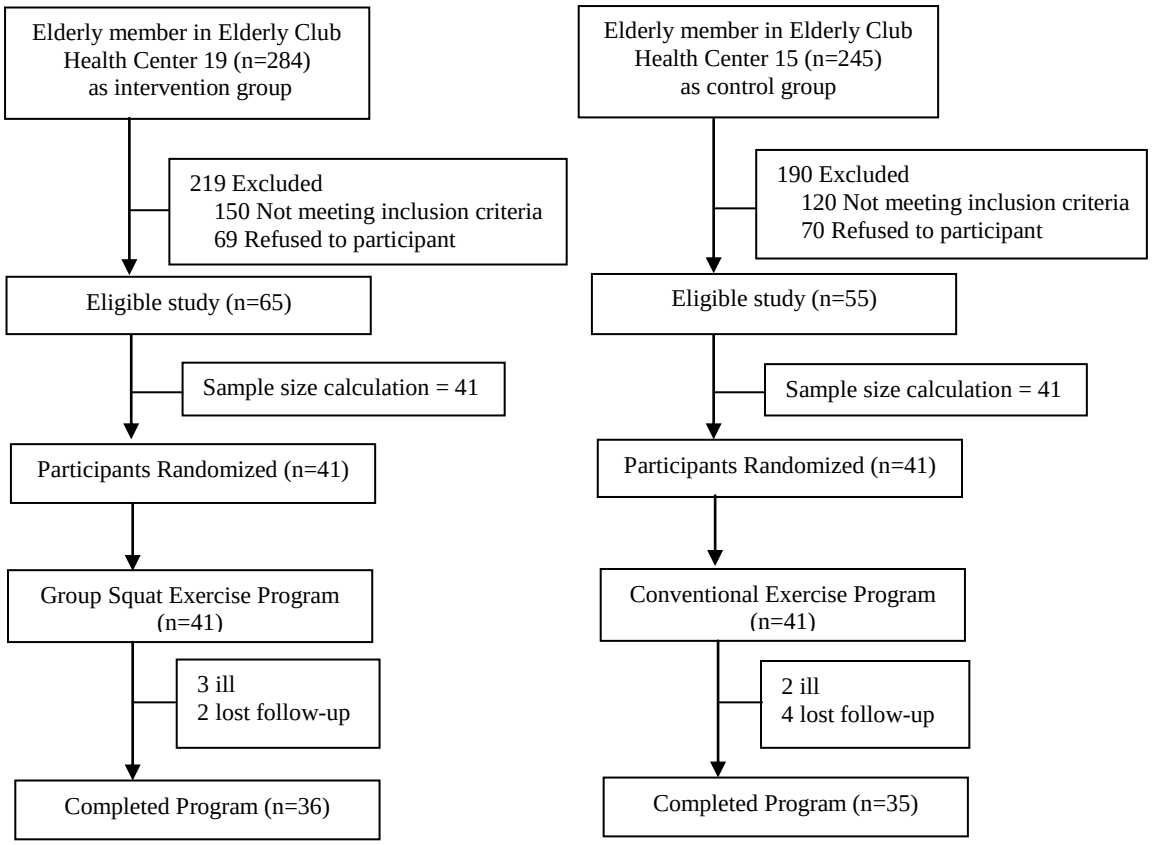

Figure 1 Participant breakdown

study. Exclusion: participants are diagnosed with psychiatric conditions, who have a cardiac event and/or procedure within the past 6 months, who exhibit chest pain or shortness of breath, who have severe knee problems, who are unable to provide their own transportation, who have severe visual impairment, who have severe hearing loss or speech disorder, who have a co-morbid condition that would impair their ability to safely exercise, or who refuse or are reluctant to undergo the physical test prior to baseline testing.

A between-groups difference in success rate of 25% [3] was considered to be statistically significant. The researcher needed 37 experimental subjects and 37 control subjects to be able to reject the null hypothesis that the failure rates for experimental and control subjects are equal with power = 0.9. The Type I error probability associated with this test of the null hypothesis is 0.05. Finally, the researcher added 10% for dropouts and missing data. Hence, total number of participants was 41 elderly persons in each arm. In the intervention group, out of 41 participants 36 persons (87.8%) completed the program to the end. In the control group, out of 41 participants 35 persons (85.3%) completed the program to the end. The total of sample on the start of the program was 82 people, and 71 completed the program (Figure 1). Elderly of both groups were recruited by simple random sampling by lottery without replacement, then matching at the similar age and gender to reduce confounding of results.

Intervention

The Intervention group (the Group Squat Exercises program)

The group squat exercises program was monitored by a trained leader of elderly people, member of the Elderly Club in Health Center 19. There are sixteen variations of the squat. In this study, the researcher selected four kinds of squat to adapt for elderly people i.e. chair squat, single leg squat, pistol squat, and jumping squat. Moreover, these squats are an easy exercise, no expensive equipment or annual gym fees are required, are safe for untrained subjects, and have only minimal risk of delayed-onset muscle soreness [4]. The group squat exercises group met for 15-30 minutes, 3 times per week, for 8 weeks. Each session of group squat exercise consisted of a 5 minutes' warm-up, followed by specific group squat exercises. The session ended with stretching and relaxation exercises for 5 minutes. The program was conducted from January to March, 2011.

The Control group (the Conventional Exercise program)

The participants assigned to the control group received conventional exercise program with no additional attention. This group was monitored by leaders of Elderly Club 15. The control group met

for 20-30 minutes three times per week for 8 weeks. Each session of conventional exercise consisted of a 5 minutes' warm-up, followed by conventional exercises, the session ended with stretching exercises for 5 minutes. Like the experimental program, the conventional exercise program was conducted from January to March, 2011.

Measurement Tools

The construct interviewer-administered questionnaire was submitted to three experts for content validity, then was revised and pre-tested in 30 elderly who had similar characteristics to the full-scale study participants. Questions were then analyzed for their reliability using Cronbach's Alpha. Reliability for ADL was 0.88 and perceived self-efficacy exercise was 0.96. The questionnaire was administered before and after the intervention and consisted 5 parts, as follows:

Part 1: Socio-demographic characteristics;

Part 2: Questions assessing previous 7 days of exercise. Questions were about practice of exercise in previous 7 days. If they practiced, they were asked about the frequency, intensity and time. The questionnaire was adapted from Kusinitz and Fine [5];

Part 3: Questions assessing activity of daily living (ADL) were adapted from Mohoney and Barthel [6]. The Barthel index of ADL assesses the ability of participants to perform 10 ADL. The index assesses the ability of participants to perform 10 ADL: eating, grooming, transfer, toilet use, dressing, stairs, bathing, mobility, bowels, and bladder. Eating and grooming were graded as "dependent or need help someone care" and "independent". Transfer and mobility were graded as "unable or immobile", "needs major help", "needs minor help", and "independent". Other ADLs were graded as "dependent", "needs help", and "independent". Summation of item scores yields a range of possible scores of 0 to 20. Zero means totally dependent in all aspects and 20 means totally independent in all aspects;

Part 4: Questions assessing perceived self efficacy of exercise, adapted from Theppipit [7] and Sriposhang [8], consisting of 13 questions on ability for health exercise in which the elderly felt confidence: having skill for participating by themselves, ability in self-assessment and giving support to social healthcare as an issue connected with the exercise program. The questions were positive questions and each question had a three-point rating scale asking the respondents to indicate their degree of agreement (1, no; 2, uncertain; 3, yes);

Part 5: Satisfaction questionnaire toward squat exercises program, as adapted from Theppipit [7]. There were 10 positive questions and each question was ranged in a five-point rating scale to indicate the degree of agreement (1, lowest satisfaction; 2, low satisfaction, 3, middle satisfaction; 4, high satisfaction; 5, highest satisfaction). This part was administered only in the experimental group after completion of the squat exercise program.

Physical independence was measured by three tests:

a) The timed "Get-up-and-go Test" is an assessment that should be conducted as part of a routine evaluation when dealing with older persons. It is measuring walking speed, agility and balance while moving. This test was administered using the procedures of Podsiadlo and Richardson [9]. Low scores correlate with good functional independence; high scores correlate with poor functional independence and higher risk of falls.

b) Chair Stand Test is a physical performance test used to assess lower-extremity function. Lower-extremity function has been shown to predict subsequent development of disability because it reflects the effects of chronic disease, coexisting conditions, and overall physiologic decline. This test was adapted from Jones and Rikli [10]. The score is the number of completed chair stands in 30 seconds.

c) Standing Balance Test is the measurement of functional balance by the person standing on one leg for as long as possible. This test was adopted from Bohannon, Larkin, Cook, Gear and Singer [11].

Data Analysis

After reviewing the data for completeness, the data were encoded and processed for statistical analysis using SPSS version 17. Data analysis was performed as follows:

1. Descriptive statistics of frequency, percentage, mean, and standard deviation were calculated for socio- demographic characteristics, self efficacy level and satisfaction level toward the group squat exercise program.
2. Paired t-test was used to compare the ADL scores, physical independence, and Perceived self-efficacy of exercise of individual subjects before and after the program, within the intervention and control groups.
3. Independent t-test was used to compare ADL score, physical independence, and perceived self-efficacy of exercise between the intervention group and control group.

A critical level of 0.05 was chosen to indicate statistical significance.

Ethical Consideration

The experimental protocol was approved by the Committee on Human Rights Related to Human Experimentation of Chulalongkorn University No 126.1/53 on January 18, 2011. Informed consent for intervention and control group had to be signed by subjects prior to their entry into the study.

Table 1 General characteristics of the intervention and control groups

General Characteristics	Intervention group (n=36) n (%)	Control group(n=35) n (%)	p-value
Gender			.962
-Male	5 (13.9)	5 (14.3)	
-Female	31 (86.1)	30 (85.7)	
Age (Mean±SD)	69.8±5.4	68.2±5.7	.686
Marital status			.058
-Single	2 (5.6)	4 (11.4)	
-Married	17 (47.2)	23 (65.7)	
-Widowed	14 (38.9)	7 (20.0)	
-Divorced or Separated	3 (8.3)	1 (2.9)	
Education level			.009
-Less than primary school	1 (2.8)	3 (8.6)	
-Primary school	10 (27.8)	18 (51.4)	
-Secondary school	5 (13.9)	5 (14.3)	
-High school or diploma	9 (25.0)	5 (14.3)	
-Undergraduate	8 (22.2)	2 (5.7)	
- Higher undergraduate	3 (8.3)	2 (5.7)	
Residence			.466
- housing with no floor	3 (8.3)	5 (14.3)	
- housing with two floor	20 (55.6)	13 (37.1)	
- brick house with three floor	9 (25.0)	11 (34.4)	
- brick house with more than three floors	4 (11.1)	6 (17.1)	
BMI (kg/m^2) (Mean±SD)	23.64±2.71	23.69±3.81	.920
WHR (Gw / Gh)			.563
-Small waist	7 (33.4)	10 (28.6)	
-Normal waist	26 (58.3)	17 (48.5)	
-Big waist	3 (8.3)	8 (22.9)	
-Fat	0 (0.0)	0 (0.0)	
Exercise frequency			.663
< 3 time / week	1 (2.8)	6 (17.2)	
≥ 3 time / week	35 (97.2)	29 (82.8)	
Exercise duration			<.001
< 30 minutes / time	2 (5.6)	15 (42.9)	
≥ 30 minutes / time	34 (94.4)	20 (57.1)	
Exercise intensity			.253
-No change in pulse resting	10 (27.8)	8 (22.9)	
-Little change in pulse from resting	13 (36.1)	9 (25.7)	
-Slight increase in pulse and breathing	9 (24.9)	12 (34.3)	
-Moderate increase in pulse and breathing	2 (5.6)	2 (5.7)	
-Intermittent heavy breathing and sweating	2 (5.6)	4 (11.4)	
-Sustained heavy breathing and sweating	0 (0.0)	0 (0.0)	
Level of exercise for health			.482
-Lowest	15 (41.7)	19 (54.2)	
-Low	10 (27.8)	7 (20.0)	
-Moderate	8 (22.2)	7 (20.0)	
-High	3 (8.3)	1 (2.9)	
-Highest	0 (0.0)	1 (2.9)	

RESULTS

General characteristics of sample

As shown in Table 1, the majority of elderly in the intervention and the control groups (86.1%, 85.7%, respectively) were female. The average age of the intervention group was 69.8 (SD=5.4) whereas the average age of the control group was 68.2 (SD=5.7). 47.2% and 65.7% of intervention and control group participants, respectively, were married. The intervention group was statistically significantly more highly educated than the control group (p=.009). The groups did not differ significantly with respect to home type, body mass index (BMI), or waist-to-hip ratio (WHR).

The groups did not differ significantly with respect to frequency or intensity of pre-program exercise. A significantly higher percentage of the intervention group than the control group exercised for at least 30 minutes per exercise session. The overall level of exercise tended to be low to moderate in both groups.

Perceived self-efficacy of exercise in the intervention and control groups

Mean self-efficacy improved in both groups from pretest to posttest. According to paired t-test, the results showed that the intervention group had

Table 2 Distribution of mean score on perceiving self-efficacy for exercise before and after the program between the intervention and control group by Pair t-test

Perceiving self-efficacy for exercise	Before program	After program	Paired t-test	p-value
	Mean±SD	Mean±SD		
Intervention group	22.00±3.99	24.11±3.50	2.513	.017
Control group	20.97±5.31	21.91±4.01	0.951	.348

Table 3 Distribution of the mean difference on perceived self-efficacy for exercise between before and after the program between the intervention and control group by using Independent t-test

Measurement	Mean difference	SD	Independent t-test	p-value
Intervention group (n=36)	2.11	5.04	2.234	.029
Control group (n=35)	0.94	6.41		

Table 4 Distribution of ADL and physical independence testing mean score before and after the program in the intervention and control groups by using paired t-test

Variable	Before the program	After the program	Paired t-test	p-value
	Mean±SD	Mean±SD		
Intervention Group				
ADL	18.75±1.87	19.91±0.28	3.765	.001
Physical Independence				
-Time Get-up-and-go	10.05±1.90	6.16±1.72	12.246	<.001
-Chair Stand	15.22±5.84	19.97±6.31	6.034	<.001
-Standing Balance				
Right leg	22.38±12.83	29.72±16.16	3.550	<.001
Left leg	24.00±15.51	31.15±17.56	3.062	.004
Control Group				
ADL	19.02±1.63	19.37±0.77	1.457	.154
Physical Independence				
-Time Get-up-and-go	10.04±1.60	8.75±1.82	3.044	.004
-Chair Stand	11.88±3.49	14.37±4.81	3.935	<.001
-Standing Balance				
Right leg	18.31±14.40	21.00±14.76	4.623	<.001
Left leg	19.94±14.33	22.34±15.33	3.588	<.001

significantly higher mean score after than before the program (p=.017), while the control group showed no significant pre-post difference (p=0.348), as shown in Table 2.

Additionally, the mean difference of perceived self-efficacy for exercise before and after the program between the intervention and control group was assessed by Independent t-test. The intervention group had mean difference of 2.11 (SD = 5.04) after the program and the control group had mean difference on perceived self-efficacy for exercise of 0.94 (SD = 6.41). The groups differed significantly by independent t-test (p=.029), as shown in Table 3.

The ADL scores and physical independence testing between the intervention and control group

In both groups, mean scores for ADL and physical independence improved over time. The paired t-test analysis showed that there was a significant difference mean ADL score in the intervention group (Mean before= 18.75, SD=1.87; Mean after = 19.91, SD=0.28; P=.001), but not in the control group (Mean before= 19.02, SD=1.63; Mean after = 19.37, SD=0.77; P=.154) as shown in Table 4.

In term of the physical independence testing—Timed Get-up-and-go test (TUG test), Chair Stand test (CS test) and Standing Balance test (SB test) in right leg and left leg—it revealed there significant pre-to-post differences in TUG test score in the intervention group (Mean before= 10.05, SD=1.90; Mean after = 6.16, SD=1.72; P<.001) and in the control group (Mean before= 10.04, SD=1.60; Mean after = 8.75, SD=1.82; P=.004). Moreover, it revealed that there was a significant difference on CS test score in the intervention group (Mean before= 15.22, SD=5.84; Mean after = 19.97, SD=6.31; P<.001), as well as a significant difference in the control group (Mean before= 11.88, SD=3.49; Mean after = 14.37, SD=4.81; P<.001).

In addition, there was a significant difference on SB test with right leg score within the intervention group (Mean before= 22.38, SD=12.83; Mean after = 29.72, SD=16.16; P<.001) as well as in the control group (Mean before= 18.31, SD=14.40; Mean after = 21.00, SD=14.76; P<.001). There was a significant difference on SB test with left leg score within the intervention group (Mean before= 24.00, SD=15.51; Mean after = 31.15, SD=17.56; P=.004) as well as in the control group (Mean before= 19.94, SD=14.33; Mean after = 22.34, SD=15.33; P<.001).

As shown in Table 4, pre-to-post improvements in scores were generally larger in the intervention

Table 5 Distribution of mean difference on ADL and physical independence between before and after the program between the intervention and control groups by using independent t-test

Measurement	Mean difference	SD	Independent t-test	p-value
ADL				
Intervention group (n=36)	1.17	1.86	2.109	0.039
Control group (n=35)	0.34	1.39		
Physical Independence				
- **Time Get-up-and-go**				
Intervention group (n=36)	3.89	1.91	4.932	<.001
Control group (n=35)	1.29	2.51		
- **Chair Stand**				
Intervention group (n=36)	4.75	4.72	2.236	0.029
Control group (n=35)	2.49	3.74		
- **Standing Balance**				
Right leg				
Intervention group (n=36)	7.33	12.39	2.166	0.063
Control group (n=35)	2.69	3.44		
Left leg				
Intervention group (n=36)	7.15	14.01	1.956	0.057
Control group (n=35)	2.40	3.96		

group than the control group. Mean differences in ADL and physical independence testing before and after the program between the intervention and control group were assessed by independent t-test. As shown in Table 5, the intervention group had mean difference of 1.17 (SD = 1.86) after the program and the control group had mean difference on ADL score of 0.34 with standard deviation of 1.39. The improvement in ADL score was significantly greater in the intervention group than the control group (p=.039).

Between-groups comparisons for physical independence were as follows:

a) Timed-Get-up-and-go test (TUG test): there was a significant difference between the mean TUG test score of the intervention and control group (p<.001). The intervention group had mean difference of 3.89 (SD = 1.91) after the program and the control group had mean difference of 1.29 with standard deviation of 2.51.

b) Chair Stand test (CS test): there was a significant difference between the mean CS test score of the intervention and control group (p=.029). The intervention group had mean difference of 4.75 (SD = 4.72) after the program and the control group had mean difference on CS test of 2.49 with standard deviation of 3.74.

c) Standing Balance test (SB test) in right leg: there was a marginally significant difference between the mean SB test in right leg score of the intervention and control group (p=.063).

d) Standing Balance test (SB test) in left leg: there was a marginally significant difference between the mean SB test in left leg score of the intervention and control group (p=.057).

Satisfaction of participating in group squat exercises in the intervention group after the program

In the intervention group, satisfaction with the squat exercise program was high (Mean = 4.20, SD = 0.67).

DISCUSSION

In the present study, participation in a squat exercise program was clearly associated with improved effectiveness in performing activities of daily living and improved physical independence in elderly people in Bangkok. The results supplement previous research which suggests that chair squat places greater demand on the hip extensors, whereas normal squat places greater demand on the knee extensors and ankle plantar flexors. Hip and knee extensor, and ankle plantar flexors have been shown to be particularly important for the ability to perform physical activity of daily living, such as stair climbing, walking and rising from a chair [12]. To the best of our knowledge, comparisons of ability to perform activities of daily living and to gain physical independence in elderly people between those practicing group squat exercises and those performing conventional exercises have not been previously reported. However, there is evidence that frequent practice of squat exercise improves physical independence function [12, 13-15].

The Timed Up and Go Test, a simple measure of physical independence function that involves lower extremity strength, dynamic balance, gait, and agility, was used to measure physical function The significant decrease in time in TUG seen in the group squat exercises practitioners is supported by previous research that reported scores on the TUG to significantly decrease in time in community dwelling men and women 60 years of age or older from East Providence, Rhode Island, and the surrounding area, and who participated in the Study of Exercise and Nutrition in Older Rhode Islanders (SENIOR) Project [15]. Decreases in time in TUG,

as seen with the group squat exercises, might be explained by increases in size and strength of the legs and buttocks, and increase in knee extensor muscle strength, resulting from the squat exercises [12].

The chair stand test (CS) is a physical performance test used to assess leg strength and endurance. After the program, the intervention group had higher (better) mean score than the control group (P=.029), consistent with Ronnarithivichai, et al. [14]. These investigators evaluated physical fitness before and after 9-square-table aerobic excise and rubber ring stretching of elders in the health promotion program for the elderly, Faculty of Nursing, Mahidol University. They found that muscle strength and endurance, muscle and joint flexibility, and cardiorespiratory endurance after the exercise program were significantly higher than before it ($p<0.05$). In agreement with the study of Lovell, Cunco and Gass [16], they observed that strength training increased rate of force development, maximum bilateral isometric force, upper leg muscle mass and strength above pre-training values, respectively ($p<0.05$). Also, in most analyses, the group squat exercise group showed greater improvement on all scales than did the control group.

In the present study improvement in the standing balance tests was only marginally significantly greater in the intervention group than the control group. This is partially consistent with previous research [13]. This research showed that squat exercise could increase the ambulatory competence. That is the step length, maximum torque of the knee extensor muscle, and maximum standing time on one leg were found to have significantly increased by 4.5%, 6.8%, and 72.5%, respectively ($p< 0.001$). This study agreed with Vereeck, et al. [17] who found that older women have longer TUG times and poorer standing balance than do older men. It is possible that in this particular sample, the control group practiced forms of conventional exercises that were beneficial for balance. It is also conceivable that a dynamic balance test instead of a static balance test would have shown a significant result. The reason for the observed increase in the SB remains uncertain. Basically, each stride during squat exercises practiced consists of the stance and swing phases. Thus, increased maximum standing time on one leg and knee extensor muscle strength could produce a more stable gait. That is, the more the stance phase of each leg was stabilized by training, the greater the swing of the other leg could become, resulting in an increase in SB.

Regarding results relating to self efficacy, it is conceivable that squat exercises confer greater enjoyment of being active, or greater perception of value in being active, than do conventional exercises. It is also possible that participants who practice group squat exercises are more determined to participate in physical activity. Group squat exercises program were arranged to increase the perceived self-efficacy of exercise among elderly in three areas: (1) ability to exercise for health (2) ability to assess health, and (3) ability to give social support on health care. This study adapted the self-efficacy theory to promote exercise among elderly people in the intervention group by arranging activities, such as model presentation, practicing exercise, invitation from friends, and prompts and reminders to exercise. The study agreed with Sriponhang [8] who studied the effectiveness of holistic exercise promotion program among the elderly in Thamacala Municipality, Nakhonpathom Province, Thailand. The result suggested that the holistic exercise promotion program had significantly increased level of perceived self-efficacy ($P<.001$). There was also agreement with Rejeski, et al. [18] who observed benefit in treating disability in knee osteoarthritis with exercise therapy.

Differences found between the group squat exercises and control groups may be explained partially by the form of exercise itself and by demographic factors. Age-related decrease in ADL and the muscle strength is known to be much more marked in the lower extremities than in the upper extremities, and gait in the elderly is characterized by a decreased TUG [15, 19]. Impairment of muscle strength of the lower extremities, balance/postural control, and gait have been found to be important risk factors for falls [20]. While the present study found age-related impairment of TUG and CS in the intervention group, it did not detece any age-related changes in the body balance in these subjects, possibly because the sample size in the study was small. Besides, population studies report more mobility limitations in older women compared with than older men [21, 22]. The present study did not investigate sex differences in the ability to perform ADL, and times on the TUG, CS, and SB, due to relatively small sample size.

The study had other potential limitations. The sample was relatively small in size (which likely influenced the lack of significant results) and comprised primarily women, thus it was not representative of the entire population. In addition, the researcher did not measure participants' health status in detail, and the extent to which this could have influenced results is unknown. Even so, the consistency of the results strongly suggests that a regular program of squat exercises in beneficial in several ways in elderly people.

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