LONG STICK EXERCISE TO IMPROVE MUSCULAR STRENGTH AND FLEXIBILITY IN SEDENTARY INDIVIDUALS

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Abstract. The objective of this study was to investigate the effects of long stick exercise training on the strength and flexibility of sedentary individuals. An observational prospective study was conducted at the Prince of Songkla University. Eighty-five subjects who did not engage in any regular physical activity for at least three months before the study. A long stick exercise program was taught by a master for 45 minutes, at least three times weekly, for three months. Handgrip strength, back-leg strength, and flexibility were measured at the beginning of the program as a baseline, and at one, two, and three months of training. The subjects had increased back-leg strength and flexibility. Median back-leg strength increased from the baseline by 0.07 kg/weight, 0.19 kg/weight, and 0.21 kg/weight, at one, two, and three months, respectively ($p < 0.05$). Median flexibility (sit-and-reach test) improved from the baseline by 4.34 cm, 4.71 cm, and 5.56 cm, at one, two, and three months, respectively ($p = 0.001$). There were no statistically significant changes in handgrip strength.

INTRODUCTION

According to the World Health Organization (WHO, 1999, 2000, 2001, 2002) and the Ministry of Public Health in Thailand (Wibulpolprasert *et al*, 2002), the leading causes of death in Thailand are increasingly similar to those of Western industrialized countries. Thai people are increasingly susceptible to heart disease, smoking-related diseases, hypertension, stroke, obesity, and diabetes. Thus, there is a need to provide public awareness and education campaigns, as well as to promote healthy lifestyles that include regular exercise in a low-technological, cost-effective manner.

Long stick exercise (LSE), or *Krabong*, is a Thai practice of disciplined exercise that is practiced by adults and older people in the parks and open spaces of Thailand (Cheewajit, 2005). The practice is characterized by stretching and moving all bodily parts during exercise by using a long stick of bamboo (Anonymous, 2004). When performed for 40 to 60 minutes, several times a week, LSE may provide multisystemic health benefits and appears to hold promise as a health-promoting initiative (Krabong group, 2003). Specifically, the type of exercise, its intensity, duration, and frequency, hence, workload, can be specifically quantified and controlled to elicit specific physiologic responses. Unlike conventional aerobic and strengthening exercises that are typically taught in classes in the West, LSE is a complex system of movements that requires body awareness, motor coordination, agility, stretching, and breathing (Indrakamhaeng, 1998b). Although LSE is practiced in many areas and has potential benefits, particularly in the areas of mental health, weight management, stroke and cardiac rehabilitation (Indrakamhaeng, 1998a), the effects of LSE on muscular strength and flexibility of sedentary individuals have not been studied. Therefore, the aim of this study was to evaluate the training effects of a LSE program on muscular strength and flexibility in sedentary individuals.

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MATERIALS AND METHODS

Subjects

Persons aged between 20 and 60 years of age who lived in Hat Yai were eligible for this study. Medical and physical activity histories were obtained by questionnaire from the volunteers. All subjects lived in the community and led a normal lifestyle. In addition, subjects had not engaged in any strength-training program or regular aerobic exercise (defined as that exceeding two times weekly) for at least three months.

Exclusion criteria included angina pectoris, history of myocardial infarction, stroke, chronic obstructive pulmonary disease, uncontrolled diabetes and hypertension, neuromuscular disease, rheumatoid arthritis, spondyloarthropathy, and other major diseases (Fletcher *et al*, 1995; Gill *et al*, 2000; Singh, 2000). This study was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University. The purpose and procedures of the study were fully explained to all subjects; informed consent was obtained.

Long stick exercise (LSE) training

Subjects voluntarily participated in a three-month long stick exercise training program. They practiced LSE at least three times a week, in the evening, within a university park. Each session included 10 minutes of warm-up exercises (*ie*, gentle calisthenics), 30 minutes of LSE practice, and 5 minutes of cool-down exercise. Each set of LSE included 12 postures with some repeated movements (Fig 1). During the exercise sessions, subjects were led by an instructor, and they imitated the motions and postures at the same speed.

Testing protocol

The study consisted of two phases. In phase 1, a convenience sample of subjects who had no formal experience in LSE was recruited through poster advertisements circulated through the local residents' association. The exercises were led by a qualified LSE master with assistants. The program was conducted at 17 00, for 1 hour, five times a week, for three months. Four research assistants were trained in the LSE procedure and collected baseline measurements under the direct supervision of the investigators.

Dependent variables of interest included resting heart rate, diastolic and systolic blood

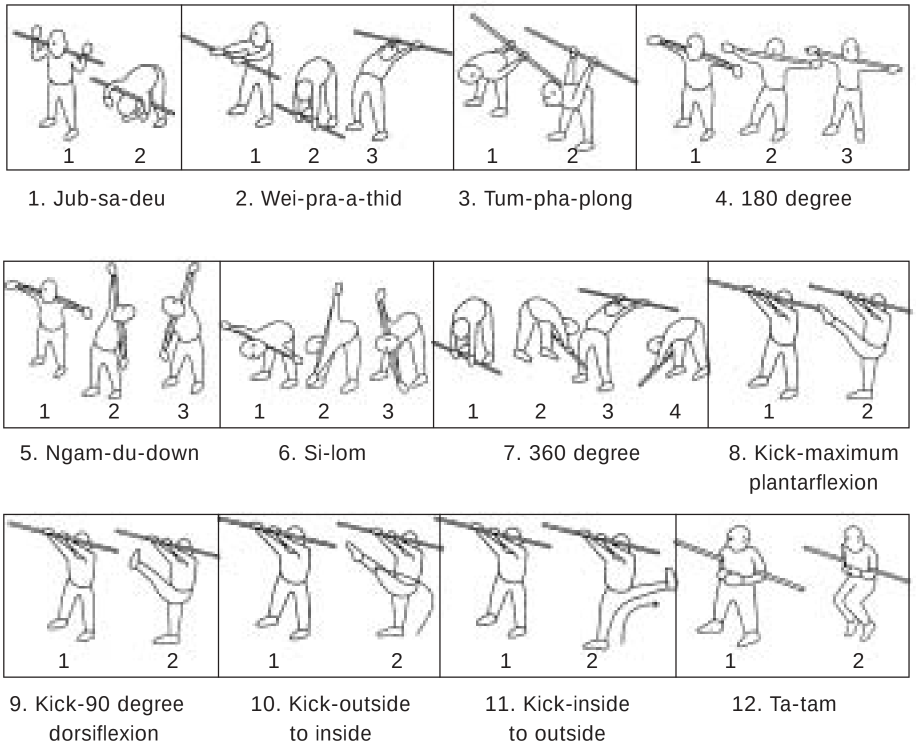

Fig 1–Twelve sets of long stick exercise.

Table 1
Baseline demographics.

Characteristics	Mean ± SD		
	Male	Female	Total
Age (y)	38.7 ± 11.3	39.7 ± 9.3	39.6 ± 9.5
Body mass (kg)	66.3 ± 9.5	54.4 ± 8.8	56.0 ± 9.7
BMI (kg/m^2)	24.1 ± 2.9	23.0 ± 3.7	23.1 ± 3.6
Systolic blood pressure (mmHg)	123.9 ± 7.5	113.4 ± 10.9	114.7 ± 11.1
Diastolic blood pressure (mmHg)	79.1 ± 8.0	72.4 ± 8.0	73.2 ± 8.2
Resting heart rate (beats/min)	68.1 ± 8.8	73.0 ± 7.3	72.4 ± 7.6
Chronic condition			
Diabetes	0	1	1
Hypertension	2	1	3
Arthritis	1	0	1
Coronary arterial disease	1	0	1
Others	1	2	3

pressure, flexibility, and strength. All of these parameters were measured before the program began, and after one, two, and three months of participation in the program.

Flexibility

Flexibility was measured by a sit-and-reach test (SRT) (American College of Sports Medicine, 1998; Sport Authority of Thailand, 1999). The subjects sat on the floor with legs extended, reached forward with their hands, one placed on top of the other, and held the terminal position for at least two seconds. Two practice trials were conducted, followed by two test trials. The dependent measure was measured as the highest number of centimeters reached during the two test trials.

Strength

Strength was measured by hand-held and back-leg dynamometers. Isometric assessment was conducted by using the TKK 5001 (grip strength) and the TKK 5102 (back-leg strength) manual muscle tester. Each subject performed two repetitions as a warm-up before they were tested twice. The dependent variable was measured by the highest number of kilograms achieved during the two test trials represented.

Data analysis

Data were analyzed using SPSS (Version 10.0 for Windows). Descriptive analyses were used to summarize and display subjects' descriptive and outcome variables. A repeated measure analysis of variance (ANOVA) was used to identify differences in the means for each variable over time (baseline, one month, two months, three months). A paired *t*-test was used for comparisons of pre-training and post-training for strength and flexibility on the same subject. A $p<0.05$ was considered statistically significant. All data are presented as mean ± standard deviation (SD).

RESULTS

A total of 122 subjects volunteered to participate in this study. Of these, 85 (69.7%), who were aged from 20 to 60 years, completed the three-month LSE training program. Table 1 summarizes the baseline characteristics of this group. Thirty subjects discontinued participation during the first month of exercise and therefore could not be included in the analysis of changes with respect to the baseline. After the second-month measurements, seven additional subjects were lost to follow-up. Thirty-three of the 37 reported dropping out because of conflicts with their work and family schedules. The remaining subjects who discontinued dropped out because of study reasons.

Grip strength

At the baseline, the mean grip strength was 0.53 ± 0.10 kg/weight. The median improvement

Table 2
Strength and flexibility at baseline, and one, two, and three months after exercise.

Fitness	Mean ± SD	Coef (95% CI)	p-value
Grip strength (kg)			
Before exercise	23.35 ± 6.73	Baseline	
after exercise 1 month	29.85 ± 7.00	0.54{(-0.12)-1.20}	0.12
after exercise 2 month	30.40 ± 6.73	0.98 (0.32-1.65)	0.32
after exercise 3 month	30.54 ± 7.26	1.13 (0.47-1.79)	0.47
Grip strength (kg/weight)			
Before exercise	0.53 ± 0.10	Baseline	
after exercise 1 month	0.54 ± 0.11	0.01{(-0.02)-0.04}	0.723
after exercise 2 month	0.54 ± 0.30	0.01{(-0.02)-0.05}	0.371
after exercise 3 month	0.55 ± 0.11	0.02{(-0.01)-0.05}	0.251
Leg strength (kg)			
Before exercise	104.49 ± 31.36	Baseline	
after exercise 1 month	109.79 ± 34.58	5.03 (0.39-9.67)	0.339
after exercise 2 month	115.94 ± 35.63	11.22 (6.58-15.86)	0.034
after exercise 3 month	116.29 ± 35.68	11.57 (6.93-16.21)	0.028
Leg strength (kg/weight)			
Before exercise	1.88 ± 0.48	Baseline	
after exercise 1 month	1.96 ± 0.93	0.07{(-0.09)-0.23}	0.376
after exercise 2 month	2.07 ± 0.57	0.19 (0.03-0.35)	0.020
after exercise 3 month	2.09 ± 0.56	0.21 (0.05-0.37)	0.011
Flexibility (cm)			
Before exercise	6.90 ± 8.53	Baseline	
after exercise 1 month	11.25 ± 6.32	4.34 (3.62-5.07)	0.001
after exercise 2 month	11.67 ± 6.49	4.71 (3.98-5.43)	0.001
after exercise 3 month	12.52 ± 6.12	5.56 (4.82-6.28)	0.001

from the baseline to one, two, and three months after participating in the exercise program were 0.01 kg/weight, 0.01 kg/weight, and 0.02 kg/weight, respectively. The changes in grip strength were not statistically significant (Table 2, Fig 2).

Back-leg strength

At the baseline, the mean back-leg strength was 1.88 ± 0.48 kg/weight. The median improvement from the baseline to one, two, and three months after participating in the exercise program were 0.07 kg/weight, 0.19 kg/weight, and 0.21 kg/weight, respectively, with a statistically significant increase in back-leg strength from two months after exercise (Table 2, Fig 3).

Composite flexibility

At the baseline, the mean composite flexibility distance was 6.90 ± 8.53 cm. The median improvement from the baseline to one, two, and three months after participating in the exercise program were 4.34 cm, 4.71 cm, and 5.56 cm, respectively, with a statistically significant increase in flexibility from one month after exercise (Table 2, Fig 4).

DISCUSSION

The full compliance rate (completing the three-month program) for the LSE subjects was 69.7%. This finding is high in comparison with other compliance rates (50%-70%) (Li *et al*, 2006). Factors that were thought to have contributed to this high rate were the relatively short duration of the exercise program (three months), the time of the year (winter and summer), and perhaps the benefits of LSE programs.

This study provided some initial insight into the potential beneficial effects of LSE. Musculoskeletal flexibility, that is, the ability of muscle to move a body segment through its range of

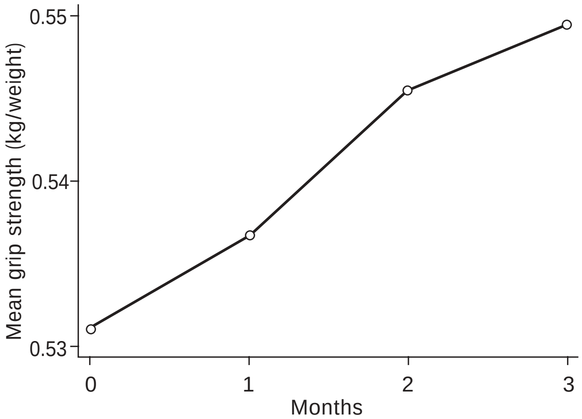

Fig 2–Mean grip strength recorded from baseline and one, two, and three months after exercise.

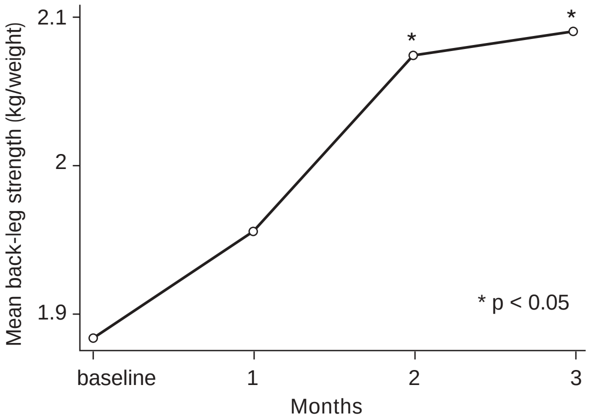

Fig 3–Mean back-leg strength recorded from baseline and one, two, and three months after exercise.

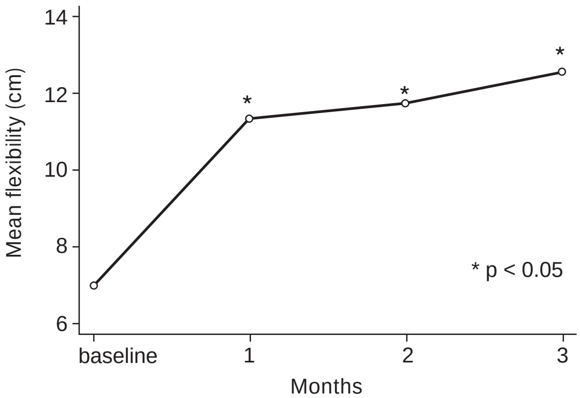

Fig 4–Mean flexibility recorded from baseline and one, two, and three months after exercise.

motion, is an important component of health. Sedentary individuals with low back pain (LBP) or arthritis in physical programs aimed at improving strength, flexibility, and mobility have reported better function and fewer symptoms (Blair *et al*, 1998). Flexibility may contribute to improved physical performance, reduced energy requirements for the movement of joints (from reduced tissue tension), and reduced likelihood of soreness or injury with physical exercise (Hoeger *et al*, 2002). Thus, the improved composite flexibility observed in this group of subjects suggests an important health benefit, which deserves further study.

In sedentary groups, loss of spinal agility and flexion may compromise both balance and ventilatory response to exercise. The distance reached by the arms with knees straight in sitting position (the SRT) has been validated previously as a measure of spinal flexion (Heyward, 1998). Spinal flexion was greater after training when compared with the condition as measured at the baseline. Thus, our results suggest that there is a beneficial effect of LSE on spinal mobility. This effect may be greater in the lower extremities because LSE stretches the hamstrings and gastrocnemius muscles. We selected handgrip strength because of its association with general strength in sedentary people, and because this measure has well-documented reliability (Peolsson *et al*, 2001).

LSE is an exercise with low velocity and low impact, and the possibility of orthopedic complication is minimal. Moreover, LSE is a low technology approach to conditioning that can be implemented economically in the community. Therefore, it has the potential to reduce expenditures associated with poor health by facilitating a lifestyle that promotes wellness among people of all income levels and all ages. From the perspective of exercise prescription, LSE is a promising alternative for strength training because of its efficacy and safety.

This study had several possible limitations. One limitation was the absence of a suitable cohort of control subjects. Selection of an appropriate subject would be more appropriate by including various groups that are composed of subjects with similar levels of physical conditioning, health status, and motivation to these in a LSE intervention. Despite the effort to ensure internal validity, there may have been some experimental mortality over the course of the study, which may have affected our findings. Future studies should explore the effects of LSE in patients with other musculoskeletal problems and with diabetes.

In conclusion, this is the first study that has suggested that a long stick exercise could have a positive effect on flexibility and back-leg strength. We recommend the further study should explore the other parameters, the effects of LSE on other patients, and the risks that may be associated with this type of exercise.

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