

Positive Effects of Group Exercises Using a Resistance Band on Trunk Balance of Elderly Thais in Rural Communities

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ABSTRACT

Objectives: To determine the effects of a group exercise program using a resistance band on the trunk balance of elderly Thais in rural communities.

Study design: A quasi-experimental study.

Setting: Ten villages in two districts of Phayao Province, Thailand.

Subjects: A total of 196 elderly people aged over 60.

Methods: The ten villages were randomly divided into two groups of five, the exercise (EX) villages group and the non-exercise (NE) villages group. Participants in both groups, village residents age > 60 were given instruction on the risks and prevention of falls, but only the EX group received training and then participated in group exercises using a low resistance band (a yellow Thera-Band®) for 30 minutes 3 times a week for 8 weeks. They were evaluated using the Berg Balance Scale (BBS) and the Timed Up and Go (TUG) test before and at the end of the study. Comparisons were made both within groups and between groups using the dependent t-test and the independent t-test. The occurrence of falls in the 6 months prior to the study and falls during the study were also recorded.

Results: At the conclusion of the study, the EX group (n = 99) had a significant higher BBS score and a shorter TUG time ($p < 0.001$) than before the exercise program, while the NE group (n = 97) had a significantly lower BBS score and a longer TUG time ($p < 0.001$) than at the start of the study. The BBS scores of the EX group were significantly higher than those of the NE group (independent t-test, $p < 0.001$) and their TUG times were also significantly lower (Gaussian process regression, mean difference -1.22 (95%CI = -1.68, -0.75, $p < 0.001$). Of the EX group participants, 28.2% reported a fall in the six months prior to the study as did 25.5% in the NE group. No falls were reported by either group during the 8 weeks of the study.

Conclusions: A 30-minute session of group exercises using a low resistance band 3 times a week for 8 weeks can have positive effects on the trunk balance and mobility of elderly individuals living in rural communities.

Keywords: elderly, exercise, resistance band, trunk balance, fall
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Introduction

According to a report from the National Health Security Office, Thailand will become an ageing society, i.e., a society whose median age rises due to rising life expectancy and/or declining birthrates, as the elderly population is expected to be 20.5 million in 2040.¹ A 2015 health survey by the Ministry of Public Health of 6.4 million elderly adults reported 21% of that group could not help themselves and were counted as people with disability, i.e., individuals who require health care as well as social support.¹ During the period 2015 to 2020, there was an increase in the average life expectancy of both the female and male populations in Thailand to 80.10 and 73.28 years, respectively.² That suggests an increase in elderly dependency from 14.30% of the population in 2000 to 36% in 2027.²

According to an international report on falls, hip fractures, traumatic brain injuries and upper limb injuries are the major underlying causes for fall-related hospital admission.³ In addition to any significant physical injuries, the psychological impact of a fall or near fall often results in a fear of falling as well as an increase in self-restriction of activities.⁴

In Thailand, two studies have been done of hip fractures in people over 50 years old, one in Chiang Mai for the period 2006-2007⁵ and one in Nan for the period 2014-2017.⁶ Both studies reported that a simple fall was the most common cause of the hip fractures and that most occurred in individuals over 70.^{5,6} More than 80% needed surgery, internal fixation and/or prosthesis replacement at an average cost of treatment of approximately 50,000 baht, 3.1 times more than for treatment of non-surgical cases.⁶

Factors increasing the risk of falls include lack of regular exercise, a low body mass index, and having musculoskeletal, mental, and/or neurological problems.⁷⁻⁹ It is recommended that the elderly should do exercises such as muscle stretching, exercises to strengthen the ankle muscles, and physical activities during the day to delay the onset of dysfunction of trunk balance and to reduce the risk of falls.⁹⁻¹³

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There have been several studies of exercises for the elderly in Thailand. Ballroom dancing,¹⁴ exercises with a long stick¹⁵ and Tai Chi Chuan¹⁶ have been reported to improve trunk balance and to reduce the risk of falls. Exercises with resistance bands have become more popular among all age groups, including elderly, because they are convenient to do anywhere.¹⁷ There have been studies in Thailand of exercises with elastic or resistance bands. Some studies of exercises using resistance bands, e.g., Thera-Band[®], have reported significant improvement in muscle strength of the upper and lower extremities¹⁸ as well as balance in the elderly.¹⁹ One small experiment which involved 12 weeks of exercise with an elastic band reported improvement in strength and endurance of the arm muscles and endurance of the leg muscles in older adults.²⁰ A comparison study of a home-based exercise program comparing stationary cycle elastic bands and resistance bands reported that leg muscle strength increased in both groups. However, in that study the dropout rate was high, and the level of resistance of the band was not specified.²¹ A study of elderly villagers reported that individuals exercising with an elastic band improved their physical fitness, muscle strength, flexibility and cardiovascular fitness compared to others who did not exercise.²²

In Thailand, village-level groups of elderly people have been formed and have received support from health-promoting hospitals, encouraging the elderly to exercise as a part of a health promotion program. In Mae Jai sub-district of Phayao Province in the north of the country, a community survey of exercises done by elderly people found that 63.7% had done exercises in the previous month, and that cycling was the preferred mode of exercise (32.2%) followed by brisk walking (26.7%).²³ The researcher, a physiatrist at the provincial hospital which is responsible not only for rehabilitation but also for disease prevention and health promotion, thought that exercises with resistance bands would be safer than cycling and might benefit a wider range of elderly people. In another study, community-based group exercise programs have been shown to have long-term adherence rates of almost 70%.²⁴ However, the above-mentioned studies have some limitations, e.g., a small number of participants,^{20,22} high dropout rates,²¹ not specifying the level of resistance of the bands used.²¹⁻²² Additionally, some of the studies included institutionalized elderly people.¹⁹ The present study avoided those limitations by using a group exercise program that involved a specific single low resistance band, a yellow Thera-Band[®], to evaluate the effects of exercise on trunk balance among the elderly living in rural areas.

Methods

This quasi-experimental research study was approved by the Phayao Hospital Research Ethics Committee, (HE-60-02-0010).

Participants

The districts of Phukamyao and Muang in Phayao Province were purposively selected as the study area because of their high number of elderly people compared to others districts. Using a simple randomization, five villages from each district were selected: five were assigned to be the exercise (EX) group villages and five to be the non-exercise (NE) group villages. Residents of these villages who were at least 60 years old were invited to participate in the study. After receiving informed consent, the health records of the participants were obtained from the public health database and their physical fitness and health problems were assessed. Inclusion criteria were the ability to independently perform daily self-care activities and to be able to walk without a gait aid. Individuals who had a medical history of ischemic heart disease or heart failure, dizziness caused by low blood pressure (hypotension), uncontrolled high blood pressure, or acute arthritis/arthritis in the upper or the lower extremities, were excluded from the study.

Intervention

After screening based on the inclusion and exclusion criteria, the participants in both groups were asked about the occurrence of falls in the previous 6 months. Each group then separately attended a 2-hour health education program on risk factors for and how to prevent falls which was conducted by an internist. Participants in the NE group were advised to perform their daily physical activities as usual, whereas the participants in the EX group received a low resistance band (a yellow Thera-Band[®]) 1.5 m long and with a resistance of 1.3 kg with 100% elongation and 2.0 kg with 200% elongation, and were taught how to perform exercises using the resistance band.

Exercises for participants in the EX group included 5 different calisthenics for warm-up followed by 8 exercises using the resistance band (see Appendix). The exercise program was modified from a study conducted by the Department of Health, Ministry of Public Health²⁰ and was conducted by trained health personnel from health promoting hospitals, village headmen and/or leaders of village elderly groups. The duration of the exercises was 30 minutes per session, and participants were instructed to practice 3 times a week for 8 weeks, a total of 24 sessions. This regimen was based on a study that found 8 weeks of exercising with a Thera-Band[®] resistance band yielded gains in the Berg Balance Scale score and in the Timed Up and Go (TUG) test.²¹ Participants who were absent for more than 3 consecutive sessions and those who were not re-assessed at the end of the study were counted as dropouts and were not included in the analysis. Participation in the EX group was monitored and individuals were reminded to join the group exercise sessions. If they were unable to join a group exercise session, they were told they should practice the exercises at home. If a resistance band became torn, a new one was provided gratis. Participants

in the EX group were asked to record the number and duration of exercises in a logbook provided by the study. Nurses at health promoting hospitals helped collect the logbooks for the researcher.

Outcome measures

The primary outcome measure was the Berg balance scale (BBS), which has demonstrated adequate internal consistency reliability, inter-rater reliability, and construct validity for measuring balance in community-dwelling older adults.²⁵ The secondary outcome measure was the Timed Up and Go test (TUG).²² A systematic review of TUG found it to be a valid and reliable mobility test. It is recommended in fall prevention guidelines, TUG is moderately associated with BBS, and can be used in most settings.²⁶ In this study, trained research assistants (physical therapists and occupational therapists) were responsible for the assessments. They assessed participants before and at the end of the 8-week group exercise program. In addition, the participants were asked whether any falls had occurred during the 8 weeks of the study.

Statistical analysis

Descriptive statistics, including frequency, percentage, mean and standardization, were used to describe the demographic data. Chi-square and the independent t-test were used for comparing baseline data between the EX and the NE groups. The dependent t-test was used to evaluate differences between means of BBS scores and TUG times before and after intervention within groups, and the independent t-test was used to evaluate differences between the groups.

Results

Of a total of 300 elderly individuals from the 10 study villages, 280 met the inclusion criteria and 20 were excluded due to various reasons (Figure 1). At the start of the study, there were 220 participants (110 in each group) all of whom voluntarily participated in a 2-hour educational program on the risks for and means of prevention of falls. During the study, 11 participants (10%) in the EX group failed to complete the program, 8 moved out of the study village, 3 were hospitalized for treatment of illness not related to falls, and in

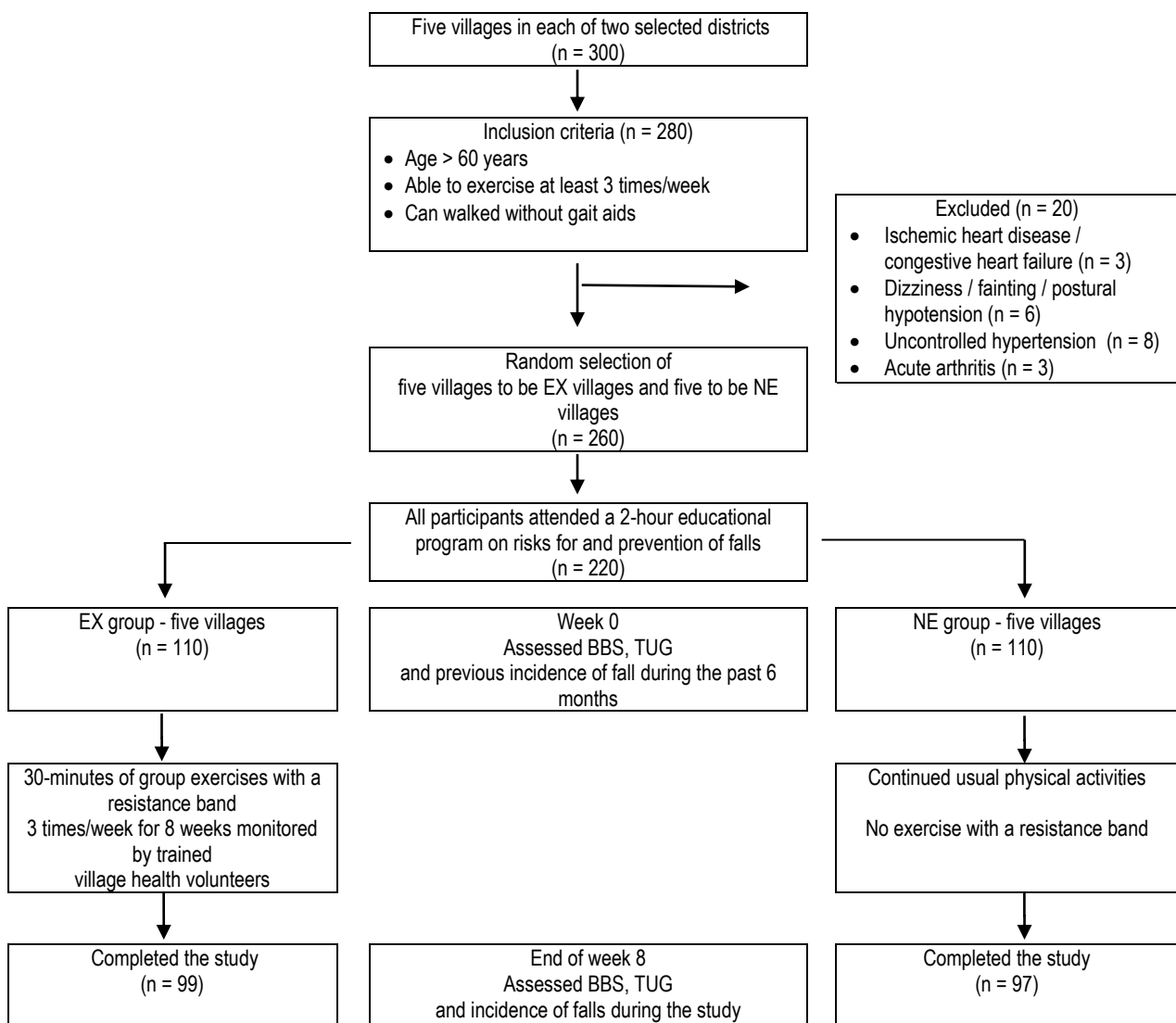


Figure 1. Flowchart of the study

Table 1. Socio-demographic data of participants who completed the study

	Exercise group (n = 99)	Non-exercise group (n = 97)	p-value
Age ¹	66.95 (5.32)	67.75 (5.85)	0.244 ^a
Gender (male) ²	36 (18.37)	44 (22.45)	0.20 ^b
Body mass index (BMI) ¹	22.05 (3.25)	21.98 (3.61)	0.86 ^b
Marriage status (married) ²	93 (47.45)	91 (46.43)	0.942 ^b
Education level (primary or below) ²	93 (47.45)	91 (46.43)	0.942 ^b
Income below 3,000 baht/month ²	80 (40.82)	78 (39.79)	0.889 ^b
Alone more than 16 hours/day ²	3 (1.53)	4 (2.04)	0.221 ^b

¹Mean (SD), ²number (%)

^aIndependent t-test; ^bchi-square test; * $p < 0.05$

Table 2. Comparison of Berg Balance Scale (BBS) scores and Timed Up and Go (TUG) times of the EX and NE groups both between and within groups pre- and post-study

	Exercise group (n=99)		Non-exercise group (n=97)		t	p-value
	Mean	SD	Mean	SD		
BBS score						
Pre-study	54.48	1.89	54.84	1.57	1.406	0.161 ^a
Post-study	55.30	1.25	53.28	1.87	9.013	< 0.001 ^{a*}
	t 4.663, $p < 0.001$ ^{b*}		t 9.047, $p < 0.001$ ^{b*}			
TUG time (seconds)						
Pre-study	9.44	2.16	8.34	2.01	3.700	< 0.001 ^{a*}
Post-study	8.42	2.22	8.83	2.14	1.331	0.185 ^a
	t 5.113, $p < 0.001$ ^{b*}		t 3.808, $p < 0.001$ ^{b*}			

^aIndependent t-test; ^bdependent t-test; * $p < 0.05$

Table 3. Mean difference in TUG time post study between the exercise and non-exercise groups

	Mean difference	Standard Error	t	95%CI	p-value
Group	-1.22	0.23	-5.20	-1.68, -0.75	< 0.001 [*]

Gaussian process regression; * $p < 0.05$

Table 4. Incidence of falls in the 6 months prior to the study and during the study

	Exercise group (n = 110)	Non-exercise group (n = 110)
During the 6 months prior to the study	31 (28.2)	28 (25.5)
During the 8 weeks of the study	0 (0)	0 (0)

Number (%)

the NE group 13 (11.8%) did not complete the program due to absence from the post-study re-assessment. At the end of the study, there were 87 participants in the EX group (87.9%) who had attended all 24 sessions and 12 participants (12.1%) who had missed only one session. The baseline socio-demographics of the two groups are shown in Table 1.

The pre-study BBS scores were not significantly different between the two groups, but the post-study score of the EX group was significantly higher than that group's pre-study score ($p < 0.001$) and significantly higher than the NE group ($p < 0.001$) (Table 2). Regarding the TUG time, there was no statistically significant difference between the two groups post study; however, the NE group had a significantly shorter pre-study average time than the EX group ($p < 0.001$) (Table 2). Gaussian process regression was applied to adjust for the

difference in TUG times at the beginning point before testing the effect of intervention on TUG time. The TUG time of the EX group was significantly shorter than NE group at post study with a mean difference of -1.22 (95%CI = -1.68, -0.75, $p < 0.001$) (Table 3).

The overall incidence of falls during the 6 months period immediately prior to the study was 26.8%: 28.2% in the EX group and 25.5% in the NE group. Neither group reported falls during the study (Table 4). Sixteen participants received a replacement resistance band when their original band became torn due to practicing the exercises on a rough surface.

Discussion

The study found that after the healthy elderly had practiced the group exercises using a low resistance exercise

band for approximately 30 minutes 3 times per weeks for 8 weeks, trunk balance improved as shown by the EX group's significantly higher BBS scores and shorter TUG times at the end of the study compared to the negative results in the NE group (lower BBS scores and longer TUG times at the end of the study). The findings of the EX group are in line with previous studies that reported exercises with a resistance band improved the balance of elderly adults.^{20,21}

In this study, the initial mean BBS scores of both groups were close to the maximum score of 56. The average BBS scores in the NE group declined about 1.5 points, from 54.84 to 53.28 at the end of the study, but the EX group increased about 1 point, from 54.48 to 55.30. The value of recommending such exercises for 8 weeks for a gain of only 1 point may not be immediately obvious. However, according to a study by Shumway-Cook et al.,²⁷ a 1-point increase in BBS score was found to lead to a reduction in the probability of falling, i.e., in the BBS score range of 54 to 46, a 1-point decline is associated with a 6% to 8% increase in fall risk, while in the range of 56 to 54, the same 1-point reduction is associated with a 3% to 4% increase in fall risk.²⁷

In addition to BBS, this study also assessed TUG time. The average pre-study TUG times of both groups were less than 10 which is normal for healthy older adults based on the manual of evaluation and screening older adults published by the Department of Medical Service, Ministry of Public Health.²⁸ At the end of this study, the average TUG time was shorter in the EX group but longer in the NE group, with a mean difference of 1.22 seconds which was statistically significant (Table 3).

How does a program of exercises with a low resistance exercise band improve trunk balance? As shown in the appendix, all the exercises focus on isometric and isotonic contraction of muscles of the upper extremities. While distal muscles act as agonists and antagonists, the proximal muscles, such as trapezius and latissimus dorsi which are superficial muscles of the back, act as stabilizers. In addition, when exercising the upper extremities, especially bilateral shoulder extension and unilateral horizontal shoulder extension in a standing position, core trunk muscles are indirectly activated.²⁹

Previous studies of exercises with resistance/elastic bands have demonstrated increased strength of upper and lower extremities.¹⁹⁻²⁰ This study, however, did not measure participants' muscle strength, so it cannot be concluded that the observed improvements in trunk balance were due to an increase in muscle strength. A low resistance band such as the one used in this study is suitable for elderly individuals. The exercise program in this study was not designed to increase loads over the duration of the study. For strengthening exercises, bands with higher resistance are recommended.

Exercise programs using resistance bands can help the elderly to improve their balance over a period of from 5 to 12 weeks.¹⁹⁻²¹ This study's results are comparable to a previous

study of an 8-week exercise program with resistance bands,²¹ including positive effects on trunk balance. In that study,²¹ it was not mentioned whether a low, medium or high resistance band was used. In a comparison between a resistance band and a cycle with elastic resistance bands, both were found to result in significant improvement in both BBS and 8-foot TUG results.²¹ In this study, the NE group had an increase in TUG time and a decline in BBS score, suggesting an increase in fall risk.²⁷ This result would indicate that elderly individuals should exercise regularly to maintain good balance.

Although this study found positive effects on the trunk, that only demonstrates that the exercises program was safe during the period of the study as no EX group participants reported falls. Data on the incidence of falls after the end of the exercise program, which could have permitted evaluation of the reduction in the incidence of falls over a longer period, was not recorded. The 26.8% of the participants in this study who reported falls during the 6 months prior to the study is similar to the 27% reported in a study of falls and balance in the elderly which included regular exercises conducted in Khon Kaen province, Thailand. The Khon Kaen study reported the causes of falls as follows: inappropriate environment (42.9%), inappropriate shoes (14.3%), alcohol drinking (14.3%) and fast movement (8.6%).³⁰

Compared with other studies using different modes of exercise, e.g., walking on a treadmill with partial body weight support,³¹ exercise programs using a resistance band are cost-effective. Resistance bands cost about 160 baht per piece, much less than a dumbbell or weight training equipment. A resistance band can be easily carried anywhere, and exercises with a band can be done even in a small area, unlike dancing exercises¹⁴ and exercises with a long stick¹⁵ which need a larger space (and perhaps more training). The resistance band does have one disadvantage: it is not durable when used on a rough surface, as reported by the participants in this study. It should, therefore, be used on a smooth surface or else a resistance band made of a different material must be selected. A Thai-style braided rubber rope is cheaper than most resistance bands, but the level of resistance of the rope is inconsistent, depending on the number of rubber bands used in each loop.³²

In planning this study, the researcher reduced selection bias by using simple randomization when selecting villages and by increasing the sample size by purposively recruiting from two districts with a high percentage of elderly people. Design bias was reduced by having participants from the same village all be in the same group, either EX or NE. The participant drop-out rate was reduced by having the group exercises conducted and monitored by trained local health personnel and village leaders.

This study had some limitations: there was no sample size calculation, no data on participants' physical activities (other than the exercise program), no sub-group analysis of participants who reported falls during the 6 months prior to

the study, and no long-term follow-up study to determine if the incidence of falls declined. A well-planned prospective cohort study is needed to determine if an exercise program using a low resistance band can significantly reduce the incidence of falls in the elderly and whether using a higher resistance band or increasing the level of resistance over time would result in better muscle strength and trunk balance.

Conclusions

A group exercise program consisting of 5 calisthenics for warm-up and 8 exercises using a low resistance band such as a yellow TheraBand® for 3 sessions per week for 8 weeks can increase BBS scores and shorten TUG times, thus indicating improvement in trunk balance and mobility of functionally independent elderly persons in rural communities. It is noteworthy that having the group exercises facilitated and monitored by trained health village volunteers and health personnel from a health promoting hospital in this study helped achieve a high level of adherence to the program. In the group of individuals who did not participate in the 8-week exercise program, there was a decline in trunk balance although factors related to that decline were not immediately apparent. A group exercise program using a low resistance band is a safe option to help elderly individuals in rural communities maintain or improve their trunk balance and potentially reduce their risk of falls.

Disclosure

The researcher received no compensation from the Thera-Band® Company.

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Appendix: Exercise program for improving trunk balance and prevention of falls

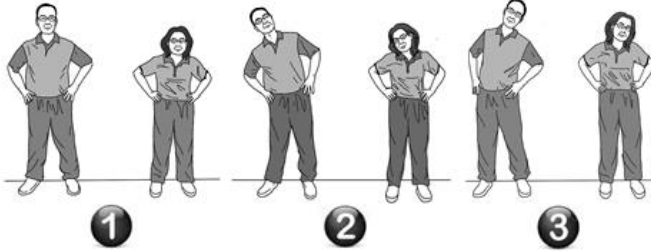
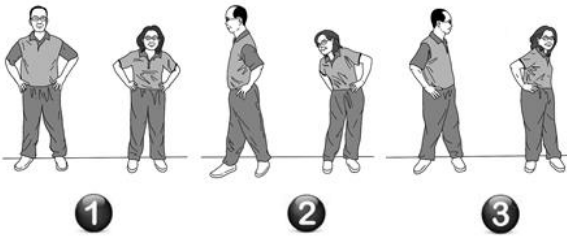



Instruction:

The starting position is standing upright with feet apart as wide as the shoulders and looking straight ahead.

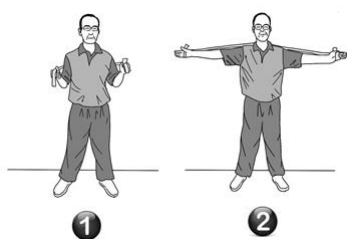
Start from Part A, 5 simple calisthenics exercises to warm up your body.

Then, do Part B, 8 exercises with a resistance band.

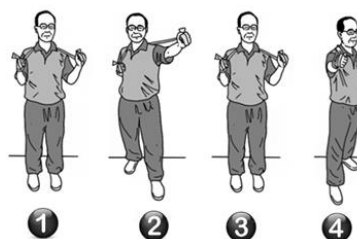
Repeat regularly, at least 3 days per week.

Part A. Simple calisthenics for warm-up	
	
<p>Exercise 1: Neck and side bending Bend to the right, hold for few seconds, and then to the left. Repeat 10 times for each side.</p>	
	
<p>Exercise 2: Trunk twisting Turn your body to the right, and then to the left. Repeat 10 times for each turn.</p>	<p>Exercise 3: Raising hands up and down Raise the right hand up and lean the body to the left, and then repeat on the opposite side. Repeat 10 times for each side.</p>
	
<p>Exercise 4: Shaking hands Shake both hands 10 times.</p>	<p>Exercise 5: Ankle rotation Rotate the right ankle 10 times. Repeat 10 times, then switch to the opposite side and repeat.</p>

Part B. Exercises with a resistance band



Exercise 1: Stretching the band out laterally
Start with the elbows bent at the chest level; then stretch the band by straightening the arms at shoulder level. Hold and count to 5; Then return to the starting position.
Repeat 10 times.



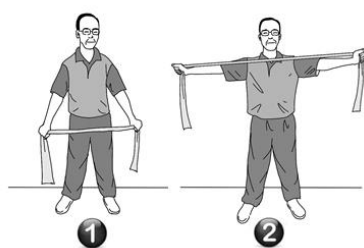
Exercise 2: Stretching one end of the band in front
Start with the elbow bent at chest level, then stretch the band by extending the left elbow and moving the left foot forward. Hold and count to 5; Then return to the starting position.
Repeat 10 times, then switch to the opposite side and repeat.



Exercise 3: Stretching the band forward in a diagonal direction
Pull the band upward in front of the body with one hand and downward with the opposite hand. Hold and count to 5.
Repeat 10 times, then switch to the opposite side and repeat.



Exercise 4: Stretching the band backward in a diagonal direction
Pull the band upward with one hand and downward and backward with the opposite hand. Hold and count to 5.
Repeat 10 times, then switch to the opposite side and repeat.



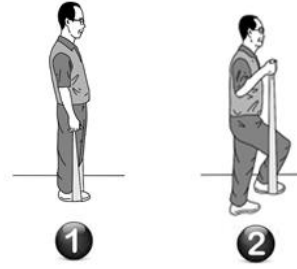
Exercise 5: Stretching the band while raising it upward
Place the band in front of the body at hip level. Slowly stretch it while lifting it to shoulder level with both arms straight.
Hold and count to 5. Then return to the starting position.
Repeat 10 times.



Exercise 6: Stretching the band up
Step on the band with both feet. Pull the elastic band up until the elbows are bent at the waist level. Then pull it up further to chest level.
Hold and count to 5. Then return to the starting position.
Repeat 10 times.



Exercise 7: Stretching the band with one hand
 Step on the band with the left foot.
 Pull it up with the left hand until the elbows are bent at the waist level. Lean the body to the right side.
 Hold and count to 5.
 Then return to the starting position.
 Repeat 10 times, then switch to the opposite side and repeat.



Exercise 8: Stretching the band with one foot
 Step on the band with the right foot.
 Pull the band up while lifting the right foot.
 Hold and count to 5.
 Then return to the starting position.
 Repeat 10 times, then switch to the opposite side and repeat.