



Original Article

## Effects of elastic-band resistance exercise on balance, mobility and gait function, flexibility and fall efficacy in elderly people

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**Abstract.** [Purpose] The purpose of this study was to analyze the effects of elastic-band resistance exercise on balance, gait function, flexibility and fall efficacy in the elderly people of rural community. [Subjects and Methods] It is selected by 45 outpatients. They have come into the clinic continually to treat of physical therapy at least 1–2 times for a week. A group treated with both general physical therapy and elastic-band resistance exercise (23 patients), and the other group treated with only general physical therapy (22 patients). Elastic-band resistance exercise is composed of 8 movements of lower extremity joints. It is performed for 30 minutes during 8 weeks by 3 times for a week. It is measured and recorded at the pre and post test that sit and reach test (SRT), functional reach test (FRT), timed up and go test (TUG) for every subjects by measurement equipments. And, subjects performed for the form of performance and question as its rated scale by Berg’s balance scale (BBS), dynamic gait index (DGI), activities-specific balance confidence scale (ABC). [Results] In the study, both the elastic-band exercise group and the general physical therapy group showed a significant improvement in balance, gait function, flexibility and fall efficacy. And the group with elastic-band resistance exercise showed more effectiveness than the contrast group in value of variation. [Conclusion] From this study, it was confirmed that elastic-band resistance exercise has influence on balance, gait function, flexibility and fall efficacy are working for agriculture of elderly people of rural community. Based on this result, elastic-band resistance exercise can be better instrument and easier to elderly people of rural community for the improvement in balance, gait function, flexibility and fall efficacy as it performing along with and reciprocal physical therapy.

**Key words:** Balance, Elastic-band resistance exercise, Falling prevention

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### INTRODUCTION

Fall is the situation that part of the body posture change in the through loss of balance in daily activities are contacted the floor<sup>1)</sup>. Fall is generated in absence of the balance due to loss of confidence<sup>2)</sup> and it is a major cause leading to the death of the elderly. The process of aging accompanied by mental changes of the elderly induce more than 10 times of falling risk than young adults and middle-aged people. According to the statistics on the fall down of domestic elderly people, 15.3% at 65 years of age or older, more than 70 years of age 20% and 35% more than 75 years of age experience fall down. In this, repeated fall down is more than 50%<sup>3)</sup>. The elderly people who experienced fall down received a severe injury such as hip fracture and traumatic brain injury, as a result, the restricted in movement and independence induce a risk that can be killed secondary complications<sup>4)</sup>. This also lowered quality of life<sup>5)</sup>.

10 to 20% of the elderly fall dawn associated with balance and gait disturbance<sup>6)</sup>. Also decreased muscle strength and balance of elderly resulted in decreased gait ability. It would be cause that fall down<sup>7)</sup>.

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When I look for a previous research related to the improvement of the balance of the elderly, there are gait training<sup>8)</sup>, muscle strength training<sup>3, 9)</sup>, elastic band training<sup>10, 11)</sup>, and exercise training<sup>12)</sup>. In the exercise form to enhance the strengthening of balance, there are weight load, flexibility exercise, resistance exercise and aerobic exercise<sup>13)</sup>. Bushner reported that application of three times a week for 12 weeks muscle strengthening and exercise of endurance training was raise the balance ability in 68–85 year-old elderly 106 people training<sup>14)</sup>.

Even though there is no physical damage due to fall down, fear of recurrence and anxiety syndrome after damage is accompanied by a general depression and social isolation<sup>15)</sup>. Fear of fall down is associated with decreased fall down-efficacy. Older people take a passive attitude toward exercise, so decreased physical activity due to lack of exercise Increases the risk of fall downs<sup>16)</sup>. Regular practice for the elderly is possible to reduce the mortality associated with aging that it improves Cardiovascular, central nervous system, endocrine and metabolic function and immune function. And it is possible to reduce the depressive and anxiety symptoms and to promote such as fall efficacy and health sense<sup>17)</sup>. Therefore, it is necessary to promote physical activity in order to enhance fall efficacy.

Elastic-bands is capable of load from all directions. And it is able to adjust the intensity of the natural load, so it is useful for muscle strengthening exercise in the elderly<sup>18)</sup>.

Nowadays, muscle strengthening exercise using elastic-band easy to adjust the resistance and inexpensive and simple. So it is widely used for rehabilitation treatment of disorders and sports injuries<sup>19)</sup>.

Continued training is difficult for elderly. So, researcher considers that elastic-band resistance exercise after general physical therapy will enhance balance, gait ability, flexibility, fall efficacy.

Prior studies have accounted for most of muscle strengthening exercises. However Researcher considers that decreased balance and walking ability of the elderly attribute to weaken muscle stretch. So, concentric muscle strengthening exercise and eccentric joint flexibility exercise will enhance balance for the fall and gait balance. After all, Researcher considers that elastic-bands elastic exercise is not only enhanced physical activity but also depressed and anxiety<sup>20)</sup>.

This study was to analyze the effects of elastic-band resistance exercise on balance, gait function, flexibility and fall efficacy in the elderly people of rural community.

## **SUBJECTS AND METHODS**

As the subjects of this study, 45 people who have no problem in cognitive capability and communication and have independent life skills were selected through the selection process and whether to agree after the interview among old patients aged 65 or older who visited D Hospital in G city Chungcheongnamdo in May 2013. Those who scored more than 24 points in Korean- Mini Mental State Examination (K-MMSE) and can carry on daily living activities independently without the assistance of an aid and have no major defects of the central nervous system and have no visual problems and a ringing in the ears or dizziness were included in this study. In addition, those who require professional treatment of doctors, take excessive drugs of more than 5 kinds, and have severe balance disorders, cardiovascular diseases with comorbidities of more than 4 regions were excluded. The methods and procedures of the study were explained to the selected subjects and the approval of voluntary participation was obtained. This study was carried out after obtaining approval of S University Institutional Review Board.

The experiment was composed of the experimental group of 23 people and control group of 22 people and was conducted over 8 weeks (Table 2). Each training method and test method were explained to the study subjects.

The control group and control group underwent a preliminary examination for balance, gait, flexibility, fall efficacy before starting the experiment. The experimental group conducted elastic band resistance exercise in 1 time 3 sets, 30 minutes per time, 3 times a week for 8 weeks and both experimental group and control group underwent typical physical therapy 60 minutes per time, 3 times a week for 8 weeks. Of the subjects, 2 people in the experimental group were transferred to another hospital in the 2nd week and 6 were eliminated by deteriorated condition in 4th and 5th week. 2 people in the control group were eliminated due to transfer to another hospital and 5 patients were eliminated due to deteriorated condition. 15 people in the experimental group and 15 people in the control group participated to the final and after 8 weeks, post-test of re-measuring balance, gait, flexibility, fall efficacy was carried out.

Elastic band resistance exercise was conducted for 8 weeks, 3 times a week, 30 minutes per time and 3 sets after general physical therapy was finished (Table 1). This study was carried out with 1 elastic band resistance exercise research assistant and 2 research assistants for measurement. Prior to each experiment and measurement, education was performed about exercise instruction method and equipment directions, measurement method for 2 hours 1 time a week 1 week ago.

For elastic band resistance exercise, 'lower limb strengthening training using elastic band resistance exercise' of "The Scientific & Clinical Application of Elastic Resistance" of Pill & Todd was applied<sup>21)</sup>. Warm-up was performed for 5 minutes and stretching and joint mobilization exercise promoting movement around spine and large joint exercise, head, trunk, pelvis were carried out.

Resistance exercise of lower limbs by using elastic band was conducted for 30 minutes. First, it was conducted in the order of ankle joint, knee joint, hip joint, the distal joints of the body. The ankles and knees, flexion and extension exercise was carried out while lying face down or lying or sitting straight on the bed or by tying band to the corners or poles of the bed and in hip joint, flexion and extension, pronation and supination were carried out while tying band to the corners or poles

**Table 1.** Elastic-band resistance exercise program

Warm-up exercise	Stretching ROM Exercise	5 minutes
Resistance exercise	1. Ankle flexion (10 <sup>a</sup> × 3 <sup>b</sup> )	30 minutes, 3 times/week (8 weeks)
	2. Ankle extension (10 × 3) + resting time(2 <sup>b</sup> )	
	3. Knee flexion (10 × 3)	
	4. Knee extension (10 × 3) + resting time	
	5. Hip flexion (10 × 3)	
	6. Hip extension (10 × 3)	
	7. Hip adduction (10 × 3) + resting time	
	8. Hip abduction (10 × 3)	
	*week 1–4; yellow band, week 5–8; green band	
Warm-down exercise	Self massages deep breath	5 minutes

<sup>a</sup>times, <sup>b</sup>minutes

**Table 2.** General characteristics

		Experimental group (n=15)	Control group (n=15)
Gender	Male	5 (33.3) <sup>a</sup>	6 (40.0%)
	Female	10 (66.6)	9 (60.0%)
Age (years)		80.1 ± 4.7 <sup>b</sup>	77.4 ± 5.5
Height (cm)		156.5 ± 10.5	158.34 ± 10.5
Weight (kg)		54.4 ± 11.2	56.0 ± 10.6
MMSE-K		25.8 ± 0.9	25.3 ± 0.3

<sup>a</sup>number (%), <sup>b</sup>Mean ± SD. MMSE-K: Mini Mental State Examination-Korea

of the bed and standing on the floor. Both left and right were performed alternately and one motion was conducted 10 times. An ankle flexion exercise is to sit and stretch the legs on the bed and wrap band around top of the foot and then tie band to the pole at the end of the bed and the try to bend the ankle while withstanding the resistance of the band. An ankle extension exercise is to sit and stretch the legs and then pull the band wrapped around top of the foot toward the body with both hands and try to extend while withstanding resistance. A knee flexion exercise is to lie face down on the bed and tie the band to the bar at the bottom of the bed and tie the other side to the ankles and take resistance on the back of the ankle and then try to bend while bending the knees and withstanding the resistance of the band. A knee extension exercise is to sit on the bed and take the resistance of the band forward below the knee and tie the other side to the bedside corner or appropriate fixing place. If relaxing, the knees become flexible. Try the knee extension while withstanding resistance. Flexion and extension, pronation and supination of hip joint are conducted while standing on the floor and tie the band on bedpost and tie the other side to the ankle and stand toward the opposite direction to take resistance in flexor and extensor, abductor and adductor and try joint motion while withstanding resistance. After all motions, subjects rested for 1 to 2 minutes and went on to the next set. Whole motion was carried out for 8 weeks, three times per week, 30 minutes per time and 3 sets. For the first 1 week to 4 weeks, the weakest yellow band was used and the green band with one rating higher resistance strength for 5 weeks to 8 weeks was used. The use of the band was equally applied to all patients. Each motion was conducted in a convenient state on the bed and floor. Exercise assistants instructed patients not to escape from a fixed posture and cause compensation exercise.

Warm-down was carried out for 5 minutes and a deep breath and self-massage were conducted. A deep breath was conducted for up-and-down motion of the diaphragm and internal and external motion of the rib cage and self-massage for the soft parts of abdominal and body connection.

General physical therapy was applied to all participating subjects. For patients who may affect falls, first, pain was mainly treated and selected joints of waist and lower limbs or parts that may help agility and balance of the upper body such as grasping or catching were treated alternately. As general physical therapy, hot pack was first applied for 30 minutes (or cold pack 20 minutes) according to the doctor's prescription and ultrasound was performed for 5 minutes and then electrical stimulation treatment was carried out for 15 minutes. Stretching and joint ROM exercise were conducted for 5 minutes around the spine and large joint and a deep breath and simple self-massage were carried out for 5 minutes. For the intervention period of treatment, the entire period was set to 8 weeks. 3 times were carried out for 1 week and when absent due to holiday or personal circumstances, it was conducted the next day so all three times per week were performed. 1 time were performed for 60 minutes.

**Table 3.** Change in balance (N=30)

	Test	Experimental group (n=15)	Control group (n=15)
FRT (cm)	Pre	18.1 ± 3.6 <sup>a</sup>	18.6 ± 1.9
	Post	22.0 ± 3.6	18.8 ± 2.6
	Pre-post	3.96 ± 0.7 <sup>***†††</sup>	0.1 ± 1.0
BBS (scores)	Pre	36.9 ± 12.9	42.0 ± 8.0
	Post	46.0 ± 10.1	44.4 ± 6.8
	Pre-post	9.07 ± 4.2 <sup>***†††</sup>	2.4 ± 2.7

<sup>a</sup>Mean ± SD.

FRT: functional reach test; BBS: Berg's balance scale

Significant difference, paired t-test: \*p&lt;0.05; \*\*p&lt;0.001; \*\*\*p&lt;0.0001

Significant difference, independent t-test: †p&lt;0.05; ††p&lt;0.001; †††p&lt;0.0001

**Table 4.** Change in gait ability (N=30)

	Test	Experimental group (n=15)	Control group (n=15)
DGI (scores)	Pre	16.0 ± 4.3 <sup>a</sup>	17.6 ± 3.6
	Post	19.6 ± 3.5	18.3 ± 3.4
	Pre-post	3.6 ± 1.2 <sup>***†††</sup>	0.6 ± 0.6 <sup>***</sup>
TUG (seconds)	Pre	11.4 ± 2.2	12.3 ± 2.0
	Post	10.4 ± 2.0	12.1 ± 2.1
	Pre-post	1.0 ± 0.5 <sup>***†††</sup>	0.1 ± 0.2 <sup>***</sup>

<sup>a</sup>Mean ± SD

DGI: dynamic gait index; TUG: timed "up &amp; go" test

Significant difference, paired t-test: \*p&lt;0.05; \*\*p&lt;0.001; \*\*\*p&lt;0.0001

Significant difference, independent t-test: †p&lt;0.05; ††p&lt;0.001; †††p&lt;0.0001

The measurement of the balance ability was tested by using functional reach test and Berg's balance scale (Table 3). A functional reach test is an economical tool that can be easily used in clinical practice to replace the balance measurement using existing equipment applying expensive equipment and advanced technology. When measuring with the functional reach test, the subject was asked to bend the shoulder joint by 90° and stretch forward on parallel while standing straight and practice the distance from the end of third median condyle of the start posture to the end of third median condyle when stretching forward as much as possible one time and then measurement was conducted. After measuring three times, the mean value was recorded and subjects were allowed to take a rest to prevent fatigue at each measurement. The reliability between measuring points within the measuring point of this test was high, r=0.89 and r=0.98, respectively<sup>22</sup>).

Berg's balance scale is equipment used to test the balance ability of each individual<sup>23</sup>). A total of 14 items are composed of five-point (0–4) scale. The total score is 56 points. Prior to the measurement, the posture was explained and demonstrated and then measurement was carried out after several practices. Measurement contents are as follows: standing from a sitting posture, standing without holding anything, sitting straight without leaning against the backrest of the chair, sitting in a standing posture, moving from chair to chair, standing without holding anything with eyes closed, standing without holding anything with keeping two feet together, stretching arms forward in a standing posture, picking up things on the floor, looking back to the left and right, rotating 360 degrees in place, putting feet alternately on the foothold of a certain height, standing with one foot in front of the other in a line, standing on one leg. The reliability between measuring points within the measuring point was 0.98 and internal consistency was 0.96. In this study, 2 research assistants conducted measurement and this researcher recorded scores.

In order to measure the gait ability, this study used "Timed Up & Go test" accompanied by body movement and "Dynamic Gait Index" for measuring functional gait (Table 4).

TUG test was carried out in a sitting posture on the chair without armrests of 46 cm height. With the start signal of the tester, time that the subject stands up and comes back after 3 m of round-trip and then sit again independently was measured three times with a stopwatch and the mean value was recorded. The reliability within the measuring point of this test was r=0.99 and reliability between measuring points was r=0.98 so it is a reliable tool<sup>24</sup>). This test has been used to assess the balance and functional exercise of the elderly and predict the risk of falling and is also applied to weak elders, Parkinson's disease and arthritis patients, stroke patients in recent years<sup>25</sup>). DGI is a test tool made to assess the ability to change gait adaptably so that one individual can be suitable for job requirements and the reliability between measuring points was 0.96 and test-retest reliability was 0.98. The total score of Dynamic Gait Index (K-DGI) was 24 points and it consists of a 4-point scale (0–3) with eight different gait tasks. Eight gait tasks consist of walking on a flatland, walking while changing speed, turning the head up and down and left and right while walking, going up and down the stairs, passing and detouring the obstacle, stopping after turning the contact point<sup>26</sup>). In this study, a box of the same height was used instead of 'cone' as the obstacle and 2 research assistants supervised in preparation for falls.

In order to measure flexibility, 'Sit & Reach Test' was conducted. Flexibility refers to the characteristic that the musculoskeletal system can exert a normal function as all joints maintain proper operating range (Table 5). This study measured the distance of the fingertip outstretched forward as much as possible after bending the upper body in a state of spreading both knees, maintaining the ankle at right angle, stretching the back and bending the shoulder by 90° on equipment made by modifying Ruler Box. Greater values mean better flexibility of joints and waist, hamstring muscle and lower limbs muscle. The reliability of sit & reach test (SRT) was found to be 0.89 to 0.98 and validity to be 0.71 to 0.74<sup>27</sup>).

In order to measure fall efficacy, ABC scale (Activities-specific Balance Confidence scale) was used (Table 6). ABC Scale is the balance confidence scale for special activities and was designed to measure the confidence of individuals from the ability to perform activities of daily living without falling and is one of several tools measuring fall efficacy and was designed

**Table 5.** Change in flexibility (N=30)

Test	Experimental group (n=15)	Control group (n=15)
SRT (cm)	Pre	62.2 ± 1.8 <sup>a</sup>
	Post	63.9 ± 1.9
	Pre-post	1.7 ± 0.4 <sup>***†††</sup>

<sup>a</sup>Mean ± SD

SRT: sit &amp; reach test

Significant difference, paired t-test: \*p&lt;0.05; \*\*p&lt;0.001; \*\*\*p&lt;0.0001

Significant difference, independent t-test: †p&lt;0.05; ††p&lt;0.001; †††p&lt;0.0001

**Table 6.** Change in Fall-efficacy (N=30)

Test	Experimental group (n=15)	Control group (n=15)
ABC (score)	Pre	67.0 ± 14.7 <sup>a</sup>
	Post	73.9 ± 14.8
	Pre-post	6.9 ± 2.8 <sup>***†††</sup>

<sup>a</sup>Mean ± SD

ABC: Activities-specific Balance Confidence scale

Significant difference, paired t-test: \*p&lt;0.05; \*\*p&lt;0.001; \*\*\*p&lt;0.0001

Significant difference, independent t-test: †p&lt;0.05; ††p&lt;0.001; †††p&lt;0.0001

for the elderly. It includes wider series of difficult activities and describes more detailed items than FES (Fall Efficacy Scale). Fear of falling may make the subjects embarrassed in assessing posture performance so measurement is important. Decrease in balance may result in activity restrictions measured as fear of falling. A total of 16 items, a total of 1,600 points by 100 points. The reliability study showed basic line 0.96, 0.98 after 8 weeks in internal consistency of the study of Hwang in Taiwan in 2009. The test-retest reliability showed  $r=0.92$  in the study of Powell in 1995. In relation to BBS, validity of ABC Scale showed 0.75 in the study targeting 50 elders living in the community and showed the relevance of 0.70 with TUG<sup>28</sup>. This study scored by converting it to 100%. Face-to-face interview survey was conducted.

All results and statistics in this study were coded and converted into data using SPSS ver. 19.0. Frequency analysis was performed regarding general characteristics of the subject and a paired t-test examined pre- and posttest differences. An independent t-test was used to determine between-group differences, and, for all data, statistical significance was set at 0.05.

## RESULTS

FRT (functional reach test) and BBS (Berg's balance scale) significantly increased in both groups ( $p<0.05$ ). Measured pre- and post-test values for FRT and BBS significantly increased in both groups ( $p<0.05$ ). Measured pre- and post-test values for stable DGI (dynamic gait index) and TUG (timed "up & go" test) significantly increased in both groups ( $p<0.05$ ). There were differences in the experimental group than in the control group ( $p<0.05$ ). Measured pre- and post-test values for SRT (sit & reach test) significantly increased in both groups ( $p<0.05$ ), and there were differences in the experimental group than in the control group ( $p<0.05$ ). Measured pre- and post-test values for ABC: Activities-specific Balance Confidence scale significantly increased in both groups ( $p<0.05$ ), and there were differences in the experimental group than in the control group ( $p<0.05$ ).

## DISCUSSION

This study was carried out to apply the most suitable combination form of general physical therapy and therapeutic exercise that can promote the independent activities of daily living in that elderly people living in rural area are highly likely to be in the risk of falling because exposed to agricultural and labor conditions despite being old. The purpose of this study is to find out if there is any effect when doing elastic band resistance exercise after general physical therapy under the supervision of a physical therapist based on the existing previous studies. Since this study was carried out targeting external elderly patients, many were eliminated due to personal reasons. As the characteristics of the rural elderly doing actual day-to-day life, the study was conducted to reflect the factual situation of outpatient clinical patients rather than significant results according to the arbitrary control.

FRT is a functional performance assessment that can obtain quantitative information on the balance ability<sup>22</sup>. Duncan et al.<sup>22</sup> reported that the elderly of less than 15.24 cm showed four times higher risk of falls than those of less than 25.4 cm in measured values. And Kim Gun et al.<sup>10</sup> showed an increase from pre 16.89 cm to post 23.41 cm in FRT that applied lower limb muscle strengthening exercises for 9 weeks targeting 30 elders at around 75 years old by using the elastic band and then measured balance. Also in the study of Han SW et al.<sup>11</sup>, FRT measurements in 50-minute exercise 3 times a week for 8 weeks targeting<sup>10</sup> 75 year-old elderly women with intervention using the elastic band equipped with a motion setting device showed a difference from pre 11.01 cm to post 13.68 cm. Putting the results of the above previous studies and those of this study together, it can be considered that the balance ability was promoted because resistance exercise using the elastic band strengthened muscular strength of lower limbs. In addition to the above results, muscle strengthening exercise of the abdomen and waist can be applied by using the elastic band after general physical therapy and hence, exercise therapies combined with general physical therapy are strongly recommended for the elderly.

Muscular strength is an important element in the balance adjustment and has been reported as a major cause of falls of the

elderly by aging<sup>29</sup>). Therefore, a muscular strength strengthening exercise was introduced as a means to promote the balance ability and resistance exercise using the elastic band is an effective way for the elderly that can promote decrease in muscular strength with aging. An increase in muscular strength through resistance exercise is to apply the physical laws of motion and is known that it is possible to be applied to the elderly of more than 90 years old<sup>30</sup>. This may be an important factor in maintaining independence of the elderly with futility atrophy who suffer from activity limitations in everyday life.

BBS is a 56-point scale and reports that the probability of falling is high when the point is less than 49<sup>31</sup>). Lee HS et al.<sup>32</sup>) reported an increase from 46.9 points before the experiment to 51.5 points after the experiment in BBS of the experimental group in resistance exercise for 4 weeks using the elastic band targeting 24 elders aged 65 or older and Kim OJ et al.<sup>9</sup>) combined muscular strength strengthening and extension exercise of 45 minutes per time, 3 times a week, a total of 6 weeks targeting the elderly aged 60–79 years old and as a result, reported that points increased to 51 points, 52 points and 53 points in the measurement before the experiment, after 3 weeks and 6 weeks.

Lee SY et al.<sup>33</sup>) conducted therapeutic exercise for purpose of the trunk extension targeting 15 elders aged 65 or older and then reported an increase from pre 52 points to post 54 points in BBS measurement. The subjects of this study are the 80 year-old elderly and measured scores were low but many points have been improved. In this study targeting 80.13 year-old elders, 9.07 points was improved from 36.93 points before the experiment and 46 points after the experiment and this showed that the intervention using the elastic band promotes the prevention of falls in the elderly. Measuring the effect on balance, it was found to be improved in the degree lower than most measured standard scores. Given that subjects are old, this is shown to be the appropriate intervention means because it was carried out after lowering intervention intensity and performing comfortable general physical therapy. Exercise programs for preventing falls have been studied a lot but it is unreasonable to perform active sustainable motion for more than 30 minutes for the elderly. Therefore, securing flexibility of soft tissue and promoting blood circulation through nerve stimulation and application of hyperthermia in the elderly and combining general physical therapy that can promote the body vitality or alternately conducting other intervention exercise programs and general physical therapy may be measures that can reduce falls of the elderly in everyday life.

In order to study changes so that DGI can sense minimum falls with clinical measurement equipment, the average of the initial value using measurement standard error in 42 elders aged 65 or older with a risk of falling was 12.9 points and the mean value was 12.7 points in the study of Romero et al.<sup>34</sup>). According to the study of Bishop et al.<sup>35</sup>), the lower body strengthening exercise was carried out for each muscle group with home-based exercise program for 12 weeks targeting the elderly aged average 76.6 years old and as a result, pre 11.8 points and post 14.5 points were shown in DGI. This is not a resistance exercise using the elastic band but was applied in the form of the same muscular strength strengthening exercise to strengthen the lower body. And the study of Shumway-cook et al.<sup>6</sup>) divided 105 elders aged 65 or older into three groups and conducted individualized exercises of various aspects for preventing falls and as a result, pre/post DGI comparison values were improved by 20% and 37% in two groups who performed an exercise and DGI of the control group with no intervention was reduced to -7%. In this study, 3.6 points were improved from pre 16.07 points to post 19.67 points in the measurement of the gait ability through DGI. In total 24 points of DGI, less than 19 points can predict the risk of falls and more than 22 points ensure safe movement. In the results of this study, post measured value of DGI improved by 3.60 points is considered to be the result of conducting resistance exercise of lower limb strengthening by using the elastic band and providing training advantageous to adapt to a variety of ground environments by carrying out individual strengthening the muscles of the lower body and main exercise of each joint. Improved measurements of DGI show that the risk of falls has reduced in the gait ability through the movement of the elderly.

In TUG study, O'Sullivan et al.<sup>36</sup>) classified the range of 11–20 seconds to the weak or the elderly with disabilities. Kim G et al.<sup>10</sup>) carried out fall prevention exercise for 9 weeks by 3 times a week by applying the elastic band to 30 elders aged around 75 years old and then measured TUG and as a result, it was found that there is a difference between groups, pre 13.46 seconds to post 12.11 in the experimental group and pre 12.54 seconds to post 13.83 seconds in the control group. Han, SW et al.<sup>11</sup>) are to obtain balance promotion by increasing hip joint strategy and strategy through gait in the trunk and lumbar part through the exercise using the elastic band and Swiss Ball. This shows that elastic band exercise is an appropriate intervention element when TUG test measures the gait ability through movement. This study showed the improvement of 1.02 seconds, from pre 11.42 seconds to post 10.41 seconds. Therefore, by conducting elastic band resistance exercise, TUG measurement in the elderly labor population in rural areas shows that it is effective for preventing falls in the moving ability through gait.

Flexibility deteriorates with an increase in age<sup>37</sup>). Also, reduction in flexibility of the lower body may have a negative impact on gait speed. In exercise programs of the elderly, therefore, flexibility promotion and assessment are as important as muscular strength improvement.

The study of Kim<sup>38</sup>) circularly conducted elastic exercise, yoga, walking exercise, Latin dance for 12 weeks targeting the elderly and as a result, flexibility was found to be increased. The study of Kang<sup>39</sup>) also compositely applied the elastic band exercise and walking exercise for 15 weeks targeting the elderly in the rural area and found an increase in flexibility. The study of<sup>40</sup>) measured the flexibility of the trunk in resistance exercise using the elastic band. Elastic band resistance exercise for 12 weeks of 3 times per week was applied and then SRT was carried out and as a result, the flexion amount of the trunk was improved from pre 7.1 cm to post 9.4 cm. This is the same measurement information as the measurement method of this study and shows that intervention has been appropriate. According to the study of Park EY et al.<sup>41</sup>), complex-motion using elastic band and Swiss Ball, dance sport, Tai Chi etc. is effective for preventing falls through flexibility and balance

adjustment of joints, muscular strength improvement etc. And according to the study of Han SW et al.<sup>11)</sup>, elastic band and Swiss ball exercises were conducted for 8 weeks targeting the elderly aged 70 or older and as a result, balance control ability through joint flexibility, muscle strengthening and improvement of weight movement capability were reported. In this study, 1.73 cm was improved from pre 62.24 cm and post 63.97 cm. In the above SRT measurement, an increase in flexibility of lower limbs was identified mainly around hamstring muscle of the hip joint. For more precise flexibility test of the elderly, elongation of iliopsoas muscle or movement of joint of the hip region and soft tissue must be assessed through 'Modified Thomas Test' or 'straight leg raising test' and the study of measuring hip joint angle. And in order to obtain increased flexibility, it is considered to have access to a comprehensive problem through exercise of the whole body through flexibility improvement and function improvement of pathological part.

Fall efficacy refers to the degree of confidence in falls. Confidence in fall can be found by answering through the objectified survey. In order to measure fall efficacy, this study used ABC Scale. In "Prediction of Fall Probability of the Elderly using TUG" studied by Shumway-cook et al.<sup>6)</sup>, ABC Scale (Converted to a 100-point scale) was measured in 15 people who experienced falls and 15 people who did not experience falls and as a result, those who experienced falls got 53.0 points and those who did not experience falls got 93.2 points. And in order to find out the reliability and validity of modified gait efficiency scale (mGES), Newell et al.<sup>42)</sup> measured ABC Scale targeting 102 elders at the average age of 78.6 years and the mean value was 75.95 points, the median was 82.81 points, standard deviation was 18.91 points and ceiling effect was 2%. In ABC Scale of this study, pre-measured score was 67 points and post score was 73.92 points. In ABC Scale, 81.1 points are the turning point that can predict falls<sup>31)</sup>. Higher score indicates more confidence and it was effective though appearing lower than the standard score in the above scale.

The fall prevention program conducted by Kwon MS<sup>43)</sup> investigated fall efficacy by applying elastic band intervention of 10 times, every 20 minutes in a total of 60 minute-motion per time and there was no difference prior and 12 weeks but significant differences were shown in the results measured in the 20th week. The study of Bishop et al.<sup>35)</sup> shows that the improvement of measured values after intervention in BBS, DGI, Geriatric Depression (GDS) is also effective for fall efficacy. This study also found out that there was a significant effect in fall efficacy when post measurements are improved in FRT, BBS, TUG and DGI that measured the balance and gait ability.

This study has several limitations. First, the number of the subjects is small and the results of this study are limited to be generalized and interpreted for the elderly staying in nursing homes or rural elderly in other circumstances and different ages because this study targeted old outpatients in rural areas and second, the study period is short, 8 weeks so changed effects and sustainability should be identified through post review of subsequent 12 weeks, 6 months, one year. Third, only general physical therapy was applied to the control group and in follow-up studies, sham therapy and various intervention methods in addition to general physical therapy should be also applied and comparative study of the elastic band resistance exercise should be carried out.

Fourth, it is difficult to completely exclude medication and nutrition due to the relevance between the general health maintenance of the elderly and them. Resistance exercise using the elastic band is attempted as intervention for improving various diseases and therefore, this can be used as materials for other treatment as well as fall prevention of the elderly.

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