Rehabilitation Practice and Science

Volume 48
Issue 1 *Taiwan Journal of Physical Medicine and Rehabilitation (TJPMR)*

Article 6

12-31-2020

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Recommended Citation

Tseng, Yu-Hsuan; Chen, Hsiu-Hui; Wu, Wen-Chi; Chen, Fang-Ping; Chen, Jung-Fu; and Hung, Jen-Wen (2020) "Using a Towel for Resistance Training in Non-exercising Elderly Women: A Cluster Controlled Trial," *Rehabilitation Practice and Science*: Vol. 48: Iss. 1, Article 6.
DOI: https://doi.org/10.6315/TJPMR.202006_48(1).0006
Available at: https://rps.researchcommons.org/journal/vol48/iss1/6

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Original Article

Using a Towel for Resistance Training in Non-exercising Elderly Women: A Cluster Controlled Trial

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Background: Aging results in deterioration of physical performance, including muscle strength, gait, and balance. Resistance training has been shown to be effective in enhancing physical function in elderlypeople. For people, who do not have regular exercise before, an easily available tool might increase their motivation to do exercise training. A towel is available for any person and it could be used in low intensity resistance training. The purpose of this study was to evaluate the effects of resistance training with a towel in community-dwelling elderly women who did not have regular exercise before.

Methods: This was a cluster controlled study. We recruited 25 elderly women in the experimental group and 24 in control group. The experimental group did resistance exercise training with a towel, one hour per section, twice per week for 3 months. We did the outcome measurements, including grip strength, biceps curls, chair stand test, gait speed, six minute walk test, before and after 3-month intervention. We used Mann-Whitney's U-tests to evaluate the differences in change scores between groups.

Results: The experimental group showed significant improvement in biceps curls, gait speed and six minute walk test as compared with control group (p=0.004, 0.003, 0.005 respectively). The intervention group had improvement in grip strength, while the control group showed deteriorated performance after training, but there was no significant difference in change score between the two groups.

Conclusion: Resistance training with a towel was feasible and effective for community dwelling elderly women who was a beginner of exercise. (Tw J Phys Med Rehabil 2020; 48(1): 53 - 61)

Key Words: strengthening training, geriatric, physical performance

INTRODUCTION

An increased lifespan has major implications for our health care and social system. According to the Report of the Senior Citizen Condition Survey 2017 by the Ministry

Submitted date: 29 April 2020 Revised date: 24 June 2020 Accepted date: 1 July 2020
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doi: 10.6315/TJPMR.202006_48(1).0006

of Health and Welfare, Taiwan, the prevalence of elderly people (above 65 years) in Taiwan was more than 14% in March 2018. On the basis of this statistic, the prevalence of elderly people will be about 20% in 2026. Aging is accompanied by a decline in physical characteristics, such as muscle strength, gait, balance, and postural stability.[1,2] Impaired physical function increases the risk of falling, mental health problems, hospitalization, functional dependency, and mortality.[1,3-5]

There is convincing evidence that exercise is an effective approach to prevent a decline in physical performance associated with aging. Several studies show that resistance training can improve the recruitment of motor units, increase their firing rate, enhance muscle mass, muscular strength, and functional performance.[6-8] Mayeret al.[8] suggested that resistance training also promotes inter- and intramuscular coordination. When resistance training is combined with sensorimotor training, improvement is observed in postural control. Elastic bands or dumbbells are common tools used for resistance training.[9-11] However, for people, who do not have a regular exercise program previously, buying a special sports equipment may be a barrier for them to do the exercise. Using an easily available training tool for exercise probably can increase people's motivation and adherence of exercise, especially for the beginners. The towel is not only easily available, but also suitable for-low-intensity resistance training. For example, when we straighten the towel, the grasping strength on both ends of the towel would compete with each other. That means one hand provides resistance force to against the other hand during exercise. If one foot steps on the towel and the upper extremities pull the towel up, the hands need to offer the counteract force of the leg. In the consideration of the intensity of resistance training, the American College of Sports Medicine (ACSM) guidelines for exercise prescription (10^{th} edition) emphasized a gradual progression of intensity for resistance training. Because the resistance came from our own limbs, the intensity of resistance would not be too high to induce soft tissue injury. Additionally, when the muscle strength increases after training, the intensity of resistance would increase. Therefore, the towel might be a feasible tool for resistance training for the beginners. This study aimed to assess the feasibility and effect of using a towel for resistance exercise in the elderly women who did not receive regular exercise training before.

MATERIALS AND METHODS

Participants

This was a cluster controlled study. We enrolled participants from two communities. Inclusion criteria in both groups were the following: women aged ≥65 years, capable of performing everyday activities independently, and willing to attend exercise program regularly. Exclusion criteria were falling down or fracture noted in recent one year, concomitant chronic diseases such as uncontrolled hypertension, heart failure, chronic obstructive pulmonary disease, poorly-controlled diabetes mellitus, end stage renal disease and mental disorders, which limiting the ability to perform exercises and assessments. In one community, which was chosen as the experimental group, we only recruited participants who did not have regular exercise program for at least one year. In another community, which was chosen as the control group, we only recruited participants who had regular recreational exercise at the activity center. The decision of which community being the experimental group was not randomized, it depended on the exercise habits of most residents in each community.

Interventions

Two certified athletic trainers were responsible for resistance training using a towel. Each training session lasted 1 hour, twice per week for 3 months. The exercise program included warm-up (including gentle stretch exercise for neck, shoulder, elbow, wrist, hip, knee, ankle and trunk) for 10 minutes, followed by resistance exercise with a towel for 40 minutes (rating of perceived exertion around 11-13) and cool-down (flexibility exercise for neck, shoulder, elbow, wrist, hip, knee, ankle and trunk) for 10 minutes. This resistance training program was designed for the major muscle groups such as elbow flexor and extensor (Figure 1); shoulder external and internal rotator (Figure 2); elbow flexor, knee extensor, and ankle plantar flexor (Figure 3); and elbow extensor and hip flexor (Figure 4). We used the rating of perceived exertion (RPE) around 11-13 to quantify the adequate

intensity of the towel exercise, because we think the RPE could be more understandable for the elderly people as compared with the repetition of maximum. During training, athletic trainers would supervise and correct the posture of participants individually.

The control group did their recreational exercises (such as dancing, dropping or catching the ball, designed by the qualified volunteers in the community) 1 hour per session, twice a week, for 3 months. These included dancing, ball activity, and playing games.

Assessment

Three physical functions, namely, muscle strength, gait speed, and walking endurance, were chosen as outcome measures. We used grip strength and biceps curls to assess muscle strength of the upper extremity and chair stand test for lower extremity muscle strength. Only the dominant side was assessed. The 10 meter walking test was used for gait speed and 6 minute walk test for the evaluation of cardiopulmonary endurance. All assessments were performed before and after the 3-month intervention.

Descriptions of the outcome measures are as follows:

1. Grip strength: Hand grip strength was measured using the CAMRY electronic hand dynamometer in a standing position.[12]
2. Biceps curls: Number of bicep curls within 30 s holding a 5 lb dumbbell while sitting was counted.[13]
3. Chair stand test: Times of full stands done in 30 s with the arms folded across the chest were assessed.[13]
4. Gait speed: Participants walk at their usual speed for 6 m with 2 m provided for acceleration and deceleration.[14]
5. 6 minute walk test: We recorded the maximum distance walked by the elderly subjects within 6 min.[14]

We also recorded the compliance and any adverse events, such as pain, numbness or falling, during the intervention period.

Table 1. Basic characteristics of participants

	Experimental group (N=25)	Control group (N=24)	p value
Age (y/o)	74.92±4.96	76.42±7.55	0.446
BMI (kg/m^2)	23.72±3.51	25.07±4.04	0.168
Hypertension(n (%))	11(44.0)	16(66.7)	0.114
Diabetes mellitus (n (%))	5(20.0)	6(25.0)	0.678
Heart disease (n (%))	4(16.0)	5(20.8)	0.666

BMI (body mass index)

Continuous variables were showed as mean ± SD; categorical variables were showed as number (%)

Table 2. Physical performance at baseline

	Experimental group (N=25)	Control group (N=24)	p value
Grip strength (kg)	19.98±4.43	18.77±3.14	0.288
Biceps curls (number)	16.92±3.13	18.54±4.26	0.563
Chair stand test (times)	14.28±5.14	13.00±3.44	0.336
Gait speed (m/s)	1.12±0.26	1.12±0.35	0.948
Six minute walk test (m)	337.19±80.05	331.61±76.60	0.807

Variables were showed as mean ± SD

Table 3. Change of physical performance after exercise

	Experimental group (N=25)	Control group (N=24)	p value
Grip strength (kg)	0.58±2.47	-0.40±1.79	0.161
Biceps curls (times)	1.80±2.36	-0.76±3.13	0.004*
Chair stand test (times)	-0.32±2.97	0.59±2.98	0.337
Gait speed (m/s)	0.16±0.18	-0.02±0.18	0.003*
Six minute walk test (m)	30.45±38.86	-2.42±29.56	0.005*

Variables were showed as mean ± SD
*p<0.05


Figure 1-a


Figure 1-b


Figure 2-a


Figure 2-b


Figure 3-a


Figure 3-b


Figure 4-a


Figure 4-b

Figure 1-4 Examples of resistance training with a towel

Legend

Figure 1-a, 1-b: Straighten the towel with bilateral hands; one upper limb should do elbow flexion and the other should do extension, alternatively.

Figure 2-a, 2-b: Straighten the towel with bilateral hands; one upper limb should do external shoulder rotation and the other should do internal rotation, alternatively.

Figure 3-a, 3-b: Flex one leg with the towel across the foot, both hands hold the ends of the towel, then do knee extension and simultaneously pull the foot toward the trunk as close as possible, with both hands.

Figure 4-a, 4-b: Compress both thighs with a towel, and then try to stand up slowly resisting the towel.

Statistical Analysis

The Shapiro-Wilk test was used to test the normality of data. For the variables were not normally distributed, nonparametric statistical analyses were used. To help quantify the magnitude of intervention, we subtracted the pre-training score from the post-training score as the change score for further analysis. We used the Mann–Whitney U-test to assess group differences at baseline data and change score after a 3-month intervention. $p<0.05$ was considered statistically significant. The Statistical Package for Social Science (SPSS 20.0 for Windows, SPSS, and Chicago, IL, USA) was used for statistical analyses.

RESULTS

We recruited 25 elderly women in the experimental group and 24 in the control group. The mean age of patients in the experimental group was 74.92±4.96 year-old and that in the control group was 76.42±7.55 year-old. There was no significant difference in baseline characteristics and physical performance between these two groups.(Table 1, 2)

All participants completed the study, no one was dropped out. There was no adverse event during the intervention period in the two groups.

After 3 months of exercise training, there were significant differences in the change score of biceps curls, gait speed, and 6 minute walk test between the two groups (p=0.004, 0.003, and 0.005 respectively) (Table 2). In the experimental group, grip strength increased by 0.58±2.47 kg, and in the control group, it decreased by 0.40±1.78 kg, but there was no significant difference between these two groups (p=0.161).

DISCUSSION

In our study, we found that towel resistance training was safe, feasible, and effective for the elderly women who had no regular exercise before. Participants' compliance was high; all of them completed the 3-month training program. During the intervention period, no adverse events were observed. After the 3-month intervention, the experimental group had considerable gains in the strength of upper limb, walking speed, and walking endurance compared to the control group.

Resistance training could effectively induce muscle hypertrophy, improve muscle strength, lead to better exercise capacity, help to accomplish daily living activities, and improve the quality of life ofthe elderlypeople.[7,10,15] It was interesting to study whether low-intensity resistance exercise was effective in improving muscle strength. Several studies have confirmed that both high- and low-intensity resistance exercise increased muscle strength significantly. A randomized control trial revealed that after 12 months of resistance exercise, both high- and low intensities increased the muscle strength significantly, including the shoulders, arms, upper back, lower back, hips, and legs.[16] Sahin et al.[17] designed an 8-week resistance training study for the frail elderly people. There were three groups: high resistance training (70% of 1-RM), low resistance training (40% of 1-RM), and control groups. Compared to the control group, both high- and low-resistance training groups showed considerable improvement of the strength of all four limbs after intervention. However, between the low- and high-resistance groups, there was no difference in strength improvement of all four limbs. The study by Hortobagyi et al.[17] showed that both low- and high-intensity strength training were equally effective in restoring muscle strength in the elderly people. Our study found that elderly women who did not do regular exercise before could increase muscle strength of the upper extremity (biceps curls) significantly by using a towel to perform low- intensity resistance training. The grip strength of the experimental group increased, whereas that of the control group worsened. After 70 years of age, people have a rapid loss of muscle mass and physical performance.[18-20] The average age of our participants was around 75 years, therefore, they had very high risk of functional deterioration. The decrease of grip strength in control group maybe due to that the recreational exercise training did not provide adequate training for grip strength. Although there was no significant difference between the two groups in the change scores of grip strength, our findings indicated that towel training could have the possible benefits of improving grip strength. We did not find any improvement in chair stand test in the experimental group, it was probably because the towel exercise focused on the upper extrem-

ity mainly and resistance from towel exercise was not enough to increase the strength of the lower extremities.

Elderly people with higher walking speed have a higher probability of independent everyday activities.[21] Resistance exercise interventions can increase habitual and fast gait speed and slowdown the loss of gait speed or delay its onset in healthy elderlies.[22] Nicholson et al.[23] revealed that low-load high-repetition resistance training improved both lower limb strength and gait speed. Likewise, we did not find any improvement in chair stand test for the experimental group; the gait speed increased by 0.16±0.18 m/s, which was above a meaningful change of gait speed (0.05 m/s, suggested by Perera et al.[24]). One possible reason for this result is that the lower limb muscles for chair stand test may not be the same as that for walking. The other reason is that the gait speed improvement resulted from mechanisms other than muscle strength enhancement. Martínez-Amat et al. revealed that proprioception training program in elderly people was effective in postural stability, static, and dynamic balance and could contribute to an improvement in gait speed.[25] Because the towel lacks elasticity, it may produce a compression force to the lower limb joints when doing lower limbs resistance training, which would stimulate the proprioceptors within the lower limb joints. We assumed that reciprocal rhythmic towel resistance training enhances the proprioceptive sensation and coordination of lower extremity joints and subsequently improves the gait speed of participants. The other possible cause might be the fact that the experimental group did not have an exercise routine before; regular exercise made them to be more active in their daily living. Thus the towel training did have a positive impact on the walking speed earlier than the improvement in muscle strength of the lower extremities. Further study is necessary to clarify the possible cause of improvement of the walking speed in the experimental group.

The 6-minute walk test can be used clinically to measure exercise capacity and endurance in elderly subjects. Gait speed is positively correlated with 6-minute walk distance in the elderly people.[26] As the experimental group had superior improvement in walking speed than the control group, it was not surprising that there was a significant difference between the experimental and control groups in the 6-minute walk test. The experimental group improved by 30.45±38.86 m, which was greater than the small meaningful change (20m) for 6-minute walk distance.[24] Enright et al.[27] reported that a shorter 6-minute walk distance was correlated with older age, weaker grip strength, symptoms of depression, and decreased mental status. It was possible that the significant improvement in 6-minute walk distance in the experimental group resulted not only from the improvement in walking speed but also from gains in other physical function such as grip strength or the psychosocial benefits.

LIMITATION

There were the following limitations in our study: First, the study had a small sample size that would limit the statistical power. Second, due to the difficulty of creating a randomized control study, we did a cluster controlled trial instead. The selection bias should be considered. Third, we only recruited elderly women; thus, the results are not relevant for all elderly population. Fourth, we only performed 3-month intervention without follow-up. Although the results of this preliminary study were not powered to make any definitive conclusion about the efficacy of the towel training, this study may provide some directions for future study. Because the towel is available at every one's home, the towel exercise maybe suitable as home exercise to improve the declining physical functions during the aging process. Further researches with larger sample sizes, randomized control trials and long-term follow up in community-dwelling elderly people are suggested.

CONCLUSION

Low-intensity resistance training with a towel was a feasible program for community-dwelling elderly women who were beginners in exercise training. In this study, we also found the exercise program might enhance the strength of the upper limb, gait speed, and endurance. Further study to provide more robust data about the efficacy of this exercise is warranted.

ACKNOWLEDGEMENT

This study was supported by the Medical Research Center and Clinical Monitoring Research Program (CORPG8F0031) of Chang Gung Memorial Hospital, Keelung and a research grant from the Wang Jhan-Yan Charitable Trust Fund.

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無運動習慣的女性長者接受毛巾操阻力訓練：族群對照研究

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隨著年紀增長，肌肉質量及肌力會逐漸衰退，進而影響體適能的表現及增加日常生活的依賴性。先前的研究證實阻力訓練可以有效提升年長者的體適能表現。本篇研究收錄先前無運動習慣的年長女性，欲提升參與度並考量到安全性，我們利用居家即可取得的毛巾爲低強度阻力訓練的工具。本篇研究分析毛巾操阻力訓練對體適能表現的影響。

這是一個群組對照研究，研究組收錄了 25 位女性長者，對照組收錄了 24 位女性長者。研究組接受了爲期三個月、一週兩次、一次一小時的毛巾操阻力訓練；對照組則接受了爲期三個月、一週兩次的社區動態活動。經過三個月的訓練後，相較於對照組，研究組在慣用側二頭肌屈舉、步行速度及六分鐘行走測試的進步有顯著差異(p 值分別爲 0.004、0.003、0.005)。

低強度的毛巾操阻力訓練可以有效提升年長女性的體適能表現。毛巾對於初學阻力運動的長者是一個方便、便宜、安全又有訓練效果的工具。希望透過毛巾的居家方便取得性，讓更多長者可以有興趣從事阻力運動。（台灣復健醫誌 2020；48(1)：53 - 61）

關鍵詞：阻力運動(strengthening training)，老年(geriatric)，體適能(physical performance)

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doi: 10.6315/TJPMR.202006_48(1).0006