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Research Article

Effectiveness of Shoulder Physical Therapy in Reducing Fall Risk among Rural Older Adults

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ABSTRACT

Background: This study aimed to assess shoulder problems among elderly people in rural areas and improve their function through customized shoulder physical therapy interventions. The goal was to enhance daily living activities and balance abilities, thereby reducing fall risk factors.

Methods: This study was conducted on 44 elderly people aged 65 years or older in five rural areas in Gyeongsangnam-do, South Korea. Subjects were evaluated before and after the program, conducted twice at two-week intervals. Shoulder functionality was evaluated using the Apley's scratch test and shoulder abduction and flexion muscle strength using TheraBand. Mobility was evaluated using the Sit to Stand (STS) and Timed Up and Go (TUG) tests. Balance was assessed using the BT-4 (Balance Trainer) for static and dynamic balance. The physical therapy intervention was performed by a therapist with over five years of experience, with more than 20 min of individual therapy and 20 min of customized shoulder exercises by a student researcher.

Results: There was no significant change in the STS and TUG tests before and after the intervention. However, the range of motion of the shoulder increased, and the strength of shoulder abduction and flexion significantly improved ($p<0.05$). The static index showed a significant increase in the C90 area ($p<0.05$). Dynamic balance ability also improved significantly in forward and lateral movements ($p<0.05$).

Conclusion: The results showed that a shoulder intervention program for the elderly in rural areas can effectively improve balance by enhancing the range of motion and muscle strength of the arms, thereby reducing the risk of falls. This program can be recommended to alleviate fall risk by improving upper limb function.

Keywords: Shoulder; Physical therapy; Postural balance; Accidental falls; Rural population

INTRODUCTION

Health problems among the elderly in rural areas are becoming increasingly important, with a high prevalence of chronic musculoskeletal problems, especially shoulder pain [1,2]. Shoulder pain is second only to knee pain, the most common degenerative arthritis among the elderly. These problems are particularly prevalent among the elderly in rural areas in Gyeongnam Province of Korea, and the results of the 21st smart community study (identification of musculoskeletal problems of the elderly in rural areas) showed that posture and shoulder flexibility were identified as weaknesses [3].

Falls are the number one cause of traumatic death among the elderly, accounting for more than half of all physical injuries among people aged 65 and older in Korea (national survey of the elderly 2020) [4]. Falls can result in serious brain injuries, such as hip and leg fractures and brain hemorrhages, and the resulting lengthy hospitalization and treatment can significantly reduce quality of life after treatment. Many elderly people who have experienced a fall are reluctant to move around for fear of falling and injuring themselves again, resulting in weaker muscle strength and a higher incidence of falls after the initial injury.

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Rural areas in Gyeongnam province are at a disadvantage compared to other regions in terms of fall risk management. In 2020, the fall rate in the combined rural-urban area was 3.0% in Gangwon, 3.6% in Chungcheongbuk-do, and 2.2% in Gyeongbuk, compared to 8.4% in Gyeongnam. Furthermore, due to the inaccessibility of hospitals in rural areas, the rate of hospital treatment for falls among the elderly in towns and villages (68.8%) is lower than that in cities (73.5%) [4].

The most frequent place where falls among the elderly occur is in the home, with the highest frequency occurring when using the toilet [5]. Transitioning from a standing position to a sitting position occurs in many places, such as a dining table or sofa, but in the case of a dining table, stability can be maintained near the base between the legs by changing the position of the chair, but in the case of using the toilet, the chair is fixed and the center of gravity shifts are large, resulting in a high risk of falling. In response to this, local governments are making efforts to prevent falls by installing safety bars in toilets for long-term care insurance recipients, who are at high risk of falling, but the installation of safety bars has not changed the actual fall rate [6]. Elderly people with narrow arm range of motion and weak muscle strength have difficulty distributing their weight properly on the safety bars and the range of motion required to rotate their body to sit down is also narrow, making it difficult to fully utilize the safety bars, resulting in a high frequency of falls.

Recent studies have shown that improving shoulder function is associated with a decrease in falls among older adults [7]. In addition to improving quality of life by enabling many of the movements of daily living, improved shoulder function appears to be effective in preventing falls by stabilizing the weight of the upper body and keeping it within the base of the legs. Overseas studies have examined the effectiveness of functional programs that include shoulder joint range of motion and strength in preventing falls in the community [2]. However, Korean studies have been conducted in hospitals or facilities for older adults, but community-based observational studies are difficult to find.

In anticipation of the entry of the ultra-elderly society in 2025, the government and local governments are implementing various policies to improve the quality of life and reduce the risk of falls for the elderly living at home, such as improving environmental factors in and around the home and providing safety items for the home, but vulnerable people in rural areas face difficulties in accessing health care due to a lack of caregivers. Although health centers in towns and villages have designated administrators, their number is small and it is difficult for them to be responsible for a large number of people in a large area. This situation has been pointed out as a social problem for improving the quality of life of the elderly and managing the risk of falls. Therefore, in rural areas, there is a growing need for collaboration between university experts with human and physical infrastructure and local healthcare personnel.

This study aimed to assess individual shoulder problems among elderly people in rural areas, which are medically underserved regions and to improve their function through customized shoulder physical therapy interventions. The goal was to enhance daily living activities and balance abilities, thereby reducing fall risk factors.

MATERIALS AND METHODS

Subjects

This study initially recruited 52 elderly individuals from five rural areas in Gyeongsangnam-do. Due to personal circumstances (such as health issues or mobility difficulties), 8 participants withdrew during the intervention period, leaving a final sample size of 44. The inclusion criteria for the study required participants to be 65 years or older, currently residing in rural areas and not diagnosed with any musculoskeletal diseases by a physician. Additionally, participants who did not have specific conditions affecting the neck or shoulder but experienced discomfort or had limited range of motion in these areas were also included in the study (Table 1).

Table 1: Characteristics of subject (n=44).

Gender (M/F)	Age	Height	Weight
15/29	77.14 ± 10.21	152.62 ± 9.21	57.43 ± 7.82

Experimental procedures

The experimental procedures follow personalized physical therapy intervention and fall prevention exercise:

Personalized physical therapy intervention and fall prevention exercise: The intervention consisted of personalized physical therapy and fall prevention exercises. Initially, an experienced, licensed physical therapist conducted an evaluation to identify muscle imbalances around the shoulder, followed by targeted interventions to either relax or strengthen these muscles. Based on the therapist's postural assessments, customized functional shoulder strengthening exercises were designed and administered by student researchers. The intervention prioritized the improvement of functional activities of daily living, such as hair washing, dressing overhead and back cleaning, with the aim of enhancing weight-bearing capacity and range of motion progressively.

Individualized exercise routines, incorporating specific stretching and strengthening movements tailored to each participant's shoulder condition, were applied by student researchers for 20 min per session, with each student researcher overseeing two elderly participants. To support continued practice at home, participants were provided with instructional handouts. The program was executed by two teams, each comprising one expert therapist and two student researchers, under the guidance of Co-researcher professor and four student researchers.

Research devices and instruments

Subjects were assessed before and after the intervention 4 weeks later. During the intervention, the subjects were administered two interventions. This included a detailed evaluation of the range of motion using both shoulder and neck full range of

motion tests, as well as the Apley's scratch test. The stability of the shoulder complex was assessed by a physiotherapist with over five years of experience, using the scapular stability test and the shoulder blade imbalance pattern test [8].

The assessment of fall risk was conducted using highly reliable equipment, specifically the BT-4 (Balance Trainer). The BT-4 system connects to a laptop and allows for external measurements by moving only the force plate, offering both static and dynamic balance evaluations. The equipment's reliability is supported by research results, including studies on shoulder complex function and fall risk factors. All measurements were conducted with the assistance of student evaluators to ensure safety.

Static balance measurement: Subjects stood comfortably with bare feet centered on the V-shape marked on the force plate. They were instructed to maintain their balance for 30 seconds. During this period, the total moving distance of the center of gravity was recorded to calculate the balance index.

Dynamic balance measurement: For dynamic balance assessment, subjects shifted their body weight forward, backward, left and right for 8 seconds each, with their feet placed together. The maximum displacement of the center of gravity was measured. Throughout the process, student researchers assisted the participants to prevent falls. The sense of balance and overall functional capacity of the elderly participants were also assessed through a series of well-established tests, including the Sit to Stand (STS) test, the Timed Up and Go (TUG) test [9]. To evaluate lower extremity strength, leg abduction strength and adduction strength were measured using a TheraBand [10]. These tests were integral in evaluating both static and dynamic balance, contributing to the comprehensive fall risk assessment (Figure 1).

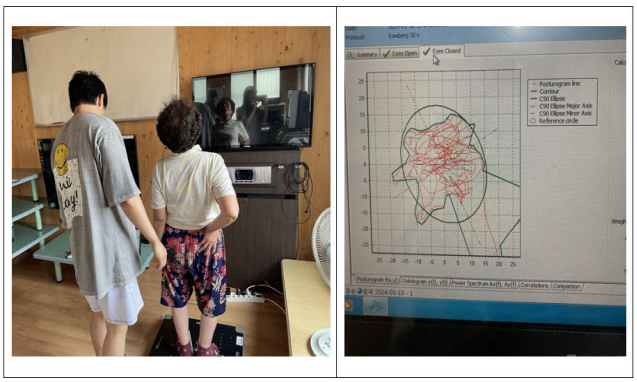

Figure 1: Dynamic balance measurement and data.

Data analysis

A paired t-test was performed on 44 subjects using SPSS 20.0 statistical analyses. This test was used to evaluate whether the mean difference between the interventions of the same subjects was statistically significant. The analysis results focused on confirming the mean difference and the statistical significance thereof and a p-value of less than 0.05 was interpreted as a significant difference.

RESULTS

There was no significant change in the STS and TUG tests before and after the intervention ($p>0.05$). On the other hand, improvements in shoulder mobility and strength were observed after the intervention. After the program, the range of motion in the Apley's scratch test increased and the strength of shoulder abduction and flexion significantly improved ($p<0.05$) (Table 2).

Table 2: Results of STS, TUG, Apley scratch test, strength test.

	STS (s)	TUG (s)	Apley (mm)	Abduction (mm)	Flexion (mm)
Pre	14.19 ± 6.46	9.99 ± 3.24	17.45 ± 4.31	65.90 ± 21.32	64.90 ± 19.46
Post	13.35 ± 5.15	10.23 ± 2.35	12.31 ± 3.86	74.25 ± 24.66	75.23 ± 20.53
p-value	0.245	0.425	0.024*	0.019*	0.032*

Note: STS: Sit To Stand; TUG: Timed Up and Go; Apley: Apley's scratch test

Among the balance ability for static balance, the static index showed a significant increase in the C90 area, which is an index indicating the area of movement when the eyes are closed ($p<0.05$) (Table 3). In dynamic balance ability, significant improvements in ability were observed for forward, left and right movements ($p<0.05$) (Table 4).

Table 3: Balance ability for static balance.

	Eye open		Eye closed	
	C90 area	Trace length (mm)	C90 area	Trace length (mm)
Pre	432.28 ± 192.79	550.55 ± 239.42	668.92 ± 384.85	900.38 ± 458.88
Post	349.82 ± 175.65	446.43 ± 226.63	455.87 ± 294.55	624.96 ± 392.42
p-value	0.119	0.368	0.042*	0.059

Table 4: Balance ability for dynamic balance.

	Forward (°)	Reward (°)	Leftward (°)	Rightward (°)
Pre	1.74 ± 2.43	3.05 ± 1.64	2.98 ± 1.74	3.19 ± 1.62
Post	2.58 ± 1.94	3.56 ± 1.87	4.11 ± 1.82	4.29 ± 2.24
p-value	0.046*	0.411	0.038*	0.041*

Note: °: Degree

DISCUSSION

This study evaluated the effects of a shoulder intervention program on reducing the risk of falls among elderly people living in rural areas. The results demonstrated significant improvements in both the range of motion and strength of the shoulder joint. Notably, the increase in shoulder flexion and abduction strength suggests potential contributions to the functional recovery of the joint. These findings imply that enhanced shoulder function can lead to more efficient arm movements in daily activities and greater movement safety. Previous studies have also emphasized that improving shoulder strength and range of motion fosters physical independence and facilitates smoother performance of everyday tasks [9,11].

Furthermore, it is noteworthy that this study found shoulder function improvements correlated with enhanced static and dynamic balance abilities. Static balance refers to maintaining body stability while stationary, while dynamic balance involves adjusting the center of mass during movement. Strengthening shoulder muscles through the program appears to have bolstered overall body stability, thereby potentially reducing the risk of falls. This is particularly important for older adults, as increased shoulder strength can aid in supporting balance during various arm-involved activities and contribute to maintaining stability during movements like walking. Prior research has reported that improved shoulder strength plays a crucial role in helping older adults stabilize their body's center of mass during weight-bearing activities [12]. These findings underscore the practical impact of this study in enhancing the safety and efficiency of daily living activities for the elderly.

The findings of this study highlight the potential impact of shoulder function improvements in enhancing both static and dynamic balance abilities. Static balance refers to the ability to maintain the body's center of mass while stationary, while dynamic balance involves adjusting the body's center of mass during movement. As the shoulder muscles were strengthened through the program, overall physical stability improved, which can contribute to reducing the risk of falls. This is especially important for older adults, as enhanced shoulder strength can support body balance in activities involving the arms and play an important role in maintaining stability during movements like walking. Pontillo et al., has emphasized the role of shoulder strength improvements in assisting the body's balance and stabilizing the center of mass during weight-bearing activities, which is vital for older adults [13]. These findings suggest that the results of this study could have practical implications in enhancing the safety and efficiency of daily living activities for older adults.

CONCLUSION

The results of this study showed that a shoulder intervention program targeting the elderly in rural areas can effectively improve the balance ability of the body by improving the range of motion and muscle strength of the arms, thereby reducing the risk of falls. Therefore, the shoulder intervention program applied to rural areas can be recommended as a program that alleviates the risk of falls by improving the function of the upper limb.

LIMITATIONS

The limitations of this study can be summarized as follows. First, the study was restricted to older adults residing in rural areas, which may limit the generalizability of the findings to other populations. Second, the intervention's long-term effects were not tracked, leaving gaps in understanding the sustainability of the improvements over time. Lastly, the study relied on subjective assessments, highlighting the need for future research to incorporate objective measurement tools to more accurately evaluate changes in balance and functional capacity.

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