The effect of Pilates and square-stepping exercises on physical and cognitive functions related to falling and fear of falling in elderly women

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Introduction:
Falling is one of the leading causes of unwanted injuries and deaths in the elderly. Most falls occur due to the interaction between multiple physical and cognitive risk factors. Meanwhile, physical activity has been accepted as a beneficial factor in preventing falls in the elderly. Therefore, the present study aimed to investigate the effect of a Pilates and Square-stepping training on cognitive and physical functions related to falling and fear of falling in older women.

Methods:
A quasi-experimental study was conducted on a number of 20 older women with an age range of 60 to 70 years. Participants were selected through convenience sampling and were randomly assigned to Pilates (n=10) and Square-stepping (n=10) groups. Both groups did exercises for 12 weeks and participated in a pre-test and post-test. The Wisconsin Card Sorting Task, Wechsler Memory Test, Stork Test, Berg Balance Test, and the Falls Efficacy International Scale were used to measure executive functions, memory quotient, static balance, dynamic balance, and fear of falling, respectively. Analysis of variance with repeated measures was used to analyze the collected data.

Results:
Results revealed the main effect of time in categories achieved, perseverative errors, memory quotient, static balance, dynamic balance, and fear of falling were significant, and the mean scores of perseverative errors and fear of falling decreased in the post-test compared with the pre-test. In addition, the mean scores of categories achieved, memory quotient, static balance, and dynamic balance, were higher in the post-test relative to the pre-test. In addition, results indicated no significant main effect of group and the interaction of group and time.

Conclusion:
Therefore, it can be concluded that both Pilates and Square-stepping training can be an appropriate intervention to improve cognitive functions and physical functions related to falling and decrease fear of falling in older women.

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Extended Abstract

Introduction
Aging is a part of the natural process of human life and is a dynamic, progressive, and irreversible process closely related to biological, psychological, and social factors. Most of the body's physiological functions, such as the central and peripheral nervous systems, deteriorate over time in the aging process. One of the physical and mental health problems is falling, which will reduce daily activities in the elderly. Studies have shown that falls in the elderly...
are associated with lower limb weakness, especially imbalance and poor cognitive functions. Overview research shows that falls are one of the leading causes of death in the elderly population, and older adults who fall are hospitalized ten times more often than normal people. Prevention of falls in the elderly is one of society’s primary concerns. In the meantime, exercise, and physical activity are beneficial factors in preventing falls in the elderly. In the past, it was believed that only exercise at a young age would help increase endurance in old age, while research has shown that exercise is beneficial for anyone of any age. Exercise with a suitable duration and intensity reduces the risk of falling. Because most falls occur due to the interaction between multiple physical and cognitive risk factors; therefore, to prevent and reduce falls, methods should be used that include all risk factors. Therefore, it seems helpful to use mental and physical exercises that can simultaneously affect the mind and body and improve motor, physical and cognitive functions in the elderly. Research has shown that mind-body exercises can reduce the rate of falls in the elderly by affecting balance and cognitive function. Exercises such as yoga, tai chi, Pilates, and more recently, Square-Stepping EExercises (SSE) are among these exercises. The SSE exercises are low-cost, home-based, safe exercises that do not require special sports equipment that can be easily used by the elderly. Therefore, in the present study, researchers investigated the difference between the effect of Pilates and SSA exercises, which have recently been used in research, on cognitive and physical functions related to falling and fear of falling in older women. If the beneficial effect of the mentioned exercises is the same, the use of SSE exercises can be recommended as an alternative method of training that can be easily performed at home and by the person herself in comparison with other types of mental-physical exercises. It is hoped that the present study results can be used by people active in this field.

**Methods**

A quasi-experimental study was conducted on 20 older women (60 to 70 years old). Participants were selected through convenience sampling. The code of ethics (IR. UI.REC.1399.046) was obtained from the Scientific Research Committee of the University of Isfahan. The participants completed the consent form. Then, they were randomly assigned to Pilates (N=10) and square-stepping (N=10) groups. Both groups did exercises for 12 weeks (3 days a week for 70 minutes) and participated in a pre-test and post-test. Pilates exercises largely avoid high impact, high power output, and heavy muscular and skeletal loading. As the elderly progressed, the complexity of the exercises increased. The Square Stepping Exercises were performed on a thin mat measuring 250x100 cm, which was divided into 40 squares of 25x25 cm. Participants were asked to follow the pattern from the beginning of the mat to the end. The patterns were explained and displayed by the instructor. Once the seniors became familiar with the gait pattern, they were asked to walk on their toes so that they did not step on the square lines. The step patterns included forward, backward, lateral, and diagonal steps, and the patterns gradually became more complex. A total of 196 step patterns were designed based on difficulty level progress in eight categories (beginner 1 and 2, intermediate 1 and 2 and 3, advanced 1 and 2 and 3), which according to the existing conditions, a total of 156 step patterns in six levels (beginner 1 and 2, intermediate 1, 2 and 3, advanced 1) were performed. Each step pattern was repeated four to ten times according to the learning of the elderly. The Wisconsin Card Sorting Test, Wechsler Memory test, Stork Test, Berg Balance Scale, and The Falls Efficacy International Scale were used to measure executive functions, memory quotient, static balance, dynamic balance, and fear of falling, respectively. Analysis of variance with repeated measures was used to analyze the collected data.

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Results

Results showed that the main effect of time in categories achieved (F(1,18)=112.03, P<0.001, η²=0.862), perseverative errors (F(1,18)=147.49, P<0.001, η²=0.891), memory quotient (F(1,18)=45.44, P<0.001, η²=0.716), static balance (F(1,18)=48.78, P<0.001, η²=0.730), dynamic balance (F(1,18)=29.51, P<0.001, η²=0.621), and fear of falling (F(1,18)=54.68, P<0.001, η²=0.752) were significant, and the mean scores of perseverative errors and fear of falling decreased in the post-test compared with the pre-test. In addition, the mean scores of categories achieved, memory quotient, static balance, and dynamic balance were higher in the post-test relative to the pre-test. In addition, results indicated no significant main effect of group and the interaction of group and time.

Conclusion

The study results showed improving cognitive and physical functions related to falling and reducing the fear of falling following Pilates and square stepping exercises. Therefore, the use of both training methods can be recommended as multidimensional interventions to improve cognitive functions (executive functions and memory), physical functions (static and dynamic balance), and reduce the fear of falling in older women. The SSE compared to Pilates has recently been proposed in research in this field due to the fact that there is no difference in the effect of these two training methods and the unique advantages of the SSE compared to Pilates, including portability of training mats, low cost and simple design, the possibility of performing these exercises in different open and closed environments, especially at home and without the need for instructor supervision. Preferring these exercises seems an easier and more accessible option for the elderly.

Ethical Considerations

Compliance with ethical guidelines

The present study was conducted after confirmation and receiving the code of ethics (IR.UI.REC.1399.046) from the Scientific Research Committee of the University of Isfahan. Besides, an informed consent form was obtained from participants.

Authors’ contributions

The first author did the data collection, and the second and third authors were involved in research design and data analysis.

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Conflict of interest

The authors declared no conflicts of interest.