IMPACT OF CORE FITNESS ON BALANCE PERFORMANCE IN THE ELDERLY

IMPACTO DO CONDICIONAMENTO FÍSICO DO CORE SOBRE O DESEMPENHO DO EQUILÍBRIO NOS IDOSOS

IMPACTO DEL ACONDICIONAMIENTO FÍSICO DEL CORE EN EL RENDIMIENTO DEL EQUILIBRIO EN LOS ANCIANOS

Original Article
Artigo Original
Artículo Original

Yuan Xu[1]
(Physical Education Professional)

1. Liaoning Equipment Manufacturing Vocational and Technical College, Department of Physical Education, Shenyang, China.

Correspondence:
Yuan Xu
Shenyang, China. 110161.
asdfgqwert001@126.com

ABSTRACT

Introduction: Relevant monitoring data show that falls have become the leading cause of death in adults over 65 years old, especially among elderly people who have no exercise habits. Physiological function decline caused by the aging process can be slowed with specific training. It is believed that exercises focusing on the core muscles can benefit balance ability among the elderly. Objective: The paper explores how core muscle training impacts balance performance in the elderly. Methods: The article randomly divides elderly volunteers (n=24) into two groups. The experimental group received specific core physical conditioning, and the control group received no intervention. The physical quality indicators of both groups were compared and statistically analyzed after the experiment. Results: The physical fitness indicators (weight, aerobic endurance, static balance ability) in the groups differed (P<0.05). Conclusion: Core training can improve the elderly´s functional physical ability and static balance capacity. ***Evidence level II; Therapeutic Studies - Investigating the results.***

Keywords: Strength training; Sports; Fitness testing.

RESUMO

Introdução: Dados relevantes de monitoramento mostram que as quedas se tornaram a principal causa de morte em adultos maiores de 65 anos, especialmente entre idosos que não têm hábitos de exercício. O declínio das funções fisiológicas causado pelo processo de envelhecimento pode ser retardado com treinos específicos e acredita-se que exercícios concentrados na musculatura do core podem beneficiar a capacidade de equilíbrio entre idosos. Objetivo: Este artigo explora o impacto do treino muscular do core no desempenho do equilíbrio nos idosos. Métodos: O artigo divide os voluntários idosos (n=24) em dois grupos de forma aleatória. O grupo experimental recebeu condicionamento físico específico do core enquanto o grupo controle não recebeu intervenção. Os indicadores de qualidade física dos dois grupos foram comparados e analisados estatisticamente após o experimento. Resultados: Os indicadores de aptidão física (peso, resistência aeróbica, capacidade de equilíbrio estático) dos dois grupos diferenciaram-se (P<0,05). Conclusão: O condicionamento físico do core pode melhorar a aptidão física funcional e a capacidade de equilíbrio estático dos idosos. ***Nível de evidência II; Estudos terapêuticos - Investigação de resultados.***

***Descritores*:** Treinamento de Força; Esportes; Testes de Aptidão Física.

RESUMEN

Introducción: Datos relevantes de seguimiento muestran que las caídas se han convertido en la principal causa de muerte en adultos mayores de 65 años, especialmente entre los ancianos que no tienen hábitos de ejercicio. El declive de las funciones fisiológicas provocado por el proceso de envejecimiento puede ralentizarse con un entrenamiento específico y se cree que los ejercicios centrados en los músculos del core pueden beneficiar la capacidad de equilibrio entre las personas mayores. Objetivo: Este artículo explora el impacto del entrenamiento de los músculos del core en el rendimiento del equilibrio en los ancianos. Métodos: El artículo divide a los voluntarios de edad avanzada (n=24) en dos grupos al azar. El grupo experimental recibió un acondicionamiento físico básico específico mientras que el grupo de control no recibió ninguna intervención. Los indicadores de calidad física de los dos grupos fueron comparados y analizados estadísticamente después del experimento. Resultados: Los indicadores de aptitud física (peso, resistencia aeróbica, capacidad de equilibrio estático) de los dos grupos fueron diferentes (P<0,05). Conclusión: El condicionamiento físico del core puede mejorar la aptitud funcional y la capacidad de equilibrio estático de los ancianos. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

***Descriptores*:** *Entrenamiento de Fuerza; Deportes; Pruebas de Capacidad Física.*

DOI: http://dx.doi.org/10.1590/1517-8692202228062022_0096 Article received on 01/06/2022 accepted on 02/18/2022

INTRODUCTION

Relevant monitoring data show that falls have become the leading cause of death in older adults over 65. Especially the elderly who lack exercise habits. Various physiological functions influence each other and present a close relationship that is interlocking and indispensable.[1] Falling will cause further physical and mental damage and accelerate the degradation of other physiological functions. This dilemma increases the burden on society and families, increases social, medical costs, and affects their physical and mental health. However, the decline of physiological functions caused by the aging process is the only way for an individual to grow and develop. However, many studies have confirmed that exercise can effectively delay the decline of physiological functions and reduce the restrictions on healthy living functions. Core muscle exercises can also help.[2] This study explored the effects of 8-week core muscle exercise on the functional fitness and balance ability of the elderly.

METHOD

Object

We selected healthy 65-70-year-olds as the research objects. Subjective wishes were divided into 14 persons in the control group and 14 persons in the experimental group.[3] There was no significant difference in the basic physiological parameters between the two groups (P>0.05). (Table 1)

Table 1. Comparison of basic physiological parameters of each group.

Group	Control group	Test group	P
Age	65.43±4.66	65.10±4.08	0.73
Systolic blood pressure (mmHg)	124.78±14.57	124.48±17.87	0.95
Diastolic blood pressure (mmHg)	77.65±16.43	75.93±10.01	0.64
Resting heart rate (times/min)	77.61±8.45	75.93±8.32	0.48
Height (cm)	158.39±6.85	155.95±6.12	0.18

Research methods

The experimental group performed core muscle exercises, and the control group did not perform any intervention. Perform functional physical fitness and balance tests before and after the intervention.

Functional fitness test

Functional fitness refers to the basic physical activity ability of the body to take care of daily life independently under the premise of safety,[4] including factors such as muscle strength, muscle endurance, cardiorespiratory endurance, flexibility, balance ability, coordination ability, reaction time and body mass. This study refers to the elderly physical fitness test (SFT) for 7 test items. The content includes the 30s sitting and standing test, 30s arm bending test, sitting body forward bending test, back extension test, 3m sitting and winding object test, 2min knee lift test, and body mass index.

Balance test

We use the Biodex dynamic balance system to use the clinical sensory integration and balance test as a fall risk assessment program for static balance ability testing.[5] The test content includes sensory input of four different combinations of conditions: Mode 1-Stand on a stable surface with your eyes open. Mode 2-Stand on a stable surface with eyes closed. Mode 3-Stand on an uneven surface with eyes open. Mode 4-Stand on an uneven surface with eyes closed. The Sway Index (SI) is an evaluation parameter. The smaller the value, the better the static balance ability. We used 3m to sit up and walk around the object to test the dynamic balance ability. The shorter the time, the better the dynamic balance ability.

Muscle force prediction model

We use optimization methods to predict muscle strength. The general equations based on the constrained optimization method are as follows:

$$\begin{aligned} &\min J(x_k) \\ &s.t. \quad h_i(x) = 0 \quad i = 1,2,\ldots,I \\ &x_{kL} \le x_k \le x_{kU} \quad k = 1,2,\ldots,n \end{aligned} \tag{1}$$

$J(x_k)$ is the objective function. $h_i(x)$ is the equality constraint. I is the number of equality constraints. x_{kL}, x_{kU} represents the lower and upper bounds of the k variable. n is the number of variables in the objective function.

Let $f_{m,o}$ be the maximum contraction force produced during isometric contraction of the muscle. $f_{m,o} = A_{PCSA}\,\sigma_{max}$, σ_{max} be the maximum stress of the muscle. When the human body is in motion, the contraction component of the muscle is activated under the influence of nerve impulses.[6] Its strength is determined by the magnitude of the force exerted by the instantaneous contraction component. Based on this, Delp proposed the dynamic muscle force function:

$$f_{CE} = f(l_{CE}, v_{CE}, a) \tag{2}$$

l_{CE} is the length of CE. v_{CE} is the speed of muscle contraction. a is the degree of muscle activation.[7] It is usually assumed that when $a = 0$ is the minimum muscle strength, when $a = 1$ is the maximum muscle strength. We take the minimum square sum of muscle stress as the objective function:

$$J = \min \sum_i \left(\frac{f_{m,i}}{A_{PCSA,i}} \right)^2 \tag{3}$$

$f_{m,i}$ is the muscle strength of the i muscle. $A_{PCSA,i}$ is the physiological cross-sectional area of the i muscle.

RESULTS

Comparison of body weight and BMI before and after exercise

After exercise, the weight and BMI of the experimental group were significantly different from those of the control group (P<0.05). (Table 2)

Comparison of functional fitness test results before and after exercise

The experimental and control groups had significant differences in the range of changes in the 30s sitting the test and 30s arm bending test (P<0.05). There was no significant difference in the change range of the sitting body forward bending test and back extension test between the two groups (P>0.05). There was a significant difference in the range of changes in the 2min knee lift test (P<0.05). There was no significant difference in the range of changes in the test of 3m sitting up and around objects (P>0.05). (Table 3)

Static balance ability

There was no significant difference between the experimental group's mode 1 and mode 2 measured value changes (P>0.05). The variation range of mode 3 and mode 4 both reached significant differences (P<0.05). (Table 4)

DISCUSSION

The physical decline and psychological obstacles that occur in aging will reduce the willingness to exercise and the amount of physical activity. This increases body fat, decreases net weight, and decreases basal metabolic rate, resulting in changes in body mass.[8] The results of

Table 2. Comparison of body weight and BMI before and after the experiment.

	Weight (kg)		BMI (kg/m²)	
Group	Control group	test group	Control group	test group
Before the experiment	61.26±11.26	57.71±9.96	24.34±3.47	23.70±3.55
After the experiment	61.56±11.15	57.46±9.85	24.45±3.43	23.29±3.41
Δ(%)	0.48	-0.43	0.48	-1.75
P	0.049		0.01	

Table 3. Comparison of the results of functional fitness tests before and after the two groups of experiments.

	Group	Before the experiment	After the experiment	Δ(%)	P
30s sitting and standing test (times)	Control group	15.87±3.31	16.96±4.19	6.81	0.01
	test group	17.59±4.44	20.97±4.65	19.22	
30s arm bending test (times)	Control group	19.00±5.41	20.22±4.86	0.48	0.02
	test group	19.45±5.10	22.86±4.04	17.53	
Sitting body forward bending test (cm)	Control group	4.33±12.03	5.50±13.43	26.15	0.43
	test group	9.77±6.87	11.30±5.57	15.36	
Back extension test (cm)	Control group	0.50±7.50	-0.43±7.87	-180	0.96
	test group	3.57±6.57	2.33±7.00	-34.58	
2 min knee lift test (times)	Control group	98.70±11.06	92.65±11.60	-6.13	0
	test group	102.82±16.83	108.57±18.11	5.59	
3 m sit-up test(s)	Control group	6.00±1.41	6.07±1.85	1.17	0.28
	test group	5.71±1.04	5.54±0.83	-2.98	

Table 4. Comparison of CTSIB measured values before and after the two groups of experiments.

CTSIB	Group	Before the experiment	After the experiment	Δ(%)	*P*
Mode 1	Control group	0.48±0.22	0.36±0.13	-25	0.79
	test group	0.45±0.17	0.36±0.11	-17.78	
Mode 2	Control group	0.78±0.34	0.81±0.31	3.85	0.35
	test group	0.66±0.26	0.70±0.21	6.06	
Mode 3	Control group	0.95±0.28	0.83±0.28	-12.63	0.04
	test group	0.95±0.36	0.72±0.17	-23.16	
Mode 4	Control group	2.85±0.81	2.87±0.88	0.7	0
	test group	2.84±0.63	2.31±0.52	-18.66	

this study suggest that core muscle group exercise helps improve body quality. Although exercise training improves body quality, the design of exercise prescriptions is also very important. Muscle strength is an important indicator that determines the functional ability of the elderly, and it is also one of the key factors affecting whether they can live independently. Regular exercise can maintain or enhance the strength of aging muscles, and core muscle training can effectively improve upper limb muscle strength. Core muscle training does not have the benefit of improving individual flexibility.

The physical status of the elderly will gradually decline with age, and aerobic endurance has decreased by 1.54% annually since the age of 50. However, physical exercise can effectively improve or slow down its decline because the training courses in this study belong to compound exercises. Muscle strength of lower limbs is positively correlated with aerobic endurance.[9]

Regular exercise can enable the elderly to have better daily life functions and reduce their reaction time when they are imbalanced. This can reduce the incidence of fall accidents.[10] However, the sensitivity test of the experimental group did not significantly improve after core muscle exercise.[11] Therefore, in the future, further research will be conducted on training programs that can improve the agility of the elderly.

The decline of physiological function will affect the body's postural balance mechanism. Young people will adopt more efficient ankle strategies in the choice of balance strategies. Long-range muscle actions start earlier than the proximal muscles. On the contrary, the elderly tends to adopt hip strategies. Adjust and maintain the balance of body posture by proximal muscle movements. Young people adopt an ankle joint strategy to maintain a balance of 8° forward and 4° backward swing. However, for the same degree of swing, the elderly must use the hip joint strategy. It can be seen that the muscle strength of the lower limbs of the elderly will appear to be more unstable due to the decline.[12] Nerve conduction makes the small muscles too late to respond, and the gastrocnemius and anterior tibial muscles, which are mainly responsible for standing, become weak. This motivates the elderly to adopt hip joint strategies instead of ankle joint strategies that control small muscle groups to adjust and maintain the balance of body posture. Mode 1 and Mode 2 in the CTSIB test represent the ankle joint balance strategy for balance control on hard ground. Mode 3 and Mode 4 represent hip balance strategies adopted on uneven ground. The experimental results confirm that this study can effectively improve the static balance ability of the elderly on uneven surfaces.[13] The core muscles used by the elderly to maintain individual posture balance and stability and support the spine for exercise are the waist, hip, and hip complex, including abdominal muscles, spinal muscles, quadriceps femoris, and biceps femoris. This is consistent with the muscle groups strengthened by the training content of this research. It is proved that core muscle exercise can effectively improve the phenomenon of the elderly who lose their balance due to instability of the center of gravity. At the same time, this can reduce the incidence of accidental falls in the elderly.

CONCLUSION

Core muscle exercise can significantly improve the body mass index, upper limb muscle strength, lower limb muscle strength, and aerobic endurance of middle-aged and older adults. It can significantly reduce the shaking index of middle-aged and older adults standing on uneven surfaces. Core muscle exercise helps to improve the static balance ability of middle-aged and older adults. Although core muscle exercises did not significantly improve the dynamic balance of middle-aged and older adults, they showed improvement. Therefore, it is inferred that core muscle group exercise may be helpful to delay the decline of dynamic balance ability.

The author declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. YX: writing and performing surgeries; data analysis and performing surgeries, article review and intellectual concept of the article.

REFERENCES

1. Shamsoddini A, Morovati Z, Farhadian M. The effect of core stability and theraband strength training exercises on cardiovascular risk factors and cardio-respiratory fitness in elderly. Journal of Isfahan Medical School. 2019;36(501):1288-96.
2. Tsai YJ, Chia CC, Lee PY, Lin LC, Kuo YL. Landing kinematics, sports performance, and isokinetic strength in adolescent male volleyball athletes: influence of core training. Journal of sport rehabilitation. 2020;29(1):65-72.
3. Katsanis G, Chatzopoulos D, Barkoukis V, Lola AC, Chatzelli C, Paraschos I. Effect of a school-based resistance training program using a suspension training system on strength parameters in adolescents. Journal of Physical Education and Sport. 2021;21(5):2607-21.
4. Bagherian S, Ghasempoor K, Rahnama N, Wikstrom EA. The effect of core stability training on functional movement patterns in college athletes. Journal of sport rehabilitation. 2019;28(5):444-9.
5. Zhang J. Biological analysis of trunk support strength training in sports training. Network Modeling Analysis in Health Informatics and Bioinformatics. 2021;10(1):1-12.
6. Lum D, Barbosa TM. Brief review: effects of isometric strength training on strength and dynamic performance. International journal of sports medicine. 2019;40(06):363-75.
7. Song HS, Chun BO, Lee K. Relationship between anaerobic power and isokinetic trunk strength in college male soccer players. Journal of Men's Health. 2021;17(1):44-9.
8. Genç H, Ciğerci AE. The Effect of the Core Exercises on Body Composition, Selected Strength and Performance Skills in Child Soccer Players. International Journal of Applied Exercise Physiology. 2020;9(6):101-8.
9. Raya-González J, Suarez-Arrones L, Sanchez-Sanchez J, Ramirez-Campillo R, Nakamura FY, Sáez De Villarreal E. Short and long-term effects of a simple-strength-training program on injuries among elite U-19 soccer players. Research quarterly for exercise and sport. 2021;92(3):411-9.
10. Yagci G, Yakut Y. Core stabilization exercises versus scoliosis-specific exercises in moderate idiopathic scoliosis treatment. Prosthetics and orthotics international. 2019;43(3):301-8.
11. Firouzjah EMAN, Daneshmandi H, Norasteh AA. Effect of Core Stability Training on the Endurance and Strength of Core in Basketball Players with Trunk Dysfunction. Journal of Rehabilitation Sciences & Research. 2020;7(2):80-6.
12. Kumahara R, Sasaki S, Sasaki E, Kimura Y, Yamamoto Y, Tsuda E et al. Effect of a simple core muscle training program on trunk muscle strength and neuromuscular control among pediatric soccer players. Journal of Experimental Orthopaedics. 2021;8(1):1-8.
13. Da Silva RP, Marcelo HI, Castoldi RC, Zanuto EAC. Effect of strength training and physiotherapy on the morphophysiological aspects and life quality of patients from the Public Healthcare System. Rev Med (São Paulo). 2021;100(3):229-37.