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Effectiveness of Exercise Programs for Older Adults Using an Augmented Reality Exercise Platform

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Introduction

Population aging is rapidly progressing worldwide, and the health management of the older adults is an important topic. To prevent the decline in physical and cognitive functions due to aging, it is crucial for older adults to maintain steady physical activity. With the development of digital technology, exercise programs using augmented reality (AR) game technology have recently been optimized for older adults.

Participants and Methods

Fifteen older adult females aged 65 years or older were enrolled into exercise programs based on the AR exercise platform. The program was conducted for 30 minutes, three times a week, for a total of six weeks. The exercise program was configured for physical and cognitive function training and consisted of six routines. Tap steps, balloon path finding, catching bugs, speed cards, shape-stepping bridges, and random squares were performed sequentially (Figure 1). To verify the effectiveness of the program and assess physical function before and after exercise the following tests were performed: timed up and go test (TUG); five to stand test (FTSST); one minute sit to stand test (1MSTST); lung capacity; respiratory muscle strength; and bioelectrical impedance analysis. Trail making test (TMT) was used for cognitive function evaluation. For statistical analysis, a paired t-test was used to verify the effects of physical and cognitive function before and after exercise. The significance level, α, was set to 0.05.

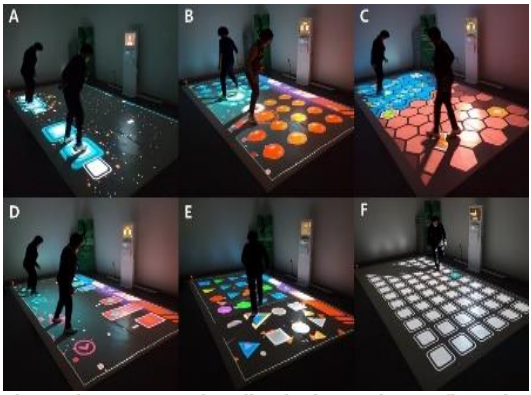

Fig 1. The augmented reality (AR) exercise configuration involves the following games: (A) tap step, (B) balloon path finding, (C) catching bugs, (D) speed cards, (E) shape-stepping bridge movement, (F) random square.

Results

The results of applying the AR exercise program to older adults are shown in Table 1. The TUG changed from 7.05 ± 0.88 to 6.24 ± 0.58, the FTSST changed from 8.11 ± 2.03 to 7.21 ± 1.05, and the 1MSTST changed from 39.60 ± 9.24 to 42.13 ± 8.37. In addition, the respiratory muscle strength maximum inspiratory pressure (MIP) changed from 64.87 ± 18.97 to 68.87 ± 16.60, and maximal expiratory pressure (MEP) changed from 79.00 ± 18.00 to 84.53 ± 16.54. The weight increased from 58.36 ± 6.64 to 59.38 ± 6.20, and body mass index (BMI) changed from 23.99 ± 2.75 to 24.43 ± 2.60. In the case of bioelectrical impedance analysis (BIA), percent body fat (PBF) changed from 31.84 ± 5.77 to 32.29 ± 5.86, skeletal muscle mass (SMM) changed from 21.21 ± 2.49 to 21.57 ± 2.52, skeletal muscle index (SMI) changed from 7.08 ± 0.69 to 7.09 ± 0.71, and fat free mass (FFM) changed from 39.59 ± 4.06 to 40.06 ± 4.09. Finally, regarding cognitive function, TMT_A changed from 30.52 ± 6.52 to 27.34 ± 12.85, and TMT_B changed from 76.25 ± 53.71 to 66.76 ± 60.55.

Table 1. Exercise program application results

		Pre-exercise	Post-exercise	*p*-value
Physical Function Test	TUG (sec)	7.05±0.88	6.24±0.58	**0.001***
	FTSST (sec)	8.11±2.03	7.21±1.05	0.072
	1MSTST (number)	39.60±9.24	42.13±8.37	0.270
Respiratory Function Test	FVC (L)	2.25±0.34	2.28±0.30	0.446
	FEV_1 (L)	1.79±0.27	1.83±0.25	0.200
	FEV_1/FVC(%)	79.40±4.70	79.73±4.50	0.511
	FVC (%)	102.27±14.14	103.40±12.92	0.476
	FEV_1 (%)	99.40±14.98	101.33±15.72	0.217
	MIP (cmH_2O)	64.87±18.97	68.87±16.60	**0.016***
	MEP (cmH_2O)	79.00±18.00	84.53±16.54	0.186
Cognitive Function Test	TMT_A (sec)	30.52±6.52	27.34±12.85	0.233
	TMT_B (sec)	76.25±53.71	66.76±60.55	**0.031***
Bioelectrical Impedance Analysis	Weight (kg)	58.36±6.64	59.38±6.20	**0.003***
	BMI (kg/m^2)	23.99±2.75	24.43±2.60	**0.003***
	PBF (%)	31.84±5.77	32.29±5.86	0.432
	SMM (kg)	21.21±2.49	21.57±2.52	**0.040***
	SMI (kg/m^2)	7.08±0.69	7.09±0.71	0.856
	FFM (kg)	39.59±4.06	40.06±4.09	0.122

* $p<0.05$, Significant difference between pre- and post-exercise
TUG; timed up and go test, FTSST; five sit to stand test, 1MSTST; one-minute sit to stand test, FVC; forced vital capacity, FEV_1; forced expiratory volume in 1s, MIP; maximum inspiratory pressure, MEP; maximum expiratory pressure, TMT; trail making test, BMI; body mass index; PBF; percent body fat, SMM; skeletal muscle mass, SMI; skeletal muscle index, FFM; fat free mass.

Conclusion

This study showed changes in the physical and cognitive functions of older adults who participated in AR-based exercise programs for 6 weeks. The programs were effective even with a short intervention period of 6 weeks. It is important to keep older adults interested in participating in exercise programs to manage their health. In the future, it will be necessary to conduct more community-based exercise programs for older adults, based on the AR exercise equipment used in this study.