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THE EFFECTIVENESS OF EXERCISE WİTH COGNITIVE TASKS IN HEALTHY OLDER ADULTS: A RANDOMIZED CONTROLLED CLINICAL TRIAL

SAĞLIKLI YAŞLI YETİŞKİNLERDE BİLİŞSEL GÖREVLİ EGZERSİZİN ETKİNLİĞİ: RANDOMİZE KONTROLLÜ KLİNİK ARAŞTIRMA

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Abstract

Objective: Cognitive functions, mobility, balance, and quality of life are affected with aging. Exercises with/without cognitive tasks can be effective in functions in aging.

Aim: The purpose of this study was to investigate the effectiveness of exercises with the cognitive tasks on cognition, mobility, balance, and quality of life in older adults.

Methods: Forty older adults aged between 60-80 were included in the study. Participants were randomly divided into the exercise with cognitive tasks group (Group 1)(n=20) and the exercise group (Group 2)(n=20). Aerobic and balance exercises combined with cognitive tasks were performed in Group 1, only aerobic and balance exercises were performed in Group 2. The exercises were performed 3 days per week over 6 weeks. Participants were evaluated by Montreal Cognitive Assessment (MoCA), Stroop Test, Benton Facial Recognition Test (BFRT), Timed-Up and Go Test (TUG), Berg Balance Test (BBT), and Short Form-36 (SF-36).

Results: Significant differences were found in MoCA, Stroop Test, BFRT, TUG, BBT, and physical function, energy/vitality, pain sub parameters of the SF-36 in Group 1 ($p<0.05$). In Group 2, significant differences were found in MoCA, BFRT, BBT, and physical function, role physical, pain, and general health sub-parameters in the SF-36 ($p <0.05$). Between-group comparison revealed significant differences in Stroop, BFRT, BBT, and pain sub-parameter of the SF-36 test in favor of Group 1($p <0.05$).

Conclusion: Exercises with cognitive tasks can be effective in attention and visuospatial functions, balance, and quality of life in healthy older adults.

Keywords: Aging, Aerobic Exercise, Balance Exercise, Cognitive Task

Özet

Giriş: Yaşlanma ile birlikte bilişsel işlevler, mobilite, denge ve yaşam kalitesi etkilenir. Bilişsel görevleri olan/olmayan egzersizler yaşlanmadaki işlevlerde etkili olabilir.

Amaç: Bu çalışmanın amacı, yaşlı erişkinlerde bilişsel görevlerle yapılan egzersizlerin biliş, mobilite, denge ve yaşam kalitesi üzerindeki etkinliğini araştırmaktır.

Gereç- Yöntem: Çalışmaya 60-80 yaş arası kırk yaşlı yetişkin dahil edildi. Katılımcılar rastgele olarak bilişsel görevle yapılan egzersiz grubu (Grup 1)(n=20) ve egzersiz grubu (Grup 2)(n=20) olarak ayrıldı. Grup 1'de bilişsel görevlerle birlikte aerobik ve denge egzersizleri, Grup 2'de sadece aerobik ve denge egzersizleri yapıldı. Egzersizler 6 hafta boyunca haftada 3 gün yapıldı. Katılımcılar Montreal Bilişsel Değerlendirme (MoCA), Stroop Testi, Benton Yüz Tanıma Testi (BFRT), Zamanlı Kalk ve Yürü Testi (TUG), Berg Denge Testi (BBT) ve Kısa Form-36 (SF-36) ile değerlendirildi.

Bulgular: Grup 1'de MoCA, Stroop Testi, BFRT, TUG, BBT ve SF-36'nın fiziksel fonksiyon, enerji/canlılık, ağrı alt parametrelerinde anlamlı farklılıklar bulundu ($p<0.05$). Grup 2'de MoCA, BFRT, BBT ve SF-36'nın fiziksel fonksiyon, rol fiziksel, ağrı ve genel sağlık alt parametrelerinde anlamlı farklılıklar bulundu ($p<0.05$). Gruplar arası karşılaştırma, Stroop, BFRT, BBT ve SF-36'nın ağrı alt parametrelerinde Grup 1 lehine anlamlı farklılıklar ortaya koydu ($p <0.05$).

Sonuç: Bilişsel görevlerle yapılan egzersizler, sağlıklı yaşlı erişkinlerde dikkat ve görsel-uzamsal işlevler, denge ve yaşam kalitesinde etkili olabilir.

Anahtar Kelimeler: Yaşlanma, Aerobik Egzersiz, Denge Egzersizi, Bilişsel Görev

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INTRODUCTION

Aging is defined as an irreversible functional change in the organism with the progression of time. With this change in the organism, physical and cognitive functions, and the potential of the person to balance between systems decline (1). Healthy aging provides harmonious transitions between childhood and other life periods; improving education, income level, health and quality of life (QoL), and preserving it throughout life (2).

Cognitive functions are defined as all the basic skills that control the behavior of people, including activities of daily living (ADL). A decline in cognitive functions may cause greater problems in performing ADL for older adults (3). Executive functions that modulate and use information from cortical sensory systems in the anterior and posterior areas of the brain include behavioral and cognitive components that require targeted actions and are essential for the control of attention. Therefore executive functions can form the basis for independent conduct of ADL(4). An insufficiency in creative thinking, difficulty in problem solving, reduction in attention and quick thinking, and inhibitions occur with aging. Regular physical activity has been reported to be beneficial in the prevention of cognitive impairment and dementia in older adults (5). Interestingly aerobic exercises have been found to benefit the brain more efficiently and adaptively and thus lead to the improvement of memory and attention (6,7).

The older adults experience mobility problems due to aging and decreased sensory input and declined muscle strength, the prolonged transmission of postural responses, and the slowing of vestibular reflexes. Approximately 25% cell loss will occur in the cerebellum with aging (8). Experiencing a decrease in mobility during the aging process is common among older adults and loss of mobility is more common than dependence on activities of daily life (9). It has been reported that in the aging accompanied with depression, levels of dopamine, serotonin, norepinephrine, Gamma-Aminobutyric Acid and metabolites decrease in the brain (10). Degenerative changes in brain structure and function negatively affect cognitive functions and psychomotor activity. Reduction in the functioning of the sensory organs with aging can lead to deterioration of cognitive functions by decreasing the clarity of perception and adversely affecting functionality (11). Aerobic exercises, muscle strengthening exercises, flexibility exercises, and balance exercises are recommended for older adults (12). Also, recent studies suggest cognitive training for the prevention of these decreases on functions in older adults (13,14).

In our knowledge, there aren't any previous research outcomes about effectiveness of exercise with the cognitive task on cognitive functions, mobility, balance, and QoL in healthy older adults.

The purpose of this study was to investigate the effectiveness of exercise with the cognitive tasks on cognitive functions, mobility, balance, and QoL.

METHODS

This study was a randomized, controlled, and single blind (participants) trial, registered in ClinicalTrials.gov (NCT03878394). The study was approved by the Institutional Non-Invasive Ethics Committee (Approval number:604).

Participants

Older adults attending Medipol University Hospital were selected for inclusion in the study. This study was concluded between October 2018 - May 2019. Forty healthy individuals aged 60-80 years who fulfilled the inclusion criteria were included in the study.

The inclusion criteria was defined as being aged 60-80 years, and 24 and over score in MMSE. The exclusion criteria was having a cardiovascular disease, a previous

cardiovascular surgery, and having a pacemaker.

All participants were evaluated by a physiotherapist at Medipol University Hospital. At the beginning of the study, 44 patients were allocated in the study, but according to exclusion criteria, 2 people with a Mini Mental State Examination test (MMSE) score below 24 and 2 people with heart disease were excluded from the study. The study was completed with 40 participants. The participants were randomly divided into the exercise with cognitive tasks group (Group 1) (n=20) and the exercise group (Group 2) (n=20).

Study Design

Participants were randomly allocated to the group 1 or 2 using Microsoft Excel 'RAND(WS)' function by the researcher. Participants were blinded regarding the group allocation. All participants had signed a written informed consent form, and the study has been conducted in accordance with the principles of the Declaration of Helsinki.

Outcome Measurements

All participants were evaluated before and after the interventions. Primary outcomes included Montreal Cognitive Assessment (MoCA), Stroop Test, and Benton Facial Recognition Test (BFRT). Secondary outcomes included Timed Up and Go Test (TUG), Berg Balance Test (BBT), and Short Form-36 (SF-36).

Demographic Information Form: Demographic Information Form was prepared to record the sociodemographic characteristics of healthy individuals included in the study.

Montreal Cognitive Assessment (MoCA): It is a short screening test that can detect mild cognitive impairment among older people. MoCA evaluates 8 different functions related to cognitive functions and general mental health. 21 points and above are considered normal in the test and the highest score is 30 (15). Minimal Clinical Change (MDC) was 3.54 and 4.21 at the 90% and 95% level, and excellent reliability of 0.81 in older adults (16). Cronbach's alpha at the level of 0.81 for the MoCA (17).

Stroop Test: The Stroop Test measures the processing speed, the ability to suppress habitual behavior, focused attention, the ability to do unusual behavior, the ability to change the perceptual setup according to changing demands, and under a disturbing effect. The tests proved to be reliable (with test/retest reliabilities ranging from acceptable (r=0.63) to high (r=0.88) and sensitive to detect small differences in subjects from different age categories (18). Cronbach's alpha is ranged from 0.780 to 0.879 (19).

Benton Face Recognition Test: The test is standardized to determine the capacity to recognize unfamiliar human faces. Internal consistency reliability estimates are 0.72 for the Long Form (FRLF), 0.53 for the Short Form, and 0.69 for a new short form (20). The Cronbach Alpha coefficient of the test is 0.78 for the short form and 0.84 for the long form (21).

Timed Up and Go Test (TUG): TUG Test evaluates falls and mobility in the elderly. TUG Test is an index of balance and walking, allowing him to stand up from a chair, walk 3 meters away, return to the chair and sit down. The time required for the task is measured in seconds. The intraclass correlations are greater than 0.90 and are similar within and between raters. In repeated measurements at the individual level, an observed value of 10 seconds is expected to vary from 7 to 15 seconds and an observed value of 40 seconds is expected to vary from 26 to 61 seconds for 95% of the observations (22). The internal consistency (Cronbach's alpha) is 0.74 (23).

Berg Balance Test (BBT): Berg balance test was created to determine the risk of falling in elderly people and to evaluate their balance performance. It is performed using a five-point rank scale to score subjects performing 14 functional activities. The maximum score on the Berg Balance Scale is 56. A score below 40

indicates an approximately 100% risk of falling. Relative reliability values are 0.95 (95% CI, 0.85-0.98) for test-retest reliability and 0.72 (95% CI, 0.31-0.91) for interrater reliability (24). Cronbach's alpha is 0.886 (25).

Quality of Life Short Form-36 (SF-36): This questionnaire is a general health screening survey. It measures eight scales: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), and mental health (MH). It also includes the physical activity limitations that the patient perceives about the disease. The reliability scores are between 0.70 and 0.92 in older adults (26). The Cronbach's alpha coefficients of each subscale of the SF-36 range from 0.7324 to 0.7612 (27).

Intervention Protocols

Exercises were performed once a day, 3 days a week over 6 weeks. The aerobic and balance exercises combined with the cognitive tasks were performed in Group 1. Only aerobic and balance exercises were performed in Group 2. Exercises were taught to all participants practically by a physiotherapist with a bachelor's degree at XXX University. The intervention protocol was administered 1 times a week with a physiotherapist, 2 times a week via telerehabilitation.

Structured Aerobic Exercises and Balance Exercises Protocol: The aerobic and balance exercise was performed in accordance with the definition of moderate-intensity exercise of the World Health Organization; that is, the individuals can walk with a tempo in a way that they can speak but not sing during moderate exercises (28). Aerobic exercise included 30 min of moderate walking. Balance exercises include 30-sec feet adjoining static, 30-sec single leg standing, 30-sec tandem position, and 30-sec heel walking exercises. The exercise order is as follows; 30 min of moderate walking, 30-sec feet adjoining static, 30-sec single leg standing, 30-sec tandem position, and 30-sec heel walking exercises. All Exercises took approximately 35 minutes. The same exercise protocol was applied to all participants by working individually with each participant.

Cognitive Task Protocol: The cognitive task was performed in addition to aerobic and balance exercises. Cognitive tasks include producing random words, producing name-fruit pairs, in order to observe the effect of doing dual task count up to 20 and count down from 20, count the days of the week backward and forward, counting by adding three forward, counting by subtracting three backward, and repeat for 30 minutes. Participants were asked to focus promptly during the dual tasks to successfully accomplish the motor tasks without a possible error in the cognitive ones. The exercise order is as follows; 30 min of moderate walking, 30-sec feet adjoining static, 30-sec single leg standing, 30-sec tandem position, and 30-sec heel walking exercises. All exercises took approximately 35 minutes. Cognitive task questions were asked by the physiotherapist. Cognitive task errors were not counted, time was kept for the dual task. Exercises were performed individually and all participants were given the same exercises.

Sample Size

The sample size was determined using the G*power sample size calculator (29). The required sample size was 21 for each group with a 85% power (α=0,05), considering the Minimal Clinically Important Difference of 33 points in the MoCA(16). We aimed to enroll at least 40 participants considering the drop-outs.

Statistical Analysis

SPSS (Statistical Package for Social Science) 25.0 for Windows was used for statistical analysis. The normal distribution of the variables was tested by the Kolmogorov-Smirnov Test. Regardless of the homogeneity of the variances, Time dependent differences within group and Time*Group interactions between groups were analyzed by Two Way

Repeated Measure ANOVA. Significance value was accepted as $p<0.05$.

RESULT

Distribution of Demographic Data

Forty healthy older adults aged between 60-80 years were included in the study. There were 14 women and 6 men in Group 1, 13 women and 7 men in Group 2. The average age was 68.45 ± 5.00 in Group 1 and the average age was 66.50 ± 4.28 in Group 2 (Table 1).

Within Group Findings

Significant differences were found in MoCA, Stroop Test, BFRT, BBT, and role physical, physical function, energy/vitality, and pain sub-parameters of SF-36 in Group 1 ($p<0.05$). Within group findings in Group 1 is shown in Table 2. In Group 2 there were significant differences in MoCA, BFRT, BBT, and role physical, physical function, pain, and general health sub-parameters of SF-36 ($p<0.05$). Within group findings in Group 2 are shown in Table 3.

Between Group Findings

There was no significant difference between groups in pre-treatment evaluations ($p>0.05$). There was a significant difference in the TUG Test between groups in post-treatment evaluations In Time*Group interaction analyses, there were significant differences in Stroop Test, BFRT, BBT, and pain sub-parameter of SF-36 in favor of Group 1 ($p<0.05$). Between group findings are shown in Table 4.

Table 1. Distribution of Demographic Data

		Group 1 (n=20)	Group 2 (n=20)	p value
Age (Avg± SD)		68.45 ± 5.00	66.50 ± 4.28	0.232
Height (Avg± SD)		1.61 ± 0.08	1.63 ± 0.10	0.635
Weight (Avg± SD)		70.05 ± 10.24	72.25 ± 19.70	0.178
Gender (n / %)	**Female**	6 / 30	13 / 65	0.739
	Male	14 / 70	7 / 35	
Marital status (n / %)	**Married**	17 / 85	14 / 70	0.262
	Widow	3 / 15	6 / 30	
Education level (n / %)	**Primary school**	2 / 10	11 / 55	0.260
	Secondary School	10 / 50	5 / 25	
	High School	8 / 40	1 / 5	
	University	0 / 0	3 / 15	

Avg=Average. **SD**= Standard Deviation

Table 2. Within Group Findings in Group 1

Group 1 (n=20)	Pre Intervention	Post Intervention	Mean Difference	(Confidence Interval)	F	Effect size (Cohen's d)	p value
	Mean (SD)	Mean (SD)					
MoCA	23.00 (2.791)	25.40 (2.604)	-2.400	(-3.489 to -1.311)	21.292	0.000	**0.000***
Stroop Test	64.90 (32.255)	51.25 (31.937)	13.650	(7.385 to 19.915)	20.796	0.523	**0.000***
BFRT	39.75 (5.014)	44.40 (5.529)	-4.650	(-6.989 to -2.311)	17.314	0.477	**0.001***
TUG	8.34 (1.535)	8.00 (1.644)	0.341	(0.043 to 0.639)	5.755	0.232	**0.027***
BBT	49.60 (5.862)	52.30 (4.293)	-2.700	(-4.050 to -1.350)	17.511	0.480	**0.001***
SF-36 PF	75.25 (18.530)	77.00 (18.453)	-1.750	(-5.642 to 2.142)	0.886	0.045	**0.358**
SF-36 RP	70.00 (40.230)	85.00 (26.157)	-15.000	(-29.897 to -.103)	4.442	0.189	**0.049***
SF-36 RE	70.00 (44.460)	86.25 (33.907)	-16.255	(-33.535 to 1.025)	3.877	0.169	0.064
SF-36 E/V	48.50 (8.599)	54.58 (9.545)	-6.080	(-10.50 to -1.659)	8.286	0.304	**0.010***
SF-36 MH	61.00 (11.743)	62.30 (10.367)	-1.300	(-4.153 to 1.553)	0.909	0.046	0.352
SF-36 SF	73.75 (18.540)	75.00 (18.585)	-1.250	(-4.482 to 1.982)	0.655	0.033	0.428
SF-36 Pain	65.38 (24.646)	75.88 (19.113)	-10.500	(-17.297 to -3.703)	10.454	0.355	**0.004***
SF-36 GH	60.00 (13.765)	60.25 (14.186)	-.250	(-3.849 to 3.349)	0.021	0.001	0.886

MoCA=Montreal Cognitive Assessment. MMSE: Mini-Mental State Examination. BFRT: Benton Face Recognition Test. TUG: Timed-up and Go Test. BBT: Berg Balance Test. PF: Physical Function. RP: Role Physical. RE: Role Emotional. E/V: Energy/Vitality. MH: Mental Health. SF: Social Functioning. GH: General Health. SD= Standard Deviation. *p<0.05

Table 3. Within Group Findings in Group 2

Group 2 (n=20)	Pre Intervention	Post Intervention	Mean Difference	(Confidence Interval)	F	Effect size (Cohen's d)	p value
	Mean (SD)	Mean (SD)					
MoCA	22.20 (3.397)	24.10 (4.352)	1.900	(-2.973 to -.827)	13.745	0.420	**0.001***
Stroop Test	62.00 (18.146)	59.40 (21.729)	2.600	(-2.831 to 8.031)	1.004	0.050	0.329
BFRT	40.10 (5.628)	41.55 (4.322)	1.450	(-2.821 to .079)	4.903	0.205	**0.039***
TUG	8.32 (1.581)	7.99 (1.544)	0.325	(-012 to .662)	4.072	0.177	0.058
BBT	50.45 (7.626)	51.70(7.012)	-1.250	(-1.836 to -.664)	19.958	0.512	**0.000***
SF-36 PF	71.25 (23.333)	73.25 (22.900)	-2.000	(-3.921 to -.079)	4.750	0.200	**0.042***

Table 3. Within Group Findings in Group 2 – continuation

Group 2 (n=20)	Pre Intervention	Post Intervention	Mean Difference	(Confidence Interval)	F	Effect size (Cohen's d)	p value
	Mean (SD)	Mean (SD)					
SF-36 RP	86.25 (33.907)	97.50 (11.180)	-11.250	(-25.693 to 3.193)	2.658	0.123	**0.042***
SF-36 RE	85.00 (36.635)	100.00 (0.000)	-15.000	(-31.146 to 2.146)	3.353	0.150	0.083
SF-36 E/V	47.25 (7.518)	49.45 (12.534)	-2.200	(-9.149 to 4.749)	0.439	0.023	0.516
SF-36 MH	59.45 (10.923)	61.60 (7,612)	-2.150	(-6.588 to 2.288)	1.028	0.051	0.323
SF-36 SF	72.50 (20.115)	74.38 (18.351)	-1.875	(-6.630 to 2.880)	0.681	0.035	0.419
SF-36 Pain	66.63 (21.753)	69.75 (21.165)	-3. 125	(-6.111 to -.139)	4.798	0.202	**0.041***
SF-36 GH	58.50 (10.273)	61.00 (9.262)	-2.500	(-4.281to -.719)	8.636	0.312	**0.008***

MoCA=Montreal Cognitive Assessment. MMSE: Mini-Mental State Examination. BFRT: Benton Face Recognition Test. TUG: Timed-up and Go Test. BBT: Berg Balance Test. PF: Physical Function. RP: Role Physical. RE: Role Emotional. E/V: Energy/Vitality. MH: Mental Health. SF: Social Functioning. GH: General Health. SD= Standard Deviation. *p<0.05

Table 4. Between Group Findings in Group 1 and Group 2

	Pre-Intervention			Post-Intervention			Difference			
	Group 1 (n=20)	Group 2 (n=20)	p value	Group 1 (n=20)	Group 2 (n=20)	p value	Mean Difference (Confidence Interval)	F	Effect size (Cohen's d)	p value
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)					
MoCA	23.00 (2.791)	22.20 (3.397)	0.421	25.40 (2.604)	24.10 (4.352)	0.259	1.050 (-0.967 to 3.067)	0.469	0.012	0.498
Stroop Test	64.90 (32.255)	62.00 (18.146)	0.728	51.25 (31.937)	59.40 (21.729)	0.351	-2.625 (-19.272 to 14.022)	7.781	0.170	**0.008***
BFRT	39.75 (5.014)	40.10 (5.628)	0.837	44.40 (5.529)	41.55 (4.322)	0.077	1.250 (-1.775 to 4.275)	6.104	0.138	**0.018***
TUG	8.34 (1.535)	8.32 (1.581)	0.959	8.00 (1.644)	7.99 (1.544)	**0.000***	0.017 (-0.968 to 1.003)	0.006	0.000	0.941

Table 4. Between Group Findings in Group 1 and Group 2 - continuation

	Pre-Intervention			Post-Intervention			Difference			
	Group 1 (n=20)	Group 2 (n=20)	p value	Group 1 (n=20)	Group 2 (n=20)	p value	Mean Difference (Confidence Interval)	F	Effect size (Cohen's d)	p value
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)					
BBT	49.60 (5.862)	50.45 (7.626)	0.695	52.30 (4.293)	51.70 (7.012)	0.985	-1.125 (-4.112 to 3.862)	4.251	0.101	**0.046***
SF-36 PF	75.25 (18.530)	71.25 (23.333)	0.552	77.00 (18.453)	73.25 (22.900)	0.572	3.875 (-9.360 to 17.110)	0.015	0.000	0.905
SF-36 RP	70.00 (40.230)	86.25 (33.907)	0.175	85.00 (26.157)	97.50 (11.180)	0.057	-14.375 (-30.679 to 1.929)	0.143	0.004	0.707
SF-36 RE	70.00 (44.461)	85.00 (36.635)	0.252	86.25 (33.907)	100.00 (0.000)	0.078	-14.377 (-32.245 to 3.490)	0.012	0.000	0.915
SF-36 E/V	48.50 (8.599)	47.25 (7.518)	0.627	54.58 (9.545)	49.45 (12.534)	0.154	3.190 (-1.599 to 7.979)	0.972	0.025	0.330
SF-36 MH	61.00 (11.743)	59.45 (10.923)	0.668	60.25 (14.186)	61.00 (9.262)	0.809	1.125 (-4.940 to 7.190)	0.114	0.003	0.738
SF-36 SF	73.75 (18.540)	72.50 (20.115)	0.839	75.00 (18.585)	74.38 (18.351)	0.915	0.938 (-10.845 to 12.720)	0.052	0.001	0.821
SF-36 Pain	65.38 (24.646)	66.63 (21.753)	0.866	75.88 (19.113)	69.75 (21.165)	0.343	2.438 (-11.022 to 15.897)	4.323	0.102	**0.044***
SF-36 GH	60.00 (13.765)	58.50 (10.273)	0.698	60.25 (14.186)	61.00 (9.262)	0.844	0.375 (-7.099 to 7.849)	1.375	0.035	0.248

MoCA=Montreal Cognitive Assessment. MMSE: Mini-Mental State Examination. BFRT: Benton Face Recognition Test. TUG: Timed-up and Go Test. 6MWT: 6 min walking test. BBT: Berg Balance Test. GDS=Geriatric Depression Scale. PF: Physical Function. RP: Role Physical. RE: Role Emotional. E/V: Energy/Vitality. MH: Mental Health. SF: Social Functioning. GH: General Health. SD= Standard Deviation. *p<0.05

DISCUSSION

This study was aimed to investigate the effectiveness of exercise combined with the cognitive tasks in healthy older adults. We found a significant improvement in directing attention, conceptual flexibility, mental processing speed, visuospatial skills, balance and quality of life after exercises performed with cognitive tasks. However, exercises alone led to improvements in general cognitive functions and mood.

Aging is a biological, chronological, and social process that cannot be avoided (30). Worldwide, the proportion of people aged 60 and over is growing faster than any other age group (31). In fact, cellular changes play an important role in the aging process. Healthy as well as pathological aging is associated with the structural and functional changes in the brain.

Although the majority of older adults are in relatively well-preserved health conditions, 20% of adults aged 60 years and older face difficulties and lose their independence in their daily activities (32). Aging with normal cognitive changes is defined as the subtle loss of cognitive and

functional performance that occurs with normal aging. Structural and physiological changes in the aging brain may affect many cognitive changes, including variations in memory, executive function, reasoning, spatial abilities, attention, visuospatial, and language abilities (33). Importantly, maintaining mobility is an important aspect of health and well-being. Changes in the sensorimotor and neuromuscular system that occur due to aging can negatively alter the mobility in elderly persons. Limitations in mobility are increasingly recognized as a major health problem among older adults. The decrease in mobility with the aging process affects 20% of adults aged 60 years and older (34). Additionally, physical and psychosocial changes seen in the aging process cause an increase in the level of depression. Finally, due to the ongoing cognitive impairments, it is assumed that the QoL may decrease gradually in older adults (35).

Cognitive and physical training are reported to improve cognitive functions and to delay neurodegenerative processes. The development of physical and/or cognitive skills associated with activities of daily living leads to improved physical and mental abilities. Physical activity has an effect on general cognitive and physical functions in healthy older adults (36). It is reported that the neural mechanisms responsible for the effect of physical training on cognition occur with the impact of neurogenesis, angiogenesis, synaptogenesis, and neurotrophins. Physical activity is accepted as the primary factor in healthy older adults to be protected from cognitive impairment (37). Importantly, aerobic exercises have been reported to make the brain more efficient and adaptive and thus leads to the improvement of attention and executive functions (38). In healthy adults, there is a moderate reduction (approximately 15-20%) in the risk of falling after exercise, which includes combinations of strength, balance, and aerobic exercises (39). Physical training consists of targeted exercises as classified by the guidelines of the WHO that involve muscle strength and/or endurance and usually includes aerobics (i.e. capacity to perform large-muscle activity over a long period of time), balance (i.e. backward walking, walking and turning around, one-leg stand), muscle-strengthening, resistance (i.e. ability to produce force to overcome inertia or a load), and flexibility (i.e. practice in the range of movements necessary in daily life) (40). Physical training, especially aerobic and balance training, has been shown to have a major impact on the aging brain, cognition, mobility, balance, mood and quality of life and delay addiction in healthy older adults. An important factor to consider when selecting the type of training is the intensity of the exercise. It has been proposed that a steady heart rate in 65–80 % of maximum heart rate during exercise training is enough to activate biological mechanisms that mediate cognitive and physical alterations (41). In our study, healthy older adults performed moderate aerobic and balance exercise once a day, 3 days a week over 6 weeks. In the exercise group, we found an improvement in general cognition, visuospatial functions, mobility, mood, and energy/vitality, pain, and general health sub-parameters of the quality of life. It can be suggested that regular aerobic and balance exercise for 6 weeks may have caused some neurotrophic factors to increase in the brain and caused plasticity, which has been manifested as improvements in the cognitive outcomes, mobility, balance, and QoL.

Cognitive training (especially for memory and executive functions) and physical training (especially aerobic exercise) are behavioral interventions aimed at protecting brain functions from aging-related decline (42). Although both cognitive and physical training seem to have an impact on cognition and brain, each type of training has specific effects that are inherent to their respective natures. Most studies involving cognitive task

training in healthy older adults have reported that cognitive training is effective in cognitive task execution (educated or uneducated) and/or brain function and structure. After training with laboratory tasks, improvements were found especially in working memory, processing speed, and executive functions (43). Combined cognitive and physical exercise interventions have the potential to elicit cognitive (attention, executive functions), physical (mobility, balance), and physiological (mood) in older adults. It has been suggested that combinations of cognitive and physical training applied as a preventive intervention may be the most promising approach to delay cognitive decline and maintain existing cognitive abilities (44). Recent studies examining the functionality of healthy older individuals suggest that combining regular physical activity with the cognitive tasks may have more effective results. The combination of physical activity and cognitive tasks may provide greater cognitive benefits than when applied alone. Furthermore, training of physical and/or cognitive skills related to the activities of daily living appears to result in improved physical and mental abilities. It has been shown that only cognitive education provides improvements in cognitive functions that are predicted to be impaired by aging, such as visual-spatial work, executive function, or information processing speed. However, simultaneous (dual-task) physical and cognitive exercise may provide better results than both types of training alone in cognitive performance. The aims of dual-task training in combining exercises with the cognitive tasks might be to focus on interfering effects of two interventions and to improve physical outcomes (e.g., decreasing falls) in older adults, especially during handling dual tasks (45). A meta-analysis by Zhu et al. (46) revealed significant benefits of combined cognitive and physical interventions, compared with both single exercise training and a control group, on overall cognitive function in healthy older adults. Interestingly, cognitive impairment leading to a decline in general cognition is also known to be associated with reduced mobility in older adults (47). It has been hypothesized that cognitive intervention can address the erroneous perceptual-motor integration (related to executive function) that leads to instability in certain automatic tasks such as walking and falling. In the exercise with cognitive tasks group, we found an improvement in general cognition, executive functions, visuospatial functions, mobility, and pain subparameter of quality of life. In particular, it seems that the improvement in attention and executive functions helps us better understand the effects of cognitive tasks on cognitive functions such as processing speed and attention.

The aerobic and balance exercises with the cognitive tasks have an effect on general cognition, visuospatial skills, balance, and quality of life. The changes brought about by both cognitive and physical training in the brain and in the cognition of healthy older adults may be related to potential cognitive and psychological improvements depending on the commitment, characteristics of the intervention, and other individual variables. In order to better understand the effectiveness of cognitive tasks combined with exercise on clinical outcomes and brain metabolism, there is a need for studies that objectively evaluate the functional and structural changes of the brain after combining motor and cognitive tasks and with larger cohorts.

Limitations

The fact that the average age of the participants in the exercise with cognitive tasks group is higher than the age of the participants in the exercise group is a limitation of this study.

CONCLUSION

In conclusion, it was observed that exercises with cognitive tasks are effective on

cognitive functions and QoL in healthy older adults. Physical exercises with the cognitive tasks may be recommended to prevent the possible adverse changes in cognitive and physical functions, and QoL in healthy older adults.

Conflicts of interest

The authors declare that they have no conflict of interest.

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