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Research Article / Araştırma Makalesi

Relationship Between Cognitive and Motor Functions and Dual-task Performance in Community Dwelling Older Adults: Gender Differences

Toplumda Yaşayan Yaşlılarda Kognitif ve Motor Fonksiyonlar ile İkili Görev Performansı Arasındaki İlişki: Cinsiyet Farklılıkları

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Abstract: Dual-task performances may be impaired with the impairment in motor performance and cognitive functions due to aging. The aim of the present cross-sectional study is to investigate the gender differences in dual-task performance. A total of 82 community-dwelling older adults (41 males and 41 females) aged between 65 and 75 years were included. Motor performance was evaluated with the sit-to-stand test, the timed up and go test, 10 m walking test and cognitive functions were evaluated with Montreal Cognitive Assessment Test. Dual-task performances were evaluated as motor-motor and cognitive-motor performance. Mean age was 70.12±3.18 years for females and 69.80±3.21 years for males. Both groups were similar with regard to age, education status, exercise habits, and working status. In dual-task performances, females were found to complete motor-motor tasks in a shorter time as compared to males (p=0.001). Cognitive-motor task performances were found to be better in males (p=0.038). It is considered that gender differences in dual-task performances could be understood better in the light of the results of the present study and treatment may be arranged in accordance with these gender differences.

Keywords: Geriatric, Dual-Task, Cognition, Motor Performance, Gender Differences.

Öz: Yaşlanmaya bağlı olarak motor performans ve bilişsel işlevlerdeki bozulma ile ikili görev performansları bozulabilir. Bu çalışmanın amacı, ikili görev performansındaki cinsiyet farklılıklarını araştırmaktır. Çalışmaya 65-75 yaş arası toplumda yaşayan toplam 82yaşlı yetişkin (41 erkek ve 41 kadın) dahil edildi. Motor performans otur-kalk testi, zamanlı kalk ve yürü testi, 10 m yürüme testi ile değerlendirildi ve bilişsel işlevler Montreal Bilişsel Değerlendirme Testi ile değerlendirildi. İkili görev performansları motor-motor ve bilişsel-motor performans olarak değerlendirildi. Ortalama yaş kadınlarda 70,12±3,18 yıl, erkeklerde 69,80±3,21 yıl idi. Her iki grup yaş, eğitim durumu, egzersiz alışkanlıkları ve çalışma durumu açısından benzerdi. İkili görev performanslarında ise kadınların motor-motor görevleri erkeklere göre daha kısa sürede tamamladıkları görüldü (p=0,001). Bilişsel-motor görev performansları erkeklerde daha iyi bulundu (p=0,038). Bu çalışmanın sonuçları ışığında ikili görev performanslarındaki cinsiyet farklılıklarının daha iyi anlaşılabileceği ve bu cinsiyet farklılıklarına göre uygulanacak tedavinin düzenlenebileceği düşünülmektedir.

Anahtar Kelimeler: Yaşlı, İkili Görev, Kognisyon, Motor Performans, Cinsiyet Farkları.

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Introduction

Double/multiple/dual task is a neuro-physiologic process that requires performing two tasks concurrently. Performing more than one task concurrently is a process that we encounter frequently in daily living (Springer et al., 2006). Postural control is defined as the response to vestibular, visual and proprioceptive information resulting from movement-related conceptual process. Many automatic activities like crossing a crowded road, talking on the phone while walking and shopping in a market require a very good postural control and attention (Dubost et al., 2006).

Many complex and unexpected conditions should be overcome for maintenance of mobility and postural control in daily living. So, sharing the attention to two or more tasks is frequently done in daily living (Swanenburg et al., 2008). In community dwelling older adults, the problems like impaired postural control and slowed down mental processes lead multiple task performances to be affected, also stability problems and consequently falls (Kelly et al., 2012; O'Shea et al., 2002; Plotnik et al., 2011).

In community dwelling older adults, more than 50% of falls occur during walk. Falls-related deaths are 49% more in males than in females. Recognizing gender differences in falls is important for the prevention of falls. (CDC, 2006).

When the studies investigating dual task performances were analyzed, while studies were found to investigate gender differences in dual tasks, direction finding strategies, object-place memory, learning and producing language, and even lateralization of cerebral hemisphere organization, very few studies were encountered investigating gender differences in dual tasks (Hollman et al., 2011).

As dual or multiple tasks accompany a great proportion of daily living activities, the present study was conducted with the aim of investigating multiple task performances in community dwelling healthy older adults, making a comparison of gender differences and investigating the influences of motor and cognitive tasks on dual tasks.

Materials and Methods

Study Design and Sample Size

Community dwelling healthy older adults aged between 65 and 75 years who met inclusion criteria and who were volunteer for participation were included in the study. This study was performed in line with the principles of the Declaration of Helsinki. All participants were informed about the study prior to the study and written informed consent was obtained.

Ethics Considerations

This study was approved by Non-interventional Clinical Research Medical Ethics Committee of Pamukkale University (Approval number: 60116787-020/77265). The study was registered at Clinical Trials.gov (ID: NCT04877600; URL: www.clinicaltrials.gov). As a result of the power analysis, it was calculated that when 82 individuals are taken into the study 90% power with 95% confidence would be obtained (Hollman et al., 2011).

Participants

The total of 82 older adults (41 males and 41 females) aged between 65 and 75 years were included in the study.

The individuals aged between 65 and 75 years, who agreed for participation, who received 8 or higher points from Hodkinson Mental test, who had no neurologic/orthopedic problems that could affect balance and walking, or communication problem were included in the study. The individuals who were using 3 or more medications that could affect motor and cognitive functions and the ones who could not complete the tests were excluded.

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Assessment Methods

Demographic characteristics, hobbies, exercising habits of the subjects, medications used and results of Hodkinson Mental Test were recorded to the socio-demographic information form.

Hodkinson Mental Test (HMT): HMT is a test that is used for assessment of memory and orientation in the elderly. Each correct answer is scored with 1 in the 10-question form. Scores of 6 and above indicates normal functions, 4-6 moderate impairment, 0-3 severe impairment (Hodkinson, 1972). The subjects who received 8 or higher scores were included in the study.

Assessment of cognitive functions: It was done by using Montreal Cognitive Assessment Scale (MoCA). The scale was developed as a fast-screening test for mild cognitive disorder. The test evaluates 8 different cognitive functions including attention and concentration, executive functions, memory, language, visual structural skills, abstract thinking, calculation and orientation. The possible maximum score is 30. The scores 21 and above are considered as normal (Nasreddine et al., 2005).

Assessment of physical performance:

- *Timed up and go (TUG) test* is a test which evaluates falls risk and mobility in community dwelling older adults. A chair and a chronometer are required for the test. The test is performed with the shoes that the patient always uses and he/she is stated to be allowed to use walking aids if he / she needs it. An area of 3 meters is determined in front of the chair. The individual is asked to get up from the chair, walk this distance and sit again. Elapsed time is recorded in seconds. The test's being completed in longer than 12 seconds indicates falls risk (Podsiadlo and Richardson, 1991).

- *30 seconds sit-to-stand test* is a test that evaluates sit-and-stand activity, lower extremity strength and dynamic balance. A seat height of about 44 cm and no recline, and a chronometer is needed. It is recommended to lean against the wall to prevent the chair from moving while sitting and standing. The feet should touch the ground when the subject sits, he/she sits on the chair and touches his/her shoulders with the arms crossed. The subject stands up completely upright and sits down on the chair again. The number of sitting and running in 30 seconds gives the result of the test. Sitting and standing for less than 10 in 30 seconds indicates lower extremity weakness (Jones et al., 1999).

- *10-meter walking test* is used for evaluating walking speed. The subject is asked to walk 10 m distance with his/her usual velocity (he/she uses his/her walking aid if using already). The time is started when the feet are on the start line and terminated when passes finish line. Two measurements are done and the better value is recorded as meter/second (m/s) (Wolf et al., 1999).

Assessment of dual task performance

In order to evaluate the durations of individuals' motor-motor performances in dual tasks, during the 10-meter walking test, 2 glasses were carried on a tray. In order to evaluate the duration of cognitive-motor performances, the tasks of counting the days of the week beginning from Sunday were given during the 10-meter walking test and the time to complete the tasks was recorded in seconds (Weightmann and McCulloch, 2014).

Dual task performances were estimated by using the formula: Dual task walking-Single task walking/Single task walking) x100 separately for motor and cognitive tasks (Weightmann and McCulloch, 2014).

Statistical analyses

The sample size was calculated using GPower 3.1.9.2 package program (Faul et al., 2007). Effect size obtained from the reference study was seen to be medium (d=0.56) (Hollman et al., 2011). Assuming that an effect size at this level can be achieved, as a result of the power analysis, it was estimated that 90% power would be obtained with

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95% confidence when 82 individuals (41 males and 41 females) were included in the study.

Data were analyzed by using SPSS 25.0 package program. Continuous variables were given as mean ±standard deviation and categorical variables were given as number and percent. As parametric test assumptions were provided, independent samples t test was used for comparison of independent groups and Pearson correlation analysis was used for detecting the correlations between variables. A p level of <0.05 was accepted as statistically significant (Sumbuloglu and Sumbuloglu, 2004).

Table 1. Demographic characteristics of the participants

Variables	Female (n=41) Mean±SD *or* n(%)	Male (n=41) Mean±SD *or* n(%)	*p*-value
Age (years)	70.12±3.18	69.80±3.21	0.655[a]
Body Mass Index (kg/m²)	26.41±2.29	25.94±3.29	0.445[a]
Education status			
Illiterated	1(2.4)	3(7.3)	0.259[b]
Literated	7(17.1)	11(26.8)	
Primary school	21(51.2)	16(39.0)	
Secondary school	10(24.4)	6(14.7)	
High school	2(4.9)	5(12.2)	
Exercise habits			
Yes / No	10(24.4) / 31(75.6)	9(22.0) / 32(78)	0.794[b]
Working status			
Yes / No	0(0) / 41(100)	2(4.9) / 39(95.1)	0.152[b]

a:Independent Samples t Test, b:Chi-square test, SD:Standard deviation, kg:kilogram, m:meter, Significance level: p<0.05.

Table 2. Comparison of cognitive performance and motor performances in single task

Variables	Female (n=41) Mean±SD	Male (n=41) Mean±SD	t	*p*-value
Cognitive Performance				
Montreal Cognitive Assessment	21.46±2.88	21.85±3.14	-0.58	0.560
Motor Performance				
30 second sit to stand test (repetition)	10.68±1.43	10.20±2.01	1.26	0.211
Timed up and go test (sec)	9.23±1.25	9.57±0.69	-1.53	0.130
10-meter walk test (sec)	9.90±1.04	10.28±1.64	-1.24	0.216

t: Independent Samples t Test, SD: Standard deviation, sec: second, Significance level: p<0.05.

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Results

Mean age was 70.12±3.18 years for females and 69.80±3.21 years for males. Of the females, 21 (51.2%) were graduates of elementary school, 10 (24.4%) were graduates of secondary school and 7 (17.1%) were literate. Of the males, 16 (39%) were graduates of elementary school, 11 (26.8%) were literate and 6 (14.7%) were graduates of secondary school. While no women were working, 39 (95.1%) males were not working actively. Groups were similar with regard to education status, exercising habits and working status ($p>0.05$) (Table 1).

No significant difference was found between males and females with regard to motor performance including cognitive performance ($p=0.560$) and sit-to-stand test ($p=0.130$), timed up and go test ($p=0.211$) and 10 m walking test ($p=0.216$) (Table 2).

The time for completing motor-motor dual tasks was 10.71±1.86 s in females and 11.82±1.10 s in males. Females were found to complete the test in a shorter time ($t=-3.29$, $p=0.001$). The time for completing cognitive-motor dual tasks was 12.73±1.06 s in females and 13.02±1.07 s in males. Males were found to complete the test in a shorter time ($t=2.10$, $p=0.038$) (Table 3).

In females, a moderate and positive association was found between cognitive function and motor-motor dual task performance ($r= 0.328$, $p= 0.036$) and a moderate and negative association was found between cognitive motor dual task ($r=-0.383$, $p=0.013$). A moderate statistically significant difference was found between motor function and cognitive-motor dual task ($r=0.427$, $p=0.005$) and cognitive-motor dual task performance ($r=-0.692$, $p=0.0001$) (Table 4).

In males, a moderate and negative association was found between cognitive function and cognitive motor dual task duration ($r=-0.312$, $p=0.047$) and cognitive-motor dual task performance ($r=-0.420$, $p=0.006$). While a moderate and positive association was found between motor function and motor-motor dual task duration ($r=0.473$, $p=0.002$), a moderate and negative association was found between motor function and cognitive-motor dual task performance ($r=-0.369$, $p=0.018$) (Table 4).

Discussion

The present study has investigated the gender differences with regard to dual task performance and the influences of cognitive and motor tasks on dual tasks in community dwelling healthy older adults. In the study, females were found to complete motor-motor and cognitive-motor dual tasks in a shorter time than males. On the other hand, males were found to achieve cognitive-motor dual task performances better. In females, cognitive function was found to be related with motor-motor dual task performance and cognitive-motor dual task duration. A relationship was detected between motor function and motor-motor dual task duration and performance, and between cognitive-motor dual task duration and performance. In males, cognitive function was found to be related with cognitive-motor dual task duration and performance. A relationship was detected between motor function and motor-motor dual task duration and cognitive-motor dual task performance.

The systemic changes occurring with aging make daily living activities difficult. When a second task is added to daily living activities, imbalance and falls may occur. In a study evaluating the older adults with or without falls, walking speed was found to decrease when a second motor task is added (Toulotte et al., 2006). In another study, adding a cognitive function while walking was concluded to decrease walking speed (Beauchet et al., 2005). In accordance with the literature data and the result of our study, motor and cognitive tasks added during walk were shown to decrease walking speed both in males and females.

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Table 3. Comparison of completion time and performance in dual tasks

Variables	Female (n=41) Mean±SD	Male (n=41) Mean±SD	t	*p*-value
Motor-Motor Dual Task Completion Time (sec)	10.71±1.86	11.82±1.10	-3.29	**0.001***
Motor-Motor Dual Task Performance	10.82±9.41	12.62±6.53	-1.00	0.319
Cognitive-Motor Dual Task Completion Time (sec)	12.73±1.06	13.02±1.07	-1.24	0.217
Cognitive-Motor Dual Task Performance	29.50±13.77	24.19±8.43	2.10	**0.038***

t: Independent Samples t Test, SD: Standard deviation, sec: second, Significance level: p<0.05.

Table 4. Relationships between parameters according to genders

Variables	Female (n=41)		Male (n=41)	
	r	*p*-value	r	*p*-value
Montreal Cognitive Assessment - Motor-Motor Dual Task Completion Time	0.013	0.936	-0.005	0.977
Montreal Cognitive Assessment - Motor-Motor Dual Task Performance	0.328	**0.036***	-0.082	0.608
Montreal Cognitive Assessment - Cognitive-Motor Dual Task Completion Time	-0.383	**0.013***	-0.312	**0.047***
Montreal Cognitive Assessment - Cognitive-Motor Dual Task Performance	0.106	0.508	-0.420	**0.006***
10-meter walk test - Motor-Motor Dual Task Completion Time	0.450	**0.003***	0.473	**0.002***
10-meter walk test - Motor-Motor Dual Task Performance	-0.509	**0.001***	0.055	0.732
10-meter walk test - Cognitive-Motor Dual Task Completion Time	0.427	**0.005***	0.170	0.289
10-meter walk test - Cognitive-Motor Dual Task Performance	-0.692	**0.0001***	-0.369	**0.018***

r: Pearson correlation coefficient, Significance level: p<0.05.

Many studies are available in the literature investigating dual task performances in community dwelling older adults (Dubost et al., 2006; Swanenburg et al., 2008; Verhaeghen et al., 2003), however there are a few studies investigating gender differences in dual task performances (Hollman et al., 2011).

Most falls occur during walk and falls-related deaths are more common among males than females. Many studies have shown that the decreased walking speed during normal and dual tasks is a risk factor for falls (Hollman et al., 2011; Kressig et al., 2008). Callisaya et al. (2008) showed that walking speed, stride length and cadence decreased similarly with age in males and females. The results of our study have revealed that females completed motor-motor and cognitive-motor tasks in a shorter time than males. However, males were found to have better cognitive-motor task performances than females.

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Gender differences in dual task performance could not be fully explained yet. However, some physiologic studies may contribute to interpret these differences. While unilateral activation occurs in cerebral hemispheres in males during dual task experiences, bilateral activation occurs in females (McGlone, 1980). While global, regional and asymmetrical neuron losses develop together with aging, the bilateral activation in females may be an advantage (Hollman et al., 2011). However, the gray matter in putamen decreases faster in males with aging (Hollman et al., 2011; Wellman, 2012). In our study, the longer completion time of motor-motor and cognitive-motor tasks in males may be explained with the fact that putamen is responsible for balance, verbal memory and walking control and losses occur in these regions with aging.

The strength of our study is evaluating the relationship between cognitive and motor functions, and dual task performances according to gender. The limitations of our study include not evaluating walking parameters during dual task according to gender in detail and not evaluating balance and falls risks. Future studies are required to investigate various dual tasks during walk and falls risks according to gender.

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