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## SOCIOLOGY | RESEARCH ARTICLE

# The effect of single-tasks and dual-tasks on balance in older adults<sup>†</sup>

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**Abstract:** *Purpose:* This study has been planned to show how the balance is influenced when additional cognitive and motor tasks are given to older people. *Methods:* 159 older adults (61 Females/98 Males) between 65 and 80 years of age were included in the study. The single and dual task performances of the individuals were evaluated with the Stand on One Foot Test, Time up and Go Test (TUG), and Sit Down-Stand up Test; and the cognitive status was evaluated with the Mini Mental Status Test. The individuals were asked to transfer an object from one hand to the other as an additional motor task during the balance tests; and were asked to count by twos as a cognitive additional task. *Results:* When the taskless balance performances of the individuals and their dynamic balances during the additional cognitive and motor tasks were compared, it was observed that the duration of completing the test increased at a statistically significant level when both motor and cognitive additional tasks were added in TUG ( $p < 0.001$ ); and in Sit down-Stand up, Stand on One Foot Tests (right and left), on the other hand, it was observed that the durations of the tests decreased when both additional motor and cognitive tasks were given ( $p < 0.001$ ). *Conclusion:* At the end of our study, we observed that

### ABOUT THE AUTHORS

The authors in this study is a physical therapist. Authors' general interests are geriatric rehabilitation and neurological rehabilitation.

### PUBLIC INTEREST STATEMENT

People need to do different things like speaking to other people, walking or carrying something when they are performing their daily life activities. In order to perform these activities in a proper manner, adequate balance, coordination, care and thinking are required. In this way, a major interaction occurs between the motor and cognitive systems. DT represents the mutual communication between the motor and cognitive functions. Due to the decreasing stability and postural control with age, older people need more attention to protect their balance. When two tasks are performed simultaneously, the attention capacity is used in an efficient manner, and is shared according to the difficulty levels of the tasks. The decrease in concentration and attention causes that the attention that is allocated for cognitive additional task affects balance in a negative way. The study has been planned to show how balance is affected in older people when additional cognitive and motor tasks are given.

the additional tasks given to the older adults decreased the balance performance. We consider that balance trainings must be given together with motor and cognitive tasks to older people.

**Subjects:** Education - Social Sciences; Gender Studies - Soc Sci; Sociology & Social Policy

**Keywords:** dual-task; balance; older people; single-task

### 1. Introduction

Sustaining a lifelong physical functioning in an independent manner is important. For an independent functioning, sufficient lower extremity force, safe and sufficient walking, and good balance functions are required (Christofoletti, Oliani, Gobbi, & Stella, 2007). In order to sustain daily life activities in a successful manner, a good balance is necessary. Balance is the ability of a person to protect the position of his/her body in various positions (Sturnieks, George, & Lord, 2008). Generally, walking speed, walking patterns and balance change with further age (Studenski et al., 2010). Balance is ensured with the contributions of the sight, vestibular system, proprioception, reaction time, and the muscle force. With ageing, there might appear balance problems as a result of possible disorders in the functions of these systems and due to physiological losses (Sturnieks et al., 2008).

People need to do different things like speaking to other people, walking or carrying something when they are performing their daily life activities. In order to perform these activities in a proper manner, adequate balance, coordination, care and thinking are required. In this way, a major interaction occurs between the motor and cognitive systems (Woollacott & Shumway-Cook, 2002). Dual tasking (DT) is an experimental neuro-physiological process requiring that the individual performs two tasks simultaneously. In addition, DT represents the mutual communication between the motor and cognitive functions (Woollacott & Shumway-Cook, 2002). When two tasks are being performed, the attention capacity must be used in an efficient manner, and must be distributed according to the difficulty and priority of the tasks. As the difficulty level increases, or as the attention capacity decreases, there will appear disruptions in performing one or both tasks (Kim & Brunt, 2007). The effect of DT on performance in different age groups is well-known (Faulkner et al., 2007). It is known that falling down occurs when the older individual tries to perform another task while standing (Kim & Brunt, 2007).

Especially in old age period, which includes physiological changes, other changes are also observed in motor development patterns (Hauer, Marburger, & Oster, 2002). It has been demonstrated in previous studies that the walking deficit in older individuals who do not have any neurological deficits cause that they fall down, and this situation is especially related to DT activities (Hirashima et al., 2015; Hollman, Kovash, Kubik, & Linbo, 2007). Because controlling the balance requires cortex and high-level cognitive function, and some activities like DT cause that postural performance is disrupted especially in older individuals (Rankin, Woollacott, Shumway-Cook, & Brown, 2000; Vander Velde & Woollacott, 2008). The cognitive functions, balances and mobility of older individuals decrease with ageing (Sertel, Simsek, Yümin, Öztürk, & Yümin, 2011). This situation decreases the physical activities performed during daily life in the individuals (Sertel et al., 2011). As the balance, cognitive and motor functions of the individuals decrease with ageing (Gobbo, Bergamin, Sieverdes, Ermolao, & Zaccaria, 2014), it is observed that they have extremely high difficulty in performing the tasks when more than one task or a complex task is given (Elaine Little & Woollacott, 2014). Due to the decreasing stability and postural control with age, older people need more attention to protect their balance. When two tasks are performed simultaneously, the attention capacity is used in an efficient manner, and is shared according to the difficulty levels of the tasks. The decrease in concentration and attention causes that the attention that is allocated for cognitive additional task

affects balance in a negative way. It is necessary to focus on studies that investigate additional tasks in order to enable older people to protect themselves from injuries in daily life and sustain their independency. This is why, the study has been planned to show how balance is affected in older people when additional cognitive and motor tasks are given.

## **2. Method**

The individuals between the ages 65–80, who came to the Kırıkkale High Specialty Hospital, Social and Psychological Health Center in walking position, and who fit the study criteria and volunteered to participate in the study, were included in the study. The Power and Sample Size Program was used for the power analysis and sampling size. The power ratio of the study was computed as 90% with an error rate of 0.05 at confidence interval; and therefore, 159 individuals were included in the study. The required permission was received from Kırıkkale University, Clinical Research Ethical Board to conduct the study (Ethical Board No: 11/08, 03.05.2016). The Informed Consent Forms were signed by each of the participants.

The inclusion criteria of the older people were determined as being between the ages of 65 and 80; accepting to participate in the study, having no cooperation problems (the individuals whose Mini Mental Test Scores were >24), and being able to walk independently. The exclusion criteria of the volunteers were having cooperation problems, having any types of orthopedic or neurological problems, having hypertension that is uncontrollable, having cardiac diseases, cardiac arrhythmia, cardiovascular diseases, having malignity, and having chemotherapy or radiotherapy leading to malignity. In the scope of the evaluations, the individuals were interviewed in a face-to-face manner. The socio-demographic characteristics of the individuals were recorded in the evaluation form. The balances and Dual Task performances of the individuals were evaluated with the Stand on One Foot Test, Time up and Go Test (TUG), and Sit down-Stand up Test; and the cognitive status was evaluated with the Mini-Mental Status Test (MMST). The individuals were asked to transfer an object from one hand to the other one as an additional motor task during the balance tests, and were asked to count by twos as an additional cognitive task. The balance tests used in the study were repeated with and without additional tasks, and additional motor cognitive tasks. The results of the performances were compared.

### **2.1. Sit down-stand up test**

This is a performance test applied to older individuals. It reflects the lower extremity muscle force of the individuals. For the testing, the individuals were made to sit in the center of a chair, which is 43.18 cm high from the ground, in upright position, by placing their feet on the ground and crossing their arms on the chest (the right hand in line with the left shoulder, and the left hand in line with the right shoulder). When the individuals were in this position, the test started with the command “Start!”, and the number of the full stand-ups within 30 s constituted the score of the individual (Fahlman, Morgan, McNevin, Topp, & Boardley, 2007). The number of sit-stand up of the individuals is recorded for 30 s.

### **2.2. Time up and go test**

The participant is told to stand up when s/he is sitting on a standard chair (with 43 cm height) leaning backward, s/he walks for 3 m, returns, comes back and sits on the chair again. The time constitutes the score (Lin et al., 2004).

### **2.3. Mini mental status test (MMST)**

In this study, the MMST has been used in order to evaluate the cognitive functions of the older individuals. The test may be applied within 5–10 min, and is used frequently. The MMST has been

collected under 5 Main Titles which are; Orientation (10 points), Recording Memory (3 points), Attention and Accounting (5 points), Recalling (3 points) and Language (9 points). The MMST consists of 11 items, and is evaluated over a total of 30 points. Receiving between 27 and 30 points is evaluated as being within normal limits, 24–27 points is considered as having mild cognitive disorder, and <24 points is considered as serious cognitive disorder (Folstein, Folstein, & McHugh, 1975).

#### **2.4. Computing the dual task deficit ratio**

The deterioration in the performance of the tasks when two activities are performed together is defined as the Dual Task Deficit. In order to compute the changes in the task performances and determine the deficit ratio, the “ $DTD = [DT - ST]/TG \times 100$ ” formula has been used, and the results have been interpreted proportionately (Demirci, Kilinc, & Yildirim, 2016; Pellecchia, 2005).

#### **2.5. Hypothesis**

H0: The balance of the older individuals is better in single task than in dual tasks.

H1: There are no differences between the balance values of the older individuals during single and dual tasks.

#### **3. Statistical analyses**

The statistical analyses were performed with the SPSS Program, Version 20.0. The fitness of the variables to a normal distribution was examined with visual (histogram and probability graphics) and analytic methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). The definitive analyses were given by using the average and standard deviations for the variables that were not distributed normally. Since it was determined that the parameters that were evaluated did not show normal distribution, these parameters were compared by using the Wilcoxon Test. The situations where the P value was below 0,05 were evaluated as being statistically significant.

#### **4. Results**

The age, height, weight and BMI values of the individuals, who were included in our study, were found as  $70.30 \pm 5.75$  years,  $1.65 \pm 0.08$  m,  $77.53 \pm 11.20$  kg,  $28.30 \pm 4.37$  kg/m<sup>2</sup>, respectively. 77.4% of the individuals were married, 18.8% were widow/widowers and 3.8% were single. 76% of the individuals were literate. Although in 29.6% of the older people, there were no chronic diseases; however, 70.4% had hypertension, diabetes, rheumatoid or orthopedic disorders and heart or lung diseases. In addition, 83.6% did not use a helping aid (Table 1).

When the taskless balance performances and the dynamic balance performances during the additional cognitive and motor tasks were compared it was observed that the durations to complete the tasks increased in a statistically significant level when the additional motor and cognitive tasks were added in TUG ( $p < 0.001$ ). In Sit down-Stand up, Stand on One Foot (right and left) tests, on the other hand, the durations to complete the tasks decreased at a statistically significant level when the additional motor and cognitive tasks were given ( $p < 0.001$ ). The Average and Standard Deviation Values of the tests are given in Table 2.

When we interpreted the issue of which task influenced the balance of the individuals, we observed that the motor tasks caused more deficits in the Right and Left Foot Standing; and the cognitive tasks caused more deficits in TUG and Sit down-Stand up Test in a statistically significant level (Table 3).

**Table 1. Socio-demographic data of the individuals**

	<b>X ± SD</b>
Age (year)	70.3 ± 5.7
Height (cm)	160.0 ± 0,0
Weight (kg)	77.5 ± 11.2
BMI	28.37 ± 3.59
MMST	28.3 ± 4.3
Sex	
Female	61 (38.4)
Male	98 (61.6)
Marital status	n (%)
Married	123 (77.4)
Widow	30 (18.8)
Single	6 (3.8)
Education level	
Primary school	84 (52.8)
Secondary school	17 (10.7)
High school	15 (9.4)
University	5 (3.1)
Illiterate	38 (23.9)
Dominant hand	
Right	150 (94.3)
Left	9 (5.7)
Smoking	
Yes	113 (71.1)
No	46 (28.9)
Chronic disease	
Yes	70 (70.4)
No	47 (29.6)
Name of chronic disease	
HT	27 (17.0)
DM	23 (14.5)
Rheumatic disease	27 (17.0)
COPD	2 (1.3)
Heart failure	12 (7.5)
Orthopedic diseases	9 (5.7)
HT+DM	12 (7.5)
Use of mobility aids	
Yes	26 (16.4)
No	133 (83.6)

Notes: MMST: mini mental status test, F: female, M: male.

**Table 2. Balance test performances with and without tasks**

Tests	Duration (s) $\bar{X} \pm SD$	Z-value	p-value
Right foot standing (cognitive)	17.4 ± 16.5	-4.73	<0.001*
Right foot standing	20.2 ± 17.4		
Right foot standing (motor)	13.5 ± 14.4	-8.15	<0.001*
Left foot standing (cognitive)	15.7 ± 15.3	-4.09	<0.001*
Left foot standing	18.0 ± 17.2		
Left foot standing (motor)	12.0 ± 13.9	-8.24	<0.001*
Time up and go test (cognitive)	12.9 ± 6.1	-6.09	<0.001*
Time up and go test	11.7 ± 5.2		
Time up and go test (motor)	12.6 ± 5.4	-5.61	<0.001*
Sit down-stand up test (cognitive)	8.3 ± 3.9	-7.80	<0.001*
Sit down-stand up test	10.1 ± 3.6	-6.07	<0.001*
Sit down-stand up test (motor)	9.2 ± 3.9		

\*p < 0.05, Wilcoxon test.

**Table 3. Balance test performances causing more deficits**

Tests	Duration (s) $\bar{X} \pm SD$	Z-value	p-value
Right foot standing (cognitive)	-10.6 ± 44.5	-4.649	<0.001*
Right foot standing (motor)	-28.8 ± 41.9		
Left foot standing (cognitive)	-7.3 ± 53.9	-4.534	<0.001*
Left foot standing (motor)	-29.4 ± 45.5		
Time up and go test (cognitive)	13.7 ± 30.9	-2.056	0.04*
Time up and go test (motor)	11.2 ± 27.2		
Sit down-stand up test (cognitive)	-18.8 ± 25.2	-4.562	<0.001*
Sit down-stand up test (motor)	-11.2 ± 22.2		

\*p < 0.05, Wilcoxon test.

## 5. Discussion

It has been observed in our study that the balance performances of the older people over the age of 65 are disrupted when additional cognitive and motor tasks are given.

It is known that the older people have difficulties (Elaine Little & Woollacott, 2014) when they are given more than one complex tasks, because balance, cognitive and motor functions deteriorate with furthering age in the older (Gobbo et al., 2014).

Lima, Ansai, Andrade, and Takahashi (2015) conducted a study in order to determine the relation between Dual Tasks and cognitive functions in 98 older individuals over the age of 60, and compared the TUG performances during additional cognitive and motor tasks with the results of the tests that examined the cognitive skills. At the end of their study, they reported that dual task skills could provide an idea on cognitive situations. van Iersel, Kessels, Bloem, Verbeek, and Olde Rikkert (2008) conducted a study on 100 older individuals whose average age values were 80, and examined the effects of functions with additional tasks on walking and balance. It was observed in previous studies that the speed of walking decreased and the body oscillation increased in walking tests that included additional tasks. In the end of their study, van Iersel et al. (2008) reported that the functions with additional tasks were related to walking and balance disorders, and these functions could be influenced by the tasks performed. As it was observed in previous studies, dual tasks affect the balance and walking performances of older people.

The relation between balance and walking with additional tasks in older individuals were examined, and 67 older individuals who were 80 years old and over were included in the study. The individuals were separated into 2 groups as those who had falling history and those who did not have any falling history. In the end, a significant relation was found between the balance and dual task variables. Those who had falling history spent more steps and time in the balance tests with additional motor and cognitive tasks (Ansai, Aurichio, & Rebelatto, 2016).

Gomes et al. (2015) conducted a study on 92 older women, and evaluated the TUG Test in a normal and in a fast manner with and without additional motor and cognitive tasks. The TUG results that were performed with dual tasks were not influenced by the physical activity levels, while it was observed that the duration to complete TUG increased in people who were much older and who had lower educational levels.

At the end of our study, when the TUG completion duration was examined when TUG score and motor and cognitive additional tasks were added, it was observed that the TUG with additional tasks increased. In Sit down-Stand up and Stand on One Foot (right and left) Tests, it was observed that the test durations decreased when the additional motor and cognitive tasks were given. As a conclusion, it was observed in our study that static and dynamic balances of the older individuals during additional cognitive and motor tasks and the balance performances without tasks were influenced, which supports the previous findings.

Taylor, Delbaere, Mikolaizak, Lord, and Close (2013) conducted a study on 64 older individuals with medium-level cognitive disorders, and showed that there were negative impacts during dual task activities; however, this did not vary according to cognitive or motor additional tasks. Baudry and Gaillard (2014) conducted a study and reported that the interaction between the postural control and dual tasks was related to sensorimotor and cognitive development in the older (Bergamin et al., 2013). Bergamin et al. (2013) made an evaluation in 30 young and 30 older people with a device that recorded the balance changes and postural oscillations, and compared the results. Different additional dual tasks, which were visual, verbal, and cognitive, were given; and it was observed in the end that the oscillations from the central area to the outer area increased during the dual tasks independent from the age; however, these increased postural oscillations were not influenced by the types of the additional tasks. In our study, when we considered the issue of which task influenced the balance of the individuals, we determined that motor tasks caused more deficits in standing on the right and left feet; and the additional cognitive task caused more deficits in TUG and Sit down-Stand up Test. Different from the previous studies, we consider that the results of our study stem from the *posture first strategy* during the balance. It is reported in the literature that postural task has priority (Baudry & Gaillard, 2014). During static balance test, the individual directs the attention to the second motor task because the risk of falling down is low; however, the attention is focused on the primary postural task during the dynamic balance test (Woollacott & Shumway-Cook, 2002). For this reason, when the individual is performing additional motor tasks during Stand on One Foot Test, the postural control may be influenced. It is considered that the dynamic balance is not affected by motor tasks because the attention is focused on the postural task, and the accuracy of the secondary motor task is not cared for. In addition, the dynamic tests include a cognitive process. It is recommended that the accuracy of the additional motor and cognitive tasks is evaluated in future studies.

## 6. Conclusion

The results of our study showed that motor and cognitive tasks performed during the balance performances of the older individuals influenced the balance of the individuals. In this situation, the balance of the older individuals during normal postural tasks of the older (standing, walking, sitting-standing up, etc.) may be disrupted with any external stimulant, and their risk of falling down may increase. In different studies, it was reported that the Dual Task performance in older individuals may give an idea on falling down events that may be experienced in the future (Hirashima et al., 2015), and increased the risk of falling (Ansai, Aurichio, & Rebelatto, 2016; Muir-Hunter & Wittwer, 2016; Priest, Salamon, & Hollman, 2008). We consider that Dual Task training must be provided to the



older together with balance training. By so doing, we believe that the number of falling down events stemming from balance problems will be decreased. In addition, it has been reported in previous studies that the control strategies are different for adapting to changing conditions in different age groups, different genders and in different educational levels (Gomes et al., 2015; Hsieh & Cho, 2012; Lima et al., 2015). For this reason, the individuals from different age groups, different genders and different educational levels may be examined separately in future studies.

## 7. Limitations

When evaluating the performances of the balance tests, also measuring the accuracy of the given additional task may produce more objective data. It is recommended that this should be cared for in future studies.

## 8. Ethical approval and consent to participate

All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study was approved by the Kırıkkale University Clinical Research Ethics Committee, Decision Number: 11/08, 03.05.2016.

## List of Abbreviations

BMI	Body Mass Index
MMST	Mini-Mental Status Test
TUG	Time up and Go Test

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