The Relationship Between Dual-Task Performance and Functional Independence in Stroke Patients: A Cross-Sectional Study

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ABSTRACT:

Purpose: Dual-task performance have a role in independent motor functions such as gait and balance. Although walking and balance parameters are important in functional independence, the level of independence is a complex condition affected by many factors. The aim of this cross-sectional study is to investigate the relationship between dual-task performance and functional independence levels in stroke patients.

Material and Methods: 26 hemiplegic patients were included in this research in a tertiary healthcare institution. The participants' independence levels were evaluated by the functional independence mesasure(FIM). Single task performance, motor dual-task performance, and cognitive dual-task performance were evaluated by calculating walking time in a 10-meter walking test. The relationship between dual-task interference and functional independence level was examined by Spearman correlation analysis.

Results: The motor dual-task interference was found as 0.7 (0.0-0.26) and the cognitive dual-task interference was found as 0.19 (0.05-0.38). There was a negative, moderate, and statistically significant correlation between the FIM score and the motor dual-task interference (r = -0.48, p = 0.01). However, no significant correlation was detected between FIM score and cognitive dual-task interference (p = 0.16).

Conclusion: The level of functional independence in stroke patients is associated with motor dual-task interference. Rehabilitation programs that improve dual-task performance can increase the functional independence levels of stroke patients.

Keywords: Stroke, Dual-task, Functional independence measure

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INTRODUCTION

Stroke is one of the three major diseases that cause mortality and disabilities in the general population (Feigin et al., 2021). The main purposes of the numerous studies in this field are to prevent stroke and reduce stroke-induced mortality and disability rates. Despite this tremendous endeavor, epidemiological studies throughout the world indicate that mortality due to stroke decreases every year, but the decrease in the incidence of stroke is not as evident as in mortality (Krishnamurthi, Ikeda and Feigin, 2020). There may be many factors affecting these data, but the main point lies in the fact that the number of patients that should be rehabilitated day by day increases (Stinear et al.,2020). Individuals with strokes are rehabilitated to recover their lost bodily functions and physical activities and to ensure that they can participate in household and social life without help from another (Stinear et al., 2020). Therefore, the main purpose of rehabilitation is to maximize independence in daily activities. It is directly associated with the level of independence of the individuals to carry out their self-care activities, control urine and gaita, make transfers and transport, communicate, and engage in social activities (Hall et al., 1993). Some factors such as mood and fatigue may affect independence indirectly (Utkan and Karataş, 2022). Investigating

and revealing the factors that may be associated with the level of independence among the individuals with stroke will provide guidelines for developing rehabilitation practices. Although conventional rehabilitation practices are carried out in a task-specific way, it is necessary to perform two or more tasks simultaneously during daily life. The most popular examples include conversing with someone while walking, protecting oneself from the vehicles in traffic while crossing the street, and walking by carrying goods at hand (Muci et al., 2022). Thus, when performing two or more tasks at the same time, the change in motor activity as a result of the distraction is defined as dual-task performance (Yang, He and Pang, 2016). Dual-task performance is subdivided into two main categories as motor and cognitive performance. It has been shown that both categories of task performance have a role in independent motor functions such as gait and balance (Deblock-Bellamy, Lamontagne and Blanchette, 2020; Tisserand et al., 2018; Tsang, Miller and Pang, 2022). In a recent review, it was published that stroke patients who walked by avoiding obstacles had a more significant decrease in their performance with cognitive or motor dual task than in aged-matched healthy individuals for and gender (Deblock-Bellamy, Lamontagne and Blanchette, 2020). In a study comparing the gait parameters of post-stroke individuals with healthy controls, it was shown that dual task interference affected the mediolateral balance strategy during walking (Tisserand et al., 2018). However, there is a lack of studies on the relationship between the general independence level of stroke patients and the dual-task performance. Although walking and balance parameters are important in functional independence, the level of independence is a complex condition affected by many factors. In the light of this information, this study aims to investigate the relationship between dual-task performance and functional independence levels in stroke patients.

MATERIAL and METHODS
Purpose and Type of the Study
The aim of this cross-sectional study is to investigate the relationship between dual-task performance and functional independence levels in stroke patients.

Sampling and Participant
This research was conducted in a tertiary healthcare institution (a university hospital physical medicine and rehabilitation clinic) between April and June 2022. A total of 26 hemiplegic patients who were over 18 years, receiving inpatient or outpatient treatment and being monitored in our clinic, could walk at least 14 meters without using any walking device (cane, crutches, tripod, etc.), and had with hemorrhagic or ischemic stroke etiology confirmed by brain imaging were included in the research. Patients with severe cognitive disorder (mini mental test score below 18, neglect, suffering severe aphasia or apraxia), who could not perform duties due to vision and hearing loss, who have any other surgical or medical disease affecting upper or lower extremity function, and who have vestibular impairment were not included (Figure 1). The sample size was calculated using G*Power (Version 3.1.9.2) program with impact size | ρ | = 0.5, α= 0.05, with 80 % power.

Data Collection Tools
The demographic data containing participants' age, gender, body mass index, stroke etiology, and the period after having a stroke were recorded. The participants' independence levels were evaluated by the functional independence mesasure (FIM). Single task performance, motor dual-task performance, and cognitive dual-task performance were evaluated by calculating walking time in a 10-meter walking test. Measures of the participants' functional independence level and walking performance were evaluated by two physiatrists who were unaware of each other's measurement. Walking performance was evaluated in a random order to prevent the effect of the learning factor.

The functional independence measure consists of 18 items and is used to evaluate how independent the individual does the basic physical and cognitive activities in daily life. The motor subscale includes activities of self-care, sphincter control, transfer, and transport.

The cognitive subscale contains daily life activities associated with communication and social detection.
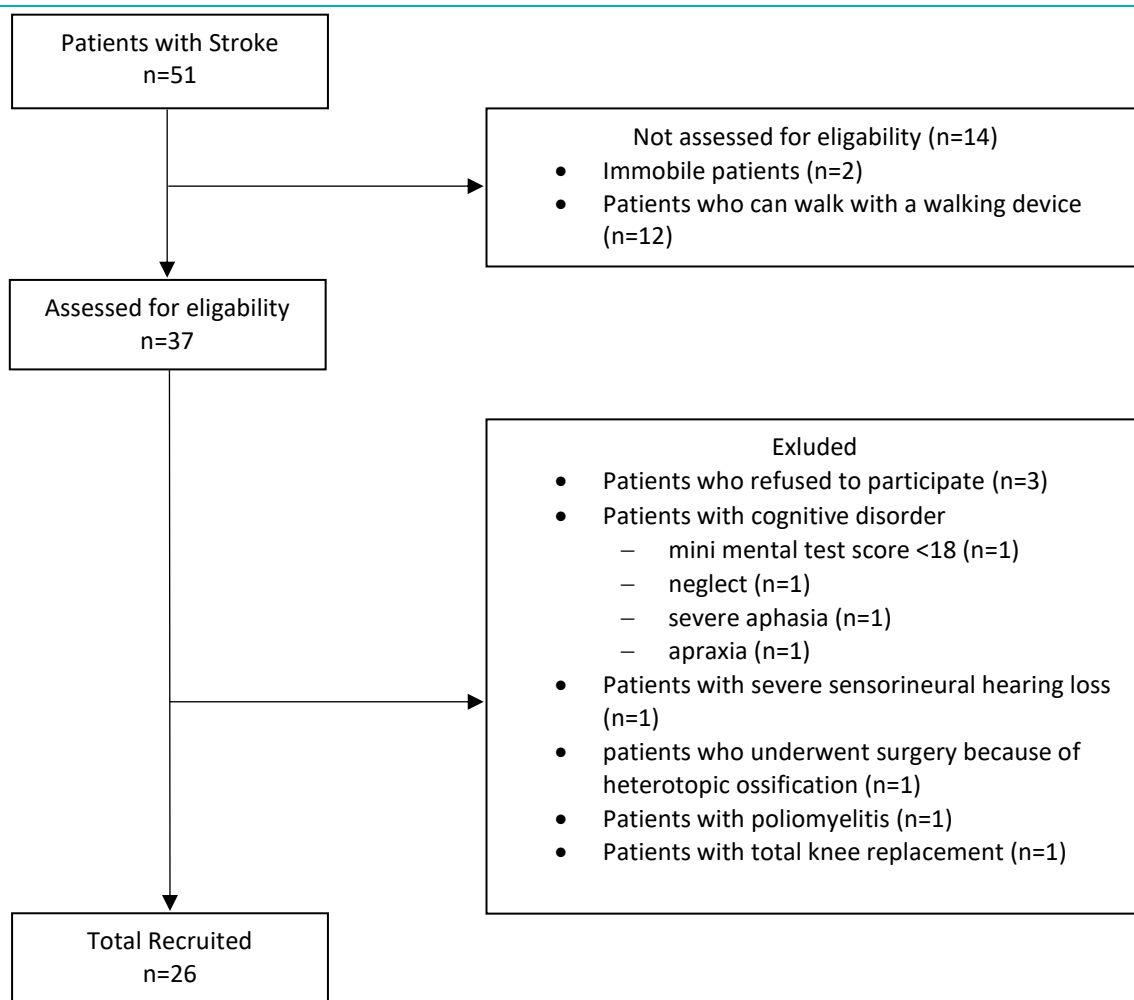
Figure 1: Study flow diagram

Each item on the scale is scored between 1 and 7 according to whether the individual receives physical help while performing the activity, how much of the effort required for performing the activity is put into practice if physical help is received, the need for verbal assistance, supervision of another person or auxiliary device use, and the length of the activity. The motor subscale score ranges between 13 and 91 points and 5 and 35 points for the cognitive subscale score. Turkish validity and reliability of the scale among the stroke patients was performed by Küçükdeveci et al. (Küçükdeveci et al., 2001) Cronbach's alpha value was found to be 0.957 for the motor subscale and the inter-rater correlation coefficient was 0.93, the Cronbach's alpha value was found to be 0.951 for the cognitive subscale and the inter-rater correlation coefficient was 0.92

Walking performance was evaluated separately in order in a random order to prevent the effect of the learning factor during the single task, motor dual-tasks, and cognitive dual-tasks in the 10 meters walking test. In order to measure the walking performance in a 10-meter walking test, the participants were asked to walk at their maximum speed in a corridor of 14 meters long, taking into account the 2 meters acceleration and 2 meters slowing distances. The time when the distance is walked up to the 10 meters was measured through the stopwatch. In order to evaluate the motor dual-task performance, the same measurement was determined by measuring the time while making the participants carry a glass full of water up to the last 1 cm, which is 10 cm long and weighs 500 grams, with their good hand. The same walking task was conducted while the participants were counting up aloud the human names starting with the letter M for the same walking task to evaluate the cognitive dual-task performance.

The dual-task interference score on the walking test was calculated separately for motor and cognitive dual tasks, using the formula for subtracting the time of dual-task from single-task performance and calculating its proportion to the single task performance (Baek et al., 2021).

Statistical Analysis

After reaching the calculated sample size, data analysis was performed with SPSS v22 software. The distribution type of the data was examined using analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk) and visual methods (histograms, probability graphics). By making descriptive analyses, the quantitative data were presented with median (minimum-maximum) because of variables were not exhibit a normal distribution, categorical data were presented with n (percentages). The relationship between dual-task interference and functional independence level was examined by Spearman correlation analysis. Type 1 error level was accepted as 0.05.

Ethical Approval

The participants were informed about the purpose and scope of the study and written, and verbal consents were provided. The study protocol and informed consents form were approved by the local ethics committee before the study (Sivas Cumhuriyet University Non-Invasive Clinical Research Ethics Committee, 2022-04/25), and the study was conducted following the Declaration of Helsinki.

RESULTS

In this cross-sectional study, 57.7 % of the participants were male (n = 15) and median age was 67 (33-78) years. 80.8 % of patients with stroke etiology were ischemic (n = 21). 16 (61.5%) participants had a left hemisphere lesion. The median stroke time was 18 (7-60) months. The demographic and clinical data of the participants are shown in Table 1.

Table 1. Demographic and clinical data of the participants

Variable[a]		Statistical value
Age, years		67 (33-78)
Gender		
	Female	11 (42.3)
	Male	15 (57.7)
Body Mass Index, kg/m^2		26.6 (21.6-30.7)
Stroke Type		
	Hemorrhagic	5 (19.2)
	Ischemic	21 (80.8)
Stroke Localization		
	Right hemisphere	10 (38.5)
	Left hemisphere	16 (61.5)
Stroke Period (month)		18 (7-60)
Brunnstrom Motor Stage		
	Upper extremity	
	4	6 (23.1)
	5	10(38.5)
	6	10(38.5)
	Hand	
	3	6 (23.1)
	6	20 (76.9)
	Lower extremity	
	5	10 (38.5)
	6	16 (61.5)
Functional Independence Measure Score		
	Motor Score (0-91)	82.5 (57-90)
	Cognitive Score (0-35)	35 (33-35)
	Total Score	116.5 (90-125)
Functional Ambulation Scale Score		
	4	21 (80.8)
	5	5 (19.2)

[a]The quantitative data were presented with median (minimum-maximum) and categorical data were presented with n (percentages).

The median 10 m walking test time of the participants was 11.6 (6.3-22.1) seconds for the single task, 12.5 (6.52-25.9) seconds for the motor dual-task, and 14.3 (7.1-29.2) seconds for the cognitive dual-task. The motor dual-task interference was found as 0.7 (0.0-0.26) and the cognitive dual-task interference was found as 0.19 (0.05-0.38) (Table 2).

There was a negative, moderate, and statistically significant correlation between the FIM score and the motor dual-task interference (r = -0.48, p = 0.01) (Figure 2). However, no significant correlation was detected between FIM score and cognitive dual-task interference (p = 0.16).

Table 2. 10 m walking test results of the participants

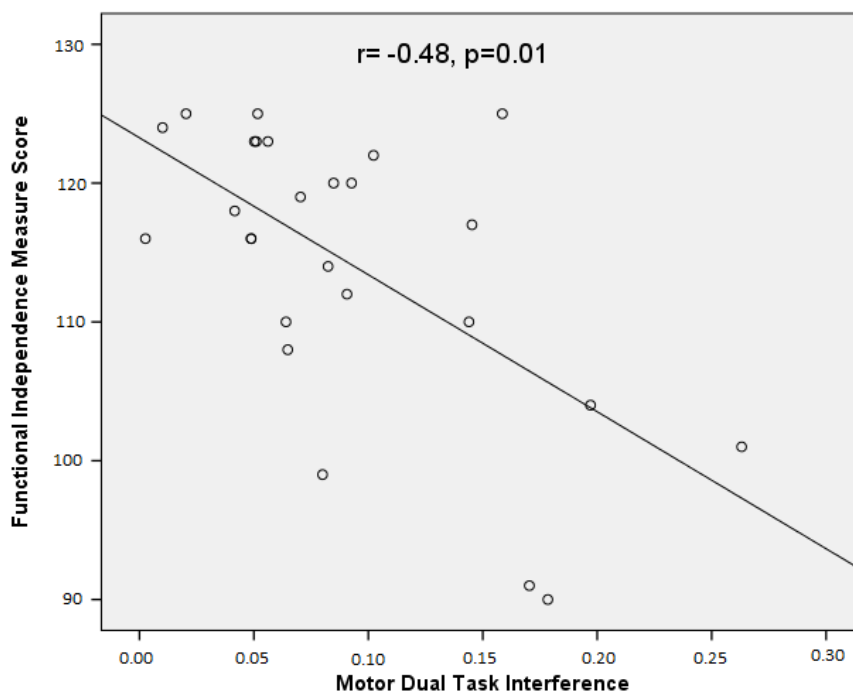| Variable	Median (Minimum-Maximum).
Single task performance	11.6 (6.3-22.1)
Motor dual task performance	12.5 (6.52-25.9)
Cognitive dual task performance	14.3 (7.1-29.2)
Motor dual task interference	0.7 (0.0-0.26)
Cognitive dual task interference	0.19 (0.05-0.38)

Figure 2: Correlation between the FIM score and the motor dual-task interference

DISCUSSION

In this study which investigates the relationship between the score of functional independence measure and dual-task performance in chronic stroke patients, it was revealed that there was a negative relationship between FIM score and the motor dual-task interference and that there was no statistically significant relationship between the cognitive dual-task interference. Many factors affecting the independence of stroke patients in daily life activities have already been investigated, but this is the first study to deal with dual-task performance with FIM.

The main purpose of rehabilitation programs after stroke is to reduce the loss of function as much as possible, minimize dependence on daily life

activities, and ensure that the individuals continue their social life (Park, 2019). In line with that, it is necessary to determine the content of the rehabilitation program to be applied to the patient and identify the modifiable factors that affect the dependence of stroke patients. Previously, in their study among acute and chronic stroke patients, Cakır et al. found that there was a negative relationship between FIM and the duration of the disease, but a positive relationship between the duration of hospital stay (Cakir et al., 2015). Lin et al. (2000) reported that age, profession, having a cardiac problem, the presence of medical complications, and bilateral stroke affected functional independence. In a recent article, it has been suggested that obesity and depression are associated with the functional independence level among stroke patients (Yun et al., 2020).

Most research assessing the dual-task performance of stroke patients have focused on specific parameters such as the risk of falling, keeping balance, walking parameters, and upper extremity functions. However, the dependence of stroke patients have a biopsychosocial background, so there is also a need for holistic assessment in addition to the specific parameters. Charlotte et al. found that basal dual-task performance can correctly determine the risk of participants with 80 % sensitivity among the chronic stroke patients, which they monitored for 1 year (Tsang et al., 2022). Moreover, Tsang et al. revealed that the high dual-task interference was associated with a low risk of falling (Tsang and Pang, 2020). Feld et al. (2018) found that dual-task performance affected the step length, cadence, and step time in the walking parameters of stroke patients who are discharged from the hospital (Feld and Plummer, 2020). Another research reported that the walking speed during the dual-task was more decisive than the walking speed of the task in determining the daily walking activity of stroke patients (Feld et al., 2018). The relationship between the motor dual-task interference and the FIM score shown in this study is compatible with the results of previous studies considering that the specific parameters in the literature are sub-groups of the general independence level. This result is an expected finding because many daily activities contain two or more components at the same time. This result supports that patients with low dual-task interference are more independent in daily living activities. This result may also suggest that when the dual-task performance of individuals with stroke improves, functional independence will also increase. However, the lack of relationship between the cognitive dual-task interference and the functional independence scale may occur due to the high cognitive subscale scores of the participants by creating a ceiling effect, and type 2 errors may have arisen.

The independence levels of stroke patients can be increased by adding dual-task exercises, dance therapies, virtual reality exercises to improve dual-task performance in the rehabilitation programs. In a review, Murillo-Garcia et al. (2021) found that dance therapies improved dual-task performance among middle-aged and older-aged patients. Bagheri et al. (2021) also revealed that both dual-task exercises and video games reduced body swing in the anteroposterior and mediolateral direction, so it is appropriate to improve the dual-task interference(Bagheri et al., 2021). Park also stated that dual-task training improved performance in the upper extremity functions and daily activity (Park, 2019). In stroke patients, detailed research is needed to investigate clinical reflections of exercises that increase dual-task performance.

This research has several limitations. First of all, the high cognitive scores of the participants cause type 2 errors in the relationship between the FIM scores and dual-task interference. In addition, the lack of parameters such as fatigue and mood disorders that may affect the dual-task performance of the participants is another missing point. In addition, the population of stroke patients in the study, who can walk at least 14 m without support, may adversely affect the generalization of the results to all stroke patients. Finally, evaluating the motor and cognitive dual-task interference by adding a single type of motor or cognitive task to single task performance is another limitation.

CONCLUSION

In conclusion, the level of functional independence in stroke patients is associated with motor dual-task

interference. The fact that the participants who can walk 14 m without support and, have high cognitive FIM score, may affect the generalizability of the results. Rehabilitation programs that improve dual-task performance can increase the functional independence levels of stroke patients. Detailed research is needed to examine the effect of exercises on clinical parameters of stroke patients for improvement of dual-task performance.

Acknowledgment
None

Conflict of Interest
None

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