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RESEARCH ARTICLE

The Effect of Cognitive Status on Work Productivity and Activities in Multiple Sclerosis

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Abstract
Multiple Sclerosis (MS) is a recurrent, chronic disease of the central nervous system (CNS) characterized by various symptoms such as vision problems, balance, gait, and cognitive impairments. In MS, the decline in cognitive function can be a difficult symptom to detect, which may lead to negative consequences in work and social situations. Consequently, this decline could impact individuals' work productivity in multiple ways, including job termination, reduced working hours, and experiencing work-related adverse events. This study aims to examine the relationship between cognitive status and work productivity and activities in individuals with MS. Sociodemographic and occupational characteristics of the patients are also considered. The Brief International Cognitive Assessment for Multiple Sclerosis (BICAMS) is used to evaluate participants' cognitive status. The Work Productivity and Activity Impairment Questionnaire (WPAI:MS) is utilized to assess work productivity and activities in MS patients. Pearson correlation and regression analysis were performed to analyze the relationship between continuous variables in the study. A total of 144 patients participated in the study. Of these patients, 81.2% have relapsing-remitting MS (RRMS). Working patients make up 42.4% of these individuals. In this study, it was observed that BICAMS subtest scores for working patients were higher than those of the non-working patient group. When analyzing the causal relationship between working patients' cognitive status scores and work productivity and activities, no statistically significant result was obtained. On the other hand, it is advised to look into larger patient groups to investigate the relationship between cognitive status and employment in individuals with MS.

Keywords
Cognitive Status, Work Efficiency, Multiple Sclerosis

INTRODUCTION

Multiple Sclerosis (MS) is a central nervous system disorder characterized by persistent inflammation and widespread neurodegenerative areas in the brain and spinal cord (Mahad et al., 2015; Lassmann et al., 2019). By the end of 2020, it is estimated that the global number of MS patients reached 2.8 million (Walton et al., 2020). MS frequently impacts individuals during their prime years when they are planning their careers and families, leading to adverse effects on their financial, occupational, and social lives (Yamout& Alroughani, 2018).

Cognitive dysfunction is a prevalent issue in MS, affecting between 40% and 65% of those with the condition (Fox et al., 2015; Amato et al., 2010). Research has also indicated that this dysfunction may be present from the early stages of the disease (DiGiuseppe et al., 2018; Anhoque et al., 2012). This decline typically impacts domains such as processing speed, verbal memory, and executive functions (Benedict, 2011; Rao et al., 1991a). Observable from the

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early stages of MS, cognitive impairment is a productivity (Amato et al., 1995; Kobelt et al., 2017). Cognitive difficulties are more prevalent among unemployed MS patients than employed ones (Langdon, 2011). A study on disease burden in a large European MS population reported that the unemployment rate for MS patients belo retirement age was about 50% (Kobelt et al., 2017). A systematic review by Clemens and

The prompt identification and management of cognitive impairments in MS patients, which has been shown to directly influence work performance and employment, is a crucial concern. In our

MATERIALS AND METHODS

The 144 patients who applied to the MS outpatient clinic at the Şişli Florence Nightingale Hospital during the three-month data collection period and met the study's inclusion criteria made up the study's sample.Patients over the age of 18, without significant hearing and visual impairment, without motor disabilities that could limit hand movements, without neuropsychiatric conditions that could affect cognitive status, and with an Expanded Disability Status Scale (EDSS) score of ≤5.5 were eligible for inclusion (Kurtzke, 1983). Face-to-face interviews were used to collect the data. Approval was granted by the Koç University Ethics Committee (approval number: 2019. 235. IRB3. 128, date: 24.07.2019). Written authorization was received from the patent holders of the scales, and informed consent was obtained from the patients who participated in the study.

Patient Information Form

The Patient Information Form used in this study collected data on various sociodemographic, occupational, and clinical characteristics, including age, gender, education level, occupation, employment status, weekly working hours, job description, history of changing jobs due to illness, duration of illness, MS type, and EDSS score.

Brief International Cognitive Assessment for Multiple Sclerosis (BICAMS):

Benedict et al. developed the Brief International Cognitive Assessment for Multiple Sclerosis (BICAMS) in 2012, which is commonly used to assess cognitive impairment related to MS (Benedict et al., 2012). BICAMS comprises three subtests: the Symbol Digit Modalities Test

significant factor contributing to reduced work Langdon (2018) found that the key distinction between unemployed and employed MS patients is impaired processing speed and executive functioning. Another study reported that after disease onset, 25% to 33% of employed individuals had to modify their work arrangements or decrease their working hours (Schiavolin et al., 2013).

(SDMT) that measures information processing speed and working memory, the California Verbal Learning Test II (CVLT II) that evaluates verbal memory, learning, and recall, and the Brief Visuospatial Memory Test-Revised (BVMTR) that examines visual memory. Each of these tests has its own scoring system, and no overall score is calculated (Özakbaş et al., 2017). The evaluation takes approximately 15 minutes, and lower scores indicate greater cognitive impairment due to MS (Çınar et al., 2017).

Work Productivity and Activity Impairment Questionnaire: Multiple Sclerosis V2.0 (WPAI:MS)

The WPAI:MS is a self-reported survey designed to measure the impact of MS on work productivity and daily activities. The questionnaire comprises six questions that evaluate the extent of MS's impact on work productivity and daily activities. The questions ask about the patient's employment status, the number of work hours missed due to MS, the total working hours, the degree to which MS affects work productivity, and the extent to which MS affects non-work-related daily activities. The responses should pertain to the past seven days. Four outcomes are calculated from the WPAI:MS questionnaire: the percentage of work hours missed due to MS, the percentage of reduced work efficiency due to MS, the percentage of work productivity loss because of MS, and the percentage of decrease in non-work-related activities due to MS. Higher scores on the WPAI:MS scale indicate greater impairment (Reilly, 2021a; Glanz et al., 2012). The Work Productivity and Activity Impairment questionnaire was translated into Turkish by three independent translators, and the Turkish questionnaires were then re-translated into English for verification purposes (Reilly, 2021b; Lambert et al., 2014).

Data Analysis

In this study, the data were analyzed using the SPSS (Statistical Package for Social Sciences) Windows 22.0 program. Descriptive statistical methods, including number, percentage, mean and standard deviation, were used to evaluate the data. The Kolmogorov-Smirnov Normal Distribution Test was used to determine if the research variables had a normal distribution. Results showed that the study variables had a normal distribution ($p>0.05$). Parametric methods were applied for data analysis. The t-test was used to compare quantitative continuous data between two independent groups, while the One-way ANOVA test was used to compare quantitative continuous data between more than two independent groups. The Scheffe test was used as a complementary post-hoc analysis to identify differences following the ANOVA test. Pearson correlation and regression analysis were performed to analyze the relationship between continuous variables in the study.

RESULTS

A total of 144 MS patients were enrolled in this study, of whom 69.4% were female and 30.6% were male. The mean age of the patients was 40.7±10.9, and the mean duration of education was 11.9±3.7 years. Among the MS characteristics, the mean disease duration was 9.5±6.2years, and the majority of patients (81.2%, n=117) had relapsing-remitting MS (RRMS). The mean Expanded Disability Status Scale (EDSS) score was 2.7±1.3 ranging from 0.0 to 5.5. Of the participants, 42.4% (n=61) were currently employed, working an average of 44.2±6.7 hours per week. Among working patients, 27.1% (n=39) had changed jobs at least once due to MS.

When the mean cognitive status scores of the patients were analyzed, the mean scores of "SDMT" were 36.4±11.4, "CVLTII" was 56.4±12, and "BVMTR" was 70.2±17.7, respectively. The mean scores of work efficiency and activities of the patients in the last week were as follows: "missed work time due to MS" means 10±21.1, "decreased work efficiency due to MS" means 29.7±20.9, "loss of work efficiency due to MS" means 36.4±24.9, "decreased activities outside of work due to MS" mean 46±27.5, respectively (Table1).

Table 1. Participants' mean scores of cognitive status and job efficiency, activity (n=144)

	Mean	Ss.	Min.	Max.
SDMT	36,4	11,4	3,6	68,2
CVLT II	56,4	12	22,5	85
BVMTR	70,2	17,7	13,9	100
Work time missed due to MS	10	21,1	0	100
Decreased activity at work due to MS	29,7	20,9	0	70
Loss of work productivity due to MS	36,4	24,9	0	100
Reduction in non-work activities due to MS	46	27,5	0	100

When the correlation analyzes between EDSS, cognitive status, work efficiency and activities are examined, respectively; A negative correlation was found between SDMT, BVMTR, CVLT II and EDSS ($p<0.05$). A positive correlation was found between a decrease in MS-induced non-work activities and EDSS, a negative correlation between SDMT, a negative correlation between CVLTII and a negative correlation between BVMTR (Table 2).

Table 2. Correlation Analysis Between EDSS Score, Cognitive Status and Job Efficiency Score

		EDSS	SDMT	CVLTII	BVMTR	Work time missed due to MS	Decreased activity at work due to MS	Loss of work productivity due to MS	Decreased activities outside of work caused by MS
EDSS	r	1							
	p	0,000							
SDMT	r	-0,503**	1						
	p	0,000	0,000						
CVLTII	r	-0,340**	0,611**	1					
	p	0,000	0,000	0,000					
BVMTR	r	-0,395**	0,650**	0,635**	1				
	p	0,000	0,000	0,000	0,000				
Work time missed due to MS	r	0,202	0,134	0,022	-0,011	1			
	p	0,119	0,305	0,868	0,93	0,000			
Decreased activity at work due to MS	r	0,052	0,036	-0,235	-0,242	0,074	1		
	p	0,691	0,785	0,068	0,06	0,573	0,000		
Loss of work productivity due to MS	r	0,173	0,107	-0,168	-0,202	0,597**	0,838**	1	
	p	0,181	0,412	0,196	0,118	0,000	0,000	0,000	
Decreased activities outside of work caused by MS	r	0,505**	-0,330**	-0,256**	-0,350**	0,223	0,785**	0,739**	1
	p	0,000	0,000	0,002	0,000	0,085	0,000	0,000	0,000

*<0,05; **<0,01

As a result of the regression analysis performed to determine the cause and effect relationship between cognitive status and work efficiency and activities, the relationship between SDMT, CVLTII, BVMTR and the decrease in MS-related activities outside of work was found to be significant (p<0.05) (Table 2).

Table 3. Effect of Cognitive Status on Work Efficiency and Activities

The dependent variable	Independent variable	ß	t	p	F	Model (p)	R^2
Work time missed due to MS	Fixed	2,626	0,139	0,890	0,424	0,736	0,030
	SDMT	0,408	1,101	0,275			
	CVLTII	-0,104	-0,332	0,741			
	BVMTR	-0,043	-0,196	0,845			
Decreased activity at work due to MS	Fixed	58,115	3,280	0,002	2,472	0,071	0,069
	SDMT	0,534	1,532	0,131			
	CVLT II	-0,510	-1,738	0,088			
	BVMTR	-0,260	-1,249	0,217			
Loss of work productivity due to MS	Fixed	58,167	2,740	0,008	2,173	0,101	0,055
	SDMT	0,775	1,856	0,069			
	CVLT II	-0,528	-1,502	0,139			
	BVMTR	-0,290	-1,159	0,251			
Reduction in non-work activities due to MS	Fixed	87,218	8,113	0,000	7,643	0,000	0,122
	SDMT	-0,430	-1,620	0,107			
	CVLT II	0,004	0,017	0,987			
	BVMTR	-0,368	-2,103	0,037			

Statistically significant differences were found in the SDMT, CVLT II, and BVMTR scores based on age and education level (P<0.05). Working patients had higher scores on these cognitive tests than non-working patients. In terms of the time of diagnosis, SDMT and BVMTR scores decreased as the diagnosis time increased. Additionally, patients with clinically isolated syndrome (CIS) had higher SDMT, CVLT II, and BVMTR scores compared to those with relapsing-remitting MS (RRMS) and secondary progressive MS (SPMS) (Table 4).

Table 4. Differentiation of Cognitive Status by Descriptive Characteristics

Demographic features	**n**	**SDMT**	**CVLTII**	**BVMTR**
Age		Mean±SD	Mean±SD	Mean±SD
≤30	24	40,189±10,250	58,333±14,155	77,199±18,261
31-40	53	38,285±12,486	58,750±12,440	73,008±16,759
41-50	35	36,649±10,118	55,964±9,922	70,079±14,560
51≤	32	29,943±9,230	51,484±10,402	60,590±18,418
F=		5,239	2,802	5,308
p=		0,002	0,042	0,002
PostHoc=		1>4, 2>4, 3>4 (p<0.05)	1>4, 2>4 (p<0.05)	1>4, 2>4, 3>4 (p<0.05)
Education Time		Mean±SD	Mean±SD	Mean±SD
≤10	27	24,949±8,337	50,324±8,740	58,230±15,360
11-15	102	37,558±9,350	56,299±11,538	71,650±17,355
16 ≤	15	48,667±11,783	67,917±12,244	82,222±11,151
F=		33,251	12,013	11,507
p=		0,000	0,000	0,000
PostHoc=		2>1, 3>1, 3>2 (p<0.05)	2>1, 3>1, 3>2 (p<0.05)	2>1, 3>1, 3>2 (p<0.05)
Working Status		Mean±SD	Mean±SD	Mean±SD
Yes	61	41,490±8,803	59,836±11,336	77,231±13,961
No	83	32,574±11,619	53,855±11,869	65,094±18,370
t=		5,025	3,045	4,322
p=		0,000	0,003	0,000
Diagnosis Time		Mean±SD	Mean±SD	Mean±SD
1-5	45	41,879±11,098	58,944±10,553	77,531±14,839
6-10	49	35,046±8,822	57,041±12,118	67,914±15,141
11-15	26	34,266±11,916	55,913±12,220	69,872±19,715
16 ≤	24	30,909±12,384	50,781±12,789	61,690±20,560
F=		6,561	2,581	5,134
p=		0,000	0,056	0,002
PostHoc=		1>2, 1>3, 1>4 (p<0.05)		1>2, 1>4 (p<0.05)
Ms Type		Mean±SD	Mean±SD	Mean±SD
KİS	12	42,955±11,162	61,458±8,010	76,620±13,214
RRMS	117	37,405±10,138	57,564±11,399	71,985±15,926
SPMS	15	22,848±11,447	43,167±10,855	51,481±22,490
F=		15,791	12,510	11,234
p=		0,000	0,000	0,000
PostHoc=		1>3, 2>3 (p<0.05)	1>3, 2>3 (p<0.05)	1>3, 2>3 (p<0.05)

After analyzing the differences between work efficiency, activities, and patient characteristics, it was found that there was a significant increase in the scores of decreased MS-related non-work activities as the patients' diagnosis period increased (p<0.05). Patients with secondary progressive MS (SPMS) had higher scores for missed work time due to MS and a reduction in MS-related non-work activities compared to other types of MS (Table 5).

Table 5. Differentiation of Business Efficiency and Activities by Descriptive Characteristics

Demographic features	n	Work time missed due to MS	Decreased activity at work due to MS	Loss of work productivity due to MS	Reduction in non-work activities due to MS
Age		Mean±SD	Mean±SD	Mean±SD	Mean±SD
≤30	10	5,111±12,746	19,000±15,951	23,200±18,624	35,833±28,425
31-40	32	11,059±21,873	31,250±21,365	38,521±25,037	43,962±25,596
41-50	16	12,864±25,571	29,375±19,822	37,838±26,660	53,714±29,314
51 ≤	3	0,000±0,000	50,000±26,458	50,000±26,458	48,438±26,410
F=		0,514	1,969	1,358	2,243
p=		0,674	0,129	0,265	0,086
Education Time		Mean±SD	Mean±SD	Mean±SD	Mean±SD
≤10	4	3,000±6,000	42,500±30,957	43,400±32,056	53,704±26,040
11-15	49	8,865±18,835	28,980±20,539	35,103±23,524	45,980±27,656
16 ≤	8	20,556±34,890	27,500±18,323	40,806±31,647	32,000±25,411
F=		1,300	0,819	0,343	3,081
p=		0,280	0,446	0,711	0,049
PostHoc=					1>3 (p<0.05)
Diagnosis time		Mean±SD	Mean±SD	Mean±SD	Mean±SD
1-5 Year	23	8,504±22,104	30,435±24,951	35,667±29,445	34,444±24,079
6-10 Year	20	15,180±26,150	29,500±19,050	39,713±24,819	47,143±28,062
11-15 Year	11	1,741±5,774	30,000±21,909	31,219±22,279	47,308±25,699
16 years and more	7	13,212±14,847	27,143±11,127	37,439±11,639	63,750±25,506
F=		1,055	0,044	0,278	6,735
p=		0,375	0,988	0,841	0,000
PostHoc=					2>1, 3>1, 4>1, 4>2, 4>3 (p<0.05)
Ms Type		Mean±SD	Mean±SD	Mean±SD	Mean±SD
KİS	7	2,736±7,238	37,143±26,904	39,058±26,787	34,167±24,293
RRMS	51	8,856±18,416	28,431±20,530	34,405±23,761	44,274±26,888
SPMS	3	46,667±50,332	33,333±11,547	64,000±31,749	68,667±24,456
F=		5,802	0,575	2,130	6,952
p=		0,005	0,566	0,128	0,001
PostHoc=		3>1, 3>2 (p<0.05)			3>1, 3>2 (p<0.05)

DISCUSSION

The study aimed to investigate the impact of cognitive status on work productivity and activities in multiple sclerosis (MS). It also aimed to determine whether cognitive status and work productivity differ based on occupational, demographic, and clinical characteristics. Findings showed that 27.1% of the participants changed jobs at least once due to MS, which is higher than the 6% reported by Julian et al. (2008). In terms of absenteeism, 10 % of the working participants in the study could not go to work in the

last seven days due to MS, and 36.3% experienced a decrease in work productivity. These figures are comparable to Glanz et al.'s (2012) study, which showed that approximately 11.9% of MS patients reported absenteeism in the past seven days. These data demonstrate that MS affects people's capacity to work efficiently.

The study found that as the duration of illness, EDSS scores, and MS severity increased, working patients had increased MS-related absenteeism and decreased non-work activities. This is consistent with several previous studies highlighting the impact of longer illness duration on work productivity and decreased work productivity in people with higher EDSS scores (Putzki et al., 2009; Beatty et al., 1995; Bøe Lunde et al., 2014). Patients with secondary progressive MS (SPMS) showed higher scores for missed work time and a reduction in MS-related non-work activities compared to other types of MS (Srpova et al., 2022; Kobelt et al., 2017; Rodriguez et al., 2022).

Working patients in the study had higher cognitive status scores than non-working patients. Schiavolin et al.'s (2013) study emphasized that higher cognitive status scores increase the probability of employment. The study also found differences in cognitive status scores among patients based on age, duration of education, and EDSS scores. Cognitive impairment was more pronounced in individuals with higher levels of physical disability (De Meo et al., 2015; Giedraitienėet al., 2015; Monica et al.,2022; Miller et al., 2006)).

Patients with clinically isolated syndrome (CIS) had higher cognitive status scores than patients with relapsing-remitting MS (RRMS) and SPMS. The study of Benedict and Ziyadinov (2011) showed that individuals with progressive disease course have more cognitive impairment. Regression analysis found that only the Brief Visuospatial Memory Test-Revised (BVMTR) subtest of the Brief International Cognitive Assessment for MS (BICAMS) was associated with reduced levels of non-work activities associated with MS. A study by Benedict et al. (2005) found that patients with cognitive impairment were less likely to be employed or socially active.

In summary, our study highlights the significance of cognitive status in relation to work productivity and activities among individuals with multiple sclerosis (MS). We found that cognitive status and work productivity were influenced by several factors such as age, length of education, duration of illness, and EDSS scores. Furthermore, our study suggests that better cognitive status is associated with increased employment and work productivity.

Healthcare professionals should consider these factors when designing interventions to support individuals with MS in the workplace. Rehabilitation programs that address cognitive impairments may help improve overall quality of life and employment opportunities for these patients. However, further research is necessary to develop more targeted and effective interventions that consider the unique demographic, occupational, and clinical characteristics of individuals with MS.

Our study has limitations, including a small sample size of working patients and being conducted in a single center, which prevented us from establishing a statistically significant relationship between cognitive status scores and work efficiency or activities. Early recognition of cognitive impairment in individuals with MS is essential in addressing employment challenges and maintaining business continuity. Further research with working MS patients can provide insight into the factors that affect work productivity and continuity.

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Conflict of İnterest

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Ethical Aspects of The Study

Approval was granted by the Koç University Ethics Committee (approval number: 2019. 235. IRB3. 128, date: 24.07.2019). Written authorization was received from the patent holders of the scales, and informed consent was obtained from the patients who participated in the study.

Author Contributions

Study design: MKT and ŞÖ; Data collection: MKT; Data interpretation: MKT and ŞÖ; Manuscript preparation: MKT and ŞÖ; Literature review: MKT and ŞÖ. All authors have read and approved the published version of the manuscript.

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