Correlation between demographic characteristics, cognitive functioning and functional independence in stroke patients

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SUMMARY

Introduction It has been assumed that there is causality of the achieved level of functional independence with the degree of preservation of cognitive function in stroke patients. Demographic characteristics may be important for monitoring the achieved level of functional independence.

Objective The aim of this study was to examine the relationship of demographic characteristics and functional independence in regard to the level of cognitive impairment in stroke patients.

Methods The study included 50 stroke patients after rehabilitation, as well as age- and gender-matched 50 subjects selected randomly, according to the demographic characteristics of the studied sample, who in their medical history had no neurological disorders. For the assessment of functional independence, the Functional Independence Measure (FIM) test was used. The general cognition was estimated by the Mini-Mental State Examination (MMSE) test. The statistical analyses included the Mann–Whitney test, for two independent samples, measures of canonical correlation, and χ^2 test.

Results There was a statistically significant difference between the groups in relation to risk factors, hypertension and diabetes mellitus type II ($p<0.001$); There was a statistically significant difference within the groups in relation to the cognitive impairment in all the examined demographic characteristics ($p<0.001$); the differences within the groups in relation to the cognitive impairment are present on all subscales of the FIM test ($p<0.05$); the differences within the groups in relation to handedness, hemiparesis, show that mild cognitive impairment is more common among left hemiparesis, while a more severe one is more common among right-sided hemiparesis ($p<0.05$); More severe cognitive impairment is common among women, the elderly and in persons with lower education ($p<0.05$).

Conclusion By prevention of risk factors, and prevention of possible cognitive impairment, consequences of stroke can be reduced, the recovery can be made more successful, and quality of life can be improved.

Keywords: stroke; demographic characteristics; cognitive function; functional independence

INTRODUCTION

Stroke is the third most common cause of death and the second most common cause of functional disability in the world, according to the World Health Organization data [1]. Risk factors for stroke that cannot be influenced are gender and age. The statistical data of the Institute of Public Health of the Republic of Serbia show that men are more often at risk from stroke, that mortality is higher in women, and that risk from stroke increases with age, with very strong heredity factor [2]. Men are 25% more likely to suffer strokes than women, yet 60% of deaths from stroke occur in women. Some risk factors for stroke apply only to women (pregnancy, childbirth, menopause).

Risk factors that cannot be influenced are arterial hypertension, diabetes mellitus, atrial fibrillation, obesity, smoking and physical inactivity. People with hypertension have a three times greater risk for stroke; hypertension treatment reduces the risk up to 36–42% [3]. People with diabetes also have twice the risk for stroke, but studies show that good control of blood glucose reduces the risk [3]. Atrial fibrillation is a very important risk factor and is responsible for the occurrence of stroke in 50% of cases, and the annual risk of these diseases is 3–5%. Anticoagulant therapy in these patients significantly reduces the risk of stroke [3]. Significant risk factors for stroke may also be other cardiac disorders such as acute myocardial infarction, mitral valve prolapse, endocarditis and dilated cardiomyopathy. Every year about 300 people per 100,000 inhabitants in Serbia are under the impact of stroke, which is the highest incidence in Europe [2]. The disease results in a high mortality rate and a high degree of functional disability. The data that indicate high degree of functional disability are worrisome. In survivors, varying degrees of functional impairment, from light (35.8%), to medium (33.3%) and severe (30.9%), were registered [4].

Physical disability, to a greater or lesser extent, may cause damage to the working ability and activities of daily living (ADL) [4]. The optimal rehabilitation included medical, cognitive, social and vocational processes.

Cognitive deficit within stroke patients has multiple meanings. It is assumed that there is an association of the quality of motor recovery and the improvement of functional status with

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the degree of preservation of cognitive function. Cognitive decline is associated with a reduced ability to perform ADL, as well as with poor functional outcomes of medical rehabilitation [5]. The cognitive rehabilitation in stroke patients is expected to increase the speed of information processing, enable the insight into their own remaining abilities and to teach them to successfully participate in social interactions accepting their own deficits [6]. It is believed that cognitive functions play a role in functional training, but it is not defined whether they are based on the quality of cognitive function, and whether they may predict functional recovery of patients. Considering the aforementioned studies, the correlation between demographic characteristics of the respondents, their cognitive competence and functional recovery, might be of great importance in the rehabilitation process.

OBJECTIVE

The aim of this study was to investigate the relations between demographic characteristics (gender, age, education, marital status, risk factors), cognitive abilities, and functional independence of stroke patients. The main goal was to analyze the demographic differences within the group of stroke patients, as well as functional independence in relation to the level of cognitive impairment.

METHODS

Participants

The study was conducted at the Department of Extended Care and Treatment with Rehabilitation of the Hospital in Ćuprija, Serbia, and at the Gerontology Center in Jagodina, Serbia, during a period from August 1, 2012, to March 1, 2013. The Ethics Committee of the General Hospital in Ćuprija gave the approval for the research, which was conducted in accordance with the ethical standards of the Helsinki Declaration. All subjects were informed about the objectives of the study and gave their consent.

The study included 100 respondents, 50 stroke patients and 50 age- and gender-matched persons without neurological damage (Table 1). Criteria for selection of patients were the following: first hemispheric stroke in the subacute phase, of both genders, age 50–80 years, presence of unilateral damage to motor function of upper and lower extremities, with the balance of hemiparesis as a result of cerebrovascular disease most often caused by thrombosis. The studies have excluded patients with the following: a history of previous stroke, multifocal stroke, and severe speech disorder (aphasia) that hinders testing. All patients were in rehabilitation. The tested variables were as follows: cognitive status as an independent variable, and demographic characteristics and functional training as the dependent variable. The analyzed demographic characteristics were gender, age, education, marital status. Monitored risk factors were hypertension and diabetes mellitus.

Table 1. Characteristics of patients and controls included in the study

Characteristics		Number of patients (%)	
		Patient group	Control group
Gender	Male	26 (52.0)	27 (54.0)
	Female	24 (48.0)	23 (46.0)
Age (years)	Mean (SD)	69.99 (7.71)	67.18 (9.27)
Education	Low (less than 8 years)	6 (12.0)	10 (20.0)
	Basic (8 years)	21 (42.0)	18 (36.0)
	High school (12 years)	20 (40.0)	13 (26.0)
	College / Higher (16 and more years)	3 (6.0)	9 (18.0)
Marital status	Married	32 (64.0)	13 (26.0)
	Widow/er	15 (30.0)	18 (36.0)
	Divorced	3 (6.0)	11 (22.0)
	Unmarried/single	0 (0.0)	8 (16.0)
Risk factors	Arterial hypertension	25 (50.0)*	11 (22.0)
	Type II diabetes	18 (36.0)**	3 (6.0)

* $p<0.05$; ** $p<0.001$

Assessment of functional independence – Functional Independence Measure (FIM)

The main purpose of the Functional Independence Measure (FIM) test is to assess the functional independence of patients with neurological impairments [7]. The FIM test provides an adequate, prompt, and valid general assessment of functional abilities of patients with neurological impairments. The FIM test covers the following six areas, with eighteen tasks: self-care; sphincter control; mobility; movement; communication; and socialization. Each of the tasks is precisely defined and contains a number of actions. The scores are given in the seven-level scale and graded according to the degree of independence: complete aid (respondent = 0% – 1 point); maximum assistance (respondents = 25% – 2 points); medium assistance (subject = 50% – 3 points); minimal assistance (respondents = 75% – 4 points); monitoring (subject only requires control – 5 points); partial independence (using adjuvant – 6 points); complete independence (temporal and spatial complete safety – 7 points). The total maximum score is 126 and is obtained by adding points of each task and expressed in row number.

Cognition assessment – Mini-Mental State Examination (MMSE)

Mini-Mental State Examination (MMSE) is a screening test for assessing the cognitive state of patients, simple to use, sensitive and valid [8]. Since the inclusion into clinical practice it has been proven as a reliable and suitable for the initial assessment of mental status follow up. Mini-Mental State Examination examines the temporal and spatial orientation, memory skills (immediate and delayed), attention, oral and written language, and constructional abilities in two dimensions. The implementation itself lasts for 10–30 minutes. The test has eleven tasks where each one scores a number of points (the total score is 30 points). The scale ranges 0–30, so that there are levels of severe cognitive impairment (from 0 to 17 points); medium im-

pairment (from 18 to 23 points) and without impairment (from 24 to 30 points). It must be taken into account that the test provides just a rough evaluation of cognitive impairment. The level of education of examinees must also be taken into account. We used the following specific standards that indicate cognitive impairment depending on the level of education: for persons with only primary school completed, 21 is considered to be the cut-off score; for those with high secondary education, less than 23; and for persons with higher education, score lower than 24.

Statistical analysis

Comparison of tests' results in stroke patients and in controls was done by arithmetic mean, standard deviation, median, χ^2 Mann–Whitney test, for two independent samples and canonical-correlation analysis.

RESULTS

The results of the MMSE test show that among stroke patients, 11 (22%) of them had no cognitive impairment, 36 (72%) had mild cognitive impairment, and three (6%) a severe cognitive impairment. Among subjects in the control group no cognitive impairment according to the MMSE test was recorded. The difference between the patients and the control group according to cognitive impairments was statistically significant (Table 2, p<0.001).

The results of functional independence test indicated that stroke patients had, on average, statistically significant lower scores on all subscales of the FIM test, compared to the control group (Table 3, p<0.001).

Table 2. The results of the MMSE test indicating the frequency and the degree of cognitive impairment in the patient group and the control group

Score	Cognitive impairment	Number of patients (%)	
		Patients group	Control group
24–30	None	11 (22.0)***	50 (100.0)
18–23	Mild	36 (72.0)***	0 (0.0)
0–17	Severe	3 (6.0)***	0 (0.0)
Total		50 (100.0)	50 (100.0)

*** p<0.001 (χ^2 test)

In the group of patients without cognitive impairment, percentage of male patients was higher than in the group with mild cognitive impairment, while in the group with severe cognitive impairment all patients were female. Patients with no cognitive impairment were significantly younger than patients with mild to severe cognitive impairment. Patients with mild to severe cognitive impairment did not differ significantly in terms of age. Patient groups, depending on the cognitive impairment, differ statistically with respect to the level of education. The highest average ranking of education is among the patients without cognitive impairment, then in those with mild impairment, while those with severe cognitive impairment had on average the lowest level of education (Table 4, p<0.001).

The results also suggest statistically significant difference in laterality of hemiparesis according to the level of cognitive impairment. In patients without cognitive impairment, left-sided hemiparesis prevailed, while in patients with severe cognitive impairment, right-sided hemiparesis was more frequent. Both types of hemiparesis were equally spread in patients with mild cognitive impairment. There was statistically significant difference of the presence of risk factors, artery hypertension and of diabetes type II in the group of patients in relation to the level of cognitive impairment (Table 4, p<0.001).

Table 4. Structure of the patient group depending on the cognitive impairment in terms of demographic characteristics and risk factors

Mark		Cognitive damage		
		No damage	Mild	Severe
Gender	Male	10	16*	0
	Female	1	20**	3
Age (years)	Mean (SD)	63.45 (8.04)	71.19 (6.67)	77.67 (2.08)
	Range	54–75	55–80	76–80
Education	Low	0	4	2**
	Basic	1	19**	1
	Secondary school	7	13*	0
	Higher	3**	0	0
Hemiparesis	Lat. dex.	1	19**	2
	Lat. sin.	10	17*	1
Risk factors	Arterial hypertension	5	18**	2
	Diabetes type II	4	14**	0

* p<0.05; ** p<0.001

Table 3. The results for the two groups on the subscale of the FIM test

Domain	Patients group			Control group		
	Mean (SD)	Median	Middle range	Mean (±SD)	Median	Middle range
Self-care	29.00 (10.45)	30	30.75	41.90 (0.58)	42	70.25**
Sphincter control	10.40 (3.21)	12	32.00	14.00 (0.00)	14	69.00**
Mobility	14.06 (5.24)	15	31.02	20.74 (0.99)	21	69.98**
Locomotion	8.94 (3.40)	9	31.54	13.44 (0.58)	13	69.48**
Communication	10.42 (1.99)	11	37.08	12.32 (1.65)	13	63.92**
Socialization	15.02 (3.04)	15	37.24	17.88 (2.59)	19	63.76**
Motor domain	62.40 (21.23)	63.50	31.47	90.08(1.63)	90.00	69.53**
Cognitive domain	25.44(4.68)	25.00	36.47	30.20 (4.16)	32.00	64.53**
Total			29.85			71.15**

** p<0.001 (Mann–Whitney U-test)

Table 5. Differences of all areas investigated by the FIM test between groups of stroke patients with and without cognitive impairments

Area	Middle range	
	Patients with no cognitive impairment	Patients with cognitive impairment
Self-care	33.64*	23.21
Sphincter control	29.68*	24.32
Locomotion	33.00*	23.38
Communication	38.36*	21.87
Socialization	38.73*	21.77

* p<0.05 (Mann–Whitney U-test)

The stroke patients showed a statistically significant difference in scores on all subscales of the FIM test in relation to the level of cognitive impairment. Patients without cognitive impairment achieved significantly higher scores on all subscales, especially on subscales of communication and socialization, compared to patients with mild and severe impairment (Table 5, p<0.05).

DISCUSSION

This study suggests the correlation between demographic characteristics, cognitive abilities, and functional independence of stroke patients and persons without neurological damage. A large part of the study is dealing with importance of demographic characteristics, but also with the impact and the role of cognitive function in achieving functional independence of stroke patients. When classifying patients into categories according to the norms of the test, the existence of special rules depending on the level of education where taken into account [9]. Considering cognitive function, the premorbid capacity and level of education were taken into account because more than half (54–56%) of the respondents were only with primary education. Regarding general characteristics of the group of stroke patients in relation to the presence of cognitive impairment we found mild cognitive impairment in both genders, while in most men and one woman there was no cognitive impairment; severe cognitive impairment was present only in women. Sex differences in the distribution of cognitive dysfunction after stroke might be attributable to differences in stroke mechanisms between men and women. Women tend to have more cardioembolic strokes, whereas men have more lacunar strokes, which might explain the higher frequency of cognitive dysfunction in women than in men. Additionally, women tend to experience strokes at an older age than men, so they might have more prestroke cognitive dysfunction that is not fully accounted for in age-adjusted analyses [10].

The age of patients compared to the presence of cognitive impairment indicates the average age of the patients without cognitive impairment after 63.45 (AM) years of life, with mild cognitive impairment at 71.19 (AM) years of life, with severe cognitive impairment at 77.67 (AM) years of life. Our findings are consistent with studies showing that in the elderly, often accompanying or subsequently, a decline in cognitive abilities (e.g. dementia) may occur. The research study, which analyzed cognitive functioning of patients after stroke within age groups, showed a statistically significant correlation between reduced cognitive functioning and age category of 70–79 years. The association explains the presence of comorbidities that lower cognitive achievement [11]. We presumed that the premorbid condition of the respondents, as well as the achieved educational level, certainly have an impact on cognitive function. The presence of severe cognitive impairment is most common in those with the lowest educational level, whereas in patients with secondary and higher education the absence of cognitive impairment is found. Our findings are in accordance with the fact that in addition to premorbid characteristics, the education of the respondents, as well as professional commitment, play an important role in the quality of cognitive function. For example, in patients with higher levels of education, especially if their profession was related to practicing mathematical skills, degree of preservation of cognitive function will be higher, and more of these skills will certainly remain preserved, despite the damage [12]. The results of the study, which analyzed the relationship between cognitive functioning and the level of education, and educational categories in patients after stroke, showed a statistically significant association between cognitive status and education at two educational categories of <4 and >12, in other educational categories significance is borderline. This result confirms the positive impact of education, particularly for damage that may cause cognitive decline [11].

Examining the correlation between marital status, stroke and cognitive impairment, we found different results. Results of this study show that 64% of patients after stroke were married, while 36% lived alone. Results of another longitudinal study on a large number of subjects for five years show that the cognitive impairment after a stroke is more common in people who live alone. A statistically significant association between independent living and cognitive impairment after a stroke is present in men. The motivational factor for recovery is present in women [13].

In the area of lateralization of hemiparesis, in the presence of mild cognitive impairment, in terms of percentages, right-sided hemiparesis is more present (ranging from mild to heavy cognitive impairment).

In a study that analyzed stroke patients divided into two groups, in half of the patients the lesion was localized in the cortex of the right or left hemisphere, and upon completion of rehabilitation, the patients with stroke in the left or the right hemisphere cortex had no significant difference in the mean values of tests which assessed motor and functional recovery. The result of this prospective study indicate no significant difference between motor and functional recovery in patients with stroke in the right, subdominant hemisphere, and patients with stroke localized in dominant, left hemisphere of the brain. However, after further selection of patients, a significantly better recovery of patients with stroke in the cortex of the dominant left hemisphere compared to the patients with a stroke in the right, subdominant hemisphere of the cortex was reached.

More specifically, patients with lesions in the cortex of the dominant left hemisphere were observed as highly significantly better in motor and functional recovery, had a greater degree of independence in activities of daily living, and were significantly better at mobility. These results are consistent with the results of many clinical studies that indicate worse functional outcome in patients with stroke localized in subdominant right hemisphere [14].

The results of our study are not fully compatible with the above mentioned, but they are consistent with the cognitive competence of patients. The presence of severe cognitive impairment was more common in the right hemiparesis, as a consequence of difficulties in speech perception, thinking, memory and praxis [6]. Left hemipareses were more frequent in our patients with mild cognitive impairment. The patients with right-sided post-stroke hemiparesis showed lower efficiency in planning, organizing and independently carrying out planned activities. According to the findings of our research, in which a given function is positively correlated with functional recovery, the results are in favor of slower functional recovery of patients with right-sided hemiparesis. A study by Tomašević et al. [15], which included 30 patients with hemiparesis, whose functional recovery was evaluated by Barthel index – a test where the same, dextral patients with hemiparesis showed significantly better recovery of function of self-care of patients with right-sided hemiparesis – showed similar results. In addition to the correlation with cognitive functions, the dominant handedness in general population was 85% of dexter type, and its share in the conquest of functional independence is not negligible. Patients with damage of the right hemisphere may have symptoms of unilateral neglect, problems with short-term memory and can be impulsive. Patients with damage to the left hemisphere may have problems with speech and understanding speech, and difficulties with memory and significant latency between receiving verbal information and execution of motor activity. Based on this, a number of studies find that the damage to the left hemisphere brings serious consequences and significant cognitive decline [16]. The most frequently mentioned reason for this is the significant role of speech in cognitive functioning. The results of clinical studies done on animals confirmed these views, showing that there is no difference in disturbances between the right and left hemisphere, after the damage. The results of the same clinical studies have shown that the presence of lesions in the dominant hemisphere did not disrupt motor recovery. Therefore, in these studies' view, the relationship between the lateralization of function and the degree of recovery should be considered, especially when planning rehabilitation [17]. The studies of interaction between cognitive and motor defects suggest that people after stroke may experience a number of limited activities [12]. The typical range of these restrictions applies to mobility, communication and self-care. These effects negatively affect movement, but also social and professional aspects of training. Few studies deal with the impact of comorbidity on the outcome of medical rehabilitation and functional recovery, but most of them suggest that 50% of stroke patients had at least one comorbidity. Most studies dealing with the examination of motor recovery of stroke patients have been trying to find out what actually influences motor recovery, both in terms of duration and efficiency of recovery, and in terms of achieving the appropriate level of functional independence [18]. Special attention in this research was dedicated to the estimation of the multivariate relationship of demographic factors, cognitive competence and functional independence of stroke patients. Motor and cognitive impairments in stroke patients may affect the functional training to variable degree. Functional ability is essentially a measure of the achieved level of skills in motor control. In our group of stroke patients, low efficiency of functional independence manifested itself through difficult performance of a given activity without stimulation and instruction, reduced impulse control, and reduced insight into their own mental and motor skills.

Assuming that the reduced efficiency of the tested cognitive traits may be an indicator of damage, it may also be an indicator of recovery of functional capacity in stroke patients. Cognitive stimulation (according to estimates) could be an integral part of medical rehabilitation [11].

Limitations of the study

Limitations of the study are reflected in the limited number of respondents, although some of the previous studies were also conducted on a similar number of patients. In addition, only respondents with hemiparesis who completed the early rehabilitation were selected, and were involved in the further process of rehabilitation. The functional recovery in relation to the level of cognitive impairment and not in relation to the localization of the lesion was evaluated. For these reasons, our results would not be generalized to the stroke patients. However, this study can serve as a good basis for a new, more comprehensive research.

CONCLUSION

The results indicate the correlation between demographic characteristics, cognitive functions and functional independence in stroke patients. This correlation is very useful for the prevention of risk factors (for smoking, obesity, diabetes mellitus, arterial hypertension, physical inactivity and stress), as well as for prevention the potential cognitive impairments. In this way the consequences of the impairment could be diminished and contribute to a faster recovery and improve the quality of life. Knowing the demographic characteristics, cognitive competence and functional status may be of importance both to the course, and the outcome of rehabilitation in patients after stroke. There is a positive correlation between the efficiency of executive functions and achieved functional independence in stroke patients. In anticipation of the possibilities and limitations of these patients, it is very important the existence of intra group differences of quality functional

capability of patients in relation to the level of cognitive impairment. Application of cognitive rehabilitation within the medical rehabilitation, contributed to good functional recovery and a better quality of life.

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Повезаност демографских одлика, когнитивног функционисања и функционалне независности код болесника после можданог удара

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КРАТАК САДРЖАЈ

Увод Претпоставља се да постоји условљеност постигнутог нивоа функционалне независности са степеном очуваности когнитивних функција код болесника после можданог удара. Демографске одлике могу бити значајне у праћењу постигнутог нивоа функционалне независности.

Циљ рада Циљ истраживања је био да се испита однос демографских одлика и функционалне независности у односу на ниво когнитивног оштећења код болесника после можданог удара.

Методе рада Истраживањем је обухваћено 50 болесника после можданог удара у процесу рехабилитације и 50 испитаника одабраних методом случајног узорка, усклађених према демографским одликама, који у својој анамнези нису имали неуролошка обољења. За процену функционалне независности коришћен је ФИМ тест (енгл. *Functional Independence Measure*), за процену когнитивног стања коришћена је ММСЕ скала (енгл. *Mini Mental State Examination*), док су за статистичку обраду података коришћени Ман–Витнијев (*Mann–Whitney*) тест, непараметријски тест за два независна узорка, мере каноничке корелације и χ^2-тест.

Резултати Постоји статистички значајна разлика између група у погледу фактора ризика, хипертензије и дијабетес мелитуса тип *II* ($p<0,001$). Статистички значајна унутаргрупна разлика забележена је и у односу на когнитивно оштећење код свих испитаних демографских одлика ($p<0,001$). Унутаргрупна разлика у односу на когнитивно оштећење постојала је на свим супскалама ФИМ теста ($p<0,05$). Унутаргрупна разлика у односу на латерализованост хемипареза показала је да је благо когнитивно оштећење чешће код левостраних, док је теже оштећење чешће код десностраних хемипареза ($p<0,05$). Теже когнитивно оштећење је било чешће код жена, код особа старије животне доби и испитаника нижег образовања ($p<0,05$).

Закључак Превенцијом фактора ризика и могућих когнитивних оштећења последице можданог удара могу се умањити; опоравак ће бити успешнији, а квалитет живота болесника бољи.

Кључне речи: мождани удар; демографске карактеристике; когнитивне функције; функционална независност

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