Factors contributing to cognitive deficits in elderly residents of rural areas

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Abstract. – OBJECTIVE: Due to the growing aging of societies an increasingly large group of people suffers from age-related impairment of cognitive functions and thus reducing the quality of life of the elderly. The purpose of the study was to evaluate the efficiency of cognitive functions in a group of aging residents of rural areas.

PATIENTS AND METHODS: The inhabitants of a rural area were recruited and assessed: cognitive function as well as intellectual and physical activity, number of years of education, presence of diseases, using stimulants, diet, sources of living, marital status and family situation Subjects were divided into two groups: persons above 65 and older, constituting the studied group and persons between 40 and 64 years of age, constituting the control group. Both groups did not significantly differ in terms of sex or years of education.

RESULTS: Statistically significant differences ($p < 0.05$) were found in the results of the tests concerning such functions as the sight recognition memory and spatial recognition memory, spatial operating memory both on the strategy level and on the level of committed errors. An analysis of the results obtained in the group of elderly people did not indicate any major differences between men and women as regards the analyzed cognitive functions, no statistically significant differences were found in cognitive testing depending on the number of years of education. The studied persons included in the physically active group scored better in the visual memory and learning tests.

CONCLUSIONS: The conducted studies elucidated the dependence of the level of cognitive functions on age, a positive impact of physical activity on some cognitive functions, however we could not find differences between the efficiency of those functions and education, sex, presence of somatic diseases and activity of persons aged > 65.

Key Words:
Cognitive ageing, Rural area, Comorbidity, Lifestyle.

Introduction

According to demographic data, populations of developed countries grow old. Population aging refers to an increase of the percentage of people above 65 years old in a population. In 2000, in 25 countries of the European Union, elderly people accounted for 15.7% of the population structure. In 2050, that percentage is expected to increase to 30%[1]. The process of aging shows a different dynamics in different persons, being contingent upon external factors (such as the social and economic status or the environment), internal factors (such as sex or health condition) and it is person-dependent. In literature, there are many hypotheses regarding the aging process which try to explain its biochemical background. Each of them may explain some elements of aging however none of them has prevailed in explaining the whole process[2]. Changes occurring during aging can be observed in the whole organism. With age, the structure and functions of individual organs and systems become altered (aging kidneys, aging alimentary system, immunological system, etc). This also applies to the brain and the entire nervous system. Due to the growing aging of societies and a higher average life expectancy, an increasingly large group of people suffers from age-related impairment of cognitive functions. Deterioration of cognitive functions

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results in functional impairment, thus, reducing the quality of life of the elderly. Which is why in the studies of the elderly a great attention is paid to the efficiency of cognitive functions, ie intellectual efficiency, memory, perception, attention, and factors relating to their deterioration, being the prospective targets of therapeutic and prophylactic activities aimed at delaying, limiting and slowing down the cognitive deficits in older age.

The purpose of the study was to evaluate the efficiency of cognitive functions in a group of aging residents of rural areas on the basis of an analysis of their dependence on the declared intellectual activity, presence of somatic diseases and physical activity.

Participants and Methods

The participants, inhabitants of a rural area in the western part of Poland, were recruited and assessed in their local General Practice. We recruited inhabitants aged over 40, who gave their written informed consent after being provided with a complete description of the study. The exclusion criteria in this study were as follows: dementia symptoms, depressive symptoms, substance abuse, epilepsy and severe somatic illnesses. Seventy persons subjected to tests were divided into two groups: persons above 65 and older, constituting the studied group (n=35), and persons between 40 and 64 years of age, constituting the control group (n=35). Both groups did not significantly differ in terms of sex or years of education. Among the studied group, single persons accounted for 37% (n=13), while in the younger group, for 9% (n=3). In the studied group, two persons were professionally active and 33 persons did not work. In the control group, 19 persons (54%) had jobs, while 16 persons (46%) did not work. In the first stage, we excluded the presence of dementia symptoms using the Mini Mental State Examination[3] and the presence of depressive symptoms using the Beck Depression Inventory[4]. The participants included in the study completed an interviewer questionnaire with the help of the researcher and underwent neuropsychological assessment with selected tests from the Cambridge Automated Neuropsychological Test Battery (Cambridge, UK)[5,6]. The test took approximately two hours.

Paired Associates Learning (PAL) test assesses visual memory and new learning. Pattern Recognition Memory (PRM) is a test of visual pattern recognition memory. Spatial Recognition Memory (SRM) is a test of visual spatial recognition. Stockings of Cambridge Planning Task (SOC) is a visual spatial planning test based on the Tower of London task. Spatial Span (SSP) is a test assessing working memory capacity. Spatial Working Memory (SWM) is a test of the subject's ability to retain spatial information and to manipulate remembered items in the working memory, which measures the working memory for spatial stimuli and requires the subject to use mnemonic information to work towards a goal. Screenshots and detailed overviews of these tests are available online[6], they have been described in our previous paper[7]. The interviewer questionnaire is a tool developed for the purpose of the study. It consists of questions concerning the intellectual and physical activity, education, number of years of education, presence of diseases, using stimulants, diet, sources of living, marital status and family situation. When evaluating the physical activity, it was verified how many times a week and what kind of activity had been undertaken by the subjects. The analysis only concerned the frequency of the undertaken activities. The studied persons were divided into two groups: active and inactive. The cut-off point was arbitrarily set at undertaking physical activity at least three times a week. Intellectual activity was assessed by analysing the frequency of declaring that a certain activity occurred. The subjects were divided into two groups: active and inactive and the arbitrarily determined minimum activity was 7 times a week. The presence or absence of a given disease was used to assign the subjects to the individual groups. Healthy persons were those who did not report any of the suggested illnesses. A group of persons with multiple morbidities consisted of the persons who reported three or more illnesses. The study was approved by the Ethics Committee of the Poznan University of Medical Sciences.

Statistical Analysis

Statistical analysis were carried out with Statistica (Tulsa, USA) version 10.0 for Windows (Polish). As most of the investigated variables were not normally distributed, non-parametric tests were employed – Mann-Whitney test (two-group comparisons) and Spearman's correlation coefficient. All results were expressed as the mean and standard deviation (SD). Statistical significance was set at $p < 0.05$ for all analyses.

Table I. Comparison of the results of selected cognitive tests comparing two groups of younger and older subjects. Values expressed as means ± standard deviation (SD)

Test	Aged >65 yrs	Aged 40-65 yrs	*p*
PAL Total errors (no)	60±62	40±41	0.144
PAL Total errors (6 shapes) (no)	18±18	13±14	0.293
PRM %correct	69±14	81±9	0.000
SRM %correct	67±12	72±12	0.053
SOC Mean initial thinking (5 moves)	7212±7229	7035±5872	0.673
SOC Mean subsequent thinking time (5 moves)	6601±8737	6397±10411	0.687
SOC Problem solved in minimum moves	6±2	7±2	0.092
SSP Span length	11±23	7±16	0.101
SWM Between search errors	61±15	53±19	0.026
SWM Strategy	39±3	38±3	0.014

Results

The participants were divided into two groups according to age. These two groups were compared in terms of cognitive functions. The differences in the efficiency of the cognitive functions between the studied groups are shown in Table I. Statistically significant differences ($p<0.05$) were found in the results of the tests concerning such functions as the sight recognition memory and spatial recognition memory (SRM, PRM), spatial operating memory both on the strategy level (SWM strategy) and on the level of committed errors (SWM between search error). Upon evaluation of each of the aforementioned functions, the studied group obtained significantly worse results. An analysis of the results obtained in the group of elderly people did not indicate any major differences between men and women as regards the analysed cognitive functions. In the studied group, no statistically significant differences were found in cognitive testing depending on the number of years of education (Table II). The intellectual activity of subjects aged over 65 more frequently consisted in reading books or solving crosswords than playing intellectual games (this was done by only two persons). Among the elder people, 10 intellectually inactive persons were selected. In the questionnaire, the subjects declared whether and how frequently they did exercises,

Table II. Comparison of the results of selected cognitive tests in >65 yrs old subjects: comparing intellectually active and not (I vs NI), lower and better educated (LE vs BE) and physically active and not active (Ph vs NPh). Values expressed as means ± standard deviation (SD).

Test	I (n=25)	NI (n=10)	LE (n=27)	BE (n=8)	Ph (n=23)	NPh (n=12)
PAL Total errors (no)[a]	61.4±65.3	56±52	64±66	47±47	31,9±38,0	76.2±67.3
PAL Total errors (6 shapes) (no)[2]	17.8±17.9	18±20	19±18	14±16	10.2±14.2	22.1±19.0
PRM %correct	71.3±14.0	64±14	68±15	74±10	67.4±14.4	70.1±14.2
SRM %correct	67.2±11.1	66±13	68±11	64±12	67.5±12.0	66.3±11.5
SOC Mean initial thinking[b] (5 moves)	8420.7±7586.2	3853±5065	6485±6249	9574±9926	5916.4±5466.6	7918.0±8061.5
SOC Mean subsequent thinking time (5 moves)	5056.4±5208.9	10890±14330	6714±9460	6234±6331	6639.2±5641.3	6579.6±10163
SOC Problem solved in minimum moves	6.6±2.3	6±3	6±3	7±2	6.8±1.3	6.1±2.9
SSP Span length	13.4±26.4	4±1	11±24	10±`18	8.3±14.7	11.9±26.0
SWM Between search errors	61.7±13.1	61±20	59±15	68±14	58.9±18.4	62.7±13.1
SWM Strategy	39.8±2.6	39±4	40±3	39±3	40.2±3.8	39,1±2,4

[a]difference between Ph and NPh groups, $p<0.05$

[b]difference between Ph and NPh groups, and between N and NI, $p = 0.06$

went for a walk, rode a bicycle. According to the adopted division criterion, 12 subjects were considered physically inactive. The differences in completing the tests resulting from the division into the groups, distinguished according to the presence/ absence of intellectual activity and physical activity, are also presented in Table II. The studied persons included in the physically active group scored better in the PAL test (visual memory and learning): a statistically significant difference was discovered as regards the number of errors made and a trend was observed (p=0.06) – based on another test (PAL no of total errors for 6 shape) – indicating the efficiency of spatial memory. No relationship between the declared intellectual activity and the efficiency of cognitive functions was found in the studied group. The subjects were also asked whether and how many diseases they suffered from. Among the elderly, only one person declared to be healthy. Other persons reported at least one of the illnesses listed in the questionnaire. The presence of multiple morbidities did not show any relationship with the studied cognitive functions. We assessed the relationship between cognitive functioning and the following diseases: hypertension, type 2 diabetes, heart diseases. Elderly persons with hypertension achieved statistically worse results in the test of the ability to store information in operating memory (SSP), they showed a trend towards worse results in the test of the visual pattern recognition memory (PRM, p=0.092) and SOC (p=0.086), which assesses visual spatial planning. No significant differences in the efficiency of cognitive functions depending on the occurrence or not of heart diseases and type 2 diabetes were found.

Discussion

Operating memory has a decisive impact on the progress and integration of such processes as planning, conceptual thinking, problem-solving, understanding the situation or learning. It provides the basis for the relationship between man and its environment at the same time being responsible for complex social behaviours. Cognitive deficits in the functioning of operating memory may lead to impairment of other processes and consequently to disadaptive behaviours and impairment of social functioning[8,9].

According to some authors aging does not necessarily result in cognitive performance decrements[10]. However, results of numerous earlier studies indicate that the aging process has, among others, a negative impact on the nervous system. The nervous system is responsible for the individual cognitive functions, including the operating memory, perception processes, attentiveness or thinking. The presented results confirm this hypothesis and prove that with age the visual recognition memory, spatial recognition memory, perceptiveness and ability to quickly change to a new activity by residents of rural areas deteriorate.

The growing interest in the aging process connected with the growing proportion of elderly people has a very practical aspect to it, namely searching for factors contributing to aging which may be influenced in order to delay, slow down and/or reduce the negative consequences of the aging process. Factors contributing to aging include the so-called lifestyle factors and biological factors (for example, somatic diseases like diabetes mellitus[11], ageing of vascular[12] system or thyroid gland[13]). Lifestyle factors analysed in the course of our study included physical and intellectual activity. Studies on animal models of physical activity and exercises training demonstrated their beneficial effects on cognitive functions. Numerous studies and meta-analyses[14-16] in populations of elderly and middle aged people have indicated the physical activity as an important factor improving cognitive functioning. The mechanism of the influence of the physical activity on attention and executive functions has not been fully elucidated. The increased oxygen consumption and angiogenesis, and the neurotransmitters level and/or the regulation of neurotrophins, such as brain-derived neurotrophic agent (BDNF), insulin-like growth factor (IGF-1) and basic fibroblast growth factor (bFGF), have been proposed[17].

Numerous studies confirm that the risk of occurrence of dementia disorders and general deterioration of cognitive functions is lower in persons undertaking physical activity, both in clinical populations and in healthy subjects[18-20]. Studies carried out by Larson et al[18] show that undertaking movement exercises significantly reduces the frequency of occurrence of dementia. However, there are also studies which do not confirm the hypothesis of a favourable impact of physical activity on the efficiency of cognitive functions[21,23]. Our research showed a significant difference between physically active and inactive persons, but only in the test analysing the visual and short memory, which may limit the interpretation of the results. Yet, research conducted earlier has also shown that the individuals whose self-reported activity or actigraphy-measured activity was higher had better results in the cognitive test compared to people who had a lower level of physical activity. Angevaren et al[21] observed better performance on cognitive tasks assessing speed, memory, mental flexibility as well as higher global cognition scores in individuals with a higher self-reported physical activity intensity which is consistent with the results of the study by Brown et al[25] who used actigraphy.

It is generally believed that intellectual activity, also in the older age groups, has a positive impact on cognitive functioning and it reduces the risk of Alzheimer disease. This has been confirmed in a longitudinal observation study where not reading books and lower education has in fact been observed in patients with disorders of cognitive functions and subsequent dementia[26]. However, in the studied group we did not discover statistically significant differences in the results of cognitive tests depending on the number of years of education or any dependence between the declared intellectual activity and the efficiency of cognitive functions. In a study comparing memory efficiency between groups of young, middle-aged and elderly (>65) people with a different number of years of education it has been found that working memory is resistant to age-related decline in the oldest, most educated group[27]. Our studies on the efficiency of cognitive functions depending on somatic diseases did not yield unambiguous results. Differences between patients with multiple morbidities and without it proved to be statistically insignificant. Taking the particular diseases into consideration, only the results of the test on the ability to store information in the operating memory in patients with hypertension appeared to be significant. We noticed in our group that elderly persons with hypertension obtained statistically significantly worse results of the test concerning the ability to store information in the operating memory (SSP); also, a negative trend was observed in the results of the visual pattern recognition memory and visual spatial planning tests; similarly worse results upon evaluation of operating memory of patients with hypertension have also been obtained in other studies[28,29]. According to Anson and Paran's review[30] mild hypertension in the old age may increase cognitive performance and positive, adverse, or no relationships between cognitive performance and blood pressure have been reported. It must not be forgotten that hypertension is a risk factor for many diseases such as diabetes, infarct, stroke or vascular dementia.

A review of the literature regarding the influence of cerebrovascular diseases on the occurrence of cognitive disorders carried out by Panza et al[31] indicates that the occurrence of cerebrovascular diseases may stimulate the occurrence of mild cognitive disorders. Reitz et al[32] compared the data from the studies on the relationship between hypertension and cognitive disorders (17 years of studies). On its basis, they have found a relationship between hypertension and mild cognitive disorders regarding executory and/or visual/ spatial memory functions. The authors emphasize that hypertension may contribute to the damage of the blood-brain barrier as well as to the development of ischemic focuses and hyperintensive changes in the white matter of the brain. And such changes may lead to the occurrence of cognitive disorders[33]. The results of the studies carried out by Solfrizzi et al[34] indicate that factors contributing to the development of cerebrovascular diseases also contribute to the progress from mild cognitive disorders to dementia. The symptoms of cognitive disorders occurring as a result of ischemic strokes mainly depend on the location of ischemia. In case small vessel diseases, there are usually numerous ischemic focuses, which impacts the activity of the cortex. Besides, patients with cerebrovascular diseases were characterized by greater impairments of episodic memory and visual and spatial abilities[33]. Diabetic patients more frequently show cognitive functioning disorders in comparison with persons of the same age without not suffering from the disease[35]. Also among persons with an incorrect glycemic curve (with no diabetes mellitus) an increased frequency of occurrence of cognitive functions impairment has been observed[36]. Other authors claim that diabetes increases the risk of vasogenic dementia and the resultant Alzheimer disease three fold[37,38]. In patients with type 2 diabetes, disorders of spatial memory, efficiency of attention processes, verbal fluency, association functions and psychomotoric skills[37,39-41].

Conclusions

The conducted studies elucidated the dependence of the level of cognitive functions on age, a positive impact of physical activity on some cognitive functions, however we could not find differences between the efficiency of those functions and education, sex, presence of somatic diseases and activity of patients aged >65. We are aware of the limitations of the study – the most important include the self-reported activity data and the failure to objectively assess the duration, intensity, and frequency of the physical and mental activities. On the other hand, to our knowledge it is the first research concerning the factors that influence cognitive functions in Polish older inhabitants of a rural area, employing such a wide and objective cognitive tests battery. Changing life-style factors is safe and non-expensive intervention so that further studies are needed to elucidate whether lifestyle interventions can improve cognitive functioning and reduce the likelihood of the development of dementia processes. According to some authors, deterioration of cognitive functions in elderly people starts as early as in the age of 20 or 30 years; therefore, it is that period of life when intervention is required if factors relating to cognitive aging are identified.

Acknowledgements

This project was supported by funding from the National Science Centre, grant No NN 402 407 539 Kraków, Poland and from DEDIPAC KH (DZP/2/JPI HDL DEDIPAC KH/2014).

Conflict of Interest

The Authors declare that they have no conflict of interests.

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