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Analysis of functional efficiency and risk of falls in patients with different types of dementia – preliminary observations

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Abstract

Introduction and Objective. Dementia is a multifactorial neurological disease that affects 50 million people worldwide. It is a disorder that impairs cognitive functions, functional efficiency, balance and gait. It contributes to an increased risk of falls, reduces independence in everyday activities and deepens disability. The aim of the study was to investigate the correlation between dementia and independence related to functional efficiency and risk of falls in the elderly.

Materials and method. The eligibility criterion for participation in the study was age over 60, the presence of cognitive disorders, including dementia, and the ability to move with the use of orthopaedic equipment or independently. A total of 51 people participated in the study, including 13 people who underwent rehabilitation procedures. Each subject was evaluated once for cognitive abilities using two types of tests: the ADL scale, MMSE (Mini-Mental state Examination) and three physical fitness tests: SPPB (Short Physical Performance Battery), TUG (Timed Up & Go) and FRT (Functional Reach Test).

Results. The average score of the MMSE test was 13.29±6.23 points, the average of the ADL scale was 4.20±1.23 points. A positive correlation was found between the level of dementia and the independence of the examined person, as well as a positive relationship between the MMSE test and the result of the Functional Reach Test, and the relationship between the ADL scale and the SPPB and 'Get-Up and Go' tests.

Conclusions. It has been demonstrated *inter alia* that static balance and functional efficiency depends on the patient's independence in everyday activities, and the level of dementia may suggest the patient's dynamic balance. In addition, the need for a broader analysis of targeted studies was recognized to confirm the conclusions obtained.

Key words

dementia, rehabilitation, risk of falls, mobility impairment

INTRODUCTION

Changes taking place in both the Polish and global populations indicate an increase in the group of people over 60 years of age. According to the forecast, the number of Polish people aged 60 and more in 2050 will amount to 13.7 million, which is 39.8% more than in 2020 [1]. According to global forecasts, by the end of this century there may already be over 2 billion elderly people, which will account for 28% of the world's population [2]. Aging is a process associated with a decrease in both cognitive abilities and functional efficiency of humans.

Dementia diseases constitute an incremental problem for modern medicine in terms of both diagnostic and therapeutic process, as well as in terms of long-term care. In the International Statistical Classification of Diseases and Related Health Problems ICD-10, dementia is characterized as a set of symptoms, resulting from a chronic, progressive brain disease manifested by deficits in higher cortical functions, such as thinking, memory, understanding, orientation, or learning capacity [3]. The problem of dementia concerns about 1% of the general population in the world. As the population ages, the prevalence of dementia increases. It is estimated that around 7.7 million new cases are diagnosed annually worldwide; moreover, 6% of people aged 60 and over show signs of dementia, and about 25% of those aged 85. According to statistics, Alzheimer's disease is the most common cause of dementia syndromes (more than 50% of all cases). Other determinants include Parkinson's disease, Pick's disease, Lewy bodies dementia (20% of cases), and cerebrovascular diseases (15% of cases) [4].

The initial stage of dementia is considered to be short-term memory impairment, which deepens over time, leading to a significant impairment of intellectual performance. The patient experiences difficulty with speech, logical thinking and spatial orientation disorders (failure to recognize immediate surroundings). Changes in the brain structures lead to a loss of independence; the phenomenon of agnosia and motor apraxia is observed, which makes behaviour unpredictable and dangerous [5].

Old age, apart from dementia, is also a significant risk factor for disorders related to the balance system, i.e. the ability to maintain the centre of gravity over the supportive base. There are two types of balance: static (assessed in the

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stationary position) and dynamic (assessed in motion). People over 65 years of age experience many changes that ultimately affect their balance, ranging from the loss of bone and muscle mass, ischemic changes in the central nervous system and circulatory system disorders, to problems with vision and hearing. Balance disorders reduce the level of independence, limit functional efficiency and carry a high risk of falls, which, along with dementia, are classified as the Common Geriatric Problems [6, 7].

The walking cycle (Fig. 1), is divided into two major groups: stance phase (phase where feet come into contact with the ground during walking) and swinging phase (phase where feet swing freely during walking). The stance phase consists of five sub-phases: heel strike, foot flat, midstance, heel-off, and toe-off (Fig. 1.) [8].

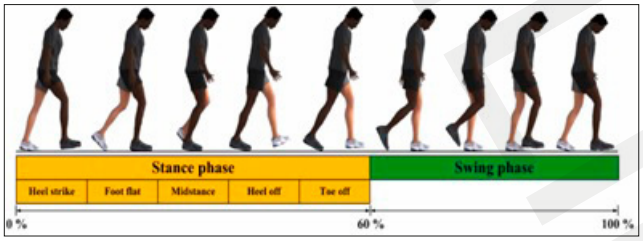

Figure 1. Phases of walking cycle [8]

Biological changes that occur over time lead to progressive and most often irreversible changes in the body. As a result of aging, increased activity of osteoclasts and a decrease in the production capacity of osteoblasts can be observed within the bone, which negatively affects bone density [9]. It causes articular cartilages to degenerate, the amount of collagen produced to lower, muscle mass to wane (sarcopenia), and the strength of contraction and muscle innervation to decrease [10, 11]. Catabolic processes dominate in the body, which results in a decline in motor functions, which translates into an increased risk of fractures and loss of independence in the activities of daily living [12]. The reduction of muscle mass linked with the decrease in its tone and strength increases the risk of functional efficiency issues, risk of falls and disability, and contributes to the deterioration of the patient's quality of life, which – in the case of people with dementia – progresses much faster [13].

The coexistence of cognitive dysfunctions and impaired functional efficiency additionally reduces older adults' quality of life and increases the risk of a faster loss of independence. The aim of the study is to assess the functional efficiency and the risk of falls in the study group of older adults, residents of nursing homes.

MATERIALS AND METHOD

The study was carried out on people residing in social welfare institutions located in the Łódź Province in Central Poland. The eligibility criterion for participation in the study was age (over 60), the presence of cognitive disorders, including dementia, and the ability to move (with the use of orthopaedic equipment or independently). The exclusion criterion were: age below 60 years, no presented cognitive impairment and no moving ability. The study group consisted of 51 people (13 males and 38 females), who were divided into three age groups according to the WHO classification: youngest-old (n=19), middle-old (n=27) and oldest-old (n=5), the mean age of the participants was $\bar{x}$ =77.49±6.61. Most of them did not use orthopaedic equipment (n=34), 1/3 (n=16) used a walker and one person used crutches. Only ¼ of the participants underwent physiotherapeutic treatments.

Individuals who met the inclusion criteria completed an examination chart with the researcher. Then, a one-time evaluation of their cognitive functions was performed using two tests: the ADL scale, MMSE (Mini- Mental state Examination), and three physical fitness tests: SPPB (Short Physical Performance Battery), TUG (Timed Up & Go) and FRT (Functional Reach Test) (Fig. 2).

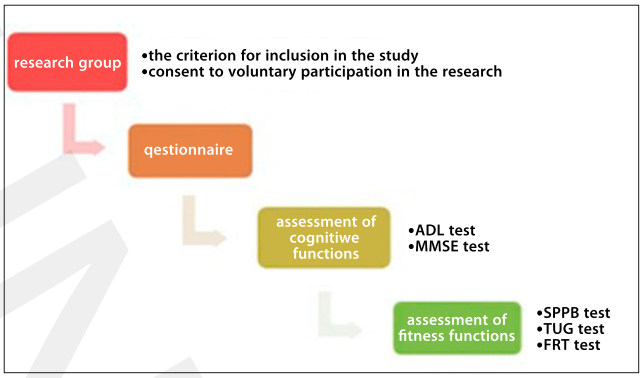

Figure 2. Stages of the study

The ADL scale is applied to assess the level of independence of people in terms of basic life activities [14]. The Folstein Brief Mental Assessment Scale (MMSE) is used as a screening test to determine whether further diagnostic of a patient for dementia is indicated [15, 16]. In the case of a low MMSE score, tests were carried out by demonstration and imitation. Due to the impact of age and level of education, the Mungas conversion factor, also referred to as the corrected MMSE test score, was used. The SPPB test measures the patient's abilities in three aspects: balance, gait speed and lower limb strength [17]. The result predicts possible disability, hospitalization or death. The TUG test is used to assess physical performance, gait speed and balance, which shows the risk of falls in the tested person [18]. The FRT test measures the risk of falling.

The collected data was statistically processed using Excel tools and Statistica 13.1. employing descriptive statistics and parametric data analysis methods. The normality distribution was evaluated using the Shapiro-Wilk test, and Pearson's r correlation coefficient was used to describe the correlation between quantitative variables. The significance level was set at $p \leq 0.05$.

The study was conducted with the consent of the Bioethics Committee at the Medical University of Łódź (No. RNN/60/23/KE).

RESULTS

In the study group, ¼ of the participants declared to be physiotherapy-treated. Due to the small number, it was not considered reasonable to divide it into age groups. The average MMSE test result in the group using treatments is 17.69±3.88 points. The most common form of rehabilitation was kinesitherapy. All subjects undergoing physiotherapy

Table 1. Descriptive analysis of the tests used

TEST	Total		Youngest-old age		Middle-old age		Oldest-old age	
	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ	$\bar{x}$	σ
MMSE	13.29	±6.23	12.95	±6.40	12.11	±5.94	13.33	±7.61
ADL	4.20	±1.23	4.37	±1.53	4.04	±1.05	4.40	±0.89
TUG	25.18	±9.25	20.66	±9.32	25.84	±9.32	24.59	±3.97
SPPB	4,24	±1.88	5.17	±2.25	3.74	±1.37	4.00	±1.87
FRT	14.34	±9.28	18.87	±11.34	11.56	±6.27	12.12	±9.25

treatments experienced its positive effects, i.e. improved range of motion, improved self-service activities, restored motor control and independent gait.

Among all study participants, the mean value of cognitive functions measured by the MMSE test was 13.29±6.23 points. No normal results were obtained, and no cases of cognitive disorder without dementia were found. The average ADL score of 4.20 ± 1.23 points was obtained for the entire study group. The results for each age group are presented in Table 1.

In the study group, a statistically significant relationship was observed between the results of the MMSE test and the ADL scale ($r=0.4945$; $p<0.05$). A moderate positive correlation indicates that higher MMSE test results correspond to greater independence in everyday life, as measured by the ADL scale.

In the 'Get-up and Go' test, the average result for the whole group was 25.18 ± 9.25 seconds. None of the tested groups exceeded the threshold of 14 seconds during the test. The average result of the study group performing the SPPB test was 4.24±1.88 points. The mean value for all persons tested with the Functional Reach Test was 14.34±9.28 centimetres (Tab. 1).

A statistically significant positive relationship was found between the MMSE test and FRT, and no relationship with the SPPB and Get Up and Go tests. This signifies that higher the MMSE scores corresponds to greater distances obtained in the FRT. On the other hand, a positive correlation was observed between the ADL scale, SPPB and FRT tests, with a high correlation between the ADL scale and FRT. A negative correlation was found between the scale of independence in activities of daily living and the 'Get up and Go' test. The correlations described means that higher scores on the ADL scale correspond to better results in the SPPB and FRT tests, while higher scores on the ADL scale correspond to shorter task completion time in the TUG test (Tab. 2.).

Table 2. Correlation analysis of MMSE, ADL, the use of rehabilitation treatments and orthopaedic aids in relation to the TUG, SPPB and FRT tests

Variable	TUG		FRT		SPPB	
	r	p	r	p	r	p
MMSE	0.1001	0.484	0.3376	0.015	0.1696	0.234
ADL	-0.3885	0.005	0.6348	0.000	0.4191	0.002
Using rehabilitation treatments	-0.3264	0.019	0.1619	0.256	0.2187	0.123
Orthopaedic aids	-0.3732	0.007	0.2208	0.120	0.4947	0.000

No correlation was found between the use of rehabilitation treatments and the results of static and dynamic balance tests (Tab. 2). However, a negative correlation occurred between the 'Get-up and Go' test and rehabilitation in the study group. This means that rehabilitation treatments reduce the task completion time in the TUG test.

A statistically significant relationship ($p\leq0.01$) was found between the use of walking aids by the participants and the results of the TUG and SPPB tests (Tab. 2). No dependence of orthopaedic equipment on dynamic balance, as measured by the Functional Reach Test, was found. The use of orthopaedic equipment was found to have a positive effect on task completion time in the 'Get-up and Go' test, and to improve static balance in the SPPB test, thereby reducing the risk of disability and death for the patient.

DISCUSSION

Dementia is a significant social and medical problem among the population over 60 years of age [19]. This disease affects 50 million people worldwide [20]. It is estimated that the incidence of age-related diseases, including dementia, will grow in society, translating into higher social and economic costs and a greater problem of care for the older adults [21]. For this reason, it seems imperative to develop diagnostic screening tools for dementia and implement early prophylaxis to delay the progression of disorders at the level of independence, functional efficiency, and to reduce the risk of falls [22].

The relationship between the risk of falling and functional efficiency was demonstrated by Skubal et al. in a study conducted on a group of 146 people aged 60–90 diagnosed with mild and moderate dementia. It was noted that a decrease in cognitive abilities negatively impacted on independence in performing daily activities. [23]. Additionally, in own analysis, a correlation between the level of dementia and the patient's independence was observed. In turn, Burge et al. attempted to determine whether the introduction of a rehabilitation programme improves the independence of patients with moderate and severe dementia. The study involved 160 people over 65 years of age. The study group (n=78) engaged in physical activities five times a week for 30 minutes. The control group (n=82) received occupational therapy and film therapy. There was a statistically significant decrease in independence in terms of mobility in the control group ($p=0.021$), with a simultaneous improvement in control in the study group ($p=0.043$). Physical exercise proved to have a positive effect on delaying the decline in independence in the patients suffering from dementia [24]. Moreover, Hiroyuki et al. conducted a study on patients diagnosed with dementia, staying at the rehabilitation ward (n=131), including patients with mild and moderate dementia (n=38) and severe dementia (n=93). Observational measurements were made at two time points for six months. The most significant factor predicting the decline in fitness was the level of cognitive functions, even to a severe and profound degree [25]. Studies by other authors do not prove the lack of correlation between the level of dementia and functional capacity, the risk of falls and the risk of disability shown in this study. This may be due to the lack of analyses in the aspect of physiotherapy using active tests in patients with severe dementia. In order to confirm or disprove the correlations, further studies in this area should be carried out [26].

The analysis conducted by Dixe et al. among elderly people staying in nursing homes confirms that the problem of falls is very common among seniors, and that it is a serious problem. Comparing the group of people with cognitive impairment and the group of people without signs of dementia, the authors

did not find any correlation. The percentage of people who fell in both groups was about 40%. What is important, is the fact that the frequency of falls in people staying in nursing homes is statistically higher than in people living in their homes. It is also worth mentioning that the fear of subsequent falls significantly limited the activity of seniors [27].

Dementia is one of the causes of decreasing independence in various areas of everyday life of people over 60. Its reduced level is associated with cognitive dysfunction. In turn, in the systematic review and Lindbergh meta-analysis, 106 research papers were included. Random-effects models yielded a large overall sum score size (Hedges g=0.76, 95% confidence interval: 0.68–0.83; p<0.001) confirmed by multi-level analysis adjusted for study record size (g=0.78, 95% confidence interval: 0.69–0.87). The results collected by the authors suggest that the decrease in functional efficiency and independence advances in people affected by cognitive dysfunction, preceding the diagnosis of dementia [28]. Moreover, Reppermund et al. conducted a study on a group of 602 people aged 70 – 90. Participants were divided into two groups: without cognitive impairment (n=375) and with mild dementia (n=227), and then subjected to a two-year follow-up. It was found that a decreasing ADL score in people without cognitive disorders may mean that they will develop dementia in the future [29]. In our own work, the dependence of functional efficiency and independence on the level of cognitive impairment in patients over 60 years of age was also demonstrated. The positive correlation obtained suggests that a higher score on the MMSE test is associated with greater independence in everyday life, as measured by the ADL scale.

The literature has repeatedly shown that patients with dementia have an increased risk of falling. A study by Staszczak-Gawełdy et al. found that 73% of the subjects (n=127) had a four-fold higher risk of falls [30]. Taylore and Close also confirm in the chapter on dementia that gait and balance difficulties are common in people struggling with dementia [31]. In addition, Yoon et al. observed a group of 295 participants who were divided into groups: without cognitive impairment (n=71), with subjective cognitive impairment (n=96), mild impairment (n=72) and Alzheimer's disease (n=56). A statistically significant relationship was found between the increase in time in the 'Get-up and Go' test and cognitive impairment (p = 0.001), as well as a decrease in functional efficiency in people with subjective cognitive disorders when performing the one-legged stand test (p = 0.001). This supports the conclusion that there is a relationship between mobility, balance and cognitive function, which is observed at an early stage of cognitive disorders [32]. In the current study, no relationship was observed between the results of TUG test and the average cognitive function measured with the MMSE test. The average result for the whole group in the 'Get-Up and Go' test was 25.18 ± 9.25 seconds, and none of the tested groups exceeded the threshold of 14 seconds during the test. The time of performing the test in particular groups increased with the age of the participants. Rajter-Zembaty also found a correlation without statistical significance between the MMSE cognitive ability test and the TUG functional efficiency test [33].

Researchers have demonstrated that rehabilitation has a positive impact on improving static and dynamic balance, reducing the number of injuries. In a randomized study by Sondell et al., a four-month high-intensity exercise programme was performed on a group of 81 subjects, leading to improvement in functional efficiency and balance in 35.8% of participants [34]. To[illegible] conducted a study in which participants (n=186, $\bar{x}_{aged}$ $\bar{x}_{aged}$=85 years) took part in a four-month physiotherapy programme, followed by a 12-month follow-up after rehabilitation to assess the number of falls and improvement of motor coordination [35]. Another example of work, which analyses problem of falls among elderly people is study by Ansai et al. A prospective study was conducted with community-dwelling older adults (40 MCI; 38 mild AD). The assessments consisted of socio-demographic and health variables, caloric expenditure, functional status, functional mobility (10-m walk test, dual-task test, and transition Timed Up and Go phases), cognitive domains, and depressive symptoms. Falls were recorded for six months by a falls calendar and monthly telephone calls. Falls were reported in 52.6% and 51.4% of people with MCI and mild AD, respectively. Among people with MCI, lower functional status, higher time spent on walk and dual task tests, and higher depressive symptom scores were associated with falls. Higher time spent on the dual-task test was independently associated with falls. Among people with mild AD, falls were associated with lower time spent on the walk test and turn-to-sit phase, and a higher visuo-spatial domain score [36].

Limitations of the study. Significant limitations can be observed in the conducted analysis. The first is a too small group of participants in the study, which may affect the results of statistical analyses. The second is the small number of men compared to women (due to the difference in the life expectancy of men and women and the predominance of the number of women over the number of men among older people). It is also worth noting that the residents of nursing homes have mostly lost the ability to move independently, which was the exclusion criterion for the study and made it difficult to select a larger number of participants for the study. It is also important that the study focused on assessing walking speed, balance, physical fitness and the risk of falls. All the tests used concerned similar parameters, therefore a small number of correlations between them was obtained. The last limitation of this study is the use only of questionnaires without using objective methods, such as assessing balance on a platform.

CONCLUSIONS

The conducted research indicates a significant correlation between the level of cognitive dysfunction and reduced functional independence in everyday activities. However, it does not fully determine the level of physical fitness, the likelihood of falls, disability, or the ability to maintain static and dynamic balance. Patients with higher levels of independence in daily life demonstrated better functional efficiency. The use of orthopaedic aids was found to effectively lower the risk of falls and hospitalization, while rehabilitation was shown to reduce the risk of falls, but not to improve test results related to static and dynamic balance performance.

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