Balance, falls and functionality among elderly persons with cognitive function impairment

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Abstract

Objective: To assess the relationship between cognitive function, balance, risk of falls and functionality in elderly persons with impaired cognitive function and verify if those with mild cognitive impairment had better balance, functionality and a lower risk of falls than those with dementia. *Methods:* An analytical cross-sectional study of 33 elderly persons of both genders, aged over 60 years, were evaluated using the Mini Mental State Examination (MMSE), Timed Up and Go (TUG) test, Berg Balance Scale (BBS), Clinical Dementia Rating Scale (CDR) and Barthel Index. Four groups were considered: mild cognitive impairment (MCI; n=9), mild dementia (MID; n=12), moderate dementia (MOD; n=7) and severe dementia (SD; n=5). Data comparison was performed by the Mann Whitney U-test and correlation by Spearman's rank Correlation Coefficient, whit a significance level of (p<0.05). *Results:* There was a statistically significant difference in the risk of falls and functionality between the MID and MOD groups, functionality between the MOD and SD groups, and balance, functionality and risk of falls between the MID and SD groups. A moderate correlation between MMSE and BBS (r=0.543; p=0.006) was observed in the MCI group, and a moderate negative correlation between MMSE and TUG (r=-0.685; p<0.001) and a strong correlation between MMSE and Barthel (r=0.708; p<0.001) were observed in the dementia group. *Conclusion:* The deterioration in cognitive function was associated with greater impairment of functionality, balance and an increased risk of falls in elderly persons with dementia, compared to elderly subjects with mild cognitive impairment.

Key words: Elderly; Risk of Falls; Postural Balance; Cognitive Functions.

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INTRODUCTION

According to the United Nations (UN),[1] dementia is a syndrome that is usually chronic and/or progressive and is characterized by the deterioration of cognitive function, affecting memory, intelligence, behavior and the performance of activities of daily living, with a substantial effect on quality of life.[1,2] Currently, close to 44 million people live with this disease.[3] Alzheimer´s disease (AD) is the most common cause of this illness, causing between 60 and 70% of cases.[1,2]

Between normal aging and dementia, there is a period known as mild cognitive impairment (MCI). This period is characterized by the maintenance of independence, from a functional perspective, and cognitive loss, when compared to normal people, without attaining the criteria of dementia.[4] Some elderly individuals with MCI develop dementia, while every year approximately 12% of the elderly population develop AD, which is more common.[5]

Cognitive function can be compromised by age through the overall slowing of cognitive resources. The brain is sensitive to numerous factors that result in damaged neural networks, despite possessing the capacity for self-repair/self-adaptation. When there is an imbalance between neuronal injuries and repairs, neuronal capacity is impaired, leading to cerebral aging and in some cases, dementia.[6] The nervous system is not the only system to experience a decline in function during the aging process. Postural balance is the result of harmonious interaction between the vestibular, visual and somatosensory (musculoskeletal) systems. Alterations to any of these systems or their interaction leads to falls.[7]

Falls are one of the main health problems faced by the elderly population. Due to their high incidence, they are considered the main cause of morbidity, mortality, decreased independence and a lower quality of life during old age, problems that also affect the lives of caregivers.[7,8,] Cognitive impairment has been identified as one of the main causative factors of falls.[8] The consequences of falls are a constant fear of falling, restrictions on activities, declining health, an increase in the risk of institutionalization, fractures and death. These consequences lead to physical and psychological damage and increase the costs of healthcare for the elderly population.[9]

Several studies have addressed the correlation between dementia and falls, balance and functionality. However, they usually compare healthy elderly individuals with those who suffer from mild and moderate dementia,[7,10,11] without considering the period prior to dementia known as MCI, or making comparisons with individuals who suffer from severe dementia.

The aim of the present study was to assess the correlation between cognitive function, balance, the risk of falls and functionality among elderly individuals with impaired cognitive function and to determine if those with mild cognitive impairment exhibited better balance and functionality, as well as a lower risk of falls, than those with dementia.

MATERIALS AND METHODS

This analytical cross-sectional study was conducted with elderly individuals who were being medically treated in the Neurogeriatric and Cognitive Disorders wards of the *Hospital de Clínicas da Universidade Federal do Paraná* (HC-UFPR). The following inclusion criteria were applied: (1) elderly individuals with MCI and dementia (mild, moderate and severe); (2) aged 60 years or more; (3) male or female; (4) diagnosis of dementia based on the criteria of the *Manual Diagnóstico e Estatístico de Transtornos Mentais* (DSM-IV);[12] (5) capable of understanding simple verbal commands, performing the tests proposed and

moving around with or without a walking device. The following exclusion criteria were applied: (1) stroke sequelae; (2) visual and auditory deficits that would impede their participation and restricted mobility.

The present study was approved by the Ethics Committee for Human Research of the *Hospital de Clínicas da Universidade Federal do Paraná* under protocol number CAAE: 10820913.4.0000.0096. All of the participants signed a statement of free and informed consent.

The sample was randomly selected during consultations in the abovementioned Neurogeriatric and Cognitive Disorder wards between March and September of 2013. After selection, individuals that had been diagnosed with dementia were invited to participate. The elderly individuals and their companions (caregivers) answered a questionnaire containing the following socio-demographic data: gender; age; education; weight; height; clinical history, including the duration of the symptoms; comorbidities; the use of drugs; the use of orthosis for mobility; institutionalization after diagnosis; the practice of physical activity (physical activity was defined as the performance of regular exercise at least twice a week for more than 30 minutes); a history of falls in the last 12 months and their characteristics, such as the quantity and frequency, as well as the consequent complications. A fall was defined as an unintentional displacement of the body to a level that is lower than the initial position, with an incapacity to correct the position in a timely manner.[13] Medical data were obtained by analyzing medical records.

From the initial sample (n=39), six elderly individuals were excluded: two were excluded due to a non-defined diagnosis; two others were excluded for refusing to finish the assessment; one was removed because they had suffered a stroke and another because they could not complete the tests proposed.

The 33 elderly individuals selected were assessed in relation to their cognitive function using the Mini Mental State Examination (MMSE).[14] Balance was assessed using the Brazilian version of the Berg Balance Scale (BBS).[15] Functional mobility/the risk of falls were assessed by the Timed Up and Go (TUG) test.[16] Functionality was determined using the Barthel index[17] and the severity of dementia was confirmed by the Clinical Dementia Rating (CDR).[18,19] The values proposed by Brucki et al.[20] were considered in the analysis of the data obtained by the MMSE.[14] When analyzing the results of the TUG test, [16] greater time values represented worse mobility and a greater risk of falls. Therefore, a time of ten seconds or less corresponded to a low risk of falls and independent individuals with normal functional mobility. A time of 20 seconds or less represented a moderate risk of falls and people who were independent in relation to basic tasks. A time of 30 seconds or more corresponded to a high risk of falls and individuals who were dependent in relation to activities of daily living and exhibited abnormal mobility.[16,21] The cutoff point on the BBS[15] is 45 points, with scores under this cutoff representing a severe balance deficit. The maximal score on the Barthel index[17] is 100 points: up to 20 points indicated that the individual is completely dependent; between 21 and 35 points indicates severe dependence; between 35 and 55 points indicates moderate dependence; between 56 and 60 points indicates mild dependence and between 61 and 100 points indicates an independent individual.

The CDR[18,19] was used to classify the severity of dementia. Its application is based on a semi-structured questionnaire, containing six categories. Each category is classified as follows: 0 – normal; 0.5 – questionable; 1 – mild dementia; 2 – moderate dementia and; 3 – severe dementia. The most important cognitive domain is memory, with all others classified as secondary. The final general classification is obtained by

analyzing the categories, following a set of rules created and validated by Morris.[22]

After the assessment, the elderly individuals were divided into four groups based on the CDR classification: CDR 0.5, mild cognitive impairment group (MCI); CDR 1, mild dementia group (MID); CDR 2, moderate dementia group (MOD); and CDR 3, severe dementia group (SD).

The statistical procedure adopted was descriptive data analysis (mean and standard deviation values). Spearman's coefficient of correlation was used to correlate cognitive function with the risk of falls, balance and functionality between the MCI and dementia groups. The Mann Whitney test was used to compare the variables balance, risk of falls and functionality between the groups, according to the severity of the dementia. BioEstat software (Version 5) was used to analyze the data, with the level of significance set at 5% ($p<0.05$).

RESULTS

The mean age of the 33 elderly individuals was 76.81 (±8.27) years. In total, 22 (66.66%) of these were female. All of the individuals were sedentary.

Table 1 displays the data obtained for the number of participants, gender, mean age, weight, height, time since the beginning of symptoms, education, diagnosis and the number of falls, considering the four groups according to the severity of the dementia.

Table 1. Characterization of the sample for the MCI, MID, MOD and SD groups. Curitiba, PR, 2013.

	MCI	MID	MOD	SD
Characterization of the sample				
Number of participants (n)	9	12	7	5
Gender (n) female/male.	6/3	6/6	6/1	5/0
Age (years) mean±sd	73.66±5.39	75.16±8.0	77.71±11.01	85.20±2.16
Weight (kg) mean±sd	68.22±12.60	71.08±9.53	64.28±11.55	52.60±8.17
Height (meters) mean±sd	1.43±0.55	1.60±0.09	1.51±0.07	1.58±0.05
Start of symptoms (years) mean±sd	4.55±3.39	4.50±5.17	6.28±4.02	6.40±4.66
Education (years) mean±sd	1.88±2.20	4.66±3.60	1.71±1.97	2.2±1.64
Diagnosis % (n)				
MCI	100.0 (9)	0	0	0
Alzheimer´s disease	0	100.0 (12)	85.71 (6)	80.0 (4)
Parkinson´s disease	0	0	14.28 (1)	20.0 (1)
Falls % (n)				
Elderly with a history of falls	44.44 (4)	8.33 (1)	28.57 (2)	40.0 (2)
Number of falls in 12 months	6	3	3	2

MCI= mild cognitive impairment; MID= mild dementia; MOD= moderate dementia; SD= severe dementia.

All of the elderly individuals that suffered falls were female. No fractures were reported in any of the groups as a result of these falls. Five of the elderly individuals used a cane (one in the MCI group, three in the MID group and one in the MOD group). One elderly individual in the SD group used a wheelchair to get around when outside the home. Concerning institutionalization, two individuals from the SD group and one from the MID group were institutionalized after their diagnosis of dementia.

Concerning comorbidities, Table 2 shows that the greatest prevalence was for systemic arterial hypertension and consequently, antihypertensives were the most commonly used drugs in all groups, with the exception of the MCI group, in which the most commonly used drug was statin.

Table 3 displays the values referring to the scores for balance, the risk of falls and functionality in the MCI, MID, MOD and SD groups.

Table 2. Comorbidities, drugs used and the number of drugs used per individual in each group. Curitiba, PR, 2013.

	MCI	MID	MOD	SD
Comorbidities % (n)				
Systemic arterial hypertension	77.77 (7)	58.33 (7)	100.00 (7)	40.0 (2)
Heart disease	33.33 (3)	16.66 (2)	42.85 (3)	0
Diabetes	22.22 (2)	33.33 (4)	28.57 (2)	0
Dyslipidemia/cholesterol	0	16.66 (2)	28.57 (2)	0
Cancer	11.11 (1)	8.33 (1)	14.28 (1)	40.0 (2)
Drugs % (n)				
Anti-hypertensive	44.44 (4)	83.33 (10)	85.71 (6)	60.00 (3)
Painkiller, anti-inflammatory and antipyretic	44.44 (4)	8.33 (1)	28.57 (2)	0
Statins	66.66 (6)	33.33 (4)	28.57 (2)	20.00 (1)
Acetylcholinesterase inhibitor, memantine	11.11 (1)	16.66 (2)	42.85 (3)	20.00 (1)
Neuroleptic, antipsychotic	0	0	14.28 (1)	60.00 (3)
Antidepressant	22.22 (2)	8.33 (1)	40.00 (2)	40.00 (2)
Neuromodulators	11.11 (1)	16.66 (2)	28.57 (2)	0
Antiparkinsonism	0	0	14.28 (1)	20.00 (1)
Number of drugs used per group of study (mean $\pm$ sd)	3.55$\pm$1.50	2.90$\pm$2.11	5.00$\pm$2.70	3.60$\pm$1.14

MCI= mild cognitive impairment; MID= mild dementia; MOD= moderate dementia; SD= severe dementia.

Table 3. Mean and standard deviation values obtained by comparing the balance, risk of falls and functionality variables between the groups. Curitiba, PR, 2013.

Groups	Balance	*p*-value*	Risk of falls	*p*-value*	Functionality	*p*-value*
MCI (n=9)	49.44±4.63		12.80±4.06		94.44±3.90	
Comparison MCI x MID		0.695		0.722		0.971
MID (n=12)	50.66±4.90		15.59±14.91		91.66±10.51	
Comparison MID X MOD		0.051		0.004**		0.011**
MOD (n=7)	42.71±8.59		31.20±15.40		75.00±15.54	
Comparison MOD x SD		0.061		0.569		0.023**
SD (n=5)	29.60±15.82		46.44±40.73		43.00± 20.79	
Comparison MID x SD		0.002**		0.006**		0.004**

MCI= mild cognitive impairment; MID= mild dementia; MOD= moderate dementia; SD= severe dementia; *Mann Whitney test

** significant difference (p<0.05)

When the variables balance, the risk of falls and functionality were compared between the groups, no significant differences were found between the MCI and MID groups for any of the variables. A statistically significant difference (p<0.05) was found between the MID and MOD groups for the risk of falls and between the MOD and SD groups for functionality. When comparing the MID and SD groups, statistically significant differences were found for balance, functionality and the risk of falls (Table 3).

Cognitive function correlated with balance, risk of falls and functionality for the MCI and dementia groups. This data are displayed in Table 4. In the MCI group, a moderate correlation was found between cognitive function and balance. No correlation was found between cognitive function and the risk of falls in this group. In the dementia group, a negative moderate correlation was found between cognitive function and the risk of falls, with a moderate correlation with balance and a strong correlation with functionality (Table 4).

Table 4. Correlation of the cognitive function scores (MMSE) with those obtained for balance (Berg), the risk of falls (TUG) and functionality (Barthel) in the MCI (n=9) and Dementia (n=24) groups. Curitiba, PR, 2013.

Variables		Cognitive function (MMSE)	
		MCI	Dementia
Risk of falls	Spearman's coefficient of correlation	0.000	-0.685
	p-value	n/a	<0.001**
Balance	Spearman's coefficient of correlation	0.543	0.683
	p-value	0.006**	<0.001**
Functionality	Spearman's coefficient of correlation	-0.284	0.708
	p-value	0.458	<0.001**

MCI= mild cognitive impairment; n/a= not applicable.

** significant correlation (p<0,05)

DISCUSSION

The present study assessed and compared the balance, risk of falls and functionality of elderly individuals with different levels of cognitive impairment. The results show that balance was worse when dementia was more severe. Although there were no significant differences for balance in the MOD and SD groups, the SD group exhibited low BBS scores, thereby confirming greater impairment of this ability in this group.

In the present study, 31 elderly individuals were diagnosed with AD. This may have occurred due to the fact that AD is the most prevalent type of dementia, and could also have been influenced by the eligibility criteria. The fact that the sample included elderly individuals monitored in the specialized Neurogeriatric Ward of a tertiary hospital was probably significant for this diagnosis.

In the sample in the present study, only two individuals (one from the MOD group and one from the SD group) suffered from AD and Parkinson's Disease (PD), although it was not possible to analyze the effect of this double diagnosis on balance in more detail. Christofoletti et al.[10] reported that a group with AD exhibited worse balance than groups with PD and control groups. The same authors stated that cognitive decline could increase the risk of falls in individuals with AD, and concluded that those with AD are effected by an eminently cognitive disorder and exhibit a greater risk of falling than patients with PD, which is a disease that is primordially characterized by motor symptoms. They also concluded that protective and preventative measures should include motor and cognitive stimulation.[10]

One factor that was associated with an increase in the risk of falls was a sedentary

lifestyle, which could explain the data found in the present study (the risk of falls was considered moderate for the MCI and MID groups and severe for the MOD and SD groups), in which all of the individuals were sedentary. These results are similar to those reported by Hernandez et al.,[7] who found that elderly individuals with AD who did not engage in systemized physical activity performed worse in terms of cognitive function, balance and the risk of falls, when compared with elderly individuals with AD who systematically exercised. The same authors concluded that physical activity is important to the maintenance of balance and consequently, a reduction in the risk of falls. These data suggest the need for preventative measures that include physical activity for this population. [7]

All of the participants who had experienced falls in the previous 12 months were female, corroborating the results of previous studies [10,23,24] which correlated the female gender with a greater risk of falls in old age. This finding has been correlated with the greater fragility of females, in relation to males, as well as the greater prevalence of chronic diseases such as osteoporosis and a greater link to domestic tasks.[9] Other factors such as advanced age, a previous history of fractures, poor sight, separation, divorce and widowhood, a sedentary lifestyle, a greater use of medicinal products (continuous use) and damaged neuromuscular functions have been indicated as responsible for the independent and significant increase in the risk of falls.[9,23,24]

It is important to state that falls are multifactorial and are correlated with both intrinsic and extrinsic factors. It was expected that there would be a greater frequency of falls among the oldest and most impaired elderly individuals in the present study.[23] However, the greatest occurrence of falls was found in the MCI group, which can be explained by the fact that the elderly individuals without dementia were more autonomous in terms of performing activities of daily living,[8] while those with MCI were independent from a functional point of view.[4] The most independent elderly individuals are more exposed to extrinsic environmental factors, such as: poor lighting; a disorganized environment with many obstacles in their path; carpets; smooth surfaces; high or narrow stairs; the lack of a handrail in hallways and bathrooms; beds and chairs of inadequate height; the use of sandals or poorly fitted shoes; and slippery slopes and poorly-conserved public sidewalks with holes or irregularities, which expressively increase the risk of falls.[25,26] Elderly individuals with more severe dementia are more dependent on their caregivers and may suffer less falls due to the fact that they are constantly supervised and have restricted mobility.

Individuals in the MOD and SD groups used neuroleptic drugs, unlike those in the MID and MCI groups. These drugs affect an individual's balance and functionality and may cause drowsiness,[27,28] thereby increasing the risk of falls. Thus, it was expected that a greater number of falls would be found in these groups. However, this was not the case, perhaps due to the restricted mobility of the elderly individuals in the MOD and SD groups. Hamr et al.[29] concluded that drugs that affect attention span, motor responses and blood pressure require special attention in this population, given that they can affect balance and increase the risk of falls. This risk increases further among patients who use more medication and is correlated with slippery areas, bathrooms and backyards.

The results of the present study show that more severe dementia leads to a greater risk of falls. This risk is even significant among individuals with mild dementia, when compared with those with moderate dementia.

Dementia has been indicated as one of the factors that contributes to an increase in the risk of falls among the elderly.[8] These individuals are affected by apraxia, agnosia, spatial deterioration

and abnormal executive functions, all of which gain significance with the evolution of the disease, which explains the fact that the patients with moderate and severe dementia in the present study exhibited a higher risk of falls. Carameli et al.[30] reported that the risk of falls is high among elderly individuals with cognitive disorders as these individuals are usually exposed to negligence, social exclusion and depressive symptoms. These factors in turn contribute to a reduction in the performance of physical activity and an increase in global muscular weakness. Other symptoms that accompany dementia include compromised gait, a lack of balance, postural instability and an increase in muscle tone, which can lead to falls.[8]

According to Carvalho & Coutinho,[8] dementia is one of the factors that increases the prevalence of falls among the elderly, followed by severe fractures that require hospitalization. The same authors noted that almost 90.0% of the falls occurred in the morning and that 99.3% had surgery as a result of the fractures generated by these falls. This finding was not found in the present study, in which none of the elderly individuals had suffered fractures as a result of falls.

Cognitive impairment also affects an individual's ability to understand and integrate the stages that characterize the performance of daily tasks, which can become progressively compromised among individuals with AD.[31] The results of the present study show that greater cognitive impairment is correlated with worse functionality, and that this was not observed when comparing elderly individuals with MCI and MID.

Zidan et al.[32] stated that, despite the decline of motor skills, cognition and functional capacity after a diagnosis of AD, the linear loss of independence related to activities of daily living is evident, particularly in the moderate and severe phases of the disease. This loss of independence worsens as the symptoms of the disease increase.

Fiqueiredo et al.[31] also correlated the MMSE score with activities of daily living and reported that individuals with better cognitive performance were more dependent while performing these daily activities.

The fact that the *Hospital de Clínicas*, where the present study was conducted, does not have an emergency ward for fractures could be considered a confounding factor if the data referring to falls were collected from medical records, given that falls followed by fractures must be sent to other services. In order to avoid this confounding factor, the data referring to falls was collected during the interviews with the elderly individuals and their caregivers.

The absence of a control group and the size of the sample were limitations of the present study. Future studies should consider using a larger sample and comparing it with a control group in order to confirm the results reported herein.

CONCLUSION

The results of the present study showed that when cognitive function is more severe, balance and functionality are also worse and the risk of falls is higher. It was also confirmed that elderly individuals with mild cognitive impairment and mild dementia exhibited a moderate risk of falls, greater functionality and better balance than those with moderate and severe dementia.

This data suggests a need for greater care, particularly concerning the type of guidance provided to these groups in relation to functionality, balance and the prevention of falls. Adding a physical activity to one's daily routine, adapting to the environment and cognitive training should be considered so that these patients can experience greater autonomy and a better quality of life.

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Received: Mar 19, 2014
Revised: Jan 06, 2015
Accepted: June 02, 2015