ORIGINAL ARTICLE

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Floor Maze Test as a predictor of cognitive decline in older adults living in nursing homes

Floor Maze Test como preditor de declínio cognitivo em idosos residentes de instituições de longa permanência

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RESUMO

Objetivo: Pesquisas em instituições de longa permanência para idosos (ILPI) mostram uma associação entre o aumento de risco de declínio cognitivo e o comprometimento das habilidades de navegação espacial dos idosos. A navegação espacial pode ser definida como uma habilidade complexa, que depende de funções cognitivas e motoras, emergindo como um importante marcador de estadiamento da demência. O presente estudo teve por objetivo comparar a navegação espacial de idosos saudáveis; institucionalizados e com demência **Métodos:** Foi realizado um estudo de corte transversal com 78 idosos (saudáveis = 37, demência = 22, institucionalizados = 19) avaliados por meio do Miniexame do estado mental (MEEM), *Floor Maze Test* (FMT) e *8-foot-up-and-go* (8UG). Uma ANOVA *One-way* foi realizada para comparar os grupos. **Resultados:** Como esperado, o grupo saudável foi mais ágil, tanto no FMT imediato ($X^2 = 31,23$; $p < 0,01$) quanto no tardio ($X^2 = 41,21$; $p < 0,01$). Quando comparados os grupos demência e institucionalizados, não houve diferença significativa no MEEM e FMT tardio. Porém, os idosos institucionalizados mostraram piores resultados que o grupo demência no FMT imediato ($p < 0,01$) e no teste 8UG ($p < 0,01$). **Conclusão:** Os resultados indicam um pior desempenho na navegação espacial, função executiva e habilidades motoras dos idosos em ILPI e com demência. A possibilidade de idosos institucionalizados serem subdiagnosticados deve ser considerada.

PALAVRAS-CHAVE

Floor Maze Test, institucionalização, idosos, declínio cognitivo, demência.

ABSTRACT

Objective: Long-term care facilities (LTCF) are associated with an increased risk of cognitive decline and impairment in spatial navigation abilities. Recent studies have demonstrated that spatial navigation as a complex skill, involving cognitive and motor functions, emerging as a new marker for the progression of dementia. The present study aims to compare spatial navigation in healthy, institutionalized, and AD elderly subjects. **Methods:** In a cross-sectional study, we evaluated 78 elderly individuals (healthy = 37, AD = 22, institutionalized = 19) using the Mini-Mental State Examination (MMSE), Floor Maze Test (FMT) and 8-foot-up-and-gotest (8UG) to assess global cognitive function, spatial navigation and motor function, respectively. **Results:** In the FMT, the immediate maze time (IMT) and delay maze time (DMT) were significantly shorter in the healthy group than those of the institutionalized and AD groups ($X^2 = 31.23$; $p < 0.01$) and ($X^2 = 41.21$; $p < 0.01$), while there were no significant differences between the AD and institutionalized groups in terms of the DMT and MMSE results. However, the institutionalized group showed worse results in terms of IMT ($p < 0.01$) and 8UG ($p < 0.01$) than those in the dementia group. **Conclusion:** Our results indicate that both institutionalized older people and patients with Dementia have a deficit in the spatial navigation ability, cognitive functions and motor skills. We should consider that there might be a possibility of underdiagnosis in institutionalized older people.

KEYWORDS

Floor Maze Test, institutionalized, elderly, cognitive decline, dementia.

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INTRODUCTION

Alzheimer's disease (AD) is the most common form of dementia[1] and the cost estimates have improved, which reflects on economic burnout, with cost of approximately $818 billion[2]. Functional dependency and cognitive decline are the major causes of institutionalization as a result of residence long-term social and nursing care facilities (LTCF)[3].

Recent studies suggested that who have become institutionalized present more cognitive decline than those who remain in the community[4-6]. Institutionalization leads to a reduction in the motor demands inherent in social life and shows an important relationship with the decrease in cognitive abilities[7]. In general, the physical activities undertaken in LTCF, in general, do not provide the appropriate intensity to improve the adaptative responses in the elderly[5]. Sedentary behaviour is associated with a decline in executive functions, a cognitive domain that is related to spatial navigation[8,9].

Spatial navigation ability is one of several interrelated cognitive domains that require contributions from cognitive processes such as visual perception, learning, memory, and executive functions[10,11]. Spatial navigation can be subdivided into egocentric and allocentric domains. Egocentric navigation is related to the construction of a static mental map, in which each object has a place in the environment, and the spatial navigation of the beginning to the final is planned. On the other hand, allocentric navigation presents a fluid environment that is susceptible to the variations required for cognitive skills associated with mental flexibility and processing speed[12].

Recent studies have shown that spatial navigation is a complex skill and an important marker of the progression of dementia. The allocentric frame is particularly related to the location of place cells, hippocampus, entorhinal, prefrontal and parietal cortexes, areas that commonly undergo degeneration in dementia[13]. The Floor Maze Test (FMT) is a new tool used to measures the capacity for path integration, planning and execution of tasks[14]. Better performance in the FMT has been associated with lower risk of cognitive decline and may be useful for assessing cognitive abilities, considering the low cost, ease of application and ecological characteristics[10-12]. Recently, Verghese *et al.* verified, that every 10 seconds in the FMT score is related to 25% increase in the risk of dementia[15].

Notwithstanding the impairment of cognition promoted by the institutionalization of the older people, studies have demonstrated changes in the ability of these elderly individuals to deal with spatial information[16]. Thus, social isolation decreases responses to motor stimuli and cognitive health, indicating a possible influence on executive function, and the risk of dementia. Furthermore, many studies have revealed that dementia and cognitive disorders are underdiagnosed in the elderly in LTCF[5]. In the present study, we compared spatial navigation in three groups of elderly individuals: healthy, institutionalized, and patients with Alzheimer's disease (AD). We hypothesize that older people with dementia would present more significant impairment, followed by institutionalized, and then healthy older people.

METHODS

Study design and participants

In this cross-sectional study, 78 older subjects (>60 years) were recruited from the community (healthy control group = 37), long-term care facilities (LTCF) (institutionalized group = 19) and in the Center for Alzheimer's Disease and other Mental Disorders in Older Persons at the Institute of Psychiatry of the Federal University of Rio de Janeiro(AD group = 22). AD was diagnosed by the medical staff composed by psychiatrists, trained to perform screening according to the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV)[17] and the National Institute of Neurological and Communicative Diseases and Stroke/Alzheimer's Disease and Related Disorders Association (NINCDS-ADRDA)[18]. Patients were classified as mild, moderate, or severe stage according to the Clinical Dementia Rating (CDR)[19].

The control group was recruited from the community and they included individuals without neurological or psychiatric diseases, who were cognitively healthy by clinical evaluation and Mini-Mental State Examination (MMSE)[20]. The clinical assessment evaluated Neurological or psychiatric diseases. The institutionalized group was recruited from four (LTCF) in the city of Rio de Janeiro.

Participants with less than 4 years of schooling; severe dementia (for AD) and diagnosis of any psychiatric or neurological disease (in the institutionalized group) were excluded from the study. This study was approved by the Ethics Committee of the Institute of Psychiatry of the Federal University of Rio de Janeiro (CAAE 42349815.0.00005263), and all participants provided written informed consent before participating in any procedure.

Procedure and tests

The global cognition was evaluated using Mini-Mental Statement Exam (MMSE)[21], Clinical Dementia Rating (CDR) scale, Floor Maze Test (FMT)[12], and 8 feet up and go test[22].

The FMT measures skills of orientation, as it entails walking through a two-dimensional maze. Participants were positioned at the entry to the maze and then given instructions to find the only correct route to the exit. Two stages were evaluated: IMT, which is the time spent walking between the entry to the maze and the successful exit, and DMT, which is the time spent in repeating the second period,

performed after 10 minutes, without planning. During this interval, the participants were not able to maintain visual contact with the maze. In this test, the time spent during each stage was measured and the wrong route was counted as an error.

8 foot-up-and-go test (8UG) assesses agility and dynamic balance and was validated[22] as a tool to evaluate motor decline, balance reduction and premature risk of mobility loss and falls. The participant started from the sitting position in a chair, walked in a straight line for 8 feet, proceeded around a cone, and returned to the initial position, as quickly as possible. Three trials were performed, and the best performance was used in the analysis.

Statistical analysis

To verify normality and homoscedasticity, the Kolmogorov-Smirnov and Levene Test were applied, respectively. Demographic characteristics, MMSE, 8UG, and FMT (IMT and DMT) results were compared among groups using ANOVA or Kruskal-Wallis tests, with Bonferroni and Tamhane's T2 post hoc analyses. The chi-square test was used to identify gender distribution for each group. All statistical analyses were performed using SPSS® version 19.0 and $p \leq 0.05$ was considered to indicate statistical significance.

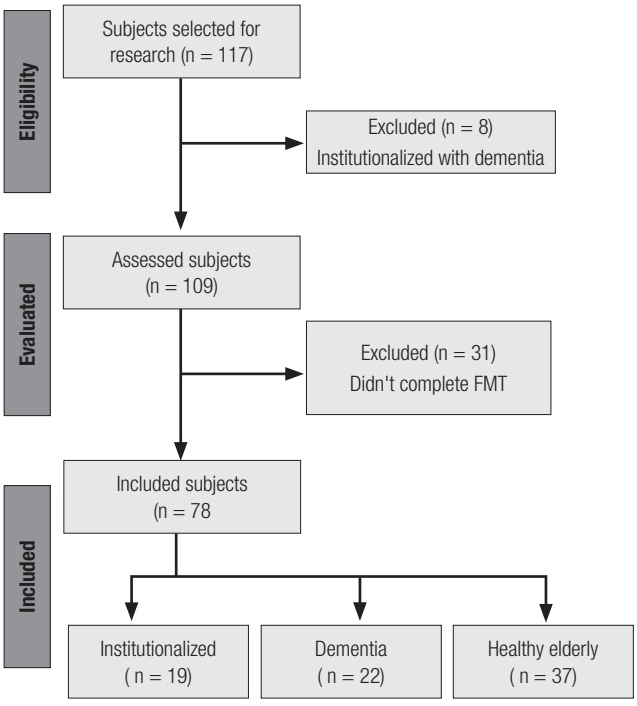

Figure 1. Flowchart of the study selection protocol.

RESULTS

We recruited a total of 117 and included 78 subjects. Among institutionalized, eight older people were excluded (dementia) and 31were not able to perform FMT (Figure 1).

There were no significant differences among the groups in terms of body mass index (BMI) and medication. The healthy group was younger than the institutionalized group ($p = 0.01$). However, there was no significant difference in age between the institutionalized and AD groups ($p = 0.56$), as well as between healthy and AD groups ($p = 0.015$). We found a higher prevalence of women in the healthy group ($p < 0.05$). We also found significant difference in gender between healthy group and both AD ($p = 0.001$) and institutionalized ($p = 0.002$). As expected, the healthy group showed better cognitive performance than the institutionalized ($p < 0.01$) and AD ($p < 0.01$) groups, while there was no significant difference between the institutionalized and AD groups ($p = 0.14$). Moreover, the institutionalized group showed a poorer performance in the 8UG than the dementia ($p < 0.01$) and healthy ($p < 0.01$) groups (Table 1).

There was no significant difference between the AD and institutionalized groups in terms of the DMT results of the FMT ($p > 0.13$). However, the IMT results were better in the AD group than those in the institutionalized group ($p < 0.01$). As expected, the IMT and DMT were faster in the healthy group than those in the institutionalized and AD groups ($X^2 = 31.23$; $p < 0.01$) and ($X^2 = 41.21$; $p < 0.01$) (Table 2).

Table 1. Demographic characteristics groups

	Institutionalized (n = 23) Mean ± SD	Dementia (n = 22) Mean ± SD	Healthy (n = 37) Mean ± SD	X^2 (p)
Age, Y	84.3 ± 6.77	81.0 ± 8.08	75.2 ± 8.43[a]	12.10 (p = 0.002)
Gender, N (Female %)	17 (65.4%)	11 (50%)	33 (89.2%)[a,b]	13.02 (p = 0.001)
BMI+, kg/m^2	26.3 ± 4.51	25.9 ± 4.28	25,8 ± 2,81[#]	0.10 (p = 0.901)
Medication, N	8.2 ± 4.40	4.8 ± 2.50	2,4 ± 2,04	1.59 (p = 0.451)
MMSE, score	22.7 ± 5.90	21.6 ± 3.91	28.3 ± 1.89[a,b]	36.72 (p < 0.001)
8UG, sec	16.0 ± 6.02	8.2 ± 2.50[a]	7.1 ± 2.87[a]	31.74 (p < 0.001)

+ 6 participants are excluded to missed odds by medical records; BMI: body mass index; MMSE: Mini Mental State Exam. # F value (ANOVA); 8UG: 8-foot up and go test.
[a] $p < 0.05$ compared to institutionalized group; [b] $p < 0.05$ compared to dementia group.

Table 2. Group comparisons of the Floor Maze Test immediate and delay times

	Institutionalized group Median (min-max)	Dementia group Median (min-max)	Healthy group Median (min-max)	X^2 (p)
FMT Immediate (s)	114 (17-274)	59, (20-188)[a]	21.06 (9.65-196)[a,b]	31.22 ($p < 0.001$)
FMT Delay (s)	88 (17-255)	86.51 (16-281)	16.34 (9.46-169)[a,b]	41.20 ($p < 0.001$)

[a] $p < 0.05$ compared to institutionalized group; [b] $p < 0.05$ compared to dementia group.

DISCUSSION

In the present study we compared spatial navigation ability in elderly healthy controls, institutionalized individuals and patients with AD. Our results showed similar cognitive impairment in older adults living in LTCFs and patients with AD, suggesting that elderly individuals in LTCF have a high risk of dementia, although few screening psychiatric evaluations are implemented, leading to underdiagnosis in this population**.** Several studies have shown a cognitive decline in institutionalized elderly individuals[3-7], and the hospitalization and social isolation have also been shown to have significant impacts[23]. Among other factors, the increased sedentary behaviour correlates with motor and cognitive decline in this population[24,25]. Institutionalization appears to contribute to the decline in executive function and motor skills associated with the reduction in mobility and social interaction of the elderly, which does not necessarily occur in the dementia group. The older people living in LTCF seem to experience more impairment of executive function than older adults living at community, while there is no difference in the decrease in memory ability between the groups.

Our results corroborate previous studies, showing that impairment in IMT and DMT FMT performance is associated withAD[11] and risk of dementia[15]. Moreover, longer times in FMT have been associated with cognitive impairment, with particular effects on executive functions, attention, learning and memory[10]. Verghese *et al.* showed that IMT in FMT was a stronger predictor of dementia than DMT[15].One possible explanation is the complexity of integration of the executive functions and dynamic balance in the IMT. Indeed, the DMT seems to be more related to hippocampus activation and memory than the IMT.

In this study, the institutionalized elderly group showed worse results in 8UG compared to that of the community-dwelling older individuals with dementia. Indeed, Maseda *et al.*[26] suggest that the institutionalization process could provide to the impairment of physical capacities. A decline in motor function among elderly people with dementia was also identified by Plácido *et al.*[27] and de Oliveira Silva *et al.*[28].

The relationship of the MMSE and the 8UG with the IMT and DMT suggests a relevant influence of motor and cognitive skills in the FMT, reinforcing the ability of this test to predict physical and cognitive decline. Particularly, in low- and middle-income countries, where dementia is widely underdiagnosed, simple strategies to screen the cognitive decline are urgently required. Estimated that 77% of people with dementia in Latin America countries have not been diagnosed[29]. The absence of diagnosis can be even worse in LTCF, considering the cognitive impairment observed after institutionalization[5].

The implementation of strategies that encourage cognitive and motor engagement of the older people in LTCF may protect their physical and mental health, contributing to improved functionality and independence. It should be noted that this study was limited by the small sample size and the cross-sectional design. The study lacks some information in the medical records, as well as the duration of disease and institutionalization. The recruitment of the control group can present a possible bias, given the lack of control by sex and age. Finally, it is not possible to guarantee that the institutionalized group was not dementia, considering the underdiagnosis observed in Brazil.

CONCLUSION

Our results suggest that the institutionalized older people have a deficit in the spatial navigation ability, cognitive functions and motor skills, similar to that observed in AD patients. Possible underdiagnosis should be considered in institutionalized older people. Studies investigating the cognitive function before and after institutionalization are needed to better understand a possible relationship between cognitive decline and long-term social and nursing care facilities, especially in low-to-middle income countries.

CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

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