Impact of the COVID-19 pandemic on the cognitive and motor functions of older people: a 3-year cohort study

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Abstract

Objective: To analyze the impact of the COVID-19 pandemic on the cognitive and motor functions in older people. *Method:* In this cohort study, 90 older persons underwent cognitive (Mini-Mental State Examination and Frontal Assessment Battery) and motor (Timed Up and Go test and International Fall Questionnaire) tests in two moments: before the first case of the COVID-19 pandemic have been identified in Brazil and after the end of the state of public health emergency. The multiple analysis of variance was applied with the Wilk's lambda test to verify the impact of the COVID-19 pandemic on the factors "time" (pre × post-pandemic), "group" (sex, marital status and education) and "interaction" (time × group). Effect size and statistical power are reported. Significance was set at 5%. *Results*: Older persons presented cognitive decline during the COVID-19 pandemic (effect size: 0.43; statistical power: 99.8%; p=0.001). The decline was similar according to sex (p=0.864), marital status (p=0.910) and schooling (p=0.969). The participants also suffered a motor decline during COVID-19 pandemic (effect size: 0.74; statistical power: 99.9%; p=0.001). The decline was similar according to sex (p=0.542) and marital status (p=0.260). Participants with lower educational level suffered greater physical decline than persons with higher schooling (effect size: 0.38; statistical power: 97.6%; p=0.004). *Conclusion:* The COVID-19 pandemic affected the cognitive and motor functions of older persons. Participants with low schooling suffered a greater decline of their physical health during the pandemic, a fact that should encourage further studies on this thematic.

Keywords: Pandemics. Covid-19. Aged. Delivery of Health Care. Public Health.

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INTRODUCTION

Since 2020, the world has been experiencing a health crisis caused by the Sars-Cov-2 virus, responsible for COVID-19. Characterized by a high rate of transmissibility and a high risk of complications, health authorities have recommended social isolation as the best way to prevent the disease[1]. With the advent of vaccination, the rigor of social isolation has been decreasing and the use of masks has been released by many governments[2].

In April 2022, the Brazilian government decreed the end of the state of public health emergency. The period between 2020 and 2021 was one of great turbulence in the country. Faced with conflicting disclosures from the federal government encouraging the use of drugs without scientific proof against COVID-19 and often questioning the use of masks and the importance of vaccination, the population found itself uncertain about the best path to follow[3,4].

By January 2023, more than 36 million Brazilians had been diagnosed with COVID-19. Of these, approximately 700,000 lost their lives to the disease. Estimates indicate that more than 100,000 older people were victims of COVID-19, impacted mainly by the physical weakness that the disease brings[5-7].

Previous studies indicate how the COVID-19 pandemic affected the health of older people. Research points to effects arising from physical inactivity, social isolation and sequelae caused by the disease[7-9]. Studies also demonstrate impairment of both physical and mental health[10-12]. Most works, however, addressed older people during the pandemic, not assessing people's health before and after the advent of COVID-19.

The aim of this study was to investigate the physical and mental health of older people before the first case of the COVID-19 pandemic was identified in Brazil and after the end of the public health emergency decreed by the federal government.

METHOD

This research consists of an epidemiological, cohort and analytical study carried out in the municipality of Campo Grande, state of Mato Grosso do Sul. The research was approved by the Institutional Research Ethics Committee (protocol n. 4,833,758). The ethical precepts present in Resolution number 466 of the Ministry of Health and in the Declaration of Helsinki were respected. All participants signed in writing their consent to participate in this research.

The methodological procedures are reported according to the criteria defined by the Strobe initiative. The sample was selected for convenience to ensure similar age and schooling between men and women. Participants were recruited in public environments in the city in a probabilistic and stratified manner so that all regions were covered.

The selection of participants was based on the quantitative identified by sample statistical calculation. For this, the researchers used the alpha error at 5%, the statistical power at 80% and the effect size of 0.30[13]. The inclusion of these factors in a longitudinal design formed with two evaluation moments found a critical value in the Fisher table of 4.05 and a non-centrality parameter of 8.28. The result indicated the need for 86 older participants so that type 1 (alpha error) and type 2 (beta error) statistical errors were controlled.

To be included in this study, participants should be at least 60 years old, have no neurological or psychiatric disorders or any motor problem that would prevent them from performing the tests. Subjects who during the pandemic period came to present diseases not present in the original recruitment were excluded. Deaths, address changes, lack of contact and withdrawal from participation were reported as sample losses.

The researchers initially collected personal, social, and demographic information from the participants. These constituted the research's independent variables. The variables collected at that time were: age, sex, education level, marital status and professional occupation. Then, a series of cognitive and motor tests were applied, with the aim of comparing the impact of the pandemic on the physical and mental health of the participants. These constituted the dependent variables of the research, evaluated before the first case of COVID-19 was identified in Brazil and after the end of the state of public health emergency

decreed by the federal government[14]. The period between assessments was three years.

The analysis of cognitive functions involved the Mini Mental State Examination (MMSE)[15] and the Frontal Assessment Battery (FAB)[16]. The MMSE was used to assess the participants' general cognitive aspects, such as temporal and spatial orientation, word registration, attention, calculation, immediate and delayed memory, language and visuoconstructive praxis. The test ranges from 0 to 30 points, and the lower the score, the greater the risk of the person having cognitive impairment[15].

The FAB was included because it assesses participants' prefrontal executive functions. The instrument assesses the following executive skills: conceptualization, mental flexibility, motor programming, task conflicts, inhibitory control and environmental autonomy. The instrument score ranges from 0 to 18 points, with lower scores indicating a higher risk of cognitive impairment[16]. Both in the MMSE and in the FAB, schooling was taken into account in the analysis of scores, given the impact it has on cognitive tests[17].

The physical health of the participants was analyzed using the Timed Up and Go test (TUG)[18] and the Falls Efficacy Scale – International (FES-I)[19] instrument. The TUG is a validated mobility test for the older population. The test measures the time and number of steps required for a person to get up from a chair, walk three meters, return and sit down in the chair. In the present study, the TUG was applied with and without dual-task distractors, given the impact that aging has on people's simultaneous functional activities[20]. Thus, the participants performed the test in a conventional way and also taking a glass of water (dual-task with motor distractor) or saying the names of animals (dual-task with cognitive distractor). The order of the tests among the participants was randomized so as not to cause a learning effect on the results.

The FES-I scale was applied to analyze the participants' concern about falls. The instrument measures both domestic activities and social and physical tasks performed outdoors. In this instrument, higher scores indicate greater insecurity and risk of falls.

In this research, the researchers listed the following statistical hypotheses: Null hypothesis (H_0) - The COVID-19 pandemic did not affect the cognitive and motor functions of older people; Alternative hypothesis (H_A) - The COVID-19 pandemic affected the cognitive and motor functions of older people.

Statistical analysis involved the characterization of results in mean and standard deviation (for continuous variables) and in relative and absolute frequency (for categorical variables). The researchers applied multiple analysis of variance tests for repeated measures associated with the Wilk lambda test to verify the physical and cognitive scores of participants before the COVID-19 pandemic and after the public health emergency.

Univariate analyzes were applied by dividing participants into groups according to social and demographic factors. With this, it was possible to compare the effects of the "group" factors (gender, marital status, education and professional occupation), under the variable "moment" (pre-pandemic situation × post public health emergency state) and in the interaction "group × moment". Effect size and statistical power were reported. Significance was assumed at 5%.

RESULTS

One hundred and ten participants were originally recruited for this research. Given the eligibility criteria and follow-up period, the sample was reduced to 90 participants, 65 women and 25 men. Sample losses did not compromise the minimum number of subjects delimited by the previous sample calculation.

The participants were all from the municipality of Campo Grande, state of Mato Grosso do Sul, living with their families. Table 1 demonstrates the socio-demographic characteristics of the participants.

Table 1. General characteristics of the participants (N=90). Campo Grande, MS, Brazil 2022.

Variables	Men	Women	*p*
Sample size, %	27.8	72.2	0.001
Age, years	68.1 ± 7.0	68.6 ± 7.3	0.797
Schooling %			0.297
University education	36.0	32.3	
High school	36.0	23.1	
Elementary School	28.0	44.6	
Marital status %			0.001
Single	4.0	15.4	
Married	80.0	41.5	
Divorced	4.0	13.8	
Widow(er)	12.0	29.3	
Professional occupation %			0.001
Retiree	64.0	35.4	
Homemaker	0.0	50.8	
Active	36.0	13.8	

Data are expressed as mean ± standard deviation for age and percentile for other variables. *p* values from Student's t test for age and chi-square for other variables.

Analyzing the impact of the COVID-19 pandemic on participants' cognition, a decline in cognitive functions was observed in the pre-pandemic × post public health emergency comparison. The inferential analysis identified that the impact of COVID-19 on the cognition of the older people had an effect size of 43%, under a statistical power of 99.8% and significance of 1%. The greatest decline occurred in the Frontal Assessment Battery, responsible for measuring prefrontal executive functions. Table 2 details the cognitive scores of the participants in the two evaluated moments.

By including the sex factor in the statistical model, it is observed that the cognitive values were similar between men and women (p=0.703). Cognitive decline during the pandemic occurred in both sexes (p=0.001) and at the same intensity (p=0.864).

Regarding marital status, cognitive values were similar among single, married, divorced and widowed individuals (p=0.285). There was cognitive decline in all groups (p=0.001) and at the same intensity (p=0.910).

Regarding schooling, participants with elementary education had lower cognitive scores on the MMSE and FAB than people with higher education (p=0.005). Cognitive decline occurred in participants of all educational levels (p=0.001) and at the same intensity (p=0.969).

Professional occupation did not interfere with cognitive decline. Professionally active participants had the same cognitive performance as retired or homemaker participants (p=0.956). With the follow-up period, cognitive decline occurred in all groups (p=0.001) and at the same intensity (p=0.308). Figure 1 shows participants' cognitive scores according to gender, marital status, education and professional occupation.

Table 2. Participants' cognitive scores, Campo Grande, MS, Brazil 2022.

Cognitive variables	Initial assessment	Final assessment	Effect size	Statistical power (%)	*p*
Mini Mental State Examination, pts	26.1±2.6	24.5±2.8	0.24	93.1	0.001
Frontal Assessment Battery, pts	14.4±2.8	12.2±2.9	0.35	99.4	0.001

Data are expressed as mean ± standard deviation. *p* values, effect size and statistical power from analysis of variance tests for repeated measures.

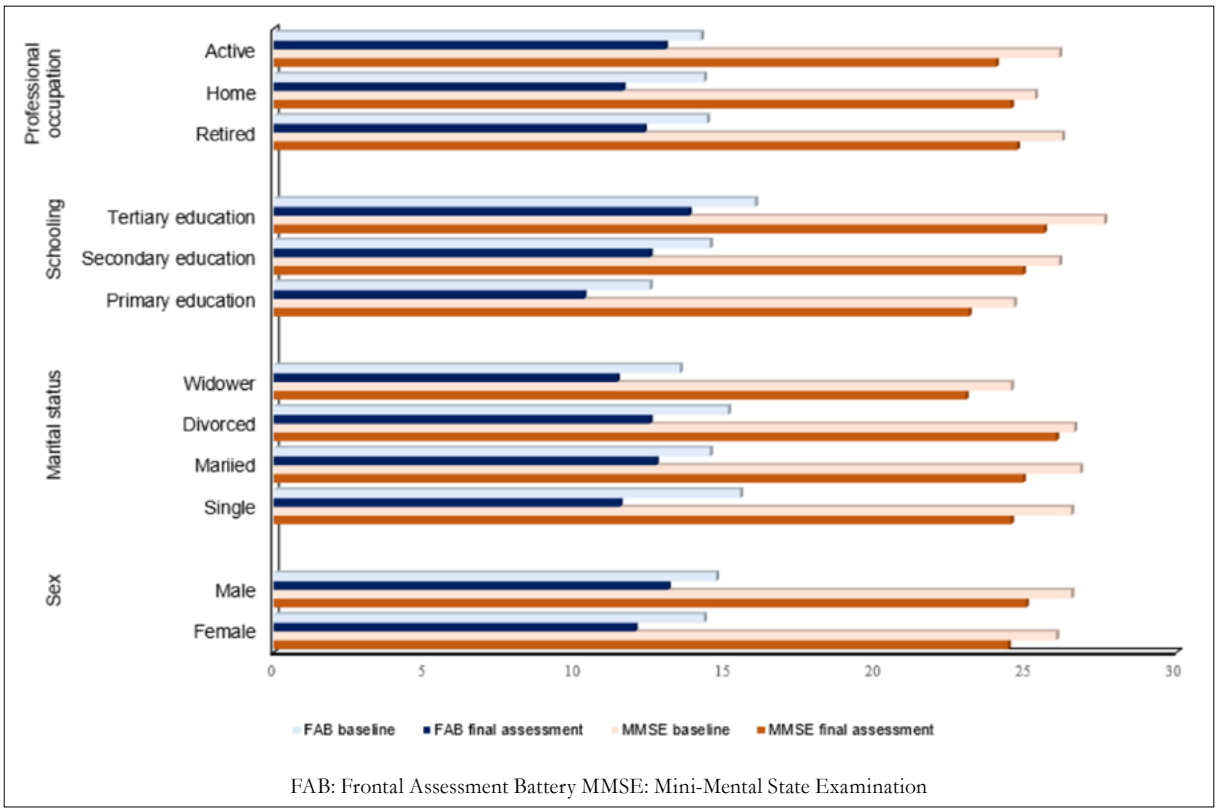


Figure 1. Cognitive scores of participants according to gender, marital status, education and professional occupation, Campo Grande, MS, Brazil, 2022.

Analyzing the impact of the COVID-19 pandemic on the physical health of the participants, a decline in scores was observed in the comparison pre-pandemic × post state of public health emergency. Inferential analysis identified that the impact of COVID-19 on the physical health of older people had an effect size of 74%, under a statistical power of 99.9% and significance of 1%. Table 3 shows the values of the TUG and FES-I tests. Univariate analyzes indicate that the impact of the pandemic was mainly on the number of steps taken in the TUG test and in the FES-I falls questionnaire ($p<0.05$).

By including the sex factor in the statistical model, it is observed that the results of the physical tests were similar between men and women ($p=0.168$). Motor decline occurred in both genders ($p=0.001$) and at the same intensity ($p=0.542$).

Regarding marital status, the motor results were similar among single, married, divorced and widowed individuals ($p=0.470$). There was motor decline in all groups ($p=0.001$) and at the same intensity ($p=0.260$).

Regarding schooling, participants with primary education had worse motor performance than people with secondary and higher education ($p=0.001$). The decline in motor functions occurred in people of all educational levels ($p=0.001$), but at different intensities. That is, people with lower levels of education showed

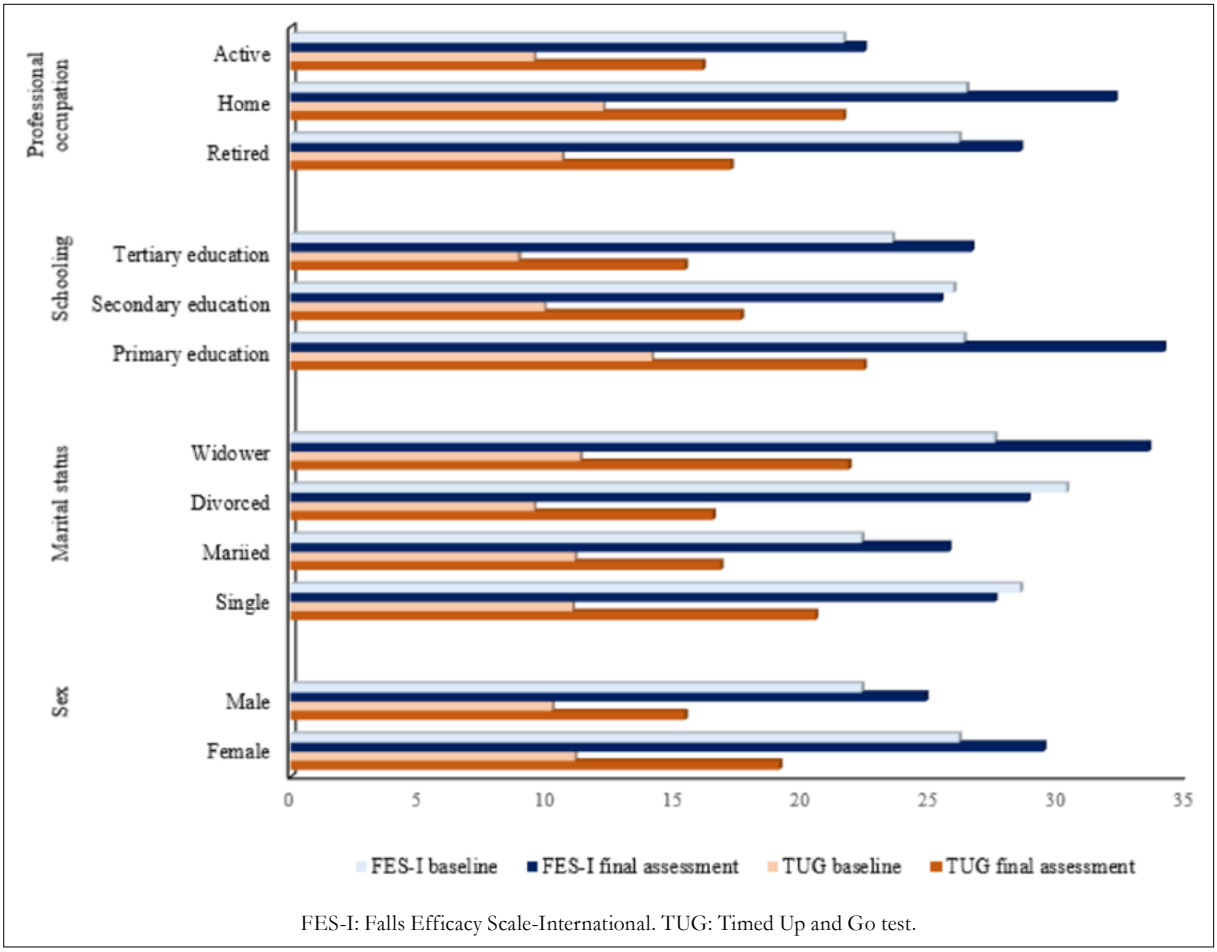
greater motor decline during the pandemic than people with higher levels of education (p=0.004).

Professional occupation did not interfere with the physical health of the participants. Active professionals had the same performance in the TUG and FES-I as retired or homemaker participants (p=0.144). With the follow-up period, motor decline occurred in all groups (p=0.001) and at the same intensity (p=0.808). Figure 2 shows the participants' physical test scores according to sex, marital status, education and professional occupation.

Table 3. Values of the physical functions of the participants, Campo Grande, MS, Brazil, 2022.

Physical variables	Task	Initial assessment	Final assessment	Effect size	Statistical power (%)	p
Timed Up and Go, time	Simple	15.0±2.7	13.9±6.6	0.05	30.3	0.147
	Motor	15.8±3.1	15.3±7.1	0.01	8.4	0.582
	Cognitive	16.5±4.6	17.2±10.1	0.01	9.8	0.516
Timed Up and Go, steps	Simple	10.8±3.5	18.3±5.9	0.74	99.9	0.001
	Motor	11.7±5.3	18.9±6.8	0.61	99.9	0.001
	Cognitive	14.2±5.5	18.0±6.4	0.35	99.4	0.001
Fall instrument, pts	Risk of falls	25.2±6.4	28.4±8.8	0.18	83.0	0.005

Data are expressed as mean ± standard deviation. p values, effect size and statistical power from analysis of variance tests for repeated measures.



FES-I: Falls Efficacy Scale-International. TUG: Timed Up and Go test.

Figure 2. Physical scores of participants according to gender, marital status, education and professional occupation, Campo Grande, MS, Brazil, 2022.

Including the variable "age" as a dependent factor in multivariate tests, it was observed that this variable did not interfere with cognitive aspects (p=0.104). Differently, age interfered with the physical health of older people. That is, older participants had worse motor responses than younger participants (p=0.001). Under a longitudinal analysis, it was found that the COVID-19 pandemic caused greater physical decline in older seniors than in younger seniors (effect size for "age × moment" interaction: 0.78; statistical power: 99.9%; p=0.001).

DISCUSSION

The aging process generates several changes in the body. These alterations involve motor and cognitive decline, which tend to affect the independence and health of the older person[21,22]. The present study was developed during the COVID-19 pandemic to verify how much the pandemic intensified the physical and cognitive losses natural to aging.

The results indicated a direct impact of the pandemic on the participants' cognitive functions. Physical decline, in contrast, has been affected by both the pandemic and aging. Gender, marital status and professional occupation had little impact on the results. Low education was a risk factor for physical decline during the pandemic. Understanding these factors is essential for providing public health policies that guarantee access to health and quality of life for the older population[23].

The assessment of cognitive functions involved the MMSE and the FAB. These instruments were chosen because they analyze both general cognitive aspects (such as temporal-spatial orientation, word registration, attention, calculation and memory) and prefrontal executive functions (known for requiring great brain connectivity and processing complexity)[24]. Thus, the inclusion of both instruments allowed a complete analysis of the participants' cognitive functions.

Table 2 details the pre-pandemic and post-state public health emergency MMSE and FAB values. Comparisons show a decline in participants' scores on both instruments during the pandemic. Even though there has been a decline in cognitive functions, the initial and final assessments show normal scores according to the cutoff scores of both instruments[25,26]. That is, cognitive decline occurred, but it was not indicative of dementia.

The inclusion of the age factor in the statistical model indicated that cognitive decline occurred exclusively due to the impact of the pandemic and little was due to physiological changes due to aging. This result is confirmed by medium- and long-term follow-up cohort studies, which indicate a longer time to justify cognitive decline caused by age[27,28].

The inclusion of social and demographic variables aimed to complement the data analysis and investigate the impact of the pandemic and these variables on people's lives. Figure 1 demonstrates that cognitive decline was similar between men and women, people in different marital situations and with different professional occupations. That is, these aspects had little impact on the decline of cognitive functions in older people.

By including social and demographic factors as independent variables, the researchers intended to strengthen the originality of this study. So far, research that has analyzed the impact of COVID-19 on mental and cognitive health has barely addressed the interference of social and demographic factors[29].

In a study carried out with 365 people, Peng *et al.*[30] identified that COVID-19 had a greater impact on the health and well-being of women than men. Married people had greater resilience during COVID-19 than single people. This result differs from that found in the present study, which observed similar responses according to gender, marital status and professional occupation. The divergent findings between studies may have occurred due to the age difference of the sample, where people aged over 60 years were approached here and the sample by Peng *et al.*[30] involved mainly adults. Differences between studies should serve as incentives for further research exploring the impact of COVID-19 on people of different age groups, gender, marital status and professional occupations.

The level of education, on the other hand, significantly interfered in the cognitive results of the participants. People with low levels of education

had lower scores on cognitive tests than people with higher levels of education (figure 1). This result was expected because the cognitive instruments have different cutoff scores according to the participants' education level[25,26]. That is, people with low literacy tend to have lower scores on cognitive instruments than people with higher levels of education.

Even though people with low education had lower initial and final values than people with higher educational levels, the longitudinal analysis showed that the difference in values was similar between groups. That is, the impact of the COVID-19 pandemic on cognitive functions was similar across different educational levels. On the one hand, this result surprised researchers, as a person's greater literacy tends to serve as a cognitive reserve mechanism and decrease cognitive decline[31]. On the other hand, the follow-up period may have been short and not sensitive to verify greater cognitive decline in one group compared to the other.

Participants' physical health was assessed using the TUG test and the FES-I scale. The researchers chose to include both instruments due to their potential to assess mobility and balance problems, so common during aging[32]. In addition, the TUG was evaluated with and without a dual-task distractor as a way to bring the mobility activity closer to the reality of the older person. As previous studies have shown motor decline in older people during the COVID-19[7-10] pandemic, the use of these instruments proved to be adequate to verify the participants' mobility and fear of falls during this period.

Table 3 details the pre-pandemic and post-state public health emergency physical test values. The analyzes prove the negative impact of the COVID-19 pandemic on the physical health of the older people, where the participants, in the end, needed to perform the activity with a greater number of steps than in the initial assessment. Carrying out the activity with a greater number of steps may demonstrate an insecurity of the older person, who needed short steps and larger support bases to perform the walk test. This finding is in line with the result of the FES-I, where, in the final assessment, the participants presented results consistent with greater fear of falls than in the initial assessment.

The inclusion of the age factor in the statistical model indicated that the physical decline of the participants was impacted by both the COVID-19 pandemic and the age of the participant. That is, the pre-pandemic and post-public health emergency follow-up period was sufficient to culminate in the physical decline of older people, whose decline was influenced by the age of the person and was intensified by the pandemic.

For this issue, the authors believe that social isolation, so important to prevent hospitalizations and deaths at a time when vaccination against COVID-19 was not yet available[33], may have intensified the physical decline of the participants. During social isolation, older people were restricted to the domestic environment and physical inactivity may have contributed to the subjects' motor decline[34].

Similar to what was found in the analyzes of cognitive functions, gender, marital status and professional occupation had little effect on the physical decline of the participants. That is, the decline was similar between men and women, people in different marital situations and with different professional occupations. Schooling, however, was a risk factor for physical decline. Statistical analysis indicated that people with a lower level of education have worse physical values than people with a higher level of education. In addition, people with less education experienced greater physical decline during the COVID-19 pandemic than people with more education.

For this question, Oehlschlaeger *et al.* [35] reported that people with lower educational levels tend to be more sedentary than people with higher educational levels. As a sedentary lifestyle has a direct impact on the physical health of older people[7,34], the authors believe that low education may be linked to a lower level of physical activity in this group, affecting the motor variables of the study.

Although this study found important results on the impact of COVID-19 on the health of older people, it has some limitations that should be taken into account by readers. The main limitation refers to the effect size of the impact of the pandemic, which was between 0.43 for cognitive variables and 0.74 for physical variables.

The effect size may have been influenced by the cognitive and physical tests chosen by the researchers. The inclusion of other tests could prove an even greater impact of COVID-19 on the lives of older people. That is, the researchers focused the analysis of mental health on cognitive aspects, not including other important aspects such as depression, anxiety level, mood and stress. The inclusion of other aspects could enhance the impact of COVID-19 on the mental health of older people and increase the size of the effect identified in this study.

Similarly, physical tests focused on mobility analysis and fear of falling. The inclusion of other factors, such as muscle strength, agility, flexibility and functional capacity could also enhance the proof of the impact of COVID-19 on the physical health of the older person.

CONCLUSION

This study identified the impact of the COVID-19 pandemic on the health of the older population, taking into account social and demographic peculiarities. Gender, marital status and professional occupation had little impact on the results. Low education was a risk factor for physical decline.

While cognitive decline was affected solely by the pandemic, physical decline was due to the association between the impact of the pandemic and the age of the participant.

The results of this study should be taken into account by professionals in the area of geriatrics and gerontology, and by health managers, with a view to proposing new health policies that guarantee health to the older population.

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