

Investigation of the Effects of COVID-19 on Perception, Attention, Memory, Balance, and Quality of Life in the Elderly

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Objective: This study was conducted with elderly individuals who had recovered from COVID-19 to investigate the effects of COVID-19 on balance, perception, attention, memory, and quality of life and produce rehabilitative solutions for these problems.

Material and Method: A total of 45 volunteers older than 65 years who had not had COVID-19 were included in group 1. A total of 45 volunteers older than 65 years who had recovered from COVID-19 were included in group 2 (elderly people who have had COVID-19 at least 6 months ago). After obtaining the individuals' demographic data, we conducted vestibular assessment for balance and administered the Stroop test for attention, the Mini-Mental State Examination (MMSE), the digit span test for short-term memory, and a quality-of-life test.

Results: Mean age of the individuals who had had COVID-19 was 68.24 ± 3.32 years, and the mean age of the individuals who had not had COVID-19 was 68.55 ± 3.34 years. There

were statistically significant correlations between the two groups for the Stroop test ($P < .05$), MMSE ($P < .05$), the digit span test for perception and attention ($P < .05$), and the vestibular assessment quality-of-life test ($P < .01$). Sensory ($P < .001$), past, present, and future activities ($P < .05$), social participation ($P < .001$), and death ($P < .05$) were found to be significant in the total score ($P < .001$). The covariance analysis of elderly individuals who had had COVID-19 revealed that they performed significantly worse on the balance, perception, attention, memory, and quality-of-life tests than elderly individuals who had not had COVID-19.

Conclusion: The negative effects of COVID-19 were found among elderly individuals older than 65 years. We suggest that telerehabilitation should be developed for elderly people who have recovered from COVID-19 and that its effects investigated.

Key words: attention, COVID-19, elderly, memory, perception, quality of life

The coronavirus disease 2019 (COVID-19) pandemic has affected millions of patients, and the number of those affected is increasing every day.¹ It is therefore

crucial to understand the short- and long-term health consequences of COVID-19.

Elderly individuals are at a high risk of COVID-19, and they experience challenging changes in their daily lives. As a protective measure, elderly individuals older than 65 years have been prevented from going out. However, the spread of the pandemic and the prolonged advice to stay at home to reduce mortality have adversely affected elderly people's mental health, functionality, physical health, balance, and quality of life.²

Coronavirus 2 (SARS-CoV-2) infection causes damage to many systems, including the respiratory, digestive, cardiovascular, renal, immune, and nervous systems.³ More than one-third of hospitalized COVID-19 patients have been reported to experience various neurological symptoms, such as altered cognitive and mental status, cerebrovascular disease, headache, vertigo, anosmia, and aging during the acute phase of infection⁴ and neurological sequelae.⁵ Acute cognitive complications are common; however, the long-term effects of COVID-19 on cognition are not yet clear.⁶

Vertigo or dizziness, which has recently been identified as a clinical manifestation of COVID-19, causes balance

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Ethics approval: All procedures performed in studies involving human participants were accordance with the ethical standards of the institutional and/or national research committee and with the Helsinki declaration and its later amendments or comparable ethical standards. The study was approved by Ankara Yıldırım Beyazıt University Non-Invasive Clinical Research Ethics Committee (16.04.2021-36 with decision no. 184).

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problems.⁷ Especially in elderly individuals, with the effect of immobility, a regression in balance functions can be observed.² The health status of elderly individuals is greatly affected by their ability to continue their daily life activities and routines. In addition, long-term restriction of the movement of elderly individuals causes sarcopenia. Both sarcopenia and conditions secondary to sarcopenia, such as increased falls, cause new problems. The pandemic has thus led to more uncontrolled comorbidities in elderly people.² Moreover, the increase in anxiety and depression, and the reduction in external stimuli due to social isolation, causes dementia and deterioration in cognitive functions as well as worsening quality of life.

The COVID-19 pandemic has affected the whole world not only physiologically but also psychologically, socially, and economically, with the effects still continuing.⁸ Although almost all population groups have been affected by the pandemic, people over a certain age had more severe disease,² and they either died or experienced continuing effects in different ways after the disease. Elderly people, who already face many problems independent of the epidemic, face many problems that affect them negatively psychosocially, as well as health problems, together with the COVID-19 epidemic.⁸

The identification of elderly people as the weakest point in the COVID-19 epidemic, along with their isolation, caused many health, economic, and psychosocial problems.⁸ Advancing age brings weakening and loss of function in movement and motor skills, which are further systemically affected due to the viral infection. We assumed that COVID-19, which affects many systems, also affects balance, attention, perception, and timed task performance, especially in elderly individuals, and accordingly worsens the quality of life.

MATERIALS AND METHODS

The study was approved by Ankara Yıldırım Beyazıt University Non-Invasive Clinical Research Ethics Committee (16.04.2021-36 with decision no. 184). Elderly individuals were evaluated in the Department of Audiology, Ankara Yıldırım Beyazıt University.

GPower 3.1 program was used to determine the sample size for the correlation analysis. At least 45 people needed to be sampled to find the effect width of 0.85 units meaningful, with the power of the test being 85% and the first-type error being 5%.

The eligibility criteria were as follows: (1) people 65 years and older and (2) who agreed to participate in this study. Subjects were excluded if they (1) did not agree to participate, did not understand the questions in the questionnaires, or had communication barriers for language or hearing reasons; (2) had preexisting subjective or diagnosed dementia; (3) had a family history of dementia that might increase the risk of cognitive impairment; (4) had

a concomitant neurological disorder potentially affecting cognitive function; (5) had had any orthopedic or vestibular disease; (6) had received education for less than 5 years; or (7) were unwilling to work.

In the study, 45 volunteers older than 65 years who had not had COVID-19 were included in group 1, and 45 volunteers older than 65 years who had had COVID-19 (elderly people who have had COVID-19 at least 6 months ago) were included in group 2.

Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) is a test that was first developed by Folstein et al for the evaluation of mental status and was found to be valid and reliable in the diagnosis of mild dementia in the Turkish population. MMSE, which measures mental state, is a scale that evaluates cognitive functions in 5 separate categories (orientation, registration, attention and calculation, recall, and language). The total score is 30. Those who score 24 and below should be evaluated for dementia.

Stroop test

The Stroop test was developed by Stroop in 1935. The “Stroop effect” is obtained when the color used in the software of the word and the color expressed by the word are different. The Stroop test measures an individual’s ability to change his or her perceptual setup in line with changing demands and under the influence of a disturbance. Furthermore, it measures an individual’s ability to suppress a habitual behavior pattern and perform an unusual behavior, focused attention, and information processing speed. The most commonly used type is the Color/Word Test.⁹

World Health Organization Quality of Life-OLD

The World Health Organization Quality of Life (WHOQOL) Module for the Elderly consists of 24 items in 6 dimensions, the answers of which are determined using a 5-point Likert scale. Possible dimension scores range from 4 to 20. In addition, the “total score” can be calculated by adding the individual score values. Higher scores indicate an improved quality of life.¹⁰

Digit span test

This is the most commonly used attention/short-term memory test. It consists of 2 parts, forward and backward number ranges. In both, random numbers are read to the subject at 1-second intervals, an increasing number of times in each trial, and the subject is asked to repeat them in the same order. For both parts, the number of digits in the sequence before the one in which the individual fails twice in succession constitutes the range. In normal individuals, the lower limit is generally considered to be 6 forward and 4 backward. The scoring of both sections is the same. If the individual is successful in one of the 2 attempts,

1 point is awarded. Forward and backward point range scores are evaluated separately as well as the sum of both. The highest score that can be obtained for each section is 7 points (14 for the whole test). Attention is necessary for the performance of all cognitive functions, and attention deficit can affect the individual's overall mental state.¹¹

Vestibular Disorders Activities of Daily Living Scale

It was translated into Turkish by Aksoy et al, and its validity and reliability were established in 2007. The scale consists of 28 items and 3 different subscales. The subscales are Functional-F (Functional), Ambulation-A (Ambulation), and Instrumental-E (Instrumental). The Functional subscale includes items related to personal care and close relationships. The Ambulation subscale includes items related to walking. The Instrumental subscale includes household chores and hobbies. In the scale, a 10-point rating system is used, which increases from 1 to 10 according to whether the activity is done independently or dependently. In addition to this decimal rating, there is an item "I am not doing the activity." While applying the scale, it is first evaluated whether the activity in the item is done by the individual. If the person does not do this activity, the item "I do not do the activity" should be marked and it is suggested by the researchers who developed the scale that this item should not be included in the scoring process.¹²

Statistical analysis

In descriptive statistics, the percentage of variables determined by counting and mean \pm standard deviation values of the age variable were used. While performing the statistical analysis, whether the data conformed to the normal distribution was evaluated with histogram curves. According to the normal distribution of the data, the homogeneity of variances, and balance of the number of subjects in the groups,

2 different groups were compared for the numerical measurements of Student's *t* test, also known as the independent-samples *t* test. The Mann-Whitney *U* test was used most often among those who did not show normal distribution.

Chi-square tests were used to test whether the distribution of categorical variables such as gender in the 2 groups was balanced or whether there was a significant difference in the groups. Statistical analyses were conducted with the SPSS10 program.

Linear and logistic regression models were utilized to assess the association between COVID-19 and cognitive outcomes. In linear regression models, cognitive outcomes (MMSE, Stroop test, digit span test) were fitted as continuous variables. Statistical analyses were conducted using SPSS statistical package version 24 (IBM SPSS Statistics for Windows, Armonk, New York).

RESULTS

Table 1 shows demographic data of those who have not had COVID-19 (group 1) and subjects with COVID-19 (group 2).

According to MMSE ($P < .05$) and the digit span test ($P < .05$) results of the cognitive functions and attention and memory assessment tests of the individuals, there was a significant difference between group 1 and group 2 scores (Table 2).

According to the results of Vestibular Disorders Activities of Daily Living Scale (V-ADL) scores used to evaluate the effect of balance on individuals' daily living activities, group 1 and group 2 were found to be significant on comparison ($P < .05$) (Table 3).

Sensory ($P = .001$), past, present, and future activities ($P < .05$), social participation ($P < .001$), observed when group 1 and group 2 scores were compared according to the results of WHOQOL, which was applied to evaluate the

TABLE 1 Demographic Data of Who Have Not Had COVID-19 (Group 1) and Subjects With COVID-19 (Group 2)

Characteristic	Group 1 ^a	Group 2 ^b	Total	<i>P</i>
Age, mean \pm SD, y	68.55 \pm 3.34	68.24 \pm 3.33	68.39 \pm 3.38	.67 ^c
Gender (female/male)	27/18	22/23	90 49/41	
Education, y	5-16	5-16		
Diseases	5	8	13	
Cardiovascular disease	13	11	24	
Diabetes mellitus	12	14	26	
Hypertension	17	12	45	
Other				

^aGroup 1, elderly patients.

^bGroup 2, COVID-19 elderly patients.

^cPearson χ^2 test.

TABLE 2 The Mini-Mental State Examination and Digit Span Test			
	Group 1,^a Mean ± SD	Group 2,^b Mean ± SD	P
<i>MMSE</i>	25.83 ± 2.37	23.40 ± 1.30	.005 ^c
<i>Digit span test</i>	3.83 ± 2.37	5.40 ± 1.30	.009 ^c

Abbreviation: MMSE, Mini-Mental State Examination.
^aGroup 1, elderly patients.
^bGroup 2, COVID 19 elderly patients.
^cMann-Whitney U test.

quality of life, death ($P < .05$), and total score ($P = .001$), were significant ($P < .05$) (Table 4).

When compared with the results of the Stroop test, which is used to evaluate the attention among elderly individuals, a significant difference was found in group 1 and group 2 scores ($P < .05$) (Table 5).

DISCUSSION

Beyond being a disease, the COVID-19 pandemic is a global pandemic that affects individuals, families, and societies biologically, physiologically, psychologically, sociologically, and economically. The pandemic has infected and sickened millions of people around the world since its emergence,¹³ and people are urged to reduce social contacts to a minimum. Although most of the infections are mild and the affected individuals survive, the situation is quite different for elderly individuals, who are among the disadvantaged groups.¹⁴ The problems of old age and the COVID-19 global epidemic have negatively affected the quality of life of elderly individuals. The relationship between COVID-19 and postinfection cognitive change is rarely explored. Our study reveals that elderly individuals who have COVID-19 are more affected physiologically and psychologically than those who do not have the disease.

We found that COVID-19 patients had worse cognitive outcomes for the first 3 months after recovery, suggesting that SARS-CoV-2 infection may affect long-term cognitive performance in patients. From the study, 59.24% of the participants had longitudinal cognitive decline. This study demonstrated a postinfection cognitive impairment in COVID-19 patients. A study by Liu et al⁶ revealed that 6 months postdischarge, the cognitive capacity of COVID-

19 patients and their noninfected spouses, assessed with IQCODE (a questionnaire to assess cognitive functions), showed higher scores indicating greater cognitive declines. Thus, those COVID-19 patients had higher IQCODE scores than controls, which is consistent with our study.⁶ According to our MMSE results, we conclude that elderly patients with COVID-19 performed worse than those who were not infected.

Short-term deterioration in hippocampus-dependent learning and reduced long-term potentiation associated with impairment in spatial memory were observed in mice infected with the influenza virus.^{15,16} In the presence of pro-inflammatory cytokines, the microglial cells also lose their capacity to phagocytose β -amyloid, which accumulates and forms amyloid plaques that are one of the hallmarks of Alzheimer disease.¹⁷ Neuropathological data on COVID-19 cases are scarce, and the few available mostly show hypoxic changes and demyelinating lesions.¹⁸ To evaluate systems with limited capacity in a versatile way, we examined why elderly patients, especially those infected with COVID-19, performed poorly on the Stroop and digit span tests, which are sensitive to hippocampal and prefrontal cortical functions in experimental animals.¹⁶ From the digit span and Stroop tests performed on the study participants, we found that those infected with COVID-19 performed worse than uninfected older individuals. The hypothesis that severely infected COVID-19 patients have poor cognitive impairment is supported by our finding, as months after recovery, these patients were in a more hypoxic state than the uninfected controls.

A study by Sia⁷ reported that dizziness was a symptom of COVID-19. Vertigo or dizziness has recently been identified

TABLE 3 Vestibular Disorders Activities of Daily Living Scale								
	Group 1^a			Group 2^b			t	P
	Min	Max	Mean ± SD	Min	Max	Mean ± SD		
V-ADL (Puan)	49.00	55.00	52.33 ± 10.04	58.00	64.00	61.77 ± 10.90	-2.78	.001 ^c

Abbreviation: V-ADL, Vestibular Disorders Activities of Daily Living Scale.
^aGroup 1, elderly patients.
^bGroup 2, COVID 19 elderly patients.
^cPaired samples t test: $P < .05$; Wilcoxon signed rank test: $P < .05$, $P < .001$.

TABLE 4 World Health Organization Quality of Life-OLD Module

WHOQOL-OLD	Group 1, ^a Mean ± SD	Group 2, ^b Mean ± SD	P
Sensory abilities	13.91 ± 2.11	11.04 ± 2.43	.001 ^c
Autonomy	13.86 ± 2.86	13.22 ± 2.32	.29
Past, present, and future activities	13.51 ± 2.70	11.37 ± 2.77	.05 ^c
Social participation	13.15 ± 2.45	11.71 ± 3.04	.001 ^c
Death and dying	15.02 ± 1.92	11.37 ± 2.52	.05 ^c
Intimacy	12.05 ± 2.09	11.57 ± 2.74	.16
Total	81.64 ± 6.74	71.42 ± 6.79	.001 ^c

Abbreviation: WHOQOL-OLD, World Health Organization Quality of Life-OLD.

^aGroup 1, elderly patients.

^bGroup 2, COVID 19 elderly patients.

^cOne-way analysis of variance, independent-samples *t* test; statistically significant (*P* < .05).

as a clinical manifestation of COVID-19. Countless studies emerging daily from around the world have revealed that dizziness is one of the main clinical manifestations of COVID-19.^{7,19,20} Dizziness has historically been associated with viral infections.

Furthermore, COVID-19, curfew, and quarantine not only made people feel lonely but also reduced mobility, thereby, increasing stress and anxiety. This negatively affects health balance of individuals, especially elderly individuals.^{21,22} It is also known that psychological conditions such as anxiety and stress can cause chronic dizziness and vertigo, which can increase vestibular disorders.^{21,23} We evaluated the effects of dizziness and balance disorders on routine independent activities of daily life using the V-ADL assessment tool. According to the results, the scores of COVID-19 elderly patients were worse than those of the uninfected elderly individuals. It shows that depression, cognitive impairment, risk of falling as a result of balance disorders, and poor quality of life are common geriatric conditions and are detected more frequently in geriatric patients with COVID-19.

The results of another study²⁴ that examined the relationship between cognitive status, balance, and depression in elderly individuals showed that there was a significant relationship between cognitive level, balance, long-term performance, and depression, and cognitive functions and depression problems in elderly individuals negatively affect balance and long-term performance.²⁴ Low morale and depression in elderly individuals negatively affect their mobility and functional levels. This leads to poor quality of life in elderly individuals. In survey studies with WHOQOL-OLD, lower quality-of-life scores were reported during COVID-19 social distancing.

Lower quality-of-life scores were reported during COVID-19 social distancing in survey studies with the WHOQOL-OLD.²⁵⁻²⁸ A study focusing on quality of life in COVID-19 patients demonstrated that WHOQOL-OLD total and subfield scores on the first day of hospitalization were significantly lower in survivors.²⁹ Our findings from WHOQOL-OLD assessment of individuals are also consistent with existing literature; we found that COVID-19 elderly patients' scores are worse than

TABLE 5 Stroop Test

	Group 1, ^a Mean ± SD	Group 2, ^b Mean ± SD	P
Stroop 1	13.08 ± 2.92	21.96 ± 3.81	.001 ^c
Stroop 2	16.52 ± 5.48	25.61 ± 3.37	.001 ^c
Stroop 3	38.72 ± 12.28	39.59 ± 13.58	.06
Stroop 4	58.16 ± 15.08	69.19 ± 13.08	.008 ^c
Stroop 5	91.02 ± 21.68	117.25 ± 21.74	.001 ^c

^aGroup 1: elderly patients.

^bGroup 2, COVID-19 elderly patients.

^cIndependent-samples *t* test; statistically significant (*P* < .05).

those of uninfected elderly individuals. Worse scores were especially evident in sensory analysis, past, present, and future activities, social participation, and death and dying.

In conclusion, attention, memory,⁶ cognitive impairment,^{4,6,17} higher risk of falls,² balance problems, and poor quality of life^{21,29} are common geriatric conditions in older adults with COVID-19.

CONCLUSION

In this study, implications for practice are as follows:

- To provide a holistic approach for treating elderly individuals in line with the findings through the multidimensional handling of the evaluation and follow-up of elderly individuals.
- To identify problems such as balance, perception, attention, and memory that may be experienced by geriatric individuals and to produce rehabilitative solutions for these problems.
- To determine individual patients' needs and create a protocol for this, from data obtained at the end of the study and telehealth, which will form the basis for rehabilitation approaches at home for geriatric individuals after COVID-19.

KEY SUMMARY POINTS

- **Aim:** To investigate the effects of COVID-19 in geriatric population, its effects on perception, attention, memory, vestibular function, and quality of life.
- **Findings:** It has been observed that elderly patients with COVID-19 have a worse quality of life and are more likely to experience problems such as perception and attention, memory, cognitive, and vestibular function than elderly individuals who have not had the disease.
- **Message:** Conditions that negatively affect vestibular function, cognitive, attention, and memory, as well as memory of COVID-19, which can increase depression and decrease the quality of life in elderly individuals, should be evaluated in the early period and necessary protective measures should be taken.

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