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Cognitive functions in COVID 19 patients in Sohag Governorate

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Abstract:

Original Article

Introduction: The majority of severe acute respiratory syndrome (SARS) patients reportedly experienced common complaints like insomnia, poor attention, and memory loss, along with symptoms of anxiety and sadness, suggesting cognitive deficits following SARS infection. ⁽¹⁾ Nevertheless, it is still unclear if cognitive damage is linked to coronavirus infection.

Aim of the work: Assess how the new coronavirus affects cognitive abilities in Sohag Governorate patients with confirmed COVID-19.

Patients & methods: To achieve the target, we enrolled 100 subjects post COVID-19 infections and 50 controls of matching age and gender. All subjects included were subjected to full history taking, otologic examination and Cognitive function assessment (Auditory P300 potential & Montreal cognitive assessment test).

Results: P300 amplitude revealed a highly significant difference (p<0.001), while P300 latency revealed a statistically significant difference (p<0.05) between patients and controls and COVID-19 patients and controls differed statistically significantly (P-value <0.05) in naming and visuospatial.

Conclusion: In COVID-19 patients, cognitive function is compromised, as evidenced by the P300 and MoCA tests. Also, with increase the severity of COVID-19 symptoms, deterioration of cognitive function increase.

Key words: SARS-COV-2 virus, P300, MoCA. **Received:** Februry 12, 2025 **Accepted:** March18, 2025 **DOI**: 10.21608/SMJ.2025.360113.1540 **Published:** May 01, 2025 Corresponding Author: Yasmeen Ali Mohamed

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Introduction:

A number of pneumonia cases in Wuhan, China, with an unclear cause were brought to the attention of the WHO in December 2019. ⁽²⁾ On January 6, 2020, it was discovered that these pneumonia cases were brought on by a novel coronavirus called severe acute respiratory syndrome coronavirus 2 [SARS-CoV-2]. ⁽²⁾

On 30 January 2020, the novel coronavirus outbreak was declared by WHO to be a global health emergency of international concern, meaning the virus was a risk to other countries and required a coordinated international response at which point the organization renamed the novel coronavirus as Coronavirus Disease 2019 [COVID-19] Then, on 11 March 2020, WHO declared COVID-19 a pandemic.^(3, 4)

The disease is mainly transmitted via the droplet route when people inhale droplets and small airborne particles (that form an aerosol). Infectious particles range in size from aerosols that remain suspended in the air for long periods of time to large droplets that remain airborne or fall to the ground $^{(5, 6)}$

Infectivity begins as early as three days before symptoms appear, and people are most infectious just prior to and during the onset of symptoms. It declines after the first week, but infected people remain contagious for up to 20 days. People spread the disease even if they are asymptomatic.

COVID-19's clinical characteristics and severity range from no symptoms to severe or lethal [8]. Coronavirus sequelae can result in fever, dry cough, exhaustion, dyspnea, ageusia (loss of taste), and anosmia (long-term or perhaps permanent loss of smell) ⁽⁹⁻¹¹⁾. The respiratory system may not be the only organ to suffer longterm health effects. Additionally, there might be consequences for medical specialties that don't seem to be connected to COVID-19. ⁽¹²⁾

Numerous symptoms of the central and peripheral neurological systems, such as cerebrovascular disease, reduced consciousness, and vision impairment, have been documented; however, it is impossible to determine if these are COVID-19 complications or drug side effects.⁽¹³⁾

Research on coronaviruses has shown that their aftereffects exhibit neurotrophic and neuro-invasive traits. ⁽¹⁴⁾ There is proof that neurological symptoms have been recorded in as many as 30% 17

of COVID-19 individuals ^(13, 15). It has been noted that COVID-19 patients exhibit symptoms such headaches, dizziness, and altered consciousness ^(16, 17), Additionally, COVID-19 patients frequently experience changes in their taste and smell .(18, 19)

Cognitive deficiencies were also linked to the clinical symptoms in patients with anxiety or depression. ⁽²⁰⁾ Nevertheless, it is still unclear if cognitive damage is linked to the infection with SARS-CoV-2.

Aim of the work:

Assess how coronavirus affects cognitive abilities in Sohag Governorate patients with confirmed COVID-19.

Patients and methods:

Procedure:

Frist Informed Witten consent was taken from all the participants. This search was submitted for approval from Research Ethics committee of Sohag Faculty of medicine according to the committee standerd operating procedure guidelines on 11/4/2021.

Design: Cross sectional study.

Patients:

One hundred patients with a confirmed COVID-19 viral infection were included in the current investigation. Within three months of infection, the age ranged from 20 to 50 years. Fifty controls of the same age and gender were paired with them. There were 57 males and 43 females in the study group, and 30 males and 20 females in the control group

Inclusion criteria:

1. Patients with a high level of education

2. Age: between 20 and 50 years old

3. No prior history of otoneurologic illness or hearing loss

4. Patients with proven COVID-19:

Individuals with coronavirus diagnosed from

-Symptoms include coughing, fever, dyspnea, and widespread malaise.

-Laboratory results include raised AST, ALT, elevated D-dimer, elevated ferritin and C-reactive protein, and abnormal complete blood count (CBC).

- -Imaging: Consolidation, crazy paving, and bilateral ground glass opacities on chest CT images.
- Swab from the nose used for SARS-CoV-2 RT-PCR (polymerase chain reaction) testing.
 (All patients were positive for SARS-CoV-2 RT-PCR)

Methods:

Every participant in this research was exposed to the following:

1- Full history taking:

Detailed information was obtained about COVID-19 include;

- Onset, course, duration of infection.
- Treatment (Responsive or not) and complication (e.g. thrombo-embolic events.
- Meticulous history of hearing disorders, tinnitus or vertigo.

2- Diagnosis of COVID-19:

Which done in pulmonary clinic at Sohag university hospitals. Done by history of characteristic symptoms (malaise, headache, muscle soreness, fever, cough, sore throat, nausea, vomiting, diarrhea, loss of taste and smell, dyspnea, and/or shortness of breath), Lab investigations (e.g. Lymphopenia, RT-PCR, elevated ESR and +CRP) and Radiological (Chest X-Ray and CT).

SARS-COV-2 infection's clinical spectrum. ⁽²¹⁾ **Asymptomatic or pre-symptomatic infection:** those without symptoms typical with COVID-19 who test positive for SARS-COV-2 by virology (i.e., nucleic acid amplification test [NAAT] or antigen test).

Mild Illness: People who do not have dyspnea, shortness of breath, or abnormal chest imaging but who exhibit any of the many signs and symptoms of COVID-19, such as fever, sore throat, cough, malaise, muscle pain, nausea, vomiting, diarrhea, and loss of taste and smell.

Moderate Illness: people whose oxygen saturation (SpO2) is 94 percent or higher on room air at sea level and who exhibit signs of lower respiratory illness on clinical evaluation or imaging.

Severe Illness: People with a respiratory rate of more than 30 breaths per minute, lung infiltrates of more than 50%, arterial partial pressure of oxygen to fraction of inspired oxygen

(PaO2/FiO2) of less than 300 mm Hg, or oxygen saturation (SpO2) of less than 94% on room air at sea level.

Critical Illness: people who suffer from multiple organ dysfunction, septic shock, or respiratory failure.

In our study, most of the study group (73%) categorized as mild COVID-19 patients, about (24%) as moderate COVID-19 patients and only (3%) as severe COVID-19 patients (**the cases** were randomly selected).

3- Examination:

- General examination.
- Otoscopic examination.

4- Cognitive function assessment:

i- Auditory P300 potential:

A. Test condition:

- Subjects were given instructions to ignore the frequent stimuli that were presented through supraaural headphones and to focus on the deviant stimulus.

- Total time of recording for each stimulus set was approximately 30-40 minutes

B-stimulus parameter:

- The stimuli were pure tones presented binaurally via headphones.
- Total stimuli were generated using stimulus generator of intelligent Hearing System, Smart EP.

An oddball paradigm was used in stimulus sets (1000 Hz standard /2000Hz deviant) the likelihood of the rare (deviant) was 20% and the likelihood of the frequent (standard) was 80%.

- Each stimulus tone had a rise and fall time of 10 ms and a plateau of 50 ms giving a total duration of 70ms.
- The stimulus intensity was 70 dBnHL
- The inter stimulus interval (**ISI**) was 500 ms.

C-Recording parameters:

- Ag /AgC1 electrodes were used. The impedance was below 5K Ohms.
- Electrode montage: After preparing the skin with cleaning gel, two active electrodes were placed at Fz and Cz sites referenced to the mastoid at both sides (M1 and M2). The

ground electrode was placed at FPz according to 10-20 electrode system.

- The response was collected with a band pass filter of 1-30 Hz.
- The analysis time (window) was 500 ms with 50 ms pre-stimulus.

ii- Montreal cognitive assessment test (MOCA): The Montreal Cognitive Assessment was a 30question test used to determine whether or not a person had dementia. ⁽²²⁾

MOCA (Montreal cognitive assessment) score: - MoCA scores ranged between 0 and 30:

- 1- 26 or higher was considered normal.
- 2- 18 to 25 indicated mild cognitive impairment.

10 to 17 indicated a moderate level of cognitive impairment.

3- Less than 10 indicated a severe level of cognitive impairment

MoCA, or Montreal Cognitive Assessment:

The purpose of the Montreal Cognitive Assessment (MoCA) was to quickly assess for cognitive impairment. Attention, concentration, executive functions, visuoconstructional skills, conceptual thinking, memory, language, orientation and calculations were among the cognitive areas that were evaluated.

Administration time: The MoCA took around ten minutes.

Results:

		Study group(N=100)	Control group(N=50)	P-value
Age	Mean ±SD	36.75 ±11.52	38.53 ±12.30	0 541
(years)	Range	20.00 - 49.00	20.00 - 49.00	0.011
Gender	Male	57 (57%)	30 (60%)	0.810
	Female	43 (43%)	20 (40%0	0.810

Table (1): Demographic data including age and sex of both study and control groups.

Neither gender nor age showed a statistically significant difference (P-Value < 0.05) between the study and control groups.

Table (2): Comparison between both groups as regards P300 late evoked potential test.

	Study group		Control group		D V I
	Mean	± SD	Mean	± SD	P- Value
Latency (ms)	291.95	29.19	267.79	21.15	0.004*
Amplitudes (uv)	5.43	2.28	20.78	5.75	0.001*

Demonstrates that P300 amplitude revealed a highly significant difference (p<0.001), while P300 latency revealed a statistically significant difference (p<0.05) between patients and controls.

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	Study group		Control group		P Value	
	Mean	± SD	Mean	± SD	I - value	
Mean total score	23.68	2.5	26.2	3.1	0.087	
Executive function	4.60	0.42	4.8	0.42	0.988	
Visuospatial	2.30	0.6	2.9	0.7	0.032*	
Naming	2.27	0.4	2.48	0.3	0.029*	
Attention	2.98	0.5	3.51	0.8	0.496	
Languge	2.09	0.53	2.56	0.92	0.07	
Abstraction	0.94	0.85	1.12	0.78	0.209	
Delayed recall	3.0	1.0	3.3	0.8	0.728	
Orientation	5.5	0.5	5.7	0.9	0.067	

There is a statistically significant difference (**P-value <0.05**) between COVID-19 patient's and controls in the domains of visuospatial, and naming.

Table (4): p300 [amplitude and latency] differences between mild and moderate-to-severe COVID-19 individuals.

	COVID-19				
	Mild (N=73)		Moderate (N=24)tosevere (N=3)		P- Value
	Mean	± SD	Mean	\pm SD	
Latency (ms)	277.24	18.63	306.66	10.83	0.001*
amplitudes (µv)	5.56	2.59	5.30	1.86	0.227

While the P300 latency differs statistically significantly (p < 0.05) between cases with mild and moderate to severe symptoms, there is no statistically significant variation in P300 amplitude.

 Table (5): Montreal cognitive assessment score differences between mild and moderate-to-severe

 COVID-19 individuals.

	COVID-19				
	Mild (N=73)		Moderate (N=24) to severe (N=3		P- Value
	Mean	± SD	Mean	± SD	
Mean total score	26.22	1.57	21.19	2.23	0.001*
Executive function	4.90	0.42	4.30	0.88	0.001*
Visuospatial	2.90	0.60	1.70	0.050	0.032*
Naming	2.83	0.42	1.71	0.59	0.001*
Attention	3.33	0.48	2.63	0.74	0.003*
Languge	2.16	0.52	2.02	0.52	0.091
Abstraction	1.10	0.42	0.78	0.44	0.009*
Delayed recall	3.39	0.52	2.61	0.88	0.001*
Orientation	5.61	0.11	5.39	0.5	0.980

There was a highly statistically significant difference between severity of infection and MOCA score regarding executive, attention, delayed recall and total score. Moreover, vasiospatial, naming and abstraction are statistically significant difference. The change, however, was not statistically significant among groups regarding language and orientation score.

Discussion:

COVID-19 not only a respiratory disease but also affects major organs and systems in the body, it may lead to multi-organ failure possibly due to inflammatory reactions or coagulopathy disorders. ⁽²³⁾ Vascular effects are caused by damage to the blood vessels and/or formation of micro emboli (tiny clots) that interrupt the blood flow. ⁽²⁴⁾ The presented study aim to Assess how the new

coronavirus affects cognitive abilities in Sohag Governorate patients with confirmed COVID-19. Ages in the study ranged from 20 to 49 years, with the study group's mean age being $36.75 (\pm 11.52)$ vears and the control group's mean age being 38.53 (± 12.30) years. Between the two groups, there was no statistically significant difference. Ages 31 to 35 were the most affected, followed by those 36 to 40. This agrees with Hamdy, Hosny ⁽²⁵⁾. who reported that the mostly affecting age population is 34.5 years and disagrees with Starke, **Reissig**⁽²⁶⁾, who reported that There was no proof of a certain age at which the danger significantly increases. The male to female ratio in the study group was 1.3:1, with 30 (60%) males and 20 (40%) females in the control group and 57 (57%) males and 43 (43%) females in the study group. The two groups did not differ statistically significantly. In our community, during the COVID-19 outbreak, the majority of men had to go to work to provide for their families, while women (mainly) stayed at home to care for the children or out of fear of infection. Additionally, coagulation pattern, previous cardiovascular smoking-related consequences, disease, and immune system activity and its modulation by sex hormones are other factors that may highlight this gender difference. (27)

In our study, most of the study group (73%) categorized as mild COVID-19 patients, about (24%) as moderate COVID-19 patients and only (3%) as severe COVID-19 patients as shown in This results is in agree with study of *Özçelik*

Korkmaz, Eğilmez ⁽¹⁶⁾, they found that; about (71.5%) of 116 patients had mild COVID-19 presentation and (28.5%) had moderate COVID-19 presentation. This could be explained by in male to female ratio, age range, associated medical conditions (e.g., DM, HTN, chronic renal disease) ethnicity and/or geography. Another explanation; patients with moderate or severe COVID-19 infection were admitted to I.C.U. and ventilated so they would not willing to share in our study. ⁽²⁸⁾

*Cognitive functions assessment:

1. P300 late evoked potential:

Regarding P300 latency, there were statistically significant distinction existed between COVID-19 patients and controls; nevertheless, there was a very significant difference for amplitude. We propose that the virus impacts the attention and memory-related neural networks, resulting in decreased P300 amplitudes that indicate a reduced allocation of cognitive resources.

Silva, Barros-Aragão et al., proposed that Delay in latency and reduction in amplitude in P300 responses could be caused by direct viral effects on brain structures, particularly those related to cognitive processing. Whether systemic or localized, inflammation can change cognitive processing and interfere with neuronal signaling.⁽²⁹⁾

ssing and interfere with neuronal signaling .⁽²⁹⁾ .*Soares, Malavolta* ⁽³⁰⁾, found no discernible differences in P300 values between the groups when measuring cognitive potential using speech stimuli. This disparity may be the consequence of using speech stimuli, which can be explained by differences in the stimuli's characteristics and the study methodology. The differences in P300 parameter values may be caused by a variety of factors, including the type of stimuli, sensory modality (voice vs. audio), cognitive demands, task specialization, participant characteristics, experimental methodology, sensitivity of measuring techniques, sample size, and temporal factors.

<u>2. Montreal cognitive assessment test:</u>

Our study revealed a statistically significant difference between the two groups (COVID-19 patient's and controls) in the domains of visuospatial, and naming. The **temporal** and **parietal lobes**, which are responsible for language and visuospatial processing, could be particularly vulnerable to the effects of neuroinflammation, oxygen deprivation, or direct viral effects.⁽³¹⁾

According to *Amalakanti, Arepalli* ⁽³²⁾, The total cognitive evaluation scores of COVID-19 patients and controls did not differ significantly; however, COVID-19 patients scored worse than controls in the areas of fluency, naming & visuoperception. However, compared to younger individuals, COVID-positive persons over 50 years of age had lower MoCA scores. *Akıncı, Oğul* ⁽³³⁾, show that, regardless of the severity of the illness, young people with mild to moderate COVID-19 infections may experience acute cognitive impairments.

****** Effect of severity of COVID-19 infection on audio-vestibular functions:

Our findings showed: while the P300 latency differs statistically significantly (p < 0.05) between cases with mild and moderate to severe symptoms, there is no statistically significant variation in P300 amplitude. Studies by *Altuna, Sánchez-Saudinós*⁽³⁴⁾ *and Shaddad, Hussein*⁽³⁵⁾, have demonstrated, in line with our findings, a substantial prevalence of cognitive impairment in severe COVID-19 cases. Furthermore, it has been demonstrated that individuals with moderate or asymptomatic history continue to experience cognitive symptoms, which negatively affects their functional abilities and productivity at work.

Our findings showed a highly statistically significant difference between the MOCA score in terms of executive, attention, delayed recollection, and total score and the severity of the infection. Additionally, the differences between Vasio-spatial, Naming, and Abstraction are statistically significant. The change, however, was not statistically significant among groups regarding language and orientation score. Also, *Hadad, Khoury* ⁽³⁶⁾ Reported executive dysfunction, attention disorders, and phonemic fluency impairments are long-term effects of COVID-19 infection. Age, premorbid conditions, or the degree of COVID-19 disease did not predict these cognitive abnormalities.

Conclusion:

Cognitive function assessment revealed delay in latency and reduction in amplitude in P300 responses in COVID-19 patients on comparing to control group. Also, COVID-19 patients secured lower scores than controls in the domains of visuoperception, naming and fluency in MOCA test scores.

In COVID-19 patients, cognitive function is compromised, as evidenced by the P300 and MoCA tests. Also, with increase the severity of COVID-19 symptoms, deterioration of cognitive function increase.

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