

SARS-CoV-2 effect on cognitive function and subjective perception of executive functions in individuals in prison in Colombia

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Abstract

Objective: The SARS-CoV-2 virus pandemic affected people deprived of liberty in Colombia, a vulnerable group due to unfavorable prison conditions and deficient protection measures. The objective of the study was to analyze the effects of SARS-CoV-2 on cognitive function and subjective perception of executive functions in this group. **Methods:** A cross-sectional study was conducted in 47 men deprived of liberty between 18 and 55 years of age, in the department of Valle del Cauca, Colombia. The Montreal Cognitive Assessment Test (MoCA) and the BANFE-2 Battery were used. The participants provided informed consent and affirmed having tested positive in the polymerase chain reaction (PCR) test. **Results:** It was determined that, 97.9% of individuals deprived of liberty had a positive PCR test, and 76.6% exhibited normal cognitive function in the MoCA Test. The subjective perception of executive functioning was recorded with normal parameters, at 68.1% according to the BANFE-2. A negative correlation was found between the MoCA Test (orientation subtest) and reported categories of SARS-CoV-2 virus symptoms. In addition, the abstraction MoCA variable showed an inverse relationship of (-3.19). **Conclusions:** The study demonstrated a negative correlation between cognitive impairment and SARS-CoV-2 symptoms in people deprived of liberty. Most of the participants presented normal cognitive and executive functioning, indicating a proportional inverse relationship between the variables evaluated.

Keywords: SARS-CoV-2. Persons deprived of liberty. Cognitive function. Subjective perception of executive functioning.

El efecto de SARS-CoV-2 en la función cognitiva y percepción subjetiva de las funciones ejecutivas en personas en prisión en Colombia

Resumen

Objetivo: La pandemia del virus SARS-CoV2 afectó a las personas privadas de la libertad en Colombia, un grupo vulnerable debido a las condiciones desfavorables en las cárceles y las deficientes medidas de protección. Analizar el efecto del SARS-CoV-2 en la función cognitiva y percepción subjetiva de las funciones ejecutivas en este grupo. **Métodos:** Se realiza un estudio transversal en 47 hombres privados de libertad de 18 a 55 años, en el departamento del Valle del Cauca, Colombia. Se utilizando el Test Montreal Cognitive Assessment (MoCA) y la Batería Banfe-2, los participantes suministran su consentimiento informado y afirman haber dado positivo en la prueba de PCR. **Resultados:** Se determina que el 97.9% de las personas privadas de la libertad tienen la prueba PCR positiva y un funcionamiento cognitivo normal del 76.6% en el test de MoCA. La percepción subjetiva del funcionamiento ejecutivo fue normal en un 68.1% según la BANFE-2. Se encontró

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una correlación negativa entre el Test de MoCA (subprueba de orientación) y las categorías de síntomas notificados del virus SARS-CoV2. Además, la variable MoCA de abstracción mostró una relación inversa de (-3.19). **Conclusiones:** El estudio demuestra una correlación negativa entre el deterioro cognitivo y los síntomas del SARS-CoV2 en personas privadas de la libertad. La mayoría de los participantes presentan un funcionamiento cognitivo y ejecutivo normal, indicando una relación inversa proporcional entre las variables evaluadas.

Palabras clave: SARS-CoV2. Personas privadas de libertad. Función cognitiva. Percepción subjetiva del funcionamiento ejecutivo.

Introduction

Over the past five centuries, pandemics have emerged approximately every 36 years¹. According to the World Health Organization (WHO), SARS-CoV-2 has become a global public health crisis²⁻⁴, with 701.168.995 million cases globally, including 110.309.712 in the United States and 6.387.145 in Colombia, with 143,110 registered deaths in this country^{5,6}. Although the mortality rates have decreased, there is still a latent risk of reinfection⁷ and vulnerable and marginalized populations will be the most affected^{8,9}.

Prison facilities with overcrowding issues and a lack of preventive measures have become a health risk in the face of SARS-CoV-2^{10,11}. In Colombia, 785 positive cases had been detected in prisons in the southwestern region¹²⁻¹⁴. The SARS-CoV-2 virus can affect the central and peripheral nervous system, with possible effects on cognitive health¹⁵⁻²⁰, increasing the risk of neurocognitive disorder in the domains of executive function, memory, and attention, in people with medical comorbidities and social vulnerabilities²¹.

Subjective complaints of cognitive impairment in prisoners are important for assessing neurocognitive disorders^{4,18,19}, as they become a predictor of mild cognitive impairment (MCI) in the pre-dementia stages of Alzheimer's disease, although they do not affect instrumental daily living skills^{21,22}. However, the relationship between SARS-CoV-2 and cognitive impairment is not yet fully understood^{23,24}, which warns of possible additional economic burdens on the social security system³, increasing morbidity and mortality^{25,26}. Consequently, further studies are needed to understand the impact of the virus on inmates' cognitive health²⁷.

Research method

This was descriptive and correlational cross-sectional study. The population consisted of adult males deprived of liberty in the southwestern region of Colombia. The sample consisted of 47 participants with a positive polymerase chain reaction (PCR) test who

willingly agreed to participate in the study, having previously signed the informed consent, following the guidelines and ethical codes for individuals persons deprived of liberty (PDL).

Inclusion criteria considered

The following criteria were included in the study:

- Be a PDL.
- Have a positive PCR test result.
- Be in the ages between 18 and 55 years.
- Mild cases were included.
- Post-COVID patients (minimum three months after infection).

Exclusion criteria

The following criteria were excluded from the study:

- PDL who verbally stated not having a positive PCR test, thus refusing to participate in the study.
- Having been referred to a second or third-level health-care facility due to complications from SARS-CoV-2.
- Present SARS-CoV-2 symptoms at the time of the study, be in isolation, or under quarantine.

Instruments

- Survey protocol based on sociodemographic and academic data that included: age, PCR test result, rural or urban origin or place of residence, number of months or years in prison, occupation before entering prison, laterality, marital status, level of education, days with SARS-CoV-2 symptoms; systemic, respiratory, sense organs, gastrointestinal and neurological general categories; number of medications administered during the SARS-CoV-2 illness; questions related to addictions: alcohol, caffeine and cigarette consumption, and drug dependence; suicidal ideation or thoughts and neurological history based on studies^{5,28}. These include SARS-CoV-2 systemic, symptomatic, and respiratory categories²³.

- The Montreal Cognitive Assessment (MoCA) screening was used²⁹. The surveyors are teachers, the corresponding author and students from the psychology program of the (Unidad Central del Valle del Cauca [UCEVA], as per its acronym in Spanish), Colombia, who received training on the instruments. The cognitive test was implemented directly and administered in one of the internal areas of the prison, individually and without distractions, applying biosafety measures with the use of face masks by both the PDL and the surveyors following WHO⁵ guidelines. The results are interpreted according to the screening test instructions.

The MoCA test duration does not exceed 20 min, and the maximum score to be obtained is 30 points. A score equal to or > 26 was considered normal, a score of 18-25 represented what is commonly called mild neurocognitive disorder; a score of 10-17 indicated mild neurocognitive disorder to a moderate degree, and a score < 10 was assumed to be major neurocognitive impairment. The MoCA test is divided into 16 items and 11 categories that evaluate the following cognitive functions: visuospatial - executive skills (both the cube copy and the abbreviated TMT-B), have a score of 1 point; and the clock test with a score of 3 points); identification (name of animals, a score of 3 points); memory (no punctuation); attention and concentration (numbers in progression, a score of 1 point, inverse, a score of 1 point, continuous auditory execution, a score of 1 point, consecutive subtraction, a score of 3 points); language (phrase repetition: phonological verbal fluency with the letter "P" with a score of 1 point); verbal abstraction (similarity, a score of 2 points); memory evocation (a score of 5 points); and orientation (time, a score of 4 points, and place, a score of 2 points) and 1 point was added to the total score for low-level education²⁹.

- The neuropsychological questionnaire of subjective perception. Behavioral-type scale contained in the Neuropsychological Battery of Executive Functions and Frontal Lobes of the Banfe-2, specifically in section number 6 of executive functioning. It consists of eight items that contain questions about daily living activities of executive functioning. In addition, the questionnaire contains a results sheet with natural scores for the executive functioning area and a table of neuropsychological scores that cover the categories of functional qualification, moderate damage, and severe damage in the frontal region³⁰.

Statistical analysis

For statistical analysis, the information was initially processed in a Microsoft Office Excel® database and exported to IBM-SPSS® v.22 statistical software. Subsequently, an exploratory descriptive analysis was carried out using frequency tables and percentages for all sociodemographic, clinical, cognitive, and cognitive functioning variables. In some of these, measures of central tendency and dispersion were used. For the cognitive health analysis, the cutoff points stipulated in both tests were taken into account.

Results

The sample was made up of 47 people (PDL) (Table 1). It is observed that, in all PDL, 97.9% presented a positive PCR test result; only one participant did not identify that he contracted the SARS-CoV-2 virus. In general, reference is made in this study to adult participants, with the highest percentage falling within a range of 31-50 years of age (48.9%) (Table 1).

The place of residence of 61.7% of the participants is the department of Valle del Cauca, Colombia, and 38.3% state a different place of origin, where 61.70 % are in urban areas. On the other hand, 78.9% have been in prison from 1 to 3 years, and in terms of occupation before entering prison, the majority were independent workers (66%); 55.3% lived with the nuclear family, 51.1% were single or divorced, and 74.5% had a basic primary and secondary education, while 23.40% of the PDL had technical and/or university education.

Medical comorbidities were present in 66% of the PDL (Table 2). 25.5% were found to be drug dependent; 34.04% reported smoking habits; 25.53% reported consumption of alcohol and 19.15% reported suicidal ideation or attempts. On the other hand, during the SARS-CoV-2 viral condition period, respiratory and sense organs problems were observed in 78.7% and gastrointestinal problems in 76.6% and neurological problems (headache, dizziness, confusion) in 70.2%, among others.

The MoCA test scores are presented in table 3, which shows that 76.6% of the participants obtained a normal score in cognitive processes, while 19.2% presented moderate cognitive impairment. According to the BANFE-2 executive functioning questionnaire behavioral scale (Table 3), normal executive functioning is evident in 68.1% and severe damage is found in 2.1% for the PDL surveyed.

Table 1. Sociodemographic characteristics of PDL who presented SARS-CoV-2

Sociodemographic characteristics of PDL	Count	%
Variable		
Yes	46	97.87
No	1	2.13
Total	47	100.00
Ages		
18-30 years old	11	23.40
31-50 years old	23	48.94
51-55 years old	13	27.66
Total	47	100.00
Municipality		
Valle del Cauca	29	61.70
Other municipalities	18	38.30
Total	47	100.00
Residence		
Rural	18	38.30
Urban	29	61.70
Total	47	100.00
Years in prison		
1-3 years	37	78.72
4-6 years	8	17.02
7-10 years	2	4.26
Total	47	100.00
Occupation		
Employed	14	29.79
None	2	4.26
Independent	31	65.96
Total	47	100.00
Living status		
Alone	12	25.53
Nuclear family	26	55.32
Extended family	9	19.15
Total	47	100.00
Marital status		
Married and free union	22	46.81
Single, widowed or divorced	24	51.06
Other	1	2.13
Total	47	100.00
Education		
Did not have	35	2.13
1-12: Basic education	11	74.47
13 or higher: Technical and university	47	100.00

Significant statistical differences were obtained between the diagnosis of SARS-CoV-2 and cognitive health in the total score of the MoCA test and the subjective perception of executive functioning of the BANFE-2 behavioral scale (Table 4). Positive associations can be observed (Table 4) that indicate an inversely proportional relationship between the variables. Thus, values directly related to the total MoCA score are identified in the orientation category, which is inversely related to common cold (−0.255) and respiratory symptoms (−0.255); with the

Table 2. Descriptive characteristics of the PDL who presented SARS-CoV2

Clinical characteristics of the PDL	Count	%
Common cold		
Presents	36	76.60
Does not present	11	23.40
Total	47	100.00
PCR		
Positive	39	82.98
No result/Negative	8	17.02
Total	47	100.00
Comorbidity		
Without comorbidity	31	65.96
Comorbidity	16	34.04
Total	47	100.00
Drug dependence		
Yes	12	25.53
No	35	74.47
Total	47	100.00
Alcoholism		
Yes	12	25.53
No	35	74.47
Total	47	100.00
Smoking		
0	2	4.26
yes	16	34.04
No	29	61.70
Total	47	100.00
Caffeine		
Yes	26	55.32
No	21	44.68
Total	47	100.00
Suicidal thoughts and/or attempts		
Yes	9	19.15
No	38	80.85
Total	47	100.00
Respiratory category		
Affected	36	76.00
Not Affected	11	23.00
Total	47	100.00
Sense organs category		
Presents	37	78.72
Does not present	10	21.28
Total	47	100.00
Gastrointestinal category		
Presents	36	76.60
Does not present	11	23.40
Total	47	100.00
Neurological category		
Presents	33	70.21
Does not present	14	29.79
Total	47	100.00

sense organs category variable (−0.294) and gastrointestinal category variable (−0.356). As for the MoCA abstraction category variable, it is inversely related (−0.319).

Table 3. Visuospatial-executive, memory, attention, language, and delayed recall categories processing level characteristics (MoCA Test) in PDL who presented SARS-CoV-2

Neuropsychological assessment	Total MoCA					
	< 26		= 26 Normal		Total	
	Count	%	Count	%	Count	%
Executive functioning						
0 a 3 normal	32	68.1	4	8.5	36	76.6
= or > 4 Moderate damage	8	17.1	1	2.1	9	19.2
= or > 6 Severe damage	1	2.1	0	0.0	1	2.1
= or > 8 Affected frontal region	1	2.1	0	0.0	1	2.1
Total	42	89.4	5	10.6	47	100.00

MoCA: montreal cognitive assessment.

Discussion

The purpose of this research was to evaluate the possible effects of SARS-CoV-2 on cognitive health and the subjective perception of executive function, with particular emphasis on incarcerated adults, as a contextual factor that intervenes in this relationship. Emerging scientific research has suggested a close correlation between SARS-CoV-2 and neurodegenerative disorders. However, it is unknown whether a causal association exists, and the direction of the cognitive effect remains uncertain³¹. The SARSCoV-2 disease pandemic imposed an unprecedented lifestyle dominated by social isolation.

The PDL were considered one of the highest risk groups in the coronavirus pandemic, in part, due to the unfavorable conditions they experienced before their detention, such as social segregation, poverty, marginalization and exclusion, as well as punitive criminal policies that favored overcrowding^{5,9}. These conditions imposed significant challenges in the management of prison guidelines to reduce the spread of the virus, following WHO recommendations⁵. All these particularities had repercussions on the PDL, since, given the probability of being infected, they were isolated from other inmates, and visits from judicial defenders, family, and friends were restricted, which possibly worsened the cognitive and behavioral awareness of people in quarantine³². As a result, a low participation of PDL was evident, since, of 118 people with positive PCR test results, only 47 agreed to participate in this study; the rest indicated that the PCR test was negative despite the statistics reporting otherwise, and therefore, reason for which they did not participate in the investigation. Various investigations suggest the existence of biases and sample reduction because respondents may lie on

their answers, especially in studies that address viral diseases, addictions to psychoactive substances, and when examinees are exposed to different surveyors³³. This bias is also reflected in this investigation, where 61.7% of those surveyed affirmed that they did not have smoking habits, 74.5% stated that they did not have alcoholism and 25.5% asserted that they were drug dependent. These data do not contrast with the reality of medium-security penitentiary and prison institutions (National Penitentiary and Prison Institute - INPEC, as per its acronym in Spanish) in the western region. In this sense, the national government allocates a large budget to strengthen the program of attention to the consumption of psychoactive substances in PDL, under the responsibility of the INPEC at the national level, according to official data from this public institution³².

The results of this study confirm that there is no long-term alteration of cognitive functions and the subjective perception of executive functioning, three months late after SARS-CoV-2 infection in adults deprived of liberty who did not experience serious medical complications, such as admission to the Intensive Care Unit without mechanical ventilation, critical respiratory conditions, or sedation, and were not associated with the aging factor.

These findings are consistent with the research of Stawicki et al. (2020), who stated that the majority of young adults who presented SARS-CoV-2 with febrile symptoms, fatigue, myalgia and dyspnea without medical complications, evolving towards a mild to moderate flu-like illness resolved approximately in the 1st weeks without cognitive sequelae⁵. These data are also consistent with this investigation in that the sample ranged from 31 to 55 years of age, being adults who have been in prison 1-3 years on average (78.9%). Following the same psychometric line in this study, a

Table 4. Correlations between the SARS-CoV2 diagnosis and cognitive functioning levels (MoCA Test and BANFE-2 executive functioning) in PDL

Spearman Rho correlation coefficient	MoCA_Executive	MoCA_Orientation	MoCA_Identification	MoCA_Attention	MoCA_Language	MoCA_Abstraction	MoCA_Delayed recall	Executive Functioning	Common cold	Respiratory category	Sense organs category	Gastrointestinal category	Neurological category	Smoking	Caffeine	Suicidal thoughts and/or attempts
MoCA_Executive	1.000	0.139	0.274	0.359	0.276	0.185	0.332	-0.127	0.044	-0.065	0.075	0.065	-0.055	0.155	-0.125	0.229
MoCA_Orientation		1.000	0.168	0.184	0.152	0.410	0.009	0.027	-0.255	-0.255	-0.294	-0.356	-0.130	0.107	-0.078	-0.172
MoCA_Identification			1.000	0.283	0.464	0.247	0.231	-0.016	0.122	0.122	0.103	0.122	0.176	0.043	-0.048	0.055
MoCA_Attention				1.000	0.344	0.179	0.287	-0.191	0.023	0.023	0.068	0.035	0.175	0.159	0.007	0.243
MoCA_Language					1.000	0.265	0.218	-0.169	0.048	-0.042	-0.161	-0.042	0.045	-0.010	0.138	-0.141
MoCA_Abstraction						1.000	0.232	-0.091	0.179	-0.042	-0.046	-0.319	0.015	0.071	-0.026	-0.190
MoCA_Delayed recall							1.000	-0.160	-0.008	-0.185	-0.041	-0.025	0.049	0.192	-0.008	0.248
Executive Functioning								1.000	-0.191	-0.191	-0.052	0.035	0.088	-0.245	0.205	-0.495
Common cold									1.000	0.763	0.572	0.288	0.629	-0.294	-0.092	0.269
Respiratory category										1.000	0.695	0.525	0.629	-0.294	-0.092	0.269
Sense organs category											1.000	0.695	0.571	-0.142	0.056	0.253
Gastrointestinal category												1.000	0.519	-0.098	0.009	0.141
Neurological category													1.000	-0.072	0.163	0.199
Smoking														1.000	0.117	0.042
Caffeine															1.000	-0.215
Suicidal thoughts and/or attempts																1.000

MoCA: montreal cognitive assessment.
Values in bold are significant.

negative association was found between the MoCA orientation variables and the common cold (−0.255), respiratory (−0.255), sense organs (−0.294), and gastrointestinal (−0.356) categories symptoms, as well as in the MoCA abstraction variable, where an inverse relationship was found (−0.319).

These SARS-CoV-2 symptoms are consistent with the prevalent data in scientific investigations that affirm the presence of systemic, pulmonary, and gastrointestinal symptoms, the latter being more frequent in the diagnosis of the disease¹⁶ and when these symptoms are combined with cognitive health³⁴, they have indicated that there is no cognitive deterioration and that, in addition, they are in line with this research because they affirm that, 67 % of a French sample did not present impairment in executive function, nor failures in attentional processes only the remaining 33% who presented executive functioning deficits after overcoming the SARS-CoV-2 disease³⁵.

In a retrospective study, a low incidence of 8.6% of neurological symptoms was identified in a cohort of 360 Mexican patients who contracted the virus²⁶. In a peer-reviewed meta-analysis with a sample of 3,559 confirmed SARS-CoV-2 cases from several countries of the world, no systematized neuropsychological evaluations that could account for neurological failures were included, so a clear causal link could not be established³⁵. Another neurobiological study has demonstrated that, the symptomatology of mild SARS-CoV2 does not cross the blood-brain barrier in patients, which does not predict any possible central nervous system involvement³⁶. A relevant piece of information that could influence adequate cognitive functioning is the higher number of education years, which allows greater cognitive reserve³⁷. In the present sample, it was found that 74.47% of the participants had secondary education training, which could have been achieved through the training and stimulation provided by the intramural rehabilitation programs of the penitentiary centers and the productive projects run by the National Learning Service (SENA, as per its acronym in Spanish). In addition, there are other non-formal education programs aimed at the INPEC's self-sufficiency, such as those related to work, teaching, and artistic activities, all of them supported by the fundamental right to education in Colombia and the national penitentiary treatment process³².

Neuropsychology literature explains that the maintenance of educational content and acquired skills requires constant stimulation and practice to be preserved and maintained over time; otherwise, they

could deteriorate substantially. Therefore, changes in the social, cultural, educational, and non-formal education contexts can positively influence performance on cognitive scales or standardized neuropsychological tests^{28,38}.

Ethical considerations

To comply with the ethical guidelines in a cross-sectional study like this one, this project is linked as a pilot institution for the purposes of implementing the practice and public field work; nevertheless, the right to privacy is safeguarded through the informed consent. The surveyors initially obtained the assent of the PDL and then the signing of the informed consent, taking into account Resolution 8430 of October 4, 1993 in article 45 of the Ministry of Health of Colombia by which, informed consent is established for special populations³⁹, is classified as an investigation with minimal risk as it focuses on the psychometrically validated pencil-and-paper application of the MoCA screening test and the subscale of the Banfe-2 neuropsychological questionnaire in a single evaluation moment. The surveyors ensured the care of the rights and interests of the PDL in favor of guaranteeing their emotional and physical well-being through biosafety measures, including the use of face masks by both the PDL and the surveyors, taking into account the 2020 WHO guidelines on the prevention of Covid-19 according to Resolution 666 of April 24, 2020⁴⁰; these informed consent documents are in possession of the corresponding author. The study was suspended due to public order conditions (November 2021/December 2022).

Limitations

The study has some notable limitations. First, a larger number of samples and control groups are required in order to generalize the data. Second, it would be important to conduct a longitudinal study to observe the long-term behavior of possible cognitive sequelae of SARS-CoV-2. Finally, a comprehensive cognitive evaluation based on standardized neuropsychological tests and neuroimaging biomarkers is necessary to examine the underlying consequences and track the potential progression of SARS-CoV-2 on cognition.

Conclusion

This study confirms that SARS-CoV-2 infection does not show evidence of nervous system involvement in

adults who had not experienced severe symptoms or required hospitalization at second and third level health-care centers for virus-related symptoms. Therefore, possible long-term effects would not be generated. According to reported medical and scientific literature, it has been demonstrated that the presence of mild SARS-CoV-2 signs and symptoms for example, such as a common cold, does not indicate an impact on the central nervous system and, nor in cognitive health. In this study, it was identified that the majority of the examined participants had a normal range score on both tests. The values obtained from the scores showed negative associations, indicating an inverse proportional relationship between the variables. Although, the data from this research cannot be generalized due to the reduced sample of the PDL.

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Conflicts of interest

The author declares no conflicts of interest.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this study.

Confidentiality of data. The authors declare that no patient data appear in this article. Furthermore, they have acknowledged and followed the recommendations as per the SAGER guidelines depending on the type and nature of the study.

Right to privacy and informed consent. The authors have obtained the written informed consent of the patients or subjects mentioned in the article. The corresponding author is in possession of this document.

Use of artificial intelligence for generating text. The authors declare that they have not used any type of generative artificial intelligence for the writing of this manuscript, nor for the creation of images, graphics, tables, or their corresponding captions.

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