

Original Article

Factors associated with cognitive impairment and the quality-of-life among COVID-19 survivors working as healthcare workers

Sondang RA. Sirait¹, Bintang YM. Sinaga^{1,2*}, Amira P. Tarigan^{1,2} and Arlinda S. Wahyuni³

¹Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia; ²Department of Pulmonology and Respiratory Medicine, Prof. Dr. Chairuddin P Lubis Universitas Sumatera Utara Hospital, Medan, Indonesia; ³Department of Community Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia

*Corresponding author: bintang@usu.ac.id

Abstract

Prolonged physical and mental health changes, known as post-COVID conditions (PCC), could impair the quality-of-life (QoL) of healthcare workers. The aim of this study was to identify factors that contribute to cognitive impairments and QoL among COVID-19 survivors working as healthcare workers. This cross-sectional study involved healthcare workers at Prof. Dr. Chairuddin P. Lubis Universitas Sumatera Utara Hospital, Medan, Indonesia. The Montreal Cognitive Assessment (MoCA) was used to assess the cognitive function, while the World Health Organization Quality-of-Life Brief Version (WHOQOL-BREF) questionnaire was used to evaluate the QoL. Factors associated with cognitive and QoL status were examined using Mann-Whitney and Chi-squared tests. A total of 100 COVID-19 survivors were included in the study, most of whom were female (74%), aged ≤ 35 years (95%), and were doctors (62%). Only 22% of the participants had a normal BMI, 93% had a history of mild COVID-19, and 54% had one comorbidity. The Overall MoCA score averaged 24.18 ± 2.86 , indicating mild cognitive impairment among the groups. The distribution of MoCA scores had similar patterns with no significant differences based on age, gender, comorbidities, BMI, COVID-19 severity, and frequency of COVID-19 infection. Interestingly, the number of vaccine doses received by the participants had a statistically significant associated with MoCA scores of which those receiving more than two doses had higher cognitive scores than those with only two doses ($p=0.008$). Based on categorized MoCA scores (normal vs cognitive impairment), none assessed factors were not significantly associated with cognitive outcomes. The WHOQOL-BREF scores ranged from 62.5 to 95.5, with a mean \pm SD of 83.67 ± 7.03 . None of the assessed factors were associated with WHOQOL-BREF scores among COVID-19 survivors. These findings highlight the need for further study to explore the protective role of vaccination frequency in cognitive impairment and the factors underlying the resilience in QoL among survivors.

Keywords: COVID-19, MoCA, WHOQOL-BREF, cognitive impairment, quality-of-life

Introduction

Coronavirus disease 2019 (COVID-19) is an infectious disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1,2]. Several studies have documented persistent symptoms following COVID-19 infection that include fatigue, dyspnea, various cognitive impairments, pain, anxiety, depression, and gastrointestinal problems [3-6]. COVID-19 symptoms increase disability and negatively impact physical function, workability, cognitive



function, and quality-of-life (QoL) [7-10]. While the COVID-19 pandemic impacts all populations, healthcare workers (HCWs) experience a greater burden of work-related stress compared to other occupations [11-13]. Despite being at the forefront of the pandemic response, HCWs may still experience heightened stress levels, potentially leading to burnout [14-17].

Post-COVID conditions (PCC) refer to a broad spectrum of physical and mental health issues that continue for more than four weeks after being infected with SARS-CoV-2 [18]. It is important to separate the effects of fatigue and psychological stress as part of PCC, which are known to harm cognitive functions in particular in HCWs due to their heavy workloads during the pandemic [19,20]. Understanding how PCC affects the cognition and quality-of-life (QoL) of frontline HCWs is crucial not only for their health but also for keeping the healthcare system running properly [21-23]. The Montreal Cognitive Assessment (MoCA) is widely adopted in studies assessing global cognitive function, while the World Health Organization Quality-of-Life Brief Version (WHOQOL-BREF) questionnaire evaluates various aspects of QoL, including physical and psychological health, social relationships, and environmental factors [24-26]. The aim of this study was to analyze factors associated with cognitive impairments and the QoL among COVID-19 survivors of hospital healthcare workers. This study is urgent because it can lead to the development of specific actions that reduce prolonged cognitive problems and improve the QoL for HCWs, supporting them now and preparing for another pandemic in the future [27,28].

Methods

Study design, setting and sampling

A cross-sectional study was conducted from December 2022 until February 2023 at Prof. Dr. Chairuddin P. Lubis Universitas Sumatera Utara Hospital, Medan, Indonesia. Participants are HCWs employed at that hospital who have been diagnosed with COVID-19 and declared recovered, known as COVID-19 survivors. The study employed a consecutive sampling method from 250 HCWs. Using the Slovin formula with a 10% margin of error, the minimum sample size was 72, which was then adjusted to 100 HCWs.

Participants

The participants of this study were COVID-19 survivors currently working as HCWs at Prof. Dr. Chairuddin P. Lubis Universitas Sumatera Utara Hospital, who met the inclusion and exclusion criteria. The inclusion criteria were HCWs who had recovered from COVID-19 in any severity levels in the last one year before the period of the study and were willing to participate by signing an informed consent form. The exclusion criteria were individuals with a communication disorder or cognitive impairment that did not enable them to finish the MOCA test, participate in interviews, and fill out the WHOQOL BREF questionnaire. No participants were excluded in this study.

Data collection

All data was collected through direct interviews. Basic characteristics of the participants included education, occupation, body mass index (BMI), COVID-19 vaccine history, history of COVID-19 frequency, history of COVID-19 severity, comorbidities and types of comorbidities. Global cognitive function and QoL were assessed using the MoCA and WHOQOL-BREF questionnaires.

Within the MoCA assessment, different domains have specific maximum scores: executive visuospatial (five points), naming (three points), memory, attention (six points), language (three points), abstraction (two points), delayed recall (five points) and orientation (six points). A time limit was set to ten minutes for the participants to answer the MoCA questionnaire. The MoCA scores range from 0 to 30 [29]. A score of ≥ 26 was considered normal and a score of < 26 indicated cognitive impairment [30].

The WHOQOL-BREF questionnaire comprises 26 items spanning four key domains of QoL: physical health (seven items), psychological health (six items), social relationships (three items) and environment (eight items). Responses for each domain are rated on a scale from 1 to 5, which are subsequently converted to a 0 to 100 scale to standardize the scores [31]. The interpretations

are as follows: very poor QoL (0–20), poor QoL (21–40), moderate QoL (41–60), good QoL (61–80), and very good QoL (81–100) [31,32].

Study variables

The independent variables in this study were age, gender, comorbidities, BMI, COVID-19 vaccine history, COVID-19 severity, and frequency of COVID-19 history. The dependent variables were the MoCA and WHOQOL-BREF result scores.

Statistical analysis

The MoCA and WHOQOL-BREF scores were initially treated as continuous variables. Since the data did not distribute normally based on the Kolmogorov-Smirnov normality test, a non-parametric Mann-Whitney test was used to assess the differences between groups. Upon categorization of the MoCA and WHOQOL-BREF scores, the Chi-squared or Fisher's exact tests were used as appropriate to evaluate factors associated with cognitive function and QoL. A *p*-value of <0.05 was designated as the threshold for statistical significance. All statistical analyses were performed using SPSS for Windows, version 23.0 (IBM, New York, USA).

Results

Characteristics of healthcare workers

A total of 100 COVID-19 survivors were included in the study, as presented in **Table 1**. Most of the HCWs were female (74%), aged ≤35 years (95%), had a bachelor's degree (79%) and were doctors (62%). Only 22% of the participants had a normal BMI. Among all the COVID-19 survivors, 59% had a history of COVID-19 vaccination as many as three times, 92% experienced COVID-19 once, 93% had a history of mild COVID-19 infection, and 54% had one comorbidity (**Table 1**).

Table 1. Characteristics of the COVID-19 survivors working healthcare workers (n=100)

Characteristics	Frequency	Percentage (%)
Age (years)		
≤35	95	95
>35	5	5
Gender		
Male	26	26
Female	74	74
Education		
Senior high school	19	19
Diploma	2	2
Bachelor	79	79
Occupation		
Doctor	62	62
Nurse	16	16
Customer service	2	2
Pharmacist	1	1
Cleaning service	19	19
Comorbidities		
None	44	44
1	54	54
>1	2	2
Type of comorbidities		
Diabetes mellitus	0	0
Hypertension	0	0
Chronic obstructive pulmonary disease (COPD)	0	0
Cardiovascular disease	0	0
Asthma	1	1
Pregnancy	0	0
Obesity	56	56
Autoimmune disease	1	1
Body mass index		
Normal	22	22
Overweight	22	22
Obese I	44	44

Characteristics	Frequency	Percentage (%)
Obese II	12	12
COVID-19 vaccine history		
None	0	0
2 times	28	28
3 times	59	59
4 times	12	12
5 times	1	1
History of COVID-19 severity		
Asymptomatic	0	0
Mild	93	93
Moderate	7	7
Severe/critical	0	0
History of COVID-19 frequency		
Once	92	92
>1 time	8	8

Cognitive impairment scores and associated factors

The overall MoCA score averaged 24.18 ± 2.86 , indicating a mild cognitive impairment among the group (**Table 2**). The orientation domain consistently achieved a score of six, indicating that survivors retained strong spatial and temporal awareness. Conversely, the language domain and abstraction domain showed a notably lower mean score of 1.88 ± 0.69 and 1.43 ± 0.64 , suggesting that linguistic and abstract thinking abilities might be more susceptible to the impacts of COVID-19. The executive visuospatial and attention domains also showed variability, with scores ranging from 1 to 5 and 1 to 7, respectively, highlighting these areas as potentially critical in understanding cognitive recovery post-COVID-19 (**Table 2**).

The distribution of MoCA scores among COVID-19 survivors had similar patterns and no significant differences based on age, gender, comorbidities, BMI, COVID-19 severity, and frequency of infection (**Table 3**).

Table 2. Montreal Cognitive Assessment (MoCA) scores among COVID-19 survivors (n=100)

Domain	Score		
	Minimum	Maximum	Mean \pm SD
Executive visuospatial	1	5	3.72 \pm 1.27
Naming	2	3	2.98 \pm 0.14
Attention	1	7	4.3 \pm 1.18
Language	1	3	1.88 \pm 0.69
Abstraction	0	3	1.43 \pm 0.64
Delayed recall	2	5	3.87 \pm 0.88
Orientation	6	6	6.0 \pm 0.00
Overall MoCA score	18	29	24.18 \pm 2.86

Table 3. Factor associated with Montreal Cognitive Assessment (MoCA) scores among COVID-19 survivors (n=100)

Variable	n (%)	MoCA score (Mean \pm SD)	MoCA score (Median)	p-value
Age	≤ 35 years	95 (95)	24.09 \pm 2.9	0.192 ^a
	> 35 years	5 (5)	25.8 \pm 0.84	
Gender	Male	26 (26)	24 \pm 2.98	0.825 ^a
	Female	74 (74)	24.24 \pm 2.83	
Comorbidities	None	44 (44)	24.07 \pm 3.22	0.936 ^a
	At least 1	56 (56)	24.27 \pm 2.57	
Body mass index	Normal	22 (22)	24.05 \pm 2.87	0.893 ^a
	Overweight/obese	78 (78)	24.22 \pm 2.87	
Vaccine frequency	2	28 (28)	22.89 \pm 3.07	0.008 ^{a*}
	> 2	72 (72)	24.68 \pm 2.63	
COVID-19 severity	Mild	93 (93)	24.15 \pm 2.87	0.639 ^a
	Moderate	7 (7)	24.57 \pm 2.88	
COVID-19 infection frequency	Once	92 (92)	24.08 \pm 2.88	0.177 ^a
	> 1 time	8 (8)	25.38 \pm 2.5	

^a Analyzed using Mann-Whitney test

* Statistically significant at $p=0.05$

The number of vaccine doses received by the participants had a statistically significant difference in MoCA scores, of which those receiving more than two doses had higher cognitive scores than those with only two doses ($p=0.008$) (**Table 3**).

Factors associated with cognitive impairment

The analysis of cognitive impairment in COVID-19 survivors, based on categorized MoCA scores (normal vs cognitive impairment), revealed that all independent variables were not significantly related to cognitive outcomes (**Table 4**). A notable observation, although not statistically significant, individuals with more than two COVID-19 vaccine doses had less cognitive impairment than those with only two doses, indicating a possible protective effect of vaccination (**Table 4**).

Table 4. Factors associated with cognitive impairment among COVID-19 survivors (n=100)

Variables		Categorized MoCA score; n (%)		p-value
		Normal	Cognitive impairment	
Age	≤35 years	35 (36.8)	60 (63.2)	0.365 ^a
	>35 years	3 (60)	2 (40)	
Gender	Male	10 (38.5)	16 (61.5)	0.955 ^b
	Female	28 (37.8)	46 (62.2)	
Comorbidities	None	17 (38.6)	27 (61.4)	0.907 ^b
	At least 1	21 (37.5)	35 (62.5)	
Body mass index	Normal	10 (45.5)	12 (54.5)	0.415 ^b
	Overweight/obese	28 (35.9)	50 (64.1)	
Vaccine frequency	2	7 (25)	21 (75)	0.095 ^b
	>2	31 (43.1)	41 (56.9)	
COVID-19 severity	Mild	34 (36.6)	59 (63.4)	0.422 ^a
	Moderate	4 (57.1)	3 (42.9)	
COVID-19 infection frequency	Once	33 (35.9)	59 (64.1)	0.253 ^a
	>1 time	5 (62.5)	3 (37.5)	

^a Analyzed using Fisher's exact test

^b Analyzed using Chi-squared test

Quality-of-life scores and associated factors

COVID-19 survivors' WHOQOL-BREF scores ranged from 62.5 to 95.5, with a mean±SD of 83.67±7.03 suggesting very good QoL (**Table 5**). Analysis of each domain revealed the physical domain had the lowest mean at 78.03±13.22 (classified as good QoL), whereas other domains scored above 80 suggesting very good QoL (**Table 5**).

Table 5. WHOQOL-BREF scores among COVID-19 survivors (n=100)

Domain	WHOQOL-BREF score		
	Minimum	Maximum	Mean±SD
Physical	44	94	78.03±13.22
Psychological	38	94	80.95±12.35
Social	56	100	87.85±9.14
Environment	56	100	87.86±9.12
Overall WHOQOL-BREF score	62.5	95.5	83.67±7.03

Analysis of WHOQOL-BREF scores indicated a consistent QoL post-recovery, unaffected by various demographic characteristics, health, or COVID-19 related factors, since there were no significant differences based on independent variables (**Table 6**).

Factors associated with quality-of-life

Next, WHOQOL-BREF scores were divided based on the classification method [31,32] of the overall scores received by the participants. There were 23 HCWs who had good QoL, and 73 had very good QoL (**Table 7**). Our data indicated that age, gender, presence of comorbidities, BMI, vaccination frequency, and the severity or frequency of COVID-19 infection had no impact on the QoL ($p>0.05$) (**Table 7**).

Table 6. Distribution of WHOQOL-BREF score results among COVID-19 survivors

Variables		n (%)	WHOQOL-BREF score (Mean±SD)	WHOQOL-BREF score (Median)	p-value ^a
Age	≤35 years	95 (95)	83.77±7.13	84.75	0.334
	>35 years	5 (5)	81.8±4.81	83	
Gender	Male	26 (26)	82.84±7.16	83.13	0.290
	Female	74 (74)	83.97±7.01	85.38	
Comorbidities	None	44 (44)	84.34±7.08	85.38	0.362
	At least 1	56 (56)	83.15±7.01	84.38	
Body mass index	Normal	22 (22)	85.28±7.59	86.13	0.110
	Overweight/obese	78 (78)	83.22±6.85	84.38	
Vaccine frequency	2	28 (28)	83.04±8.44	85.25	1.000
	>2	72 (72)	83.92±6.45	84.63	
COVID-19 Severity	Mild	93 (93)	83.78±7.13	84.75	0.413
	Moderate	7 (7)	82.29±5.85	83	
COVID-19 Frequency	Once	92 (92)	83.56±7.11	84.5	0.558 ^a
	>1 time	8 (8)	84.94±6.35	86.13	

^a Analyzed using Mann-Whitney test

Table 7. Factors associated with quality-of-life among COVID-19 survivors

Variables		Overall WHOQOL-BREF score; n (%)		p-value
		Good	Very good	
Age	≤35 years	22 (23.2)	73 (76.8)	1.000 ^a
	>35 years	1 (20.0)	4 (80.0)	
Gender	Male	8 (30.8)	18 (69.2)	0.289 ^b
	Female	15 (20.3)	59 (79.7)	
Comorbidities	None	9 (20.5)	35 (79.5)	0.592 ^b
	At least 1	14 (25.0)	42 (75.0)	
Body mass index	Normal	4 (18.2)	18 (81.8)	0.543 ^b
	Overweight/obese	19 (24.4)	59 (75.6)	
Vaccine frequency	2	6 (21.4)	22 (78.6)	0.816 ^b
	>2	17 (23.6)	55 (76.4)	
COVID-19 severity	Mild	20 (21.5)	73 (78.5)	0.197 ^a
	Moderate	3 (42.9)	4 (57.1)	
COVID-19 frequency	≤35 years	21 (22.8)	71 (77.2)	1.000 ^a
	>35 years	2 (25.0)	6 (75.0)	

^a Analyzed using Fisher's exact test

^b Analyzed using Chi-squared test

Discussion

The study findings provide valuable insights into the cognitive and QoL outcomes among COVID-19 survivors who were working as HCWs. The demographic profile of the participants, predominantly young, female, and working as doctors, reflects a specific subset of the healthcare workforce that may have unique resilience or vulnerability in the face of the pandemic. A previous study, predominantly involving doctors as participants, found that most respondents reported a significant increase in stress levels during the pandemic [33]. However, higher resilience was linked to reduced stress, anxiety, fatigue, and sleep disturbances, indicating that greater resilience and grit served as protective factors against personal and systemic stressors during the COVID-19 pandemic [33,34].

The MoCA scores reveal mild cognitive impairment across the group, with particular deficits noted in the language domain. This finding is consistent with emerging literature suggesting COVID-19's potential impact on linguistic abilities and abstract thinking, which may be attributed to the neuroinvasive nature of the virus and its effects on cognitive functions [35-37]. The consistent performance in the Orientation domain contrasts with the variability observed in the Executive Visuospatial and Attention domains, underscoring the heterogeneity of cognitive recovery and the need for targeted cognitive rehabilitation strategies [38-40].

Interestingly, the number of vaccine doses showed a significant correlation with cognitive scores, with those receiving more than two doses demonstrating better cognitive outcomes. This observation suggests a potential protective effect of vaccination against cognitive impairment, which aligns with the broader benefits of vaccination in mitigating the severity of COVID-19 and

its neurological manifestations [41-43]. Further research is warranted to explore the mechanisms underlying this association and to assess the long-term cognitive trajectories of vaccinated individuals.

The QoL, as assessed by WHOQOL-BREF scores, remained relatively high and consistent among survivors, with no significant variations across different demographic and clinical variables [44-46]. The lower scores in the physical domain compared to other domains may reflect the lingering physical effects of COVID-19, even among mild cases [46,47]. This finding emphasizes the importance of comprehensive post-recovery care that addresses not only cognitive but also physical rehabilitation needs [8,45,48]. Overall, the study highlights the possible complex interplay between COVID-19 and cognitive outcomes among HCWs, underscoring the importance of vaccination and the resilience of QoL post-recovery. It also points to the necessity for ongoing support and interventions to the specific needs of COVID-19 survivors in the healthcare workforce [49,50].

The study has its own limitations, such as a cross-sectional study design to assess cognitive function and QoL post-COVID-19 has no baseline data before the pandemic. The subjects mostly experienced mild symptoms and young adults on average that may limit the generalizability of the results. Within a small age range, there can be significant individual differences. Factors such as socioeconomic status, health conditions, and cultural backgrounds can vary widely, impacting how individuals experience and cope with post-COVID-19 challenges.

Conclusion

This study finds that COVID-19 survivors maintain strong spatial and temporal awareness, as evidenced by consistent scores in the orientation domain. However, the lower scores in the language and abstraction domain suggest a vulnerability of linguistic abilities to COVID-19. The variability observed in the executive visuospatial and attention domains underscores the complexity of cognitive recovery post-COVID-19, with an overall mild cognitive impairment indicated by the average MoCA score. Interestingly, vaccination appears to play a protective role, with higher cognitive scores associated with receiving more than two vaccine doses. QoL among survivors remains relatively high and stable across various demographics and health factors, with the physical domain slightly lower than others, reflecting possible residual physical effects of the illness. Given the variability in cognitive recovery, particularly in linguistic abilities and executive functions, targeted cognitive rehabilitation programs could be beneficial for survivors of COVID-19.

Ethics approval

This study was approved by the Ethical Committee of Universitas Sumatera Utara, Medan, Indonesia, on December 27, 2022, No: 1225/KEPK/USU/2022.

Competing interests

The authors declare that there is no conflict of interest.

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Underlying data

Derived data supporting the findings of this study are available from the corresponding author on request.

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