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THE INVESTIGATION OF THE COGNITIVE COMMUNICATION FUNCTIONS OF SURVIVORS OF CORONAVIRUS DISEASE 2019 (COVID-19): A SURVEY STUDY

KORONAVİRÜS HASTALIĞI (COVID-19) GEÇİREN BİREYLERDE BİLİŞSEL İLETİŞİM FONKSİYONLARININ ARAŞTIRILMASI: ANKET ÇALIŞMASI

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ABSTRACT

Objective: Coronavirus Disease-2019 (COVID-19) can cause problems in cognitive-communication functions such as attention, executive function, and short-term memory. The aim of the study is to investigate the cognitive-communication functions of survivors of COVID-19.

Method: A total of 484 adult individuals (Age: 18-73, M=27.2, SD=6.2) participated in the study. A 40-item survey that includes attention, memory, executive functions, language, and orientation domains was used.

Results: The common problems were related to memory function (61.4%), attention (56.2%) and executive functions (50.4%), respectively. The mainly problematic area in executive functions was found to be controlling emotions (38.9%). Participants reported that 37.6% of them had problems with their naming skills during a conversation.

Conclusion: While there may be fewer problems with orientation skills, which is one of the cognitive communication functions, in individuals with COVID-19, problems in short-term memory, maintaining attention, and organizing emotions can be seen more.

Key Words: Cognitive Communication, COVID-19, COVID-19 Survivors, Survey Study

ÖZ

Amaç: Koronavirüs Hastalığı (COVID-19); dikkat, yürütücü işlev, kısa süreli bellek gibi bilişsel iletişim fonksiyonlarında problemler oluşturabilmektedir. Türkiye'de yaşayan ve COVID-19 geçiren vakaların bilişsel iletişim fonksiyonlarındaki bozuklukların belirlenmesi amaçlandı.

Yöntem: COVID-19 geçirmiş 18-73 yaş arası, 484 yetişkin birey (M=27.2, SS=6.2) çalışmaya dahil edilmiştir. Çalışmada, bilişsel iletişim fonksiyonlarını belirlemek amacıyla dikkat, bellek, yürütücü işlevler, dil ve oryantasyona yönelik 40 maddelik bir anket kullanılmıştır.

Bulgular: En yaygın problemlerin, sırasıyla bellek (%61.4), dikkat (%56.2) ve yürütücü işlevler (%50.4) ile ilişkili olduğu saptanmıştır. Yürücü işlevlerde en çok problem yaşanan alan duyguları kontrol etme (%38.9) olarak belirlenmiştir. Katılımcıların %37.6'sı konuşma sırasında isimlendirme becerisinde problem yaşadığını bildirmiştir.

Sonuç: COVID-19 geçiren bireylerde bilişsel iletişim fonksyionlarından olan oryantasyon becerilerinde daha az problem olabilirken, kısa süreli bellek, dikkati sürdürebilme ve duyguları organize etmede daha fazla problem görülebilmektedir.

Anahtar Kelimeler: Bilişsel İletişim, COVID-19, COVID-19 Geçiren Bireyler, Anket Çalışması

INTRODUCTION

Since late 2019, millions of people have battled and continue to battle Coronavirus Disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome-related Coronavirus-2 (SARS CoV-2). While nearly four million individuals around the world have lost their lives, millions of others have recovered from the disease. As this worldwide struggle against COVID-19 goes on, we continue to learn more information regarding the effects of the disease every day. Although the main objective of the fight against the disease is to control the spread of the virus and save lives, more evidence suggesting that the virus may have long lasting neurological side effects requiring rehabilitation in recovered individuals accumulate with each day [1-4]. In the literature, certain neurological conditions that are thought to occur due to COVID-19 are reported. These conditions are: headache, dizziness, myalgia, anosmia, ageusia, encephalopathy, cognitive impairments, stroke, hemorrhagic necrotizing encephalopathy, epileptic seizures, Guillain-Barre syndrome, rhabdomyolysis [1-6]. Ramage (2020) discussed the critical disease factors that are associated with cognitive communication impairment [7]. These include prolonged hypoxia, mechanical ventilation, intermittent hypoxia, hypercoagulation and delirium. In Wuhan, 16% of the patients remained on a mechanical ventilator while

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they were hospitalized [8]. For Turkey, this rate varies between 2-5% according to data from the Turkish Ministry of Health [9]. The reason for receiving mechanical ventilation is Acute Respiratory Distress Syndrome (ARDS). Cognitive impairments may develop due to the delirium induced by ARDS. The longer is the duration of delirium, the more severe are the related cognitive impairments. Denke et al. (2018) emphasized that memory and learning abilities were particularly impacted due to ARDS [10]. Delirium is characterized by rapid fluctuations in attention (focused, sustained or alternating) and awareness (orientation) [11]. It is often accompanied by myopathy, polyneuropathy and certain psychological conditions due to prolonged stay at the intensive care unit [12].

Neurotransmitter function may be altered due to the decrease in blood oxygen saturation in COVID-19 cases and this may result in cognitive deficits [13]. COVID-19-related intermittent hypoxia, hypercoagulation and inflammatory reactivity may lead to damage in the prefrontal, medial temporal cortices, amygdala, anterior insula, thalamus and caudatus/striatum. Moreover, the high cytokine levels that appear during cytokine storms may cause hippocampal atrophy [14].

In the literature, there are studies conducted in the last two years that have investigated post-COVID-19 cognitive functions [15]. There is evidence suggesting impairment in global cognitive function [16,21], attention [16,18,19,22,25], executive function [18,19,26], short-term memory [16,18,24] and visual-perceptual abilities [20,26]. In addition to these, there may be problems in fluency of speech and language abilities. Problems were observed particularly in lexical, semantic and phonemic fluency [18,22,26]. Word finding difficulties have also been reported in some patients [22,24].

Based on this body of evidence, it is clear that individuals may have varying degrees of cognitive impairment after a COVID-19 infection. This study aims to investigate the cognitive communication functions of cases living in Turkey who have been infected with COVID-19.

METHOD

Participants and Procedure

Inclusion criteria for this study were defined as having recovered from COVID-19, being older than 18 years of age. Individuals who had psychiatric or neurological disorders prior to COVID-19 were not included in the study. A total of 497 individuals were contacted for this study. Of these 497 individuals, 13 were not included due to incomplete demographic data. In total, 484 adults (M=27.2, SS=6.2) aged between 18-73 who had recovered from COVID-19 were enrolled to the study. Characteristics of the participants are summarized in Table 1.

The questionnaire, which was constructed by the researchers of this study, was distributed via social media platforms. Participants were asked to complete the questionnaire and share it with others who have been infected with COVID-19. Data collection in this cross-sectional study was conducted according to Goodman's (1961) Snowball Sampling technique. Participants were enrolled in the study between 05/17/2021 and 09/02/2021. The research questionnaire was sent to the participants using a *Google Forms* link.

Construction of Questionnaire Items

The questionnaire is composed of four sections in total. The first of these includes demographic information (5 items), the second includes medical history (5 items), the third includes questions regarding COVID-19 (7 items) and the fourth includes cognitive communication abilities (memory-6, executive function-5, attention-4, language-5, orientation-3 items). A total of 40 items were included under these four main sections. Responses to the first three sections were obtained in the form of short answers or by providing choices. Meanwhile, the items in the last section concerned with cognitive communication abilities were rated by the participants as, "not affected, mildly affected, moderately affected, severely affected."

The symptoms found in the American Speech Language Hearing Association's (ASHA) definition of cognitive communication impairment were used as a reference while determining the items [27]. For example, ASHA uses the description "difficulty managing emotions" regarding the executive function domain of cognitive communication abilities. This item was included in the research questionnaire as, "Do you experience more difficulty controlling your emotions in the events you experience after COVID-19 as compared to before?" The questionnaire that was prepared by the authors of the present study in this direction was reviewed by three independent speech and language therapists with experience in cognitive communication impairments. Following this review stage, the phrase "After COVID-19…" was added to the beginning of the items in order to increase the comprehensibility of the questions in the questionnaire.

Statistical Analysis

Data were exported from Google Forms to a Microsoft Excel template. Then, descriptive statistics associated with the demographic data and the research questionnaire were obtained using the "IBM SPSS 23.0 software". Descriptive statistics were reported by providing mean, standard deviation, percentage, minimum and maximum values.

Ethical Consideration

This study was approved by the Ethics Committee of Ankara Yıldırım Beyazıt University (16.04.2021-25) and observed the tenets of the Declaration of Helsinki.

RESULTS

Descriptive Statistics of Demographic Data

Participants were recruited from 63 provinces in Turkey. Seventy-five percent of the participants were determined to be female. Of the total participants, 68.4% were determined to be university graduates (Table 1). The great majority of the participants were infected once with COVID-19. The duration of COVID-19 infection [days] was reported as M=11.59, SD=6.73. The large majority of the participants (93%) were not hospitalized. At least one chronic disease was found in 21.9% of the study participants. It was found that 82.6% of the participants did not use regular medications before COVID-19. Meanwhile, 70.9% of the participants used medications during COVID-19. The most common symptom among the participants was found to be joint pain with a rate of 66.3%, followed in order by headache, cough and fever. The participants in our study had no history of stay in the intensive care unit or mechanical ventilation. Data regarding COVID-19 are reported in Table 2.

Table 1. Demographic characteristics of the participants

Demographic characteristics		Mean % (n)
Age		27.2±6.2
Gender	Female	75% (121)
	Male	25% (363)
Educational level	Literacy	0.6% (3)
	Primary School	4.3% (21)
	Middle School	2.1% (10)
	High School	8.5% (41)
	Bachelor's	68.4% (331)
	Master's	15.5% (75)
	Doctorate	0.6% (3)
Numbers of attending from different cities		63

Table 2. Information about the participants' COVID-19 history

How many days it lasts? (day)		11.592±6.732
How many people COVID-19 in the same family have passed?		Median 3 (0-18)
How many times he/she had COVID-19?	1	97.1% (470)
	2	3.9% (14)
Status of chronical disease	No	78.1% (378)
	Yes	21.9% (106)
Symptoms	Joint pain	65.3% (316)
	Headache	55.4% (268)
	Cough	38.6% (187)
	Fewer	37.4% (181)
	Loss of sense of smell and taste	8.3% (40)
	Other	10.3% (50)
	No symptom	8.3% (40)
Site of COVID-19 care	Outpatient	93% (450)
	Hospital	7% (34)
Taking medicine before COVID-19	No	81.6% (395)
	Yes	18.4% (89)
Taking medicine during COVID-19	No	29.1% (141)
	Yes	70.9% (343)

Descriptive Statistics of Cognitive Communication Abilities

Approximately half (50.8%) of the study participants were determined to have problems in memory performance as compared to before COVID-19. From these individuals, 30.2% reported a mild effect, 15.5% reported a moderate effect and 5.2% reported a severe effect. Short-term memory abilities were found to be affected more severely in these individuals. In contrast, the long-term memory functions were determined to be the least affected domain.

Although 82.9% of the study participants reported experiencing no effects on the ability to control their emotions, this ability was found to be the most affected component of executive functions. When the attentional ability was considered, the domains that were affected the most negatively were, in order, sustained attention, focusing and selective attention abilities. It was found that 72.2% of the participants did not experience any problems in the domain comprising divided attention as compared to before. No problems were reported in writing by 89.9%, in visual naming by 77.7%, in reading and reading comprehension by 69.6% of the participants after COVID-19.

Regarding the ability of naming during speech, 21.1% of the participants reported a mild effect, 11.6% reported a moderate effect and 3.9% reported a severe effect as they completed the form. With respect to orientation, it was observed that 93% of the participants had no problems associated with place and 91.3% had no problems associated with person. In contrast with the majority in orientation to place and person, 18.8% of the participants reported experiencing problems with their orientation to time (Table 3).

When the problems in the subdomains of all cognitive communication impairments were compared; the most significant problem was in the memory function as reported by 61.4% of the participants, and this was followed in order by attention and executive functions. The least pronounced problem was found to be associated with the orientation ability, in 20.7% of the participants. A mild to severe cognitive communication problem was determined in at least one domain in 76.2% of all participants. The rate of individuals who reported no effect in all of their responses to the questions in the five assessed domains was 23.8% (Table 4).

Table 3. The participants' responses to cognitive communication skills

Items		Not affected	Mildly affected	Moderately affected	Severely affected
Memory	1	49.2% (238)	30.2% (146)	15.5% (75)	5.2% (25)
	2	61.4% (297)	24% (116)	11.8% (57)	2.9% (14)
	3	74.6% (361)	17.4% (84)	6.4% (31)	1.7% (8)
	4	75.2% (364)	16.7% (81)	5.8% (28)	2.3% (11)
	5	59.3% (287)	25.6% (124)	11.6% (56)	3.5% (17)
	6	87.6% (424)	10.3% (50)	1.2% (6)	0.8% (4)
Executive functions	1	61.2% (296)	25% (121)	8.3% (40)	5.6% (27)
	2	82.9% (401)	11.8% (57)	3.7% (18)	1.7% (8)
	3	72.3% (350)	18.8% (91)	5.6% (27)	3.3% (16)
	4	74.6% (361)	18.6% (90)	5% (24)	1.9% (9)
	5	73.1% (354)	19.4% (94)	5.4% (26)	2.1% (10)
Attention	1	53.1% (257)	31.2% (151)	11.6% (56)	4.1% (20)
	2	55.2% (267)	26.2% (26.2)	14% (68)	4.5% (22)
	3	56.6% (274)	27.1% (131)	12% (58)	4.3% (21)
	4	72.7%(72.7)	17.1% (83)	7.9% (38)	2.3% (11)
Language	1	63.4% (307)	21.1% (102)	11.6% (56)	3.9% (19)
	2	68.2% (330)	20.7% (100)	8.5% (41)	2.7% (13)
	3	69.6% (337)	20.5% (99)	7% (34)	2.9% (14)
	4	89.9% (435)	7.6% (37)	2.1% (10)	0.4% (2)
	5	77.7% (376)	16.9% (82)	3.1% (15)	2.3% (11)
Orientation	1	81.2% (393)	13.2% (64)	4.3% (21)	1.2% (6)
	2	93.2% (451)	5% (24)	0.8(4)	1(5)
	3	91.3% (442)	6.6% (32)	1.4% (7)	0.6% (3)

Table 4. The effects of the participants in the sub-domains of cognitive communication skills

Skills	No affected % (n)	At least mildly affected % (n)
Memory	38.6% (187)	61.4% (297)
Executive functions	49.6% (240)	50.4% (244)
Attention	43.8% (212)	56.2% (272)
Language	53.1% (257)	46.9% (227)
Orientation	79.3% (384)	20.7% (100)
Total	23.8% (115)	76.2% (369)

DISCUSSION

In this study, the cognitive characteristics of individuals living in Turkey who recovered from COVID-19 were investigated with respect to memory, executive functions, attention, language and orientation by a survey. Considering that cognitive features are affected in individuals infected with COVID-19 according to the general results of the study, the hypothesis of our study is supported. In this regard, it is possible to report effects that may be deemed important, particularly on memory, attention and executive functions.

There are several research studies[16,17,22,24,28] and a review [15] in the literature that are consistent with the hypothesis tested in this study.

A study by Almeria et al. (2021) suggests that, among memory abilities, there may be problems in verbal memory [22]. On the other hand, the studies that suggest significant post-COVID-19 problems in short-term memory, which is another memory ability, and the results of our study are consistent [16,18,24]. Considering these pieces of evidence, it is thought that, among the memory abilities of individuals infected with COVID-19, short-term memory is more likely to be affected compared with other memory abilities [e.g. long-term memory, working memory].

Woo et al. (2020) reported that individuals could experience general problems in their language abilities after COVID-19 [24]. Meanwhile, in the study by Almeria et al. (2020) that examined domains of language more specifically and used a naming test, it was reported that a naming problem could be encountered after COVID-19 [22]. In line with the study by Almeria et al. (2020), one of the findings of our study is that participants had naming problems during speech. In addition, the problems in naming during speech may be related to memory abilities and may be involved in an interaction with short-long term memory and/or working memory. Considering that there is an important and effective relationship between working memory and language, this is not surprising [29]. It may be necessary to take account of the short-term memory problems highlighted by the results of this study.

Raman et al. (2021) did not specify whether there was any effect on attentional abilities [20]; however, other studies reported that executive functions and attentional abilities of individuals were impacted after COVID-19 [18,19,25,26]. On the other hand, the present study determined more problems in the ability to control emotions among the domains of executive functions when compared with other abilities. With this finding, our study touches upon a more specific matter than other studies in the literature. Among attentional abilities, an effect was observed in the subdomain of sustained attention ability. Considering this evidence, COVID-19 is likely to form a basis for focusing problems in the daily lives of individuals. This result is corroborated by the negative effect determined by our study on the focused attention ability, which is another subdomain of attentional abilities.

In a study by Beaud et al. (2020), it was reported that there could be an impairment in orientation abilities although they are relatively more preserved than other cognitive communication abilities [26]. Helm et al. (2020) reported that nearly one-third of all patients could experience problems with orientation [30]. Meanwhile, our study found no effect on orientation, including the associated subdomains [time, person, place orientation]. As such, it could be reasoned that the problems in orientation abilities that are found in the literature even though minimal, may not appear in the same way in all individuals.

Ramage (2020) reported a potential for cognitive communication impairments in individuals who recovered from COVID-19 [7]. In view of the results of our study and studies in the literature, more evidence suggesting that being infected with COVID-19 poses a risk in terms of cognitive communication impairment has been produced.

Although the sample size of this study was limited, the fact that there was participation from many of the country's provinces (63 different provinces) may be deemed as an advantage in terms of representation of the population. On the other hand, the limited sample size may hamper the generalizability of the results to the entire population of individuals that have recovered from COVID-19. Another limitation is that the level of education was predominantly a bachelor degree. This may not be appropriate for generalization to other education levels. When the studies in the literature are reviewed, stay at the intensive care unit, its duration, and receiving mechanical ventilation are found to be associated with the degree of effect on the individuals' cognitive abilities. Since there were no individuals who stayed at the intensive care unit or received mechanical ventilation among the participants of this study, this aspect of the COVID-19-related cognitive effect could not be assessed. Gender balance also is one of the limitations given that most participants were female. The age range of participants was wide and this could be another factor affecting cognitive communication functions. Future studies may classify the participants according to age intervals and also socioeconomic status. In addition to these, our study determined the effect on the cognitive functions of the individuals using a self-rating questionnaire based on their own perceptions and complaints. It is thought that more studies are needed that assess cognitive functions using objective test methods. Since our study was conducted online via *Google Forms*, it was not possible to evaluate visuospatial abilities. This may be considered one of the limitations of this study. There is no consensus about visuospatial abilities in the literature as can be seen from the results of studies [20,22,25]. Direct administration of objective tests in further research may allow a more elaborate investigation of visuospatial abilities.

Study Limitations

Further studies may; 1) expand the sample size by including an adequate number of individuals that have recovered from COVID-19 to represent the national population in order to increase the generalizability of the results, 2) perform comparisons by grouping the socioeconomic levels of the individuals in order to evaluate socioeconomic level and cognitive abilities more thoroughly, 3) include an equal number of participants for each level of education (from illiterate to doctorate degree) in order to investigate the effect of education on the cognitive abilities of individuals infected with COVID-19. Also, examining the naming problems noted in the discussion section more carefully and using standardized tests to evaluate this ability could represent an objective for further research. Lastly, it is thought that performing studies by evaluating cognitive communication abilities with objective/standardized tests may help reach more detailed and comprehensive results.

CONCLUSION

Although an overall impairment may be encountered in the cognitive communication abilities of individuals who have recovered from COVID-19, the results of this study support the certain domains are affected more significantly. These domains are short term memory,

sustained attention, and the ability to organize emotions. In contrast, orientation abilities were found to be rarely affected.

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