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Effect of post-acute COVID-19 on motor performance and attention in children

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Abstract

Study was conducted to investigate motor performance and attention levels of children who had experienced post-acute coronavirus disease 2019 (COVID-19) infection. The study included children aged 6-14 years who were diagnosed with post-acute COVID-19 at least four weeks prior and had no history of orthopedic or neurological conditions (Group I). A control group (Group II), composed of children in the same age range, had never been diagnosed with COVID-19 and had no familial history of the virus, nor any orthopedic or neurological disorders. Demographic information for both groups was collected using a descriptive questionnaire. Motor performance was assessed through Timed Up and Go Test (TUG), Stair Climbing Test (SCT), while attention was measured using Conners' Parent Rating Scale-Revised, Short Form (CPRS-R:S). Difference in the CPRS-R:S scores of the participants based on their post-acute COVID-19 infection status was found statistically significant ($p<0.05$), but their SCT and TUG scores did not differ significantly based on their infection status ($p>0.05$). Accordingly, children who recover from post-acute COVID-19 would have a CPRS-R:S score 0.955 times as high as the score of those who have not had COVID-19 (OR= 0.955, 95% CI 0.919-0.993). The attention levels of children diagnosed with post-acute COVID-19 are affected negatively, considering relationship between attention and motor performance, it is needed to assess children holistically.

Keywords: Attention, child, motor performance, post-acute COVID-19

Introduction

Coronavirus disease 2019 (COVID-19) is a respiratory illness that has affected millions globally and led to a significant number of fatalities. [1,2]. Post-acute COVID-19 refers to a condition that develops during or after infection and lasts more than three months from the moment it first started [3]. Post-acute COVID-19 represents a strain on the healthcare system [4]. The condition is characterized by unexplained physical and neurocognitive symptoms [5]. Neurocognitive symptoms often involve executive dysfunction, while symptoms include dyspnea, memory problems, anosmia, headaches, etc. [6].

It is well-established that children of all age groups are vulnerable to severe acute respiratory syndrome Coronavirus 2 (SARS-CoV-2) infection [7]. While most cases of COVID-19 in children are either asymptomatic or mild, studies indicate that approximately one-third of these cases require treatment in intensive care units [8]. Although research indicates children generally experience mild symptoms post-acute COVID-19, neurological issues have also been documented.One study highlighted child COVID-19 exhibited dystonic leg stiffness, along with unusual changes in gaze and responsiveness. [9]. Additionally, viral encephalitis was reported in a child following the post-acute COVID-19 [10]. Neurological complications linked to post-acute COVID-19 are more commonly seen children diagnosed multisystem inflammatory syndrome [11].

Motor skills are part of daily life. Motor skills require high attention [12]. The literature reports a relationship between motor skills and attention levels [13]. The prefrontal cortex is involved in executive functions and has also been reported to be affected by motor skills [14]. One study also noted that the basal ganglia, cerebellum,

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and prefrontal cortex were activated together [15]. This situation emphasizes the importance of evaluating motor skills and attention post-acute COVID-19.

While there is some literature addressing motor performance and attention in children post-acute COVID-19, the research on topic remains limited [16].

Considering the significance of the issue in terms of children's health and societal effects, there are few studies examining motor effects and attention levels in children recovering from post-acute COVID-19. Aim of study is to add to examining motor performance, attention levels children recovering from post-acute COVID-19, enabling early intervention to prevent potential issues, and laying the groundwork for future interventional research in this area.

Material and Methods

Study Design

It was a case-control study and its size was determined with G.Power 3.1. The confidence level was calculated as 0.95 and the effect size as 0.8, with at least 56 children and 28 children in each group. The study was carried out between 01.12.2021 and 01.01.2022.

Participants

This study included two groups: children diagnosed with post-acute COVID-19 who visited Malatya Education and Research Hospital (Group I), and healthy children attending routine well-child check-ups at the same hospital (Group II). Ethical approval for the study was received from Malatya Turgut Özal University Noninvasive Clinical Studies Health Sciences Ethics Committee on 29.11.2021 in the session numbered 2021/9. Additionally, approval was received from the Ministry of Health since the study's protocol was related to the COVID-19 pandemic. Written informed consent was obtained from the parents before the study commenced. Study protocol was carried out in accordance with ethical principles outlined Declaration of Helsinki. Participants had to be between the ages of 6 and 14, had been diagnosed with COVID-19 at least four weeks ago, and did not have an orthopedic or neurological disability. Children in the control group were also within the same age range, with no personal or family history of post-acute COVID-19, and no orthopedic or neurological conditions. 5 children were excluded from the study (did not meet inclusion criteria, did not cooperate, or did not agree to participate).

Assessment and Data Collection

Data including demographic and clinical characteristics of children and their families were recorded at baseline (Demographic characteristics such as age, gender and anthropometric measurements such as height, weight, body mass index, etc. were recorded).

Motor Performance Assessment

To evaluate motor performance, Timed Up and Go Test (TUG), Stair Climb Test (SCT) were utilized. The TUG is a proven, affordable, efficient method for assessing overall functional mobility [17]. In this test, each child was instructed to get up from a chair, walk a distance of 3 meters, and then sit down again. Time taken was recorded.SCT test involves ascending a 10-step staircase and then returning to the starting point [18]. For the SCT, each child was instructed to climb the stairs quickly but cautiously, one step at a time, and return without pausing. The child was permitted to use the handrails. The total time taken to finish the test was recorded in seconds.

Attention Evaluation

Attention was evaluated using the Conners Parent Rating Scale-Revised, Short Form (CPRS-R:S). Scale includes 27 items designed for parents to assess their children's behavior. Each item offers four response options on a scale from 0 to 3. These options represent the degree to which the child exhibits the behaviors outlined in the CPRS-R:S: 0 points for never, rarely, 1 point for occasionally, 2 points for often, somewhat, and 3 points for very often, very frequently. The higher the test score, the more prone you are to the problems mentioned in the test.The validity and reliability of the CPRS-R:S were established by Kaner et al. in a Turkish population [19].

Statistical Analysis

Data for this study were analyzed using SPSS version 25.. Shapiro-Wilk test was used to evaluate normality of data distribution. [20]. Significance level of 0.05 was set for the comparison tests. As variables demonstrated a normal distribution ($p>0.05$), parametric test methods were used for further analysis.

In the study, logistic regression model was established, and factors associated with previous post-acute COVID-19 status were determined. Outcomes of motor performance and attention in those with and without a previous post-acute COVID-19 diagnosis was explained by the model. Differences were found between Groups I and II in terms of their CPRS-R:S scores. SCT and TUG were not affected according to the model.

It was observed that CPRS-R:S scores decreased in those with a previous diagnosis of post-acute COVID-19. Decrease in CPRS-R:S scores in those with a previous diagnosis of post-acute COVID-19 was interpreted logistic regression model, which showed a negative relationship between CPRS-R:S scores and diagnosis status, while SCT and TUG scores were not expected to be affected.

Results

In this study, the data of 31 children with a recent history of COVID-19 infection (Group I) and 29 sex-matched healthy children (Group II) were analyzed.

Girls constituted 48.3% (n=29) of the children in the sample, while boys constituted 51.7% (n=31). The mean age of the patients in Group I was 10.1±2.87, while that of the children in Group II was 9.83±2.78. The mean body mass ındex (BMI) values were 19.96±5.2 in Group I and 18.01±4.89 in Group II. The demographic characteristics of the children in the two groups were similar ($p>0.05$).

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Aim of study was to determine whether there were differences according to CPRS-R:S, SCT and TUG scores and the results are given in Table 1. It was found that TUG and SCT scores that changed motor performance did not show a statistically significant difference between the groups ($p>0.05$). However, CPRS-R:S score was significantly higher in Group I ($p<0.05$, Table 1).

Table 1. Comparison of test scores

Variable	Group	X±SD	Test statistic	p-value
CPRS-R:S	**Group I**	26.81±17.06	2.525	**0.014***
	Group II	16.76±13.41		
SCT	**Group I**	13.63±6.34	1.100	0.276
	Group II	12.2±3.12		
TUG	**Group I**	9.33±2.18	-0.741	0.462
	Group II	9.82±2.87		

CPRS-R:S: Conners' Parent Rating Scale-Revised, Short Form, SCT: Stair Climb Test, TUG: Timed Up and Go Test, X: mean, SD: standard deviation, Test Statistic: significance test for the difference between two mean values (t-test), p-Value: statistical significance level

Group I exhibited higher mean scores and standard deviations on the CPRS-R:S and SCT compared to Group II. On the other hand, the mean TUG score for Group I was lower than that of Group II (Figure 1).

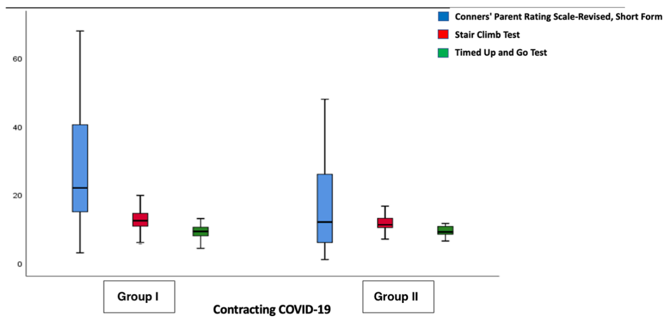

Figure 1. Standart deviation graph of scores according to post-acute COVID-19 status

Statistically significant difference was found in CPRS-R:S scores between the two groups regardless of post-acute COVID-19 status ($p<0.05$, Table 2). No statistically significant difference was observed in SCT and TUG scores ($p>0.05$, Table 2). Among children with post-acute COVID-19, CPRS-R:S score decreased by a factor of 0.955 (OR=0.955, 95% CI: 0.919-0.993).

Table 2. Statistical prediction values of the scores in the model

Scores	β	SE	W	df	p-value (sig.)	Exp (β)	95% CI for Exp (β)	
							Lower bound	Upper bound
CPRS-R:S	**-0.046**	0.020	5.436	1	**0.020**	0.955	0.919	0.993
SCT	-0.061	0.056	1.179	1	0.278	0.941	0.843	1.050
TUG	0.118	0.129	0.848	1	0.357	1.126	0.875	1.448
Constant	0.566	1.407	0.162	1	0.687	1.761		

CPRS-R:S: Conners' Parent Rating Scale-Revised, Short Form, SCT: Stair Climb Test, TUG: Timed Up and Go Test, β: parameter estimate, SE: standard error, W: Wald statistic, df: degrees of freedom, Exp(β): odds ratio, 95% CI: confidence interval, Dependent variable: COVID-19 infection history

Discussion

This case-control study evaluated motor performance, attention levels of children aged 6-14 years who had post-acute COVID-19 compared to a healthy control group. As a result of study, a statistically significant difference in attention levels was observed.

One study highlighted impact of COVID-19 on both motor performance, attention children [16]. Motor skills were observed to be affected by the prefrontal cortex [14]. Considering the connectivity between these brain regions, it is important to assess both motor skills and attention in children following acute COVID-19.

Cognitive symptoms observed post-acute COVID-19 are believed to stem from blend biological, psychological factors. [21-23]. Due to the prolonged regeneration time of neurons in the nervous system, cognitive symptoms may take longer than expected to recover post- acute COVID-19. Symptoms such as memory loss have been reported post- acute COVID-19 and have been reported to persist after infection [24]. A study in the literature has shown that changes in the nervous system were also found in animal studies infected with SARS-CoV-2 [25]. However, they cannot fully explain cognitive symptoms post-acute COVID-19 in humans [26].

One study in the literature investigated persistent cognitive impairment post-acute COVID-19, reporting that all cognitive domains were impacted, with learning and memory being the most severely affected, followed by executive functions. In line with this, attention levels also showed significant differences in the current study [27].

One study highlighted that COVID-19 had a significant impact on neurocognition [28]. Similarly, another study reported that children who recovered from COVID-19 experienced cognitive difficulties compared to the control group [16]. Consistent with these findings, study also showed that the attention levels of children who contracted COVID-19 were affected compared to the control group.

Literature, a study also examined effect of COVID-19 on motor skills in elderly individuals and found that it had a negative effect

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[29]. Similarly, another study examined effect of COVID-19 on children's home routines and found that it significantly altered their motor skills [30]. Conversely, Eberhardt et al. assessed physical fitness in children during COVID-19 period and reported no significant changes in their motor performance [31]. Although our study did not detect significant differences in motor performance, it suggests that the full extent of the effects post- acute COVID-19 remains unclear [32]. This highlights the importance of conducting further long-term observational studies to better understand the lasting effects.

Our findings suggest that the attention level will decrease in children post-acute COVID-19. It is important to evaluate executive functions post-acute COVID-19. The connection between executive function and motor skills has become a key area of research in recent years. A review of the literature reveals numerous studies indicating that executive dysfunction can negatively impact motor skills. For example, a prospective study by Gothe et al. in older adults showed that improvements in executive functions led to better performance in mobility tests [33]. Given the relationship between motor performance and executive function, it is evident that directing individuals who have had COVID-19 to appropriate rehabilitation programs at an early stage is essential.

In patients with acute COVID-19, starting physiotherapy and recording practices early will increase motor skills and attention levels and have positive effects on quality of life and daily functionality.

Study Limitations

This study assessed early motor performance post-acute COVID-19. It does not fully reflect its long-term effects. This was recognised as an important limitation of the study. The study should be validated with studies involving more populations.

Conclusion

As the most important result of ostudy, the attention levels of children diagnosed with COVID-19 are affected negatively, and considering the relationship between attention and motor performance, it is needed to assess children holistically. It is believed that raising awareness in families and society and directing children towards recreational activities will be guiding for increasing awareness regarding this issue.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

The authors declare that they have received no financial support for the study.

Ethical Approval

Ethical approval for the study was received from Malatya Turgut Özal University Noninvasive Clinical Studies Health Sciences Ethics Committee on 29.11.2021 in the session numbered 2021/9. In addition, since the study protocol included the COVID-19 outbreak, approval was obtained from the Republic of Türkiye Ministry of Health and the Helsinki principles were followed.

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