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Clinical Manifestations of Patients with COVID Admitted to Tertiary Hospital

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ABSTRACT

Background: Although COVID-19 has affected a substantial number of pediatric patients, severe illness remains relatively uncommon, with most children responding well to supportive care. The clinical presentation in this population is heterogeneous and frequently involves non-respiratory symptoms. However, adolescents and children with underlying medical comorbidities are more susceptible to developing significant respiratory complications.

Objective: This study aimed to investigate the diversity of clinical presentations and imaging findings of COVID-19 among adolescents and children.

Patients and methods: This observational, cross-sectional investigation was carried out between November 2022 and November 2023 at Mansoura University Children's Hospital, Mansoura, Egypt. All enrolled patients underwent a comprehensive evaluation conducted more than four weeks after their initial COVID-19 diagnosis. The assessment included a structured interview by a senior pediatrician to evaluate the presence of ongoing symptoms and their impact on daily functioning. Radiological investigations comprised echocardiography, chest CT, EEG, and brain MRI.

Results: Multisystem inflammatory syndrome in children (MIS-C) was identified in 22.2% of cases and represented the most frequent presentation of post-COVID syndrome. Other most reported symptoms included increased anxiety and worry (82.9%), fatigue (74.3%), breathlessness (68.6%), and the need to seek medical attention due to symptoms (60.0%). Other frequently reported symptoms were loss of appetite (57.1%), new-onset cough distinct from any pre-COVID cough (51.4%), and chest pain with palpitations (51.4%). Additional complaints included weak physical strength (37.1%), abdominal pain (34.3%), anosmia and headache (28.6%), altered sense of taste (25.7%), joint pain (22.9%), dizziness (17.1%), and diarrhea (11.4%). Notably, 11.4% of children reported that their symptoms had a negative impact on their school performance.

Conclusion: A significant proportion of children experienced long-term physical and neuropsychiatric sequelae following COVID-19, with radiological evidence of persistent organ involvement observed in some cases. These findings underscore the need for structured follow-up and multidisciplinary care for pediatric COVID-19 survivors.

Keywords: COVID; Children, Post-Acute Sequelae of SARS-CoV-2 Infection; Pediatric COVID.

INTRODUCTION

The global dissemination of SARS-CoV-2 extended to Egypt, where first confirmed case was reported on February 14, 2020. As of May 1, 2020, the country had documented 5,895 confirmed cases, with a case fatality rate of 6.9%. Although children were impacted similarly to other age groups, their overall incidence remained below 10%. Notably, healthcare workers accounted for approximately 11% of total confirmed cases [1]. Initial reports indicated that between 25% and 58% of children developed post-COVID conditions (PCCs) several months following acute phase of illness, with no apparent correlation to initial disease severity [2]. However, a later investigation focusing predominantly on nonhospitalized children who tested positive for SARS-CoV-2 found that only 4% remained symptomatic 28 days post-testing, and this proportion declined to 2% at 56 days following test [3].

Although these risks exceeded those observed in non-infected individuals, other studies have found no substantial variation in PCCs prevalence between pediatric cases with confirmed COVID-19 and their control counterparts. However, these findings are subject to several limitations, including use of testing protocols based on adult symptomatology, limited follow-up participation, dependence on healthcare utilization data, small cohort sizes, and exposure classification based on serological (antibody) testing [4]. This study aimed to assess the spectrum of manifestations and radiological findings of COVID-19 in children and adolescents.

PATIENTS AND METHODS

This observational and cross section study included a total of 54 children under the age of 18 years who had been previously diagnosed with SARS-CoV-2 infection. The study was conducted at Mansoura University Children's Hospital, Mansoura, Egypt, over a one-year period from November 2022 to November 2023.

The sample size estimation was guided by prevalence of long COVID symptoms as reported by **Chen *et al.*,** among pediatric cases with confirmed SARS-CoV-2 infection**.** Applying Daniel's formula (1999) for prevalence studies, with a 95% confidence level and a permissible margin of error set at 5%, minimum required sample size was calculated to be 150 participants. The calculation was based on following parameters: Z = 1.96, margin of error (d) = 0.05, and estimated prevalence (P = 0.11). A positive SARS-CoV-2 status was defined by a nucleic acid amplification test (NAAT) yielding a positive result from a swab specimen collected from the

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nares, nasopharynx, or oral cavity, either during the initial emergency department (ED) visit or within the subsequent 14 days. Post–COVID-19 conditions were identified when participants exhibited persistent, new, or recurrent symptoms or health-related issues following the acute phase of infection. In contrast, post–COVID-19 conditions were considered absent if reported symptoms were neither persistent nor new and were instead attributed to a pre-existing condition without clinical worsening. Pediatric patients under 18 years of age who tested negative for SARS-CoV-2 by PCR were excluded from the study.

All cases in current study underwent comprehensive history taking, which included documentation of age, sex, date of positive swab confirming infection (i.e., admission date), symptom onset date, and date of discharge. Information was also collected regarding COVID-19 vaccination status (prior to and following infection), whether child had fully recovered or continued to experience residual symptoms, nature of treatment received, presenting symptoms of COVID-19, and any associated complications.

All cases underwent a structured evaluation conducted more than four weeks following their initial diagnosis. This assessment involved a detailed interview by a senior pediatrician to evaluate persistence of symptoms and their effect on daily functioning. Radiological investigations included echocardiography, chest CT, EEG, and brain MRI.

Neurological disability was evaluated using Modified Rankin Score (mRS), a 6-point scale that quantifies degree of functional impairment, with scores ranging from 0 (no symptoms) to 6 (death). Scores between 0 and 3 were interpreted as reflecting mild to moderate disability, whereas scores of 4 or 5 were indicative of severe disability.

Ethical considerations

The study received approval from the Institutional Research Board of the Faculty of Medicine, Mansoura University (Approval Code: MS.22.12.2246) and was conducted in accordance with the Declaration of Helsinki and its subsequent amendments. Written informed consent was obtained from the parents or legal guardians of all participants, following a thorough explanation of the study's objectives, procedures, potential risks, and the intended use of anonymized data. Strict confidentiality and privacy of participant information were maintained throughout the study.

Statistical analysis

Data were analyzed using SPSS version 18 (SPSS Inc., PASW Statistics for Windows, Chicago, IL, USA). Quantitative data were presented as mean ± SD for normally distributed variables and as median (min–max) for non-normally distributed ones, with normality assessed via Shapiro-Wilk test. Qualitative data were summarized as frequencies and percentages. Group comparisons were conducted using Chi-square test, Fisher's exact test, or Monte Carlo test, as appropriate. Student's t-test was used for comparing normally distributed continuous variables between two independent groups. A p-value < 0.05 was considered statistically significant.

RESULTS

The median age of the study population was 9 years (range: 2–16 years), with males comprising 68.5% and females 31.5% of the cohort. Table 1

Table 2 demonstrates that 22 cases underwent echocardiographic imaging during the acute phase of infection, with abnormal findings reported in 50% of them. Chest CT was performed in 40 cases during infection, revealing abnormalities in 32 cases (80%). Follow-up chest CT performed more than six months post-infection was available for 28 cases, of which 6 cases (21.4%) showed persistent abnormal findings**.** Brain MRI conducted after more than six months in 20 cases revealed abnormal findings in 3 cases (15%). EEG assessments performed after more than six months post-infection showed abnormal findings in 2 cases (10%). Additionally, follow-up echocardiography **in 21 cases** demonstrated abnormal findings in 2 cases (9.5%). The median duration of hospital admission was 12 days, ranging from 3 to 116 days.

Table 3 summarizes the most frequently reported symptoms of post-COVID syndrome. The most common **were** increased anxiety and worry (82.9%), followed by fatigue (74.3%), breathlessness (68.6%), seeking medical attention due to persistent symptoms (60%), and loss of appetite (57.1%). Other frequently reported symptoms included a new-onset cough distinct from pre-COVID (51.4%), chest pain and palpitations (51.4%), weak physical strength (37.1%), abdominal pain (34.3%), anosmia and headache (28.6%), altered sense of taste (25.7%), joint pain (22.9%), dizziness (17.1%), and diarrhea (11.4%). Furthermore, 11.4% reported negative impacts on school performance**.** Less commonly reported symptoms included: positive family history of a similar condition**,** loss of motor or cognitive skills**,** and fever (each 8.6%), while **sleep disturbances more severe than before COVID-19** were reported in 2.9% of cases.

Table 1: demographic characteristics of studied cases

	Number	**%**
Age / years		
Median (min-max)	**9 (2-16)**	
Sex		
Male	**37**	**68.5**
Female	**17**	**31.5**

n: number, min: minimum, max: maximum.

Table (2): radiological examination of studied cases

	Number	%
Echo during infection	N=22	
Normal	11	50.0
Abnormal	11	50.0
CT chest during infection	N=40	
Normal	8	20.0
Abnormal	32	80.0
CT chest after more than 6 months from infection	N=28	78.6
Normal	22	21.4
Abnormal	6	
MRI brain after more than 6 months from infection	N=20	85.0
Normal	17	15.0
Abnormal	3	
EEG after more than 6 months	N=20	
Normal	18	90.0
Abnormal	2	10.0
FU ECHO	N=21	
-VE	19	90.5
+VE	2	9.5
Duration of admission(days) Median (min-max)	12(3-116)	

n: number, CT: Computed Tomography, MRI: Magnetic Resonance Imaging, EEG: Electroencephalography, FU: Follow-Up, ECHO: Echocardiography, +VE: Positive, -VE: Negative, min: minimum, max: maximum.

Table 3: clinical symptoms of COVID

	N=35	%
Fever	3	8.6
any joint pain	8	22.9
Diarrhea	4	11.4
Nausea and vomiting	7	20.0
Abdominal pain	12	34.3
Loss of appetite or weight	20	57.1
Anosmia	10	28.6
Sense of taste	9	25.7
Breathlessness	24	68.6
A cough (different from any cough before COVID)	18	51.4
Chest pain & palpitations	18	51.4
Headache	10	28.6
Dizziness	6	17.1
Loss of skills (moto-cognitive)	3	8.6
More anxious & worrying	29	82.9
More fatigued	26	74.3
Weak physical strength	13	37.1
Sleep problem more than before COVID	1	2.9
Seek medical attention	21	60.0
Positive family history of similar condition	3	8.6
Affect school performance	4	11.4

n: number, COVID: Coronavirus Disease 2019.

DISCUSSION

Since the onset of the pandemic, the WHO has documented over 650 million confirmed cases of COVID-19 worldwide as of January 13, 2023. While most individuals experience complete recovery following SARS-CoV-2 infection, a subset of both adults and children develop persistent, unexplained, or newly emerging symptoms. This clinical entity is referred to as long COVID, PCC, or post-acute sequelae of SARS-CoV-2 infection [5].

This investigation aimed to assess the spectrum of manifestations and radiological findings of long COVID-19 in children and adolescents.

This observational cross-sectional investigation was conducted at Mansoura University Children's Hospital, Mansoura, Egypt, and included pediatric cases under 18 years of age with a confirmed diagnosis of SARS-CoV-2. The median age of cohort was 9 years (range: 2–16 years), with 68.5% of participants being male and 31.5% female.

The higher male/female ratio observed in our study was comparable to previous study by Mohammad S that included 80 pediatric cases with a male-to-female ratio of 1.2 : 1 [6]. Similarly, **Yin *et al.*** reported that 62.09% of studied cases were boys [7].

Regarding radiological findings, 40 cases underwent CT chest during infection that showed abnormal findings in 32 cases (80%). Additionally, 28 cases underwent CT chest more than 6 months after infection, with 6 cases (21.4%) showing abnormal findings. In line with these findings, abnormal chest radiographs were documented in about one-third of children who underwent chest radiography; ground-glass opacities (GGOs) were seen in about half [8, 9]. **Wang *et al.*** conducted a review of 37 studies encompassing a total of 1,747 pediatric cases with COVID-19, reporting an overall prevalence of abnormal lung findings on chest CT in 63.2% of case [10]. The European Society of Pediatric Radiology Cardiothoracic Imaging Taskforce reported abnormal chest imaging findings in 64% of pediatric COVID-19 cases [11]. Moreover, subgroup analysis revealed that baseline prevalence of abnormal CT findings was 61% within China and 67.8% outside of China [12]. However, previous Egyptian study observed that all cases' radiological scans revealed unremarkable changes [13]. This observation may be attributed to early detection in these cases, as testing was prompted by documented direct exposure to infected household members.

Cardiac function was evaluated in studied cohort through echocardiographic imaging performed in 22 cases during acute phase of infection, of whom 50% demonstrated abnormal findings. Follow-up echocardiography was available for 21 cases, revealing persistent abnormalities in 2 cases (9.5%). Previous

research reported abnormal ECG findings in approximately 47% to 93% of individuals with COVID-19 [14-17].

To assess neurological complications among studied cases, 20 cases MRI brain after more than 6 months from infection that illustrated 3 cases (15%). EEG was performed after more than 6 months that illustrated 2 cases (10%) had abnormal findings and Median duration of admission is 12 days ranging from 3 to 116 days.

In a study by **Yang *et al.*** involving 125 pediatric cases with SARS-CoV-2 infection presenting with neurological manifestations, abnormal EEG findings were identified in 31.2% (n = 39) of cases [18]. **Lin *et al.*** reported that among 197 cases diagnosed with COVID-19, 181 (91.9%) underwent brain imaging via CT and/or MRI. Of these, 61 cases (33.7%) exhibited newly developed intracranial lesions, 35 (19.3%) showed pre-existing intracranial abnormalities, while 90 (49.7%) demonstrated no evidence of either acute or chronic intracranial pathology [19].

Chu *et al.* found that among 31 pediatric cases presenting with post-COVID-19 neurological manifestations, MRI abnormalities were identified in 15 cases (48.4%), with encephalitis or encephalopathy accounting for majority (73.3%) of these finding [20].

As regard clinical presentation; 25.9% of cases have pneumonia. This was lower than previous study by who found that prevalence of pneumonia in children with COVID-19 was 62.5% (40/64)[21]. **Ali *et al.*** observed that COVID-19 pneumonia was reported in 39% of pediatric cases with confirmed COVID-19 infection [6].

In our cohort, 5.9% of cases were diagnosed with viral myocarditis, 5.6% with tubulointerstitial disease, 3.8% with AKI, 1.9% with CNS infection, and 1.9% with pyrexia of unknown origin (PUO). In alignment with our findings, **Kari *et al.*** reported that among 89 pediatric cases hospitalized for COVID-19, 21% developed AKI. Among these, 58% were classified as stage I, 31.5% as stage II, and 10.5% as stage III AKI [22]. **Raina *et al.***., in a study involving 2,546 American children admitted to ICU with COVID-19, reported that AKI occurred in 10.8% of cases [23].

The present study revealed that most frequent present symptoms for COVID syndrome was more anxious and worrying (82.9%) of studied cases , 74.3% more fatigued, 68.6% breathlesness, 60% seeking mediccal attention , 57.1% loss of appetite , 51.4% A cough(different from any cough before COVID) and Chest pain & palpitations, 37.1% Weak physical strength , 34.3% Abdominal pain, 28.6% anosmia and headache , 25.7% sense of taste , 22.9% any joint pain , 17.1% dizziness , 11.4% diarrhea and affect school performance , 8.6% for following symtpoms ; Positive family history of similar condition, Loss of skills (moto-cognitive) , Fever and 2.9% present with Sleep problem more than before COVID.

Consistent with our findings, systematic reviews and meta-analyses have identified five most commonly reported clinical manifestations as mood symptoms (16.5%), sleep disturbances (8.42%), fatigue (9.66%), respiratory symptoms (7.62%), and headache (7.84%) [24].

An English study that used national-level data identified nine symptoms commonly reported in children following recovery from symptomatic SARS-CoV-2 infection. These included difficulty sleeping (8.8%), anxiety (7.8%), mood swings (7.8%), anosmia (6.9%), sadness (6.9%), confusion (5.6%), ageusia (5.3%), depression (4.1%), and eye pain (2.8%). Importantly, mental health disturbances were noted among children regardless of their SARS-CoV-2 test results, suggesting a broader psychological impact of COVID-19 pandemic on pediatric population [25].

Another English study matched 1,734 children with confirmed COVID-19 to an equal number of controls based on age, sex, and week of testing. At 28 days post-infection, most frequently reported symptoms included fatigue (84.4%), headache (77.9%), and anosmia (77.9%). The study further noted that school-aged children and adolescents exhibited a higher prevalence of mental and neurological symptoms compared to preschool-aged and younger children [26].

A recent systematic review and meta-analysis by Badenoch et al. highlighted sleep disturbances, fatigue, anxiety, PTSD, and objectively measured cognitive impairment as most commonly reported cognitive and neuropsychiatric symptoms [27]. In an Italian cohort of 402 adult COVID-19 survivors, 56% reported at least one persistent psychiatric symptom—such as anxiety, obsessive-compulsive traits, insomnia, depression, or PTSD—within one month post-discharge [28].

The variability in symptoms observed between our study and others may be attributed to heterogeneous nature of long-COVID, wherein constellation of symptoms can differ markedly between individuals, often fluctuating in both frequency and severity [24].

MIS-C was identified in 35.2% of our study population, a notably higher proportion compared to earlier reports. For example, between March 1 and May 10, 2020, state of New York reported an incidence of merely 2 cases per 100,000 individuals under age of 21 [29]. In a separate survey by Lee conducted in New York City, incidence of MIS-C was reported at 11.4 cases per 100,000 individuals under 20 years of age between March 1 and June 30, 2020 [30].

Moreover, post-COVID-19 Kawasaki disease was identified in 13% of the studied cases. This prevalence is notably higher than that reported in earlier studies from China. Data from a large pediatric cohort in Wuhan—the initial epicenter of outbreak—indicated that

majority of infected children experienced a mild clinical course, with no cases of COVID-19-associated Kawasaki disease reported to date [31].

A study conducted at a tertiary care center in Switzerland demonstrated an approximate 90% increase in incidence of Kawasaki disease following emergence of COVID-19 pandemic, with rates rising from 3.14 to 5.91 cases per 100,000 population [32].

This study is subject to several limitations. First, its cross-sectional design precludes ability to infer causal relationships between SARS-CoV-2 infection and long-term symptoms observed. Second, relatively small sample size and single-center nature of study may constrain external validity and generalizability of results. Third, lack of a control group consisting of non-infected children limits capacity to determine specificity of symptoms attributable to COVID-19. Moreover, reliance on caregiver-reported outcomes may have introduced recall bias, and radiological assessments were not uniformly conducted across all cases.

CONCLUSION

It could be concluded that a significant proportion of children experienced long-term physical and neuropsychiatric sequelae following COVID-19, with radiological evidence of persistent organ involvement observed in some cases. These findings underscore the need for structured follow-up and multidisciplinary care for pediatric COVID-19 survivors.

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