



How COVID-19 Pandemic Changed Children and Adolescents Use of the Emergency Department: the Experience of a Secondary Care Pediatric Unit in Central Italy

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Abstract

Italy was the first European country hit by SARS-CoV-2 infection, particularly northern regions. After the beginning of national lockdown (March 9th, 2020), we observed a significant decrease in pediatric emergency department consultations (daily pediatric visits; pre-lockdown, 16 (11–22); lockdown, 3 (1–3); phase 2, 3 (3–5), $p < 0.0001$). On the other hand, the percentage of children discharged right after pediatric visit significantly decreased from 80% in January to 50% in April. After March 9th, we registered a change in the diagnoses of emergency department visits, with an increase in the percentage of non-infectious acute conditions and a decrease in infectious diseases, with two cases of a noteworthy delayed access to hospital care. We performed a retrospective analysis of consultations requested to our pediatric unit for children and adolescents referred to the general Emergency Department of San Luca Hospital of Lucca (Tuscany, Central Italy) from January 1st to May 31st, 2020. We split data in two different time periods according to consultations performed before (January 1st–March 8th) and after the beginning of lockdown (March 9th–May 31st). Analyzing the number of children hospitalized from January to May 2020 in comparison with the same period in 2019, a decreased hospitalization became evident after March (March – 74.6%, April – 71.6%, May – 58.6%). Nasopharyngeal

What is Known:

Italy was the first European country hit by SARS-CoV-2 infection. Published preliminary Italian data confirmed a general favorable clinical course of COVID-19 in childhood.

What is New:

Even if COVID-19 pandemic more seriously affected Northern Italy, the admission of children and adolescents to pediatric emergency services significantly changed also in Central Italy with reduced demand and increased appropriateness.

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swabs done in 115 children showed only one case of COVID-19. Even if COVID-19 outbreak more seriously affected Northern Italy, utilization of pediatric emergency services significantly changed also in Central Italy with consequent reduced demand and increased appropriateness.

Keywords SARS-CoV-2 · COVID-19 · Emergency department · Children · Adolescents

Abbreviations

COVID-19	Coronavirus disease 2019
ED	Emergency department
IQR	Interquartile range
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2

Introduction

Coronavirus disease 2019 (COVID-19), a novel disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in China in December 2019 and rapidly spread worldwide [1]. Italy was the first European country hit by SARS-CoV-2 infection. Indeed, after detecting the first Italian patient affected by COVID-19 on February 18th, 2020, in Codogno (Lombardy, Northern Italy), SARS-CoV-2 infection affected the entire peninsula, and on June 20th, the Italian Ministry of Health reported 238,275 cases and 34,610 deaths [2]. The first Tuscan case of COVID-19 was detected on February 24th. On June 20th, Tuscany (Central Italy) was the fifth Italian region by number of cases with 10,207 confirmed cases and 1095 deaths. Lucca with 1369 cases was the second province of Tuscany after Florence [2, 3].

Available international data showed that newborns, children, and adolescents with COVID-19 usually develop a mild disease with few symptoms and a good prognosis compared with adults [4–6]. Published preliminary Italian data confirmed a general favorable clinical course of COVID-19 in pediatric age [7]. However, two Italian Pediatric Research Networks reported a not negligible rate of severe presentations in children with comorbidities [8]; four deaths (age ≤ 9 years) have been reported on June 28th [9].

To tackle COVID-19 outbreak, the Italian Government imposed strict containment measures. Since March 5th, 2020, Italian schools and universities were closed. During phase 1 (national lockdown period, March 9th–May 3rd, 2020) the Italian Ministry of Health recommended to avoid direct access to the emergency department (ED) in case of fever and/or cough or other respiratory symptoms, favoring home care or phone consultation for ill patients without compromised general conditions [10]. Phase 2 started on May 4th, 2020, and was characterized by progressive relaxation of containment measures allowing outdoor physical activity, opening of the public parks, and visits to relatives within the regional territory

(always keeping the distance of at least 1 m and with the mandatory use of masks) [11, 12]. These strategies caused a substantial decline in ED visit and hospitalizations [13, 14]. Preliminary data from 5 Italian pediatric ED showed that, during lockdown (March 1st–27th, 2020), ED visits were significantly decreased (up to 88%) as compared with the same time period in 2018 and 2019. Alarmingly, 12 cases of severely ill children with delayed access to hospital care (4 deaths) were reported [15].

The aims of this study were to (1) evaluate the impact of COVID-19 pandemic on the activity of a secondary care Italian Pediatric Unit assessing, in particular, the characteristics of pediatric ED consultations performed in 2020 before and after the beginning of lockdown; (2) evaluate the prevalence of SARS-CoV-2 infection in children and adolescents referred to ED; and (3) compare pediatric ED activity during the same period of 2019 and 2020.

Materials and Methods

We performed a retrospective analysis of consultations requested to our pediatric unit for children and adolescents referred to the general ED of San Luca Hospital of Lucca (Tuscany, Central Italy) from January 1st to May 31st, 2020. During COVID-19 pandemic, this hospital was qualified to admit patients with suspected or confirmed SARS-CoV-2 infection (“COVID-19 hospital”). From the general ED management software (Firstaid®, Dedalus Healthcare Systems Group, Florence, Italy), we extracted anonymous data such as gender, age, date (weekday or pre-holiday/holiday), and outcome (discharge after ED visit, short-stay observation (6–48 h), ordinary hospitalization (≥ 72 h), or transfer to tertiary care hospital) of patients < 16 years referred to the ED and needing pediatric visit. We split data in two different time periods according to consultations performed before (January 1st–March 8th) and after the beginning of lockdown (March 9th–May 31st). The latter was further divided in phase 1 (March 9th–May 3rd) and phase 2 (May 4th–31st), as indicated by the Italian Government [10–12]. Diagnoses of pediatric visits were grouped in 8 main categories (upper respiratory tract infections, lower respiratory tract infections, gastroenteritis/vomiting, acute abdominal pain, trauma, neurologic diseases, other acute diseases, and no urgency). We also evaluated the number of pediatric ED visits performed monthly

from January 1st to May 31st, 2020, for selected infectious and non-infectious diseases.

COVID-19 was diagnosed testing nasopharyngeal swab for SARS-CoV-2 nucleic acid using real-time reverse transcriptase polymerase chain reaction technique. Swabs were collected by trained personnel, and analyses were performed in regional referral laboratories. According to local, regional, and national recommendations, pediatric COVID-19 was initially suspected in the presence of both fever and respiratory symptoms (cough and/or dyspnea). Giving the progressive increase of SARS-CoV-2 cases in Tuscany, nasopharyngeal swab was subsequently performed in every child with fever and/or respiratory symptoms. Since April 7th, 2020, all patients possibly requiring hospitalization were tested for SARS-CoV-2, independently of presentation at ED admission. This measure was adopted to avoid nosocomial transmission of COVID-19 among hospitalized patients. Tested children were grouped in symptomatic (in the presence of fever and/or respiratory symptoms) and asymptomatic (if afebrile and without respiratory symptoms). Clinical and biochemical data were collected to compare symptomatic and asymptomatic patients.

We selected five easily recognizable and well-identifiable common causes of ED access, that is, minor head trauma, earache, crying in infant < 1 year, vomiting and/or diarrhea, and skin rash, to compare pediatric ED activity during COVID-19 pandemic and the corresponding period in 2019 (time interval available for analysis March 1st–May 20th). Finally, we retrospectively extracted anonymous data on children hospitalized from January 1st to May 31st, 2019, in our pediatric unit, after referral to the ED, by using the dedicated management software (Areas®, Engineering Ingegneria Informatica, Rome, Italy) and compared them with data observed in the same months of 2020. Children hospitalized for planned surgery or diagnostic procedures requiring general anesthesia (i.e., magnetic resonance imaging or esophagogastroduodenoscopy) were excluded from analysis. The parents of the patients and the patients themselves, as appropriate, gave their informed consent to the anonymous publication of data for scientific purposes.

Statistical Analyses

All continuous variables were not normally distributed; thus, nonparametric Mann-Whitney test and Kruskal-Wallis test were used to compare groups. Data were reported as median and interquartile range (IQR). Fisher's exact test or chi-square test was used to compare categorical variables, as appropriate. All statistical analyses were carried out using the SPSS (Statistical Package of Social Sciences, Chicago, IL, USA) for Windows software program version 19.0. A p value < 0.05 was considered significant.

Results

Impact of COVID-19 Pandemic on Pediatric ED Consultations

After the beginning of national lockdown, we observed a significant, sudden decrease in pediatric ED consultations (Fig. 1), in particular during phase 1 (phase 2 showed a slight increase in daily pediatric access to ED). During January and February 2020, pediatric visits peaked in pre-holidays and holidays, but after the lockdown started, this trend disappeared (before the lockdown beginning, weekdays = 14 daily visits (IQR 10–17, range 3–25) vs. pre-holidays/holidays = 26 (IQR 16–31, range 4–47, $p < 0.0001$); phase 1, weekdays = 2 daily visits (IQR 1–3, range 0–7) vs. pre-holidays/holidays = 2 (IQR 1–3, range 0–5, $p = 0.8385$); phase 2, weekdays = 3 daily visits (IQR 2–5, range 0–6) vs. pre-holidays/holidays = 4 (IQR 3–7, range 3–9, $p = 0.1019$). Monthly comparison of pediatric ED visits performed from January to May 2020 confirmed a significant reduction in daily consultations after February, with a considerable percentage of days with ≤ 3 visits/day (Table 1). Daily pediatric ED consultations significantly varied also considering pre- and post-lockdown beginning period (pre-lockdown, 16 (11–22); phase 1, 3 (1–3); phase 2, 3 (3–5), $p < 0.0001$).

The percentage of children discharged after ED evaluation significantly decreased from 80% in January and February to 50% in April, while children needing ordinary hospitalization increased from 5.5% in February to 14.5% and 13.8% in April and in May, respectively. During May, we registered the highest percentage of seriously ill patients requiring transfer to tertiary care hospital (4.3%). Particularly, after the beginning of lockdown, we observed two cases of a noteworthy delayed access to hospital care: a 6.9-year-old girl affected by brain tumor with hydrocephalus seen in April and a 4.7-year-old girl with Guillain-Barré syndrome seen in May. In both, parental fear of contracting SARS-CoV-2 infection in hospital setting was the main reason of delayed ED access.

By comparing pediatric visits performed before and after the beginning of lockdown, we observed that after March 9th, 2020, the percentage of male subjects referred to ED, weekday visits, and patients needing hospitalization significantly increased (Table 2). The age of patients did not change significantly, but newborns and infants (< 2 years) represented 42.4% of total consultations after the beginning of lockdown. After March 9th, we registered a change in the diagnoses of ED visits, with an increase in the percentage of non-infectious acute conditions (such as traumas or neurologic diseases) and a decrease in infectious diseases (upper and lower respiratory tract infections, gastroenteritis/vomiting). Indeed, the decrease in ED consultations monthly requested for infectious diseases

Table 1 Pediatric ED visits performed monthly from January 1st to May 31st, 2020

	January	February	March	April	May
Total pediatric ED visits, <i>n</i>	604	525	111	62	116
Δ vs. previous month, <i>n</i> (%)		− 79 (− 13.1)	− 414 (− 78.9)	− 49 (− 44.1)	+ 54 (+ 87.1)
Daily pediatric ED visits*	19 (14–25)	15 (11–21)	3 (1–5)	2 (1–3)	3 (2–5)
Days with no pediatric ED visits, <i>n</i> /tot (%)**	0/31 (0)	0/29 (0)	6/31 (19.3)	3/30 (10.0)	1/31 (3.2)
Days with ≤ 3 pediatric ED visits, <i>n</i> /tot (%)*	0/31 (0)	0/29 (0)	21/31 (67.7)	26/30 (86.7)	16/31 (51.6)
Outcome of ED visits, <i>n</i> /tot (%)*					
Discharge after ED visit	485/604 (80.3)	420/525 (80.0)	81/111 (73.0)	31/62 (50.0)	75/116 (64.7)
Short-stay observation	76/604 (12.6)	69/525 (13.2)	18/111 (16.2)	21/62 (33.9)	20/116 (17.2)
Ordinary hospitalization	39/604 (6.4)	29/525 (5.5)	11/111 (9.9)	9/62 (14.5)	16/116 (13.8)
Transfer to tertiary care hospital	4/604 (0.7)	7/525 (1.3)	1/111 (0.9)	1/62 (1.6)	5/116 (4.3)

* $p < 0.0001$ ** $p = 0.0087$

was more pronounced than that for non-infectious ones (Table 3). Interestingly, during May 2020, we observed a remarkable increase (more than 3 times) of children presenting to ED for minor head trauma or apyretic seizure in comparison with the previous month.

With the exception of one case of complete Kawasaki disease (a 2.3-year-old male successfully treated with acetylsalicylic acid and intravenous immunoglobulin) in January 2020, we did not observe any other case of the disease or of a multisystem inflammatory syndrome in the next months. Despite Italian Ministry of Health recommendations, after the beginning of lockdown, some children (25/224, 11.2%) were referred to ED for non-urgent pediatric consultation (8 follow-up visits, 3 balanoposthitis, 3 infantile colic, 4 dermatitis, 2 conjunctivitis, 2 jaundice, 2 stipsis, and 1 post-immunization fever).

Prevalence of SARS-CoV-2 Infection

During the period March 4th–May 31st, 2020, we performed nasopharyngeal swab to 115 children and adolescents requiring pediatric ED visit. Of them, 68 were suspected for SARS-CoV-2 infection (fever and/or respiratory symptoms), while 47 were asymptomatic (apyretic and without respiratory symptoms). The prevalence of fever, cough, and dyspnea in symptomatic patients was 86.8% (59/68), 41.2% (28/68), and 5.9% (4/68), respectively. Comparison between symptomatic and asymptomatic patients tested for SARS-CoV-2 is depicted in Table 4. Children referred to ED for suspected COVID-19 were significantly younger than subjects without fever and respiratory symptoms. SARS-CoV-2 negative upper and lower respiratory tract infections represented the most common diagnoses between symptomatic children. After ED visit,

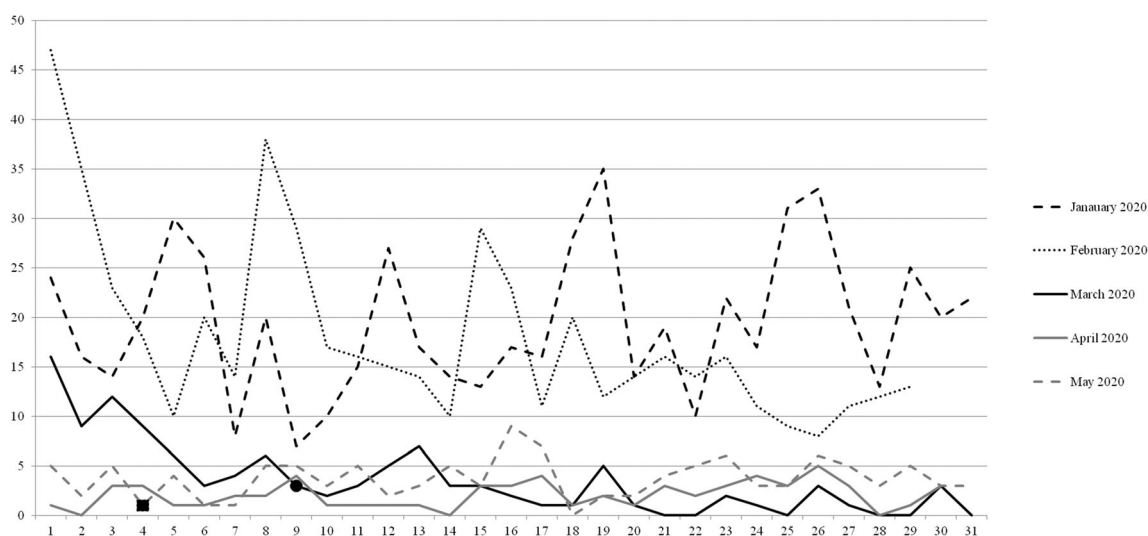


Fig. 1 Number of pediatric ED visits performed daily from January 1st to May 31st, 2020. Black circle indicates the beginning of lockdown (March 9th). Black square indicates the beginning of phase 2 (May 4th)

Table 2 Characteristics of pediatric ED visits performed in 2020 before and after the beginning of lockdown

	Pre-lockdown (January 1st–March 8th), <i>n</i> /tot (%)	Post-lockdown beginning (March 9th–May 31st), <i>n</i> /tot (%)	<i>p</i>
Gender			
Male	656/1194 (54.9)	142/224 (63.4)	0.0227
Female	538/1194 (45.1)	82/224 (36.6)	
Age, years	3.0 (1.0–7.7)	3.5 (1.4–7.3)	0.6176
Age class			
Newborns (0–28 days)	24/1194 (2.0)	8/224 (3.6)	0.0750
Infants (29 days–1.9 years)	383/1194 (32.1)	87/224 (38.8)	
Children (2.0 years–9.9 years)	608/1194 (50.9)	97/224 (43.3)	
Adolescents (≥ 10.0 years)	179/1194 (15.0)	32/224 (14.3)	
Day of ED visit			
Weekday	655/1194 (54.9)	142/224 (63.4)	0.0189
Pre-holiday or holiday	539/1194 (45.1)	82/224 (36.6)	
Outcome of ED visit			
Discharge	959/1194 (80.3)	133/224 (59.4)	< 0.0001
Hospitalization	235/1194 (19.7)	91/224 (40.6)	
Diagnosis			
Upper respiratory tract infection	501/1194 (42.0)	34/224 (15.2)	< 0.0001
Lower respiratory tract infection	160/1194 (13.4)	21/224 (9.4)	
Gastroenteritis/vomiting	125/1194 (10.5)	7/224 (3.1)	
Acute abdominal pain	90/1194 (7.5)	14/224 (6.2)	
Trauma	57/1194 (4.8)	47/224 (21.0)	
Neurologic disease	40/1194 (3.3)	25/224 (11.2)	
Other acute disease	123/1194 (10.3)	51/224 (22.7)	
No urgency	98/1194 (8.2)	25/224 (11.2)	

children with fever and/or respiratory symptoms in good general conditions (28/68, 41.2%) were discharged with nasopharyngeal swab in progress (recommending home isolation until response) to avoid unnecessary hospitalization. As expected, biochemical evaluation showed that the symptomatic patients had higher markers of inflammation (white blood cell count, C-reactive protein, procalcitonin) than the asymptomatic ones.

From March 4th to May 31st, we identified only a 1.9-year-old girl positive for SARS-CoV-2 (prevalence of 1:115). The child was referred to ED for complex febrile seizure (first episode, no familiarity) triggered by an upper respiratory tract infection without signs of central nervous system infection. Seizure, characterized by loss of consciousness and focal involvement of upper left limb, spontaneously recovered after 30 s with postictal paresis. Fever lasted 3 days (higher reported temperature 38.5 °C) and was associated with rhinorrhea and cough. Instrumental evaluation showed normal chest X-rays, pathological electroencephalogram (spikes and/or spike-and-waves in right frontotemporal and occipital derivations), and normal cerebral magnetic resonance imaging. No cases of SARS-CoV-2 were detected in asymptomatic patients.

Comparison Between 2019 and 2020

The amount of pediatric ED visits performed for 5 selected common causes of ED access during COVID-19 pandemic (March 1st–May 20th 2020) in comparison with the same time interval in 2019 was clearly lower (minor head trauma – 57.1%, earache – 97.0%, crying – 87.5%, vomiting and/or diarrhea – 94.5%, skin rash – 93.6%) (Fig. 2).

Table 5 shows the number of children hospitalized from January to May 2020 in comparison with the same period in 2019. A decreased hospitalization was appreciable at every month of 2020 becoming even more pronounced after March (January – 9.8%, February – 17.3%, March – 74.6%, April – 71.6%, May – 58.6%). Interestingly, from March 2020, we observed a more evident reduction in children needing short-stay observation than in those with more serious diseases requiring ordinary hospitalization. During May 2020, a significant percentage of children (5/41, 12.2%) was transferred to tertiary care hospital (1.4-year-old girl with ataxia, 4.7-year-old girl with Guillain-Barré syndrome, 5.2-year-old male with testicular torsion, 15.0-year-

Table 3 Number of pediatric ED visits performed monthly from January 1st to May 31st, 2020, for selected infectious and non-infectious diseases

	January	February	March	April	May
Infectious diseases, <i>n</i>					
Upper respiratory tract infection	233	237	39	8	18
Lower respiratory tract infection	82	71	19	5	4
Febrile seizure	4	7	4*	1	1
Gastroenteritis/vomiting	75	47	4	2	4
Urinary tract infection	8	4	2	1	5
Non-infectious diseases, <i>n</i>					
Acute appendicitis	4	6	2	1	2
Apyretic seizure	8	2	2	2	7
Headache	6	5	1	1	0
Minor head trauma	25	21	8	7	22
Presyncope/syncope	6	12	5	1	3

* 1 girl positive for SARS-CoV-2

old male with brain tumor-induced epilepsy, 3-month-old male with epilepsy).

Discussion

To our knowledge, this is the longest retrospective Italian study assessing the effect of COVID-19 pandemic (pre-lockdown, phase 1, and phase 2) on pediatric ED visits in a secondary care hospital. After the beginning of lockdown, we observed a remarkable decline in daily pediatric ED consultations; the highest reduction was registered in March (−414 visits, −78.9% vs. February) with the lowest absolute amount in April (62 consultations). During March, we registered 6/31 days without any request for pediatric ED visits, an absolutely unusual picture for our unit. Differently, the number of ED visits doubled during May in comparison with April, returning similar to that observed in March. Particularly, phase 2 was characterized by a moderate increase in requested pediatric ED consultations in comparison with phase 1, but the number of children needing hospitalization remained lower than half of those seen during the same period of 2019.

Interestingly, after the beginning of lockdown, we no longer observed the increase in ED visits on pre-holidays and holidays (outside the office hours of family pediatricians). In ordinary times, indeed, in the absence of their pediatrician, parents often bring not seriously ill children to ED asking for a pediatric visit that is always available (day and night) and free of charge [16]. Exceptionally, during lockdown, Tuscan family pediatricians guaranteed continuous (7 days a week) daytime availability for phone consultations, helping to manage patients at home also on weekends. We speculate that this procedure, together with lockdown retractions, contributed to reduce ED overcrowding, particularly during weekends.

COVID-19 significantly influenced the causes for referral of children and adolescents to ED. After lockdown was started, we registered an absolute and percentage reduction in infectious diseases (mainly respiratory tract infections and gastroenteritis/vomiting) associated with a percentage increase of non-infectious conditions such as acute neurological diseases or traumas. Acute onset conditions such as appendicitis, seizures, and syncope were diagnosed during this time, without reporting significant delay in ED accesses. Considering the outcome of ED visits, we observed a clear reduction in the total amount of children needing hospitalization after the beginning of lockdown (January *n* = 119, February *n* = 105, March *n* = 30, April *n* = 31, May *n* = 41) with a two-fold increase in the percentage of hospitalized children after ED evaluation (40 vs. 20% pre-lockdown). Particularly, after March, we registered a percentage increase of children needing ordinary hospitalization, and May was characterized by the highest percentage of patients requiring transfer to tertiary care hospital (4.3%). All these data suggest that during COVID-19 pandemic, fewer children were referred to the ED but with greater need for hospital care.

Similar conclusions can be inferred comparing 2019 and 2020 data. Indeed, we observed a remarkable reduction in the number of hospitalized children during the period March–May 2020 in comparison with the same interval in the previous year, associated with a similar or increased percentage of children needing ordinary hospitalization (the difference in type of hospitalization reached statistical significance in May). Moreover, the number of pediatric visits requested for common causes of ED access during the pandemic period of COVID-19 was dramatically lower than that observed in the same period in 2019.

A significant reduction in pediatric ED consultations (ranging from 73 to 84%) during COVID-19 pandemic has been reported also by few other Italian hospitals of Northern

Table 4 Characteristics of pediatric patients tested for SARS-CoV-2 ($n = 115$) from March 4th to May 31st, 2020

	Symptomatic (fever and/or respiratory symptoms), $n = 68$	Asymptomatic (without fever and respiratory symptoms), $n = 47$	p
Age, years	2.5 (1.0–6.6)	6.6 (1.4–12.1)	0.0151
Age class, n /tot (%)			
Newborn (0–28 days)	1/68 (1.5)	1/47 (2.1)	0.0470
Infant (29 days–1.9 years)	30/68 (44.1)	13/47 (27.7)	
Child (2.0 years–9.9 years)	30/68 (44.1)	19/47 (40.4)	
Adolescent (≥ 10.0 years)	7/68 (10.3)	14/47 (29.8)	
Gender, n /tot (%)			
Male	46/68 (67.6)	32/47 (68.1)	0.9606
Female	22/68 (32.4)	15/47 (31.9)	
Positive for SARS-CoV-2, n /tot (%)	1/68 (1.5)	0/47 (0.0)	0.4037
Diagnosis of patients negative for SARS-CoV-2, n /tot (%)			
Upper respiratory tract infection	27/68 (39.7)	0/47 (0.0)	< 0.0001
Lower respiratory tract infection	16/68 (23.5)	0/47 (0.0)	
Gastroenteritis/vomiting	3/68 (4.4)	0/47 (0.0)	
Acute abdominal pain	4/68 (5.9)	5/47 (10.7)	
Trauma	0/68 (0.0)	12/47 (25.5)	
Neurologic disease	7/68 (10.3)	13/47 (27.7)	
Other acute disease	10/68 (14.7)	16/47 (34.0)	
No urgency	1/68 (1.5)*	1/47 (2.1)**	
Alanine aminotransferases, U/L	$n = 50$ 17 (13–22)	$n = 25$ 16 (11–22)	0.5140
Aspartate aminotransferases, U/L	$n = 50$ 35 (27–45)	$n = 23$ 27 (22–33)	0.0096
White blood cell count, n /mm ³	$n = 52$ 11,060 (7687–16,432)	$n = 33$ 9070 (6365–11,740)	0.0360
Neutrophil count, n /mm ³	$n = 52$ 5820 (3127–9515)	$n = 33$ 3560 (2255–6320)	0.0542
Lymphocyte count, n /mm ³	$n = 52$ 3230 (1405–5882)	$n = 33$ 2690 (2005–5295)	0.6783
Lymphocytopenia (< 1000/mm ³), n /tot (%)	4/52 (7.7)	0/33 (0.0)	0.1539
Monocyte count, n /mm ³	$n = 52$ 1000 (665–1502)	$n = 33$ 560 (460–810)	< 0.0001
Platelet count, n /mm ³	$n = 52$ 316,000 (258,000–464,000)	$n = 33$ 309,000 (278,000–397,000)	0.6456
Lactate dehydrogenase, U/L (normal values 120–250)	$n = 23$ 336 (259–364)	$n = 7$ 278 (211–300)	0.1284
Lactate dehydrogenase > 250 U/L	18/25 (72.0)	5/8 (62.5)	0.6728
C-reactive protein, mg/dL (normal values < 0.5)	$n = 50$ 1.57 (0.06–5.65)	$n = 27$ 0.03 (0.03–0.05)	< 0.0001
C-reactive protein > 3.0 mg/dL	17/50 (34.0)	0/27 (0.0)	0.0003
Procalcitonin, ng/mL (normal values < 0.5)	$n = 24$ 0.28 (0.10–1.89)	$n = 10$ 0.05 (0.02–0.06)	0.0001
Procalcitonin > 1.0 ng/mL	9/24 (37.5)	0/10 (0.0)	0.0337

* Post-immunization fever

** 2 months infant with referred dyspnea by parents (not confirmed during short-stay observation)

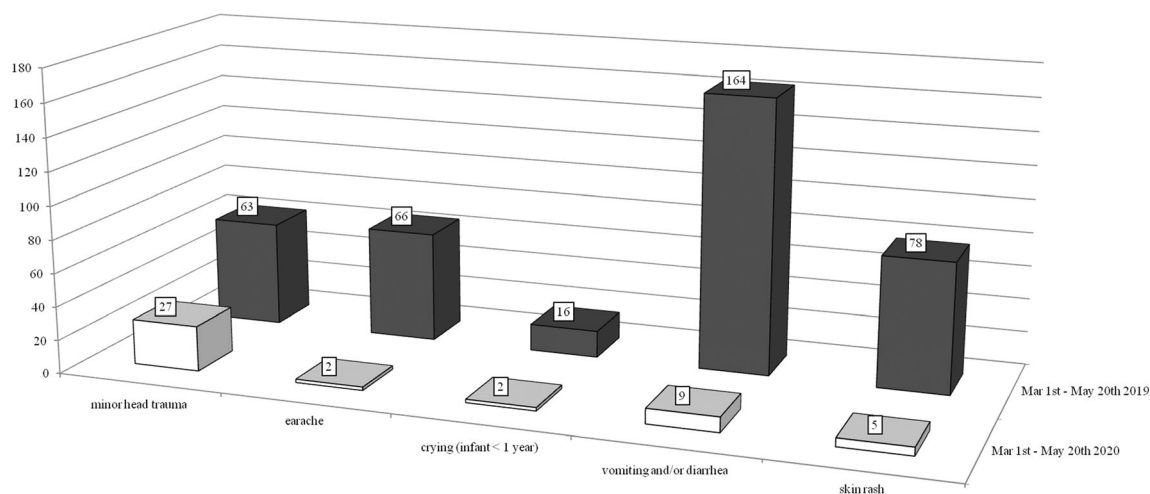


Fig. 2 Number of pediatric ED visits requested for selected common causes of ED access during the pandemic period of COVID-19 (March 1st–May 20th, 2020) and in the same period in 2019

(Biella, Alessandria, Trieste, Padua, Ravenna), Central (Rome), and Southern (Naples, Bari, Catania) Italy [15–20]. These studies compared the number of ED visits performed during a variable interval of Italian phase 1 (March–April 2020) with the corresponding period of 2019. Cozzi and colleagues compared also the number of accesses in their tertiary level pediatric ED before (February 2nd–March 8th) and after the beginning of lockdown (March 9th–April 13th), showing a 76.3% decrease [20], a finding similar to our results. Furthermore, Italian studies reported that pediatric patients had more appropriate accesses to ED during COVID-19 pandemic [16, 17, 20]. Thus, available data suggest that even if COVID-19 outbreak more seriously affected Northern Italy, utilization of pediatric emergency services significantly changed in the entire country with consequent reduced demand and increased appropriateness.

This trend was neither confined to pediatric age or to Italy. Bellan and colleagues reported a reduction of 46.3% of adult ED visits during COVID-19 from March 1st to April 13th in Novara (Northern Italy) [21]. Ophthalmological (−73% vs. 2019) and otorhinolaryngoiatric (−91% vs. 2018) ED visits also decreased during Italian COVID-19 pandemic [22, 23]. Interestingly, from March 10th to April 20th, 2020, the proportion of children and adolescents presenting to ophthalmological ED halved from 10 to 5.3% in comparison with 2019 [22]. Similarly, Del Pinto and colleagues reported a significant reduction in less all-cause and cardiovascular hospitalizations occurred from January 1st to March 31st, 2020, than in the similar period of 2019 in 5 Italian hospitals located in the province of L’Aquila (Southern Italy) [24]. These authors also reported a significant increase in intra-hospital deaths attributable to major cardiovascular diseases in March 2020 compared with the same month in 2019 (+6.8%), possibly due to barriers to seeking emergency care during COVID-19 pandemic [25]. Recent published Morbidity and Mortality

Weekly Report described a significant impact of the COVID-19 pandemic on ED visits also in the USA. Particularly, during early American pandemic period (March 29th–April 25th, 2020), the total number of ED visits was 42% lower than the same period in 2019. Visits declined in every age group, but the largest reduction was observed in children ≤ 10 years (72%) and in 11–14-year-old adolescents (71%) [26].

Several reasons may explain these results. First of all, strict limitations imposed during lockdown reduced contacts between children and consequently the dissemination of all infectious diseases (not only SARS-CoV-2). Similarly, traumas related to road accidents and outdoor activities also diminished. In addition, parental fear of contracting SARS-CoV-2 infection in hospital settings represented a significant determinant of ED accesses reduction. Late diagnoses, sometimes with consequent death due to delayed access to hospital care, have been reported in March 2020 in some [15, 19] but not all [20] Italian secondary and tertiary care hospitals. In our study, we described 2 cases of delayed ED access to hospital setting (1 in April and 1 in May), as a consequence of not justified parental fear. Indeed, being our hospital qualified as COVID-19 hospital, our ED was efficiently reorganized to avoid intra-hospital spread of SARS-CoV-2, separating suspected COVID-19 and standard care pathways. We detected only 1 case positive to SARS-CoV-2 (a 1.9-year-old girl admitted for complex febrile seizure) among 68 symptomatic and 47 asymptomatic patients tested with nasopharyngeal swab, confirming the low prevalence of COVID-19 among children and adolescents reported by other Italian records [7, 8, 17, 27]. Febrile seizures represent a rare presentation of COVID-19 in pediatric age. The most recent (April 10th) multicenter Italian study reported only 2/168 patients who presented with SARS-CoV-2 (including our own child) and a first episode of febrile seizure (without signs of encephalitis) [7]. A recent review

Table 5 Children hospitalized after ED visits from January 1st to May 31st 2020 in comparison with the same months in 2019

	January		February		March		April		May	
	2019	2020	2019	2020	2019	2020	2019	2020	2019	2020
ED visits requiring hospitalization, <i>n</i>	132	119	127	105	118	30	109	31	99	41
Type of hospitalization										
Short-stay observation, <i>n</i> (%)	94 (71.2)	76 (63.9)	85 (66.9)	69 (65.7)	86 (72.9)	18 (60.0)	74 (67.9)	21 (67.7)	73 (73.7)	20 (48.8)
Ordinary hospitalization, <i>n</i> (%)	37 (28.0)	39 (32.8)	39 (30.7)	29 (27.6)	31 (26.3)	11 (36.7)	32 (29.4)	9 (29.1)	26 (26.3)	16 (39.0)
Transfer to tertiary care hospital, <i>n</i> (%)	1 (0.8)	4 (3.3)	3 (2.4)	7 (6.7)	1 (0.8)	1 (3.3)	3 (2.7)	1 (3.2)	0 (0.0)	5 (12.2)
<i>p</i>										

confirmed that SARS-CoV-2 exhibits neurotropic properties and may cause different neurological diseases (including seizures), independently of the respiratory system involvement [28].

Our study has some limitations. Our analysis was limited to pediatric consultations requested for ED patients < 16 years; thus, children exclusively managed by ED personnel or other specialists (i.e., orthopedists, dermatologists, ophthalmologists, and otolaryngologists) were not included. So, the number of pediatric consultations we reported did not reflect the entire population of pediatric patients referred to our ED. However, the indications to request specialized consultations (including pediatric visit) did not change during COVID-19 emergency; thus, our comparison before and after the beginning of lockdown and with 2019 can be considered reliable. Regarding the prevalence of SARS-CoV-2 infection, in suspected COVID-19 patients, we performed a single nasopharyngeal swab, so we cannot absolutely exclude the occurrence of false-negative results.

In conclusion, COVID-19 emergency significantly influenced the ED utilization by children and adolescents. While the pandemic put a strain on the Italy's National Health Service overloading intensive care units and causing a high number of deaths, children and young adolescents seemed to be spared. Indeed, COVID-19 pandemic caused a remarkable reduction of pediatric ED accesses (particularly the inappropriate ones), allowing a better organization of work. We hope that Italian population can learn from COVID-19 emergency to avoid ED overcrowding in the next future. Furthermore, given the good results obtained during COVID-19 pandemic, a closer collaboration between primary and secondary pediatric care is advisable to provide a better management of not severely ill children and reduce inappropriate ED utilization.

Authors' Contributions All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by Francesco Vierucci, Caterina Bacci, Cristina Mucaria, and Francesca Dini. The first draft of the manuscript was written by Francesco Vierucci, and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Compliance with Ethical Standards

Conflict of Interest Francesco Vierucci is a consultant for Abiogen Pharma and received speaker honorarium from Abiogen Pharma. The remaining authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent The parents of the patients and the patients themselves, as appropriate, gave their informed consent to the anonymous publication of data for scientific purposes.

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