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Research Paper

Impact of COVID-19 Pandemic on Headache Evaluations in the Pediatric Emergency Department

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ABSTRACT

Background: To evaluate the impact of COVID-19 on evaluations in the pediatric emergency department (ED) because of headache as main symptom.
Methods: Number and clinical features of patients evaluated in the pediatric ED of a single site in Milan, Italy, were collected between January 2017 and January 2022. The impact of COVID-19 on evaluation rates was quantified ~~by~~ using the incidence rate ratio (IRR) and 95% confidence intervals (CI) between the pandemic (March 2020 to January 2022) and the prepandemic period (January 2017 to February 2020).
Results: During the study period, 890 evaluations were registered: 689 over the prepandemic period and 201 over the pandemic period. Mean age at evaluation was 10 years (range: 1 to 17 years). Evaluation rates per month were 18.1 during the prepandemic period and 8.7 during COVID-19 pandemic, with peaks in autumn and winter months and considerable drops in the summer. The IRR was 0.49 (95% CI, 0.40-0.61). The reduction in evaluation rate was higher for secondary headache (IRR, 0.31; 95% CI, 0.23-0.42) when compared with primary headache (IRR, 0.56; 95% CI, 0.40-0.78).
Conclusions: We found a remarkable reduction in the number of evaluations in the pediatric ED for headache during the pandemic period.

Introduction

Pediatric headache is one of the most common causes of evaluation in the emergency department (ED). Primary headaches and headaches secondary to self-limited diseases represent the majority of cases.[1,2] In particular, upper respiratory tract infections with fever are the most frequently identified cause of acute headache in children.[3]

Infection by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) can lead to a variety of clinical manifestations with different severity, mainly depending on pre-existing medical conditions and age.[4] Children and adolescents are usually asymptomatic or have mild symptoms, whereas adult patients may experience severe illness.[5] In children with laboratory-confirmed coronavirus disease 2019 (COVID-19), headache has been reported as the most common neurological symptom.[6]

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The impact of COVID-19 pandemic on ED attendances specifically for headache has been investigated only in adult patients, in whom a reduction of ED accesses without any change in the distribution of headache subtypes has been documented.[7]

Therefore, the aim of our study was to evaluate the impact of COVID-19 on evaluation rate in the pediatric ED because of headache as the main symptom. The secondary aim of the study was to define and compare the clinical features of headache in children evaluated in the ED during a period preceding the pandemic and during the COVID-19 pandemic. Based on published data on ED attendances for headache in adult patients[7] and general care in pediatric patients,[8,9] we should expect a reduction of the evaluation rate in the pediatric ED for headache during the pandemic period.

Materials and Methods

This study is based on a retrospective collection of the total number of ED attendances for headache at the Pediatric ED of Policlinic Hospital of Milan between January 2017 and January 2022. This interval includes a prepandemic period (January 2017 to February 2020, 38 months) and a COVID-19 pandemic period (March 2020 to January 2022, 23 months).

Demographic characteristics, clinical features of headache on evaluation in the ED, personal history of headache, underlying conditions, and diagnostic tests performed (laboratory tests, neuroimaging or lumbar puncture) were investigated. Anti-SARS-CoV-2 vaccination status and infectious status as determined by positive result on a real-time reverse transcription-polymerase chain reaction (RT-PCR) test for detection of SARS-CoV-2 in nasopharyngeal swab were also collected.

Headaches were classified as primary or secondary. Primary headaches were defined as headaches not caused by an underlying disease or condition. Headaches were defined as secondary if a specific cause was identified, and they were further divided into headaches secondary to viral illnesses or respiratory infections and those associated with neurological disorders. Headache of unknown cause included the headaches unclassified in the ED. Indeed, many children discharged from ED with a diagnosis of "primary headache not otherwise specified" have been reported, in whom a diagnosis of migraine was confirmed only later at headache center.[2]

The evaluation rate, expressed as number of evaluations in the ED by month, was computed and the temporal trend was estimated using a negative binomial model and displayed graphically. The model included the number of evaluations as dependent variable, a term for the pandemic period (0 = January 2017 to February 2020, 1 = March 2020 to January 2022) as predictor, and a piecewise linear spline function of the month, with equally spaced knots at quantiles 0.33 and 0.66, to account for seasonal trends. The effect of the pandemic was then quantified using the incidence rate ratio (IRR) and the corresponding 95% confidence interval (CI), with an IRR below 1 indicating a lower evaluation rate during the pandemic when compared with the prepandemic period, and its complement (1 − RR) indicating the relative reduction in the evaluation rate during the pandemic. IRR was computed for all headache and for its subtypes (primary, secondary, and headache of unknown etiology).

Clinical characteristics of headache were compared between groups evaluated before and during the COVID-19 pandemic using the chi-square test or Fisher exact test when cell counts were less than 5 (for categorical variables) and the Wilcoxon sum rank test (for continuous variables). Percentages and statistical tests for the comparison between groups were based on patients with nonmissing values. All tests were performed with $\alpha = 0.05$.

The study was conducted according to the declaration of Helsinki and was approved by the ethical committee of our hospital.

Results

During the study period 890 evaluations to our pediatric ED were collected: 689 over the prepandemic period and 201 over the pandemic period. Mean age at evaluation was 10 years (range: 1 to 17 years).

Figure shows the number of evaluations registered each month and the expected values estimated by our model. A clear seasonal trend, characterized by peaks in autumn and winter months and considerable drops in the summer, was observed in the prepandemic period as well as during the pandemic. Soon after the COVID-19 pandemic outbreak in March, evaluation rate in the ED dropped.

Evaluation rates per month were 18.1 during the prepandemic period and 8.7 afterward (Table 1), with an estimated relative decrease of 51% (IRR, 0.49; 95% CI, 0.40 to 0.61).

The decrease in the number of accesses to ED was higher for secondary headache than for primary headache (IRR: 0.31 for secondary headache and 0.56 for primary headache) (Table 1).

Table 2 shows the demographic and clinical characteristic of patients evaluated in the ED before and during the pandemic. Patients evaluated in the ED in the prepandemic period were younger with a higher percentage of preschool children (16.3% vs 9.0%, $P = 0.013$). Most patients (~90%) in both periods had no underlying conditions. Only a minority of patients evaluated during the pandemic period had an RT-PCR-confirmed SARS-CoV-2 infection (N = 12) or had been vaccinated with one or two doses (N = 18).

Table 3 describes the clinical features of headache according to the periods when patients were evaluated in the ED. During the pandemic period, more patients presented to the ED with primary headaches when compared with the prepandemic period (60.9 vs 45.8% of the patients with available information on the cause of headache, $P = 0.002$). A lower proportion of patients evaluated during the pandemic period had a previous episode before the index date (28.3 vs 38.1%, $P = 0.015$). Median duration of headache was higher among children evaluated during the pandemic when compared with those evaluated during the prepandemic period (16 hours vs 12 hours, $P = 0.011$). The distribution of the associated symptoms was significantly different during the pandemic period when compared with the preceding period ($P = 0.002$). The most common associated symptoms were vomiting, reported by 14.7% of the patients evaluated in the prepandemic period and 17.5% during the pandemic, and fever with the latter being less frequently reported during the pandemic period (9.5 vs 15.8%). Visual impairment was reported by less than 10% of the patients with a lower prevalence among those evaluated during the pandemic period (4.5 vs 9.1%).

Secondary headaches were mainly associated with viral illness or respiratory infection (83.6% in prepandemic period vs 75.9% in pandemic period).

Percentages of patients requiring hospitalization was not significantly different between the two periods (12.9% during the pandemic vs 8.1 in the prepandemic period, $P = 0.053$).

Discussion

This is the first study evaluating the impact of COVID-19 pandemic on the number of pediatric ED attendances for headache. We found a 51% reduction in the headache emergency evaluations in children during the pandemic period and a greater reduction for secondary (−69%) when compared with primary headache (−44%).

Several studies have investigated the impact of COVID-19 pandemic on ED attendances in pediatric patients, reporting a considerable reduction in general pediatric care for ED visits and admissions.[8,9] This reduction was also observed in our pediatric ED, where the number of total visits reduced by 44.4%, from 21,095 in

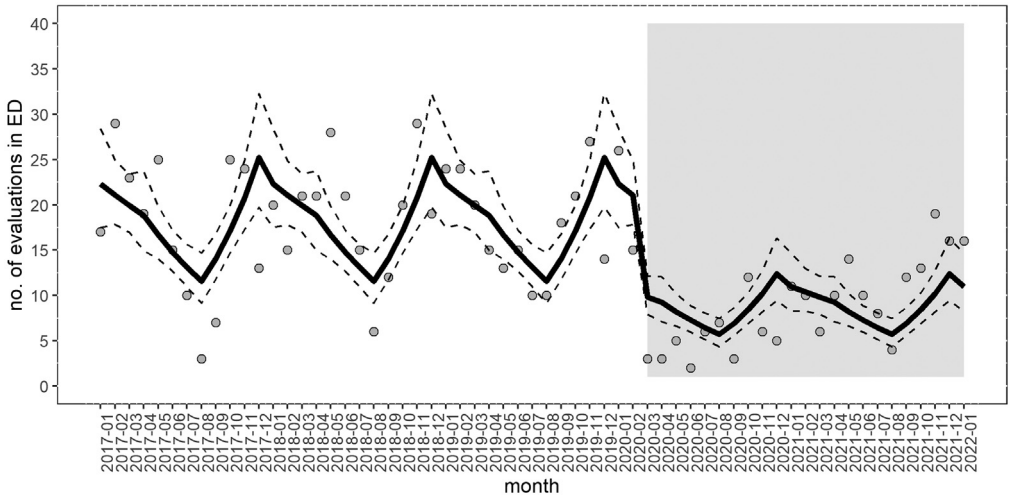

FIGURE. Monthly trend in the number of evaluations in the pediatric emergency department because of headache between January 2017 and January 2022. Dots indicate number of admissions. Lines indicate fitted values (continuous line) and 95% confidence band (dashed lines). The gray area highlights the coronavirus disease 2019 (COVID-19) pandemic period in Italy (from March 2020 to January 2022).

2019 to 11,735 in 2020. In the study of Kruizinga et al.[8] the estimated reduction in pediatric general practice care was 59% and 56% for ED visits ~~ad~~ and admissions, respectively, between January 2016 and June 2020.[8] The study by Sokoloff et al.[9] compared admissions to pediatric ED in a period from March to May 2020 with the same time period in 2018 to 2019, showing a substantial decrement of low acuity complaints such as minor injuries and headache. In particular, the relative change on admission for headache (−79%) was the most relevant change after maltreatment/abuse (−89%).[9] Several factors have been suggested to explain the observed reduction in clinical visits, including the decrease in contacts and transmissible infections after the closure of school, the refrain of parents from going to the ED due to the fear of SARS-CoV-2 infection, and the lower parental propensity to seek prompt clinical care for their children in the event of illness.[8] In our study, the evaluation rates during the COVID-19 pandemic reduced to the level observed in the summer months preceding the pandemic. This finding along with the lower proportion of secondary headaches among the evaluations registered in the pandemic period suggests a possible role of decreased upper respiratory tract infections in the observed trend.

There are many studies on children evaluated for headache ~~to~~ in the ED, and most of the headaches have been attributed to infection.[1,2] Upper respiratory tract infections with fever represent a frequent cause of acute headache (57%), including viral upper respiratory tract infection (39%), sinusitis (9%), and streptococcal pharyngitis (9%).[3] More recent studies include COVID-19 infection among the causes of headache in children.[4,6,10] Lin et al.[6] in their study of children with laboratory-confirmed evidence of COVID-19 found that the most commonly reported neurological symptoms were headache (34%), followed by fatigue (25%), altered mental status (23%), weakness (14%), and seizures (11%).[6] Güngör et al.[10] found a low rate of children and adolescents presenting to ED with chief complaint of headache and diagnosis of COVID-19 (0.54%), which was explained by the fact that most of the study period was outside the pandemic period.[2] In our study, the prevalence of RT-PCR-confirmed COVID-19 among patients evaluated in the ED was 5.9%. However, we may have underestimated the prevalence of COVID-19 since nasopharyngeal swab for SARS-CoV-2 infection was performed only in patients presenting with fever.

In conclusion, we found a remarkable reduction in the headache emergency evaluations during the pandemic period. The lower proportion of secondary headaches among the evaluations registered in the pandemic period could be explained by the reduced number of admissions to pediatric ED for upper respiratory tract infections, probably related to the benign and self-limited course of the headache. By contrast, the higher percentage of patients presenting with acquired neurological disorders, such as brain tumors

TABLE 1.
Rate of Evaluation in the Pediatric Emergency Department Due to Headache Between January 2017 and January 2022 According to Cause of Headache and Study Period (Before and During the COVID-19 Pandemic)

Cause of Headache	Period	Number	Rate per Month	IRR (95% CI)*
All	Prepandemic	689	18.13	1
	Pandemic	201	8.74	0.49 (0.40-0.61)
Primary	Prepandemic	253	6.66	1
	Pandemic	84	3.65	0.56 (0.40-0.78)
Secondary	Prepandemic	299	7.87	1
	Pandemic	54	2.35	0.31 (0.23-0.42)
Unknown	Prepandemic	137	3.61	1
	Pandemic	63	2.74	0.76 (0.54-1.07)

Abbreviations:
CI = Confidence interval
COVID-19 = Coronavirus disease 2019
IRR = Incidence rate ratio
* Estimated through negative binomial models including the number of admission as dependent variable, a term for pandemic period (0 = January 2017 to February 2020, 1 = March 2020 to January 2022) as predictor, and a piecewise linear spline function of the month, to account for seasonal trends.

TABLE 2.
Demographic and Clinical Characteristics of Patients Evaluated in the Pediatric Emergency Department Due to Headache Between January 2017 and January 2022 According to Study Period (Before and During the COVID-19 Pandemic)

Demographic/Clinical Characteristic	Prepandemic Period (N = 689)	Pandemic Period (N = 201)	*P* Value
Male sex	337 (48.9)	93 (46.3)	0.56
Age			
Mean (S.D.)	9.8 (3.9)	10.5 (3.7)	0.019
<6 years	112 (16.3)	18 (9.0)	0.013
Underlying conditions			0.121
No	612 (88.8)	183 (91.0)	
Systemic diseases	40 (5.8)	10 (5.0)	
Genetic neurological diseases	17 (2.5)	0	
Acquired neurological diseases	20 (2.9)	8 (4.0)	
SARS-CoV-2 infection*			-
Positive RT-PCR	0	12 (6.0)	
Negative RT-PCR	0	49 (24.4)	
Not performed	689	140 (69.6)	
COVID-19 vaccination			-
No	689 (100%)	125 (62.2)	
1 dose	0	3 (1.5)	
2 doses	0	15 (7.5)	
3 doses	0	0	
Unknown	0	58 (28.9)	

Abbreviations:
COVID-19 = Coronavirus disease 2019
RT-PCR = Reverse transcription-polymerase chain reaction
SARS-CoV-2 = Severe acute respiratory syndrome coronavirus-2
Data are number (%) unless otherwise specified.
* RT-PCR was performed only in patients presenting with fever.

TABLE 3.
Characteristics of Headache in Patients Evaluated in the Pediatric Emergency Department Between January 2017 and January 2022 According to Study Period (Before and During the COVID-19 Pandemic)

Characteristic of Headache	Prepandemic Period (N = 689)	Pandemic Period (N = 201)	*P* Value
Cause of headache			0.002*
Primary	253 (45.8)	84 (60.9)	
Secondary	299 (54.2)	54 (39.1)	
Associated with viral illness/respiratory infection	250 (83.6)	41 (75.9)	0.241†
Associated with neurological disorders	49 (16.4)	13 (24.1)	
Unknown	137	63	
Previous episodes			0.015
No	423 (61.9)	142 (71.7)	
Yes	260 (38.1)	56 (28.3)	
Unknown	6	3	
Location			0.461
Generalized	76 (13.0)	31 (16.6)	
Frontal/temporal area	468 (80.3)	143 (76.5)	
Occipital area	39 (6.7)	13 (6.9)	
Unknown	106	14	
Duration of headache (hour), median (IQR)‡	12 (4-31)	16 (4-81)	0.011
Associated symptoms			0.002
None	378 (55.2)	133 (66.5)	
Fever	108 (15.8)	19 (9.5)	
Vomit	101 (14.7)	35 (17.5)	
Visual impairment	62 (9.1)	9 (4.5)	
Focal deficit	14 (2.0)	4 (2.0)	
Crisis	2 (0.3)	0	
Hearing/vestibular impairment	20 (2.9)	0	
Unknown	4	1	
Neurological physical examination			0.56
Normal	676 (98.3)	196 (97.5)	
Altered	12 (1.7)	5 (2.5)	
Unknown	1	0	
Required hospitalization	56 (8.1)	26 (12.9)	0.053

Abbreviations:
COVID-19 = Coronavirus disease 2019
IQR = Interquartile range
IQR: $25^{th} - 75^{th}$ percentile
Data are number (%) unless otherwise specified.
Percentages and statistical tests were computed using nonmissing values as denominator.
* Results of the test for the comparison of the frequency distribution of primary and secondary headaches between periods. Subtypes of secondary headaches were not considered.
† Results of the test for the comparison of the frequency distribution of subtypes of secondary headaches between periods.
‡ Data not available in 175 patients admitted during the prepandemic period and 26 patients admitted during the COVID-19 pandemic.

and ventriculoperitoneal shunt malfunction, in the pandemic period suggests that concern for serious causes of secondary headache can overcome the restraint of parents from going to the ED due to the fear of SARS-CoV-2 infection.

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