Assessing the Impact of the COVID-19 Pandemic on Pediatric Emergency Department Visits in Taiwan

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Research Article

Keywords:

Posted Date: August 11th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3218932/v1

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Abstract

Background

The coronavirus disease 2019 (COVID-19) pandemic has profoundly impacted healthcare systems worldwide. To assess the effects of the pandemic on pediatric emergency department (ED) visits in Taiwan, we conducted a study to evaluate changes in pediatric ED visits during the COVID-19 pandemic.

Methods

This retrospective study included pediatric patients (age ≤ 18) who visited the ED between January 21, 2019, and April 30, 2019, at three hospitals of the Cathay Health System, and compared them with a corresponding period in 2020. Basic information, including mode of arrival, triage level, disposition, chief complaints, and incidence rates, were analyzed before and during the pandemic.

Results

A total of 10,116 patients (6,009 in the pre-pandemic and 4,107 in the pandemic group) were included in this study. There was a 31.65% reduction in ED visits during the pandemic, but ambulance use increased by 5.97%. COVID-19-related complaints (fever, respiratory tract infection, gastrointestinal complaints) decreased during the pandemic. However, we observed an increased incidence rate ratio (IRR) for shortness of breath (IRR = 1.26), glycemic problems (IRR = 5.4), and psychological problems (IRR = 4.6). Critical complaints, including cardiac arrest (IRR = 5) and altered mental status (IRR = 3.08), also increased during the pandemic.

Conclusion

This study suggests that reallocating hospital staff to appropriate units, developing effective epidemic response strategies, and improving prehospital emergency medical capabilities can enhance the preparedness of the healthcare system for future pandemics and ensure a more efficient management of emergency cases.

Introduction

Coronavirus disease 2019 (COVID-19) is a highly contagious novel virus that has caused countless deaths worldwide since its outbreak at the end of 2019. The virus spreads rapidly via droplet transmission and can travel up to one meter. The incubation period is up to 14 days, with most patients showing symptoms after 5–6 days. Common symptoms include cough, rhinorrhea, fever, and nasal congestion. Some patients develop pneumonia and respiratory failure [1].
Taiwan announced its first imported case of COVID-19 on January 21, 2020 [2]. The first in-hospital COVID-19 cluster infection occurred on February 28, 2020, marking the beginning of the peak epidemic period. From March to April 2020, the number of confirmed COVID-19 cases in Taiwan increased rapidly, with 759 confirmed cases as of December 19, 2020 [3].

The COVID-19 pandemic has had a significant impact on the healthcare system in Taiwan, and particularly on the emergency department (ED) and pediatric department. Although some countries have experienced overcrowding in their healthcare systems, data from other countries have shown a decrease in the number of ED patients [4, 5]. The pandemic has resulted in significant changes in ED visiting habits, including a decrease in visits for non-COVID-19 diseases and an increase in visits for out-of-hospital cardiac arrest (likely due to delays in seeking medical care) [6]. These changes in ED visiting habits, along with the use of emergency medical services, triage levels, and chief complaints, play a crucial role in evaluating and redistributing medical resources during the epidemic season.

Despite the significant impact of the COVID-19 pandemic on healthcare systems worldwide, there is a lack of research investigating its effects on pediatric emergency department (ED) visits. Therefore, this study aims to assess the impact of the pandemic on various aspects of pediatric ED visits, including patient volume, mode of arrival, triage level, disposition, time of visit, and chief complaints. These findings may help healthcare providers allocate medical resources more effectively and avoid potential overcrowding of the healthcare system.

**Methods**

**Study setting**

This retrospective study was conducted in three hospitals within the Cathay Health system in Taiwan. The study recruited patients who visited the ED of these hospitals between January 21, 2020, and April 30, 2020, as well as patients who visited between January 21, 2019, and April 30, 2019. One of the hospitals was a tertiary center located in Taipei City, with a capacity of 800 beds and an estimated total annual ED visit volume of 60,000. The other two hospitals were located in rural areas and had capacities of 642 and 348 beds, with an estimated annual ED visit volume of 48,000 and 30,000, respectively.

**Study design**

Patient information was extracted from the electronic medical record (EMR) system and divided into two groups: the "during epidemic" group (January 21, 2020 to April 30, 2020) and the "before epidemic" group (January 21, 2019, to April 30, 2019). The epidemic period was defined as the time between the first confirmed case of COVID-19 in Taiwan on January 21, 2020, and the end of the period on April 30, 2020, which was the fourth day after no confirmed cases were reported for three consecutive days. All patients, regardless of age, who presented at the EDs during these two periods were considered eligible for recruitment. Patients with missing and duplicate data were excluded (Fig. 1).
Variables

Basic demographics, visit characteristics, dispositions, and chief complaints of patients visiting the ED during the two periods were obtained from the electronic medical record (EMR) system. Visit characteristics, such as total daily visits, mode of arrival, and time of visits, were recorded, while chief complaints were extracted from patients' narratives recorded in the EMR and sorted into 33 common discomforts. Patients were triaged based on a combination of the Canadian Triage and Acuity Scale (CTAS) and clinical criteria. Triage nurses with formal training and more than one year of ED working experience assigned patients to different triage level.

Ethical statement

The Institutional Review Board of the Cathay General Hospital Bioethical Committee approved the study, conducted in adherence to the Declaration of Helsinki (approval number: CGH-P109047). It was an observational study without any additional interventions beyond standard patient care. Consequently, the need for informed consent was waived by the Institutional Review Board of the Cathay General Hospital Bioethical Committee.

Statistical analysis

We analyzed the data using IBM SPSS Statistics for Windows (version 25.0). Categorical variables are presented as numbers and percentages, while normally distributed continuous variables are presented as mean ± standard deviation (SD). We used the chi-square test to analyze categorical variables and independent t-test to analyze normally distributed continuous variables. Incidence rates were calculated by dividing the number of results of interest by the total number of ED visits during each period. The incidence rate ratio (IRR) was calculated by dividing the incidence rate during the epidemic period by that before the epidemic period. Further, we computed the percentage difference in the number of chief complaints between the "before epidemic" and "during epidemic" periods.

Results

A total of 10,116 children were included in this study. There were 6,009 ED visits before the pandemic (January 21, 2019, to April 30, 2019) (Figure 1). During the pandemic period, there was a reduction of 31.65% (4,107 ED visits) compared to the pre-pandemic period (Table 1). The percentage of male patients was significantly higher than that of female patients in both the pre-pandemic and pandemic periods (56.86% and 56.61% versus 43.14% and 43.39%, respectively) (Table 1).

The mean number of daily pediatric ED visits decreased significantly, from 15.2% before the pandemic to 12.5% during the pandemic. The use of the emergency medical service (EMS) system (ambulance) slightly increased during the pandemic period (5.97%) compared to the pre-pandemic period (3.41%). The percentage of patients with triage levels 1 and 2 was lower during the pandemic period (0.63% and 10.18%, respectively) than during the pre-pandemic period (0.7% and 10.9%, respectively). Additionally,
there was a higher proportion of patients discharged during the pandemic period (89.36%) than during the pre-pandemic period (88.33%) (Table 1).

Overall, the incidence rates of pediatric ED visits for infection-associated issues, such as fever and upper respiratory infection (URI) symptoms, were 0.90 and 0.89 times lower during the pandemic period, respectively. Gastrointestinal-associated issues, such as abdominal pain, acute gastroenteritis (AGE) symptoms, and constipation, had incidence rate ratios of 0.95, 0.79, and 0.82 during the pandemic period, respectively. However, chief complaints of cellulitis and Gastrointestinal (GI) bleeding increased during the pandemic period compared to the pre-pandemic period (1.56% vs. 1.25% and 0.37% vs. 0.18%, respectively).

Regarding cardiovascular-associated issues, shortness of breath was 1.28 times higher during the pandemic period. Pediatric patients visiting the ED with chief complaints of glycemic problems and urological symptoms had incidence rates of 5.40 and 1.09, respectively. Critical chief complaints, such as cardiac arrest, altered mental status, and convulsions, increased during the pandemic period compared to before the pandemic period (0.15% vs. 0.03%, 0.37% vs. 0.12%, and 0.71% vs. 0.83%, respectively). Psychological and social problems had incidence rates of 4.6 and 1.46, respectively (Table 2).

Discussion

Numerous studies have demonstrated a significant decrease in ED visits across almost all age groups during the early phase of the pandemic [7]. However, contrary to the increased proportion of adults visiting the ED, from 60.5% to 65.2% [8], our research revealed a decreased proportion and number of pediatric ED visits across all Cathay Health System hospitals during the pandemic season. Several factors, such as school closures, social distancing policies, and media influence, could have contributed to the decline in total pediatric ED visits [9, 10]. This phenomenon is particularly evident among vulnerable populations, such as pediatric patients, as parents and caregivers are often hesitant to bring their children to the hospital due to fear of COVID-19 infection during ED visits.

Based on our research, we identified several impacts of the COVID-19 pandemic on our pediatric emergency department (PED). We noted a decrease in the number of children arriving being held or walking, whereas the percentage of ambulance use increased from 3.41% to 5.97%. Additionally, the percentage of patients with low triage acuity levels (levels 3 to 5) was higher during the pandemic period (89.19 %) than during the pre-pandemic period (88.4 %). This may explain the increased proportion of pediatric patients who were discharged during the pandemic period (88.33% to 89.36%). Furthermore, we observed a decrease in the percentage of admissions, from 10.65% to 9.89%. However, we also noted an increased percentage of ambulance use during the pandemic period, indicating that parents tended to call for emergency medical attention for their children, even for mild symptoms, because of the fear of infection.

In contrast to our study, research from the United States of America reported a decrease in PED visits and an increase in admission rates during the early phase of the pandemic period [11]. Similarly, a study from
Finland revealed a decline in the number of EMS missions within the first two months after the first COVID-19 cases in the study area [12]. The contradictory results from the two studies may be due to differences in local healthcare-seeking behaviors. Taiwanese people have access to convenient medical resources but may be afraid of severe disease complications, especially given the sensationalized news on COVID-19 on social media. Parents may be anxious about their children's health but hesitant to take them to hospital. Consequently, they may opt to call an ambulance, even for minor illnesses. If the doctor's examination reveals no significant health issues, they may opt for medication instead of hospitalization.

Second, our study revealed a similar percentage of pediatric trauma cases during the pre-pandemic and pandemic periods (23.31% and 23.62%, respectively). However, two other studies have reported a decrease in the percentage of pediatric trauma cases during the pandemic period, which may be associated with reduced social activities and traffic mobility due to the implementation of the "stay-at-home" policy [13, 14]. However, further studies are required to confirm these findings.

Third, life-threatening chief complaints, including altered mental status and cardiac arrest, had IRR of 3.08 and 5.00, respectively. Our results are consistent with those of similar studies conducted in other countries (England and Singapore), which revealed an increased incidence of out-of-hospital cardiac arrest and worse outcomes during the pandemic. [15,16] Additionally, we observed an increase in the IRRs of chief complaints of shortness of breath, hypertension, and glycemic problems (1.28, 16.33, and 5.4, respectively). A prospective multicenter study reported that children with COVID-19 have significantly higher systolic and diastolic blood pressures than healthy children. [17] Moreover, a study from India found that glycemic control in type 1 diabetes mellitus patients worsened during the pandemic period, although the study mainly focused on adults. [18] Pediatric patients with asthma and acute exacerbation often present to the ED with the chief complaint of wheezing (indicated by shortness of breath). [19] Long-term medication, such as bronchodilators, antihypertensive drugs, insulin, and oral antidiabetic agents, are necessary to control these chronic diseases. During the pandemic, obtaining these long-term medications may have been difficult due to lockdown policies, reduced outpatient appointments at local clinics or hospitals, and the fear of infection. Therefore, during a pandemic, it is crucial to prepare more backup, long-term medications for the public or increase online pharmacy services for medication pickup.

An interesting finding of our study was the decreased percentage of chief complaints related to headaches and convulsions. A significant proportion of headaches in children are caused by fever, which can be associated with upper respiratory tract infections. Additionally, febrile seizures are a common cause of pediatric convulsions [20]. According to our research, the percentage of chief pediatric complaints of fever and upper respiratory tract infections decreased during the pandemic period, which may be attributed to the lockdown strategy and health education policies, such as mask-wearing and improved hygiene practices. This finding is consistent with a study from Saudi Arabia, which also found a decrease in visits for common neurological conditions, such as headache and seizures, during the pandemic period [21].
Finally, although not statistically significant, an increased proportion of children presenting with social problems was noted during the pandemic compared with the pre-pandemic period in our study. The "stay-at-home" policy during the pandemic period may have led to an increase in domestic violence [22], as the home is often an unsafe place for these victims. Additionally, the rates of suicidal ideation and attempts were higher during the pandemic season [23]. These results are consistent with those of other studies and we assume that the quarantine policy may have caused people to experience more pressure and anxiety. Therefore, more social workers should be recruited in the ED in response to these circumstances.

**Limitation**

Our study has several limitations. First, this was a retrospective study that relied on EMR data from 2019 to 2020, which may have resulted in some missing data. Second, all three hospitals included in the study are located in northern Taiwan, which may limit the generalizability of our findings to other regions of the country. Third, the number of patients in certain subgroups of chief pediatric complaints was small, which may limit the generalizability of our findings to the pandemic period. Lastly, although all triage nurses underwent formal training, they may have assigned different emergency severity indexes (ESIs) to different patients according to their preferences.

**Conclusion**

In the event of a future pandemic, we recommend reassigning staff to appropriate units, transferring medical resources to COVID-19 wards, increasing the emergency medical service (EMS) capacity and prehospital emergency medical services, establishing a non-contagious route for obtaining prescriptions for chronic medication, and increasing the number of hospital social workers to provide mental health care.

**Abbreviations**

COVID-19, coronavirus disease 2019

ED, emergency department

IRR, incidence rate ratio

EMR, electronic medical record

CTAS, Canadian Triage and Acuity Scale

SD, standard deviation

URI, upper respiratory infection

AGE, acute gastroenteritis
GI, gastrointestinal

PED, pediatric emergency department

ESIs, emergency severity indexes

EMS, emergency medical service

Declarations

Ethics approval and consent to participate

The Institutional Review Board of the Cathay General Hospital Bioethical Committee approved the study, conducted in adherence to the Declaration of Helsinki (approval number: CGH-P109047). It was an observational study without any additional interventions beyond standard patient care. Consequently, the need for informed consent was waived by the Institutional Review Board of the Cathay General Hospital Bioethical Committee.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and/or analysed regarding to the current study are available from the corresponding author on reasonable request

Competing interests

All authors declare they have no conflicts of interest to this study.

Funding

Not applicable

Authors' contributions

YTL and JYC conceived the idea of the study. YTL and YWL performed data extraction and analysis. YTL, YWL, and JYC interpreted the data and original drafts. JHC, WLC, MYW revised the manuscript for publication. All authors approved the final version of this manuscript.

Acknowledgements

We acknowledged Editage for providing professional English editing for this study.
References

1. https://www.cdc.gov.tw/Category/Page/vleOMKqwuEblMgqaTeXG8A


Tables
Table 1
Comparison of demographic characteristics of pediatric patients’ emergency department visits before and during the epidemic.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total visits / day — (mean ± SD )</td>
<td>60.09 ± 20.5</td>
<td>40.66 ± 23.6</td>
<td>-31.65</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Age — n. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 ≤ Age &lt; 18</td>
<td>1388 (23.10)</td>
<td>1103 (26.86)</td>
<td>-35.00</td>
<td></td>
</tr>
<tr>
<td>Age &lt; 12</td>
<td>4621 (76.90)</td>
<td>3004 (73.14)</td>
<td>-20.53</td>
<td></td>
</tr>
<tr>
<td>Sex — no. (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Male</td>
<td>3417 (56.86)</td>
<td>2325 (56.61)</td>
<td>-18.17</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>2592 (43.14)</td>
<td>1782 (43.39)</td>
<td>-31.25</td>
<td></td>
</tr>
<tr>
<td>Mode of arrival — n. (%)</td>
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<td></td>
<td></td>
<td>&lt; 0.001</td>
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<tr>
<td>Walk-in</td>
<td>3939 (65.56)</td>
<td>2796 (68.08)</td>
<td>-29.01</td>
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<tr>
<td>Being held</td>
<td>1511 (25.14)</td>
<td>675 (16.44)</td>
<td>-55.33</td>
<td></td>
</tr>
<tr>
<td>Ambulance</td>
<td>205 (3.41)</td>
<td>245 (5.97)</td>
<td>+19.51</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>354 (5.89)</td>
<td>391 (9.52)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Triage — n. (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Triage 1</td>
<td>42 (0.70)</td>
<td>26 (0.63)</td>
<td>-38.10</td>
<td></td>
</tr>
<tr>
<td>Triage 2</td>
<td>655 (10.90)</td>
<td>418 (10.18)</td>
<td>-36.18</td>
<td></td>
</tr>
<tr>
<td>Triage 3</td>
<td>4899 (81.53)</td>
<td>3371 (82.08)</td>
<td>-31.19</td>
<td></td>
</tr>
<tr>
<td>Triage 4</td>
<td>370 (6.17)</td>
<td>271 (6.60)</td>
<td>+26.76</td>
<td></td>
</tr>
<tr>
<td>Triage 5</td>
<td>43 (0.70)</td>
<td>21 (0.51)</td>
<td>-51.16</td>
<td></td>
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<tr>
<td>Disposition — n. (%)</td>
<td></td>
<td></td>
<td></td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

SD, standard deviation; AMA, against medical advice.
<table>
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<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission</td>
<td>640 (10.65)</td>
<td>406 (9.89)</td>
<td>-10.65</td>
<td></td>
</tr>
<tr>
<td>Discharge</td>
<td>5308 (88.33)</td>
<td>3670 (89.36)</td>
<td>-30.86</td>
<td></td>
</tr>
<tr>
<td>AMA</td>
<td>47 (0.78)</td>
<td>18 (0.44)</td>
<td>-61.70</td>
<td></td>
</tr>
<tr>
<td>Transfer</td>
<td>12 (0.20)</td>
<td>10 (0.24)</td>
<td>-16.67</td>
<td></td>
</tr>
<tr>
<td>Mortality</td>
<td>2 (0.04)</td>
<td>3 (0.07)</td>
<td>+ 50.00</td>
<td></td>
</tr>
</tbody>
</table>

SD, standard deviation; AMA, against medical advice.
Table 2
Comparison of chief complaints in pediatric patients’ emergency department visits before and during the COVID-19 epidemic.

<table>
<thead>
<tr>
<th>Chief complaints</th>
<th>Before pandemic (Jan, 2019 ~ Mar, 2019)</th>
<th>During pandemic (Jan, 2020 ~ Mar, 2020)</th>
<th>Difference (%)</th>
<th>Incidence rate ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Incidence (%)</td>
<td>n</td>
<td>Incidence (%)</td>
</tr>
<tr>
<td>Infection related complaints</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>2033</td>
<td>33.83</td>
<td>1254</td>
<td>30.53</td>
</tr>
<tr>
<td>URI</td>
<td>1148</td>
<td>19.10</td>
<td>697</td>
<td>16.97</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>75</td>
<td>1.25</td>
<td>64</td>
<td>1.56</td>
</tr>
<tr>
<td>Gastrointestinal related complaints</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abdominal pain</td>
<td>689</td>
<td>11.47</td>
<td>445</td>
<td>10.84</td>
</tr>
<tr>
<td>AGE symptoms</td>
<td>489</td>
<td>8.14</td>
<td>264</td>
<td>6.43</td>
</tr>
<tr>
<td>Constipation</td>
<td>20</td>
<td>0.33</td>
<td>11</td>
<td>0.27</td>
</tr>
<tr>
<td>GI bleeding symptoms</td>
<td>11</td>
<td>0.18</td>
<td>15</td>
<td>0.37</td>
</tr>
<tr>
<td>Cardiovascular related complaints</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest pain</td>
<td>52</td>
<td>0.87</td>
<td>98</td>
<td>2.39</td>
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<tr>
<td>Hypertension</td>
<td>2</td>
<td>0.03</td>
<td>20</td>
<td>0.49</td>
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<tr>
<td>Neurology related complaints</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dizziness</td>
<td>107</td>
<td>1.78</td>
<td>96</td>
<td>2.34</td>
</tr>
<tr>
<td>Headache</td>
<td>118</td>
<td>1.96</td>
<td>52</td>
<td>1.27</td>
</tr>
<tr>
<td>Convulsion</td>
<td>50</td>
<td>0.83</td>
<td>29</td>
<td>0.71</td>
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<tr>
<td>Altered mental status</td>
<td>7</td>
<td>0.12</td>
<td>15</td>
<td>0.37</td>
</tr>
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</table>

URI, upper respiratory infection; AGE, acute gastroenteritis; GI, gastrointestinal.

Eye, ENT, and dental problems

* Family violence and sexual assault
<table>
<thead>
<tr>
<th>Chief complaints</th>
<th>Before pandemic (Jan, 2019 ~ Mar, 2019)</th>
<th>During pandemic (Jan, 2020 ~ Mar, 2020)</th>
<th>Difference (%)</th>
<th>Incidence rate ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Incidence (%)</td>
<td>n</td>
<td>Incidence (%)</td>
</tr>
<tr>
<td>Malaise</td>
<td>12</td>
<td>0.20</td>
<td>11</td>
<td>0.27</td>
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<tr>
<td>Myalgia</td>
<td>65</td>
<td>0.01</td>
<td>83</td>
<td>2.02</td>
</tr>
<tr>
<td>Shortness of breath</td>
<td>155</td>
<td>2.58</td>
<td>135</td>
<td>3.29</td>
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<tr>
<td>Glycemic problem</td>
<td>3</td>
<td>0.05</td>
<td>11</td>
<td>0.27</td>
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<tr>
<td>Urological symptoms</td>
<td>78</td>
<td>1.30</td>
<td>58</td>
<td>1.41</td>
</tr>
<tr>
<td>Trauma</td>
<td>1401</td>
<td>23.31</td>
<td>970</td>
<td>23.62</td>
</tr>
<tr>
<td>Facial features problems+</td>
<td>217</td>
<td>3.61</td>
<td>106</td>
<td>2.58</td>
</tr>
<tr>
<td>Cardiac arrest</td>
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<td>0.03</td>
<td>6</td>
<td>0.15</td>
</tr>
<tr>
<td>Psychological problems</td>
<td>6</td>
<td>0.10</td>
<td>19</td>
<td>0.46</td>
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<tr>
<td>Social problems*</td>
<td>13</td>
<td>0.22</td>
<td>13</td>
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<tr>
<td>Others</td>
<td>49</td>
<td>0.82</td>
<td>18</td>
<td>0.44</td>
</tr>
</tbody>
</table>

URI, upper respiratory infection; AGE, acute gastroenteritis; GI, gastrointestinal.

Eye, ENT, and dental problems

* Family violence and sexual assault

Figures
Patients visiting the emergency department of the Cathay Health System hospitals in Taiwan

Pediatric patients (age < 18 years)

Pre-pandemic
January 21, 2019 to April 30, 2019 (n = 6251)

Exclusion
Duplicated data, n=28
Missing data, n=423

Pandemic
January 21, 2020 to April 30, 2020 (n = 4316)

Pre-pandemic
n = 6009

Pandemic
n = 4107

10116 pediatric patients were included

Figure 1

Flowchart of this study