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Original Article

# Pediatric emergency healthcare utilization during the coronavirus disease 2019 pandemic in Tokyo

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**Abstract** ***Background*:** Various public health interventions have been implemented against the coronavirus disease 2019 pandemic. We investigated changes in pediatric emergency healthcare utilization during the current pandemic.

***Methods*:** Based on data on outpatient healthcare visits to one pediatric emergency department in Tokyo, Japan, the descriptive, cross-sectional study compared the number of emergency department visits in 2020 to the number in the previous 3 years. Data were extracted from the electronic triage reporting system. The primary outcome was the number of emergency department visits. The characteristics of patients by age group were also investigated.

***Results*:** A 40.6% reduction in pediatric emergency healthcare utilization was observed during the study period, with the greatest decrease occurring in the number of visits for fever. However, while the number of patients with a complaint with an exogenous cause decreased, the proportion of these patients increased. Although social activities in the greater community have now almost normalized, and only a slight increase in the number of patients with fever has been reported, the number of emergency department visits remains lower than in previous years as of this writing.

***Conclusions*:** Public health interventions led to a reduction in emergency department visits, thereby allowing time to redistribute health-care resources.

**Key words** COVID-19, emergency department, pediatrics, public health intervention, school closure.

In late December 2019, the novel severe acute respiratory syndrome coronavirus (SARS-CoV-2), the cause of coronavirus disease 2019 (COVID-19), emerged in Wuhan, China.[1] After spreading quickly it was declared a pandemic by the World Health Organization (WHO) on March 11, 2020. Nations worldwide responded with various public health interventions, including social distancing, universal mask recommendations, school closures, and sheltering-in-place orders for non-essential workers. In Japan, the first COVID-19 case was reported on January 16, 2020.[2] Nationwide school closures were implemented on March 2 (week 10) to contain the pandemic. However, COVID-19 cases continued to emerge throughout the country, and a state of emergency involving voluntary closures of all non-essential businesses and avoidance of unnecessary public activities was declared on April 7 (week 15). Later, as the number of patients with COVID-19 declined, the state of emergency was lifted in week 22, and most schools reopened in week 23, at which time other social activities gradually resumed. Thereafter, the number of patients with COVID-19 bottomed out at week 20 before starting to increase again in Tokyo.[3]

Previous studies described the diagnoses that decreased in the context of the general decline in the number of ED visits,[4–7] but few studies have analyzed this topic by age group,[8] and no studies on this topic have been conducted in Japan. Moreover, no studies have yet examined changes in the trend of ED visits after a lull in the pandemic and the resumption of social activities. Therefore, based on changes over time in the frequency of pediatric ED visits at the study center, the present study analyzed pediatric emergency healthcare utilization in the pediatric ED to assess the effect of the public health interventions implemented in response to the pandemic on ED activities and to gather insights into formulating strategies for managing future emerging disease outbreaks.

## Methods

### *Study design*

Based on data on outpatient healthcare visits to the Tokyo Metropolitan Children's Medical Center's (TMCMC) pediatric ED during calendar weeks 1–39 in each year from 2017 to 2020, this descriptive, cross-sectional study compared the

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number of ED visits between 2020 (the study period) and the previous 3 years (2017–2019, the baseline period). The TMCMC, a tertiary care center with 561 beds and an estimated annual ED volume of 36 000 patient visits, including 3,200 ambulance transfers, is one of the largest comprehensive pediatric hospitals in Japan. The ethical committee of Tokyo Metropolitan Children's Medical Center approved this study (Certification Number: 2020b-108), and informed consent was obtained in the form of an opt-out clause on the hospital website.

### *Data collection*

An electronic triage reporting system, eTriage (Dank net, Tokyo, Japan), was used as a database for the present study. The volume of patient visits and patient characteristics, including age, sex, date, time of visit, complaints, method of arrival (walk-in, ambulance, or helicopter), vital signs, and triage acuity level, were collected and analyzed. Patients with a body temperature of 38.0 °C or higher were categorized as febrile. The main complaints were divided into 17 categories, which were then subdivided into 168 subcategories. Triage was performed by a registered nurse in accordance with a modified Japanese Triage and Acuity Scale (mod-JTAS) protocol.[9] Patients classified as 1 or 2 on mod-JTAS were considered to have a high degree of urgency.

**Table 1** Comparison of healthcare utilization before and after COVID-19 pandemic

| | Mean (SD) | |
|---|---|---|
| | Study time period (2020) | Baseline time period (2017–2019) |
| Weekly ED visits (*n*) | 410 (120) | 691 (104) |
| Visits outside daytime hours (%) | 55.8 (3.9) | 58.4 (2.9) |
| Age (years) | 5.0 (4.9) | 4.5 (4.3) |
| ≦1 year of age (%) | 12.0 (1.9) | 13.5 (1.9) |
| Female patients (%) | 41.3 (3.1) | 42.7 (1.3) |
| Ambulance transfer (%) | 11.1 (2.7) | 9.4 (1.6) |
| High degree of urgency (%) | 11.7 (2.4) | 11.1 (1.2) |
| Patient with fever (%) | 24.7 (5.6) | 33.2 (3.7) |
| Patient with a complaint of exogenous cause (%) | 34.8 (6.6) | 24.5 (3.0) |

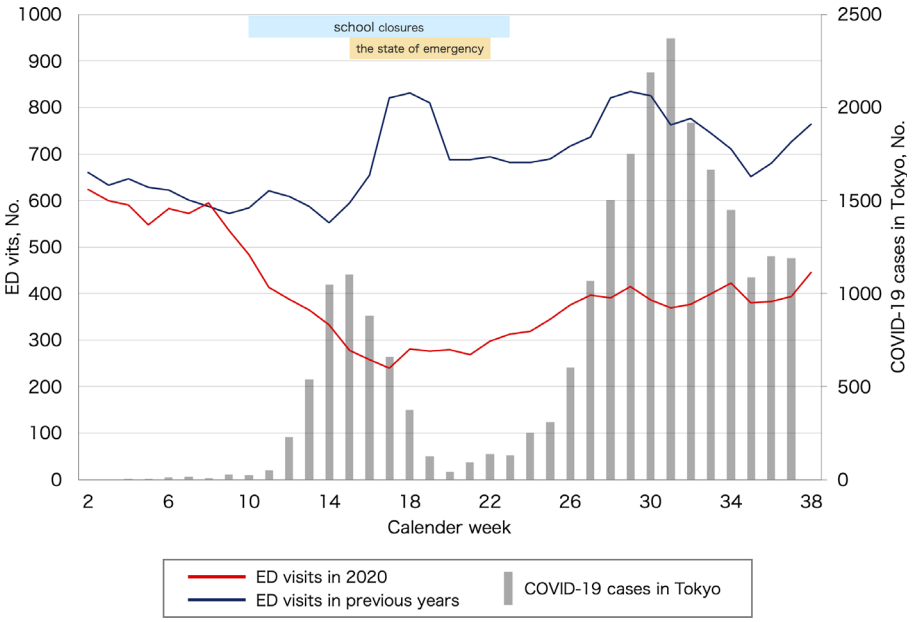
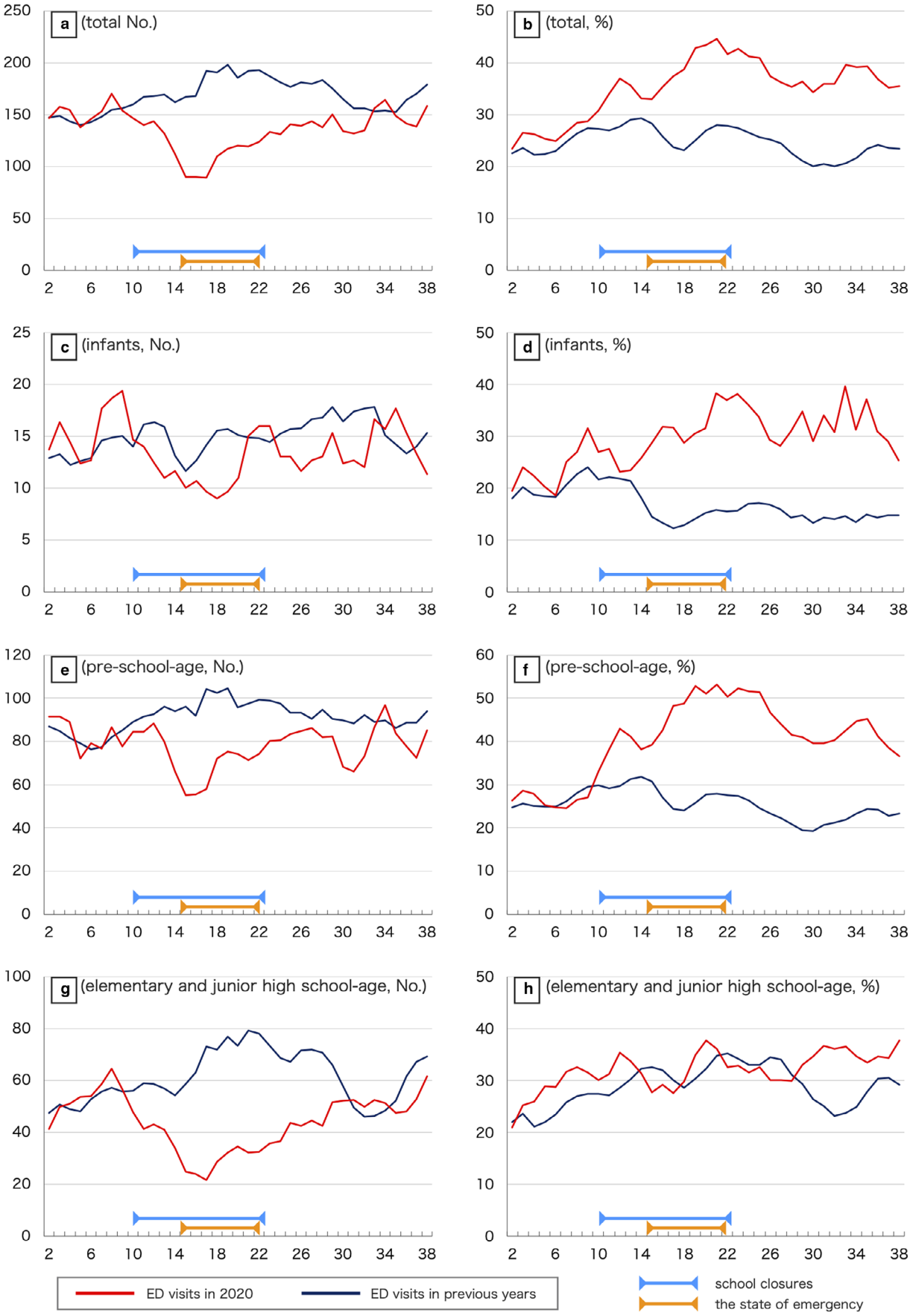



**Fig. 1** Number of emergency department visits in 2020. The horizontal axis represents the number of weeks. Emergency department visits were grouped by calendar week, and fluctuations in the number of patients per week are expressed as a moving average. Changes in the number of COVID-19 cases in Tokyo are also shown. (—), ED visits in 2020; (—), ED visits in previous years; (■), COVID-19 cases in Tokyo.

**Fig. 2** Changes in patients with a complaint with an exogenous cause. The horizontal axis represents the number of weeks. (a) Number of patients with a complaint with an exogenous cause. (b) Percentage of patients with a complaint with an exogenous cause. (c) Number of infants with a complaint with an exogenous cause. (d) Percentage of infants with a complaint with an exogenous cause. (e) Number of preschool-aged patients with a complaint with an exogenous cause. (f) Percentage of preschool-aged patients with a complaint with an exogenous cause. (g) Number of elementary and junior high school-aged patients with a complaint with an exogenous cause. (h) Percentage of elementary and junior high school-aged patients with a complaint with an exogenous cause. (—), ED visits in 2020; (—), ED visits in previous years; (⟼), school closures; (⟼). The state of emergency.



### *Outcomes*

The primary outcome was the number of emergency department visits during the COVID-19 pandemic with reference to the number of patients in the previous 3 years. The relationship between changes in the characteristics of the ED visits by age group and the implementation of public health interventions and resumption of social activities was also examined.

### *Statistical analyses*

Categorical variables were summarized as percentages and continuous variables as the mean. The patient volume and characteristics of the ED visits in 2020 (the study time period) were compared with those of the previous three years (2017–2019, the baseline period). The number of visits to the ED were grouped by the calendar week in each year, and the changes in the number of patients per week were described as a moving average.

The m-JTAS chief complaint categories are divided into 17 major categories, mainly organ specific, and further subdivided into 170 subcategories. The subcategories of complaints were divided into those with an exogenous cause (trauma, foreign objects, environmental causes, and so on), those with an endogenous cause (fever, cough, stomachache, and so on), and others (including complaints related to mental health). The patients were divided into four groups according to age as infants (under age 1 year), preschool age (age 1–6 years), elementary and junior high school age (age 7–5 years), and older (over age 16 years). All statistical analyses were performed using SPSS version 27.0 (IBM, Armonk, NY, USA).

## Results

In total, 15 998 visits occurred during the study period (calendar weeks 1–39 in 2020), during which pediatric emergency healthcare utilization decreased 40.6% compared to the mean of the preceding period ($n$ = 26 948). In the study period, the mean patient age was 5.0 years, 41.3% of the patients were female, 11.1% arrived by ambulance or medical helicopter, and 11.7% were deemed to have a high degree of urgency. The final two characteristics changed little between the study and baseline periods (Table 1).

By week 8, the number of visits was similar to that of the previous years. School closures were implemented in week 10, at which time the number of ED visits began to decrease precipitously (Fig. 1). The number of COVID-19 cases in Tokyo continued to increase,[3] and a state of emergency was declared in seven prefectures, including Tokyo, on April 7 (week 15). Most schools opened in week 23, when the number of ED visits increased at the same rate as in previous years, but the total number remained lower than the baseline.

Figure 2 shows the number of patients presenting to the ED with a complaint with an exogenous cause. Across all age groups, public health interventions led to a sharp decrease in the number of ED visits but an increase in the percentage of patients admitted. With the resumption of social activities, the number of ED visits again began to rise, and the number of patients approximated that at baseline after week 33 (Fig. 2a, b). The number of infants with a complaint with an exogenous cause was roughly the same as in the preceding years, but the proportion of infant patients with identical complaints increased (Fig. 2c,d). The number of elementary and junior high school-aged patients a complaint with an exogenous cause showed a marked decrease after the closure of schools, but their number began to increase from week 16 and reached the same level as in previous years by week 31 (Fig. 2g). The proportion of patients in the latter age group was roughly the same at week 31 as at baseline (Fig. 2h).

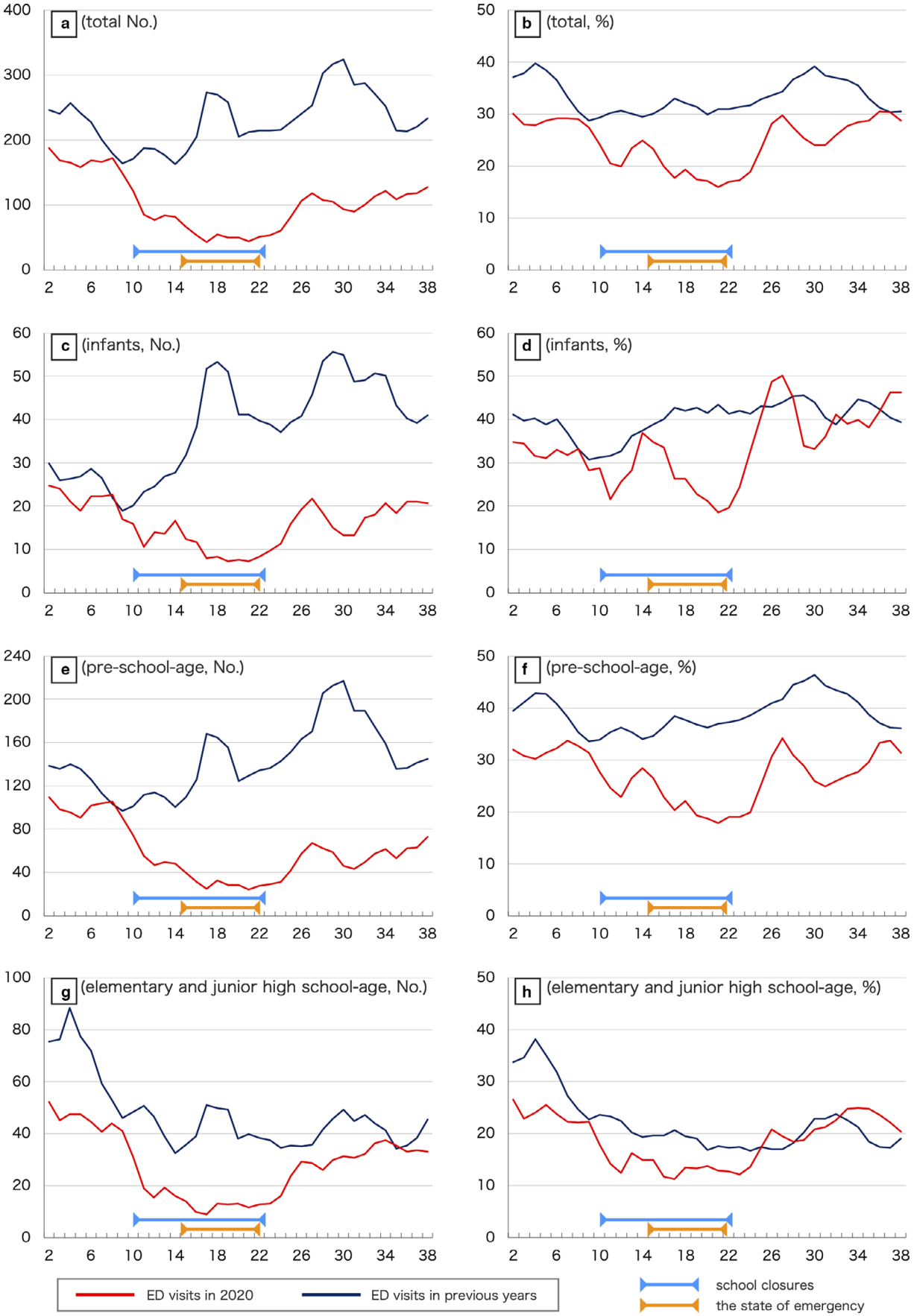
Figure 3 shows the number of patients presenting to the ED with fever. Across all age groups, public health intervention resulted in a sharp decrease in the number of febrile patients. Their number is again slowly increasing but remains much lower than in previous years (Fig. 3a,b). In previous years, the number of infants and preschool-aged patients with fever tended to increase through summer; however, this was not the case in 2020 (Fig. 3c,e). The number of elementary and junior high school-aged patients with fever decreased slightly after the closure of schools, but as social activities resumed, their number and overall proportion approximated the numbers in the preceding years (Fig. 3g,h).

Figure 4 shows the changes in the number of patients transported by ambulance or helicopter and patients deemed to have a high degree of urgency. The social interventions led to a decrease in the number of patients transported by ambulance or helicopter but also to a slight increase in the proportion of patients arriving by these conveyances (Fig. 4a,b). A similar trend was observed in patients deemed to have a high degree of urgency (Fig. 4c,d).

## Discussion

While previous studies reported a decrease in the number of ED visits due to public health interventions,[4–7] the present study investigated this trend in terms of patient age groups. The present study also identified trends in the number of ED

**Fig. 3** Changes in the number of febrile patients. The horizontal axis represents the number of weeks. (a) Number of febrile patients. (b) Percentage of febrile patients. (c) Number of febrile infants. (d) Percentage of febrile infants. (e) Number of febrile, preschool-aged patients. (f) Percentage of febrile, preschool-aged patients. (g) Number of febrile, elementary, and junior high school-aged patients. (h) Percentage of febrile, elementary and junior high school-aged patients. (—), ED visits in 2020; (—), ED visits in previous years; (⟼), school closures; (⟼), the state of emergency.



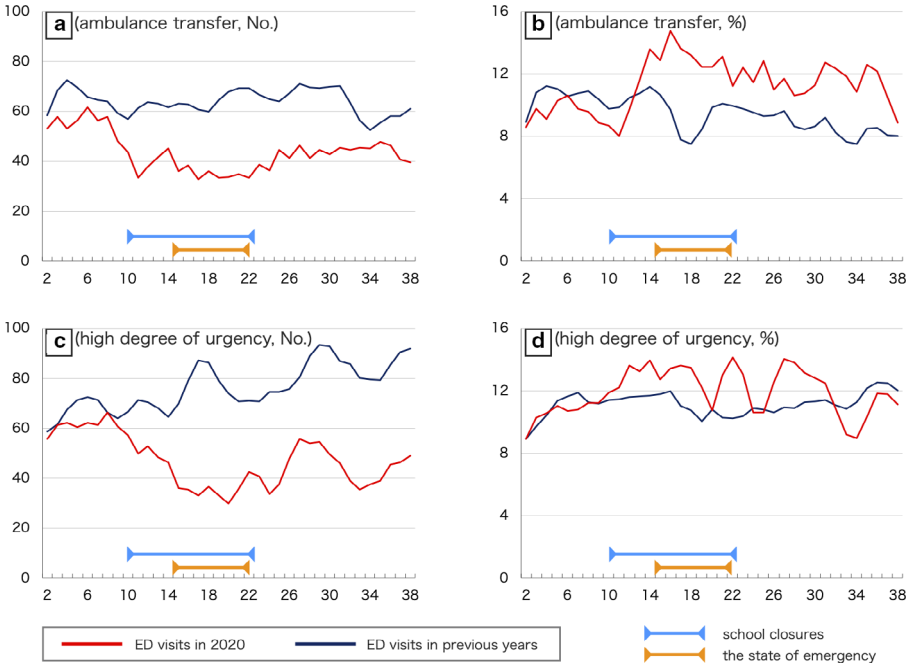



**Fig. 4** Changes in the number of patients transported by ambulance or medical helicopter. The horizontal axis represents the number of weeks. (a) Number of patients transported by ambulance or medical helicopter. (b) Percentage of patients transported by ambulance or medical helicopter. (c) Number of patients deemed to have a high degree of urgency. (d) Percentage of patients deemed to have a high degree of urgency. (—), ED visits in 2020; (—), ED visits in previous years; (⟷), school closures; (⟷), the state of emergency.

visits after the resumption of social activities. In line with previous studies, a significant reduction (40.6%) in pediatric emergency healthcare utilization was observed. Three findings in particular deserve closer scrutiny. First, the number of patients with fever decreased dramatically after the public health interventions were implemented. Second, the number of primary and junior high school-aged patients with a complaint with an exogenous cause decreased, but the number of infantile and preschool-aged patients did not change compared to previous years. Third, even after the resumption of social activities, the number of ED visits has remained low.

The number of patients with fever decreased most significantly after the implementation of public health interventions. Previous studies showed a decrease in complaints related to the common cold and gastroenteritis, which are infectious, but not in complaints related to urinary tract infections, which are endogenous.[5] Similarly, the national statistics for 2020 showed no decrease in the incidence of exanthema subitum, which is mainly caused by familial infections although the incidence of hand-foot-and-mouth disease or herpangina, which is common in the summer, decreased significantly.[9–11] On the other hand, the number of patients, apart from infants, with a complaint with an exogenous cause decreased despite an increase in the proportion of cases. The lack of change in the number of infant patients is likely due to the fact that accidental injuries in this age group typically occur indoors,[12] and the public health interventions therefore did not contribute to reducing the incidence of such complaints. Thus, medical resources need to be available continually to treat these patients even during a pandemic.

Strictly speaking, the present study was unable to determine whether the decline in the number of patients was due to a decrease in the number of injuries and illnesses or to avoidance of hospital visits. A previous study reported that some parents avoided taking their children to the hospital from fear of contracting COVID-19.[6] If the decline in the number of patients observed in the present study was due to avoidance of hospital visits, the number of relatively less urgent cases might be expected to have decreased to a greater degree and that of relatively more urgent cases might be expected to have increased to a greater degree; however, the present study found only a small increase in the proportion of patients with a high level of urgency or transportation via ambulance. Thus, it is likely that a smaller number of injuries and illnesses contributed more to the drop in the overall number of patients than the avoidance of hospital visits.

Currently, the number of ED visits is still smaller than in previous years despite the slight increase seen after the resumption of social activities. In particular, the number of patients presenting with a complaint with an exogenous cause has returned to the same level as in previous years. However, the proportion of them remains higher than in previous years. The number of febrile, infant or preschool-aged patients remained low, possibly as an effect of changes in behavior, such as more widespread mask use, more frequent hand hygiene practices, and the avoidance of the so-called 3Cs

(closed spaces, crowded places, and close-contact settings). The number of elementary and junior high school-aged patients with fever has returned to the level in previous years. Closure of schools may be more effective than the 3Cs in reducing the prevalence of infectious diseases in this age group.

The public health interventions, including school closures, succeeded in providing an opportunity to redistribute medical resources. In particular, isolation beds and personal protective equipment (PPE) tended to be in short supply during the pandemic. Owing to the massive reduction in the number of ED visits, procedures for dealing with COVID-19 patients and obtaining a sufficient PPE supply were able to be developed during the lull in ED activity created by the drop in visits. Children were considered a potential source of COVID-19 transmission because they are more susceptible than adults to various viral infections, such as influenza. Furthermore, this concern was magnified by the fact that children infected with COVID-19 are typically asymptomatic or have mild symptoms indistinguishable from those of the common cold.[12] Although the evidence supporting the effectiveness of school closures against the spread of COVID-19 is very scant, many countries, including Japan, implemented this measure, which was based on evidence showing that reduced social contact between students was able to interrupt the transmission of the influenza virus.[13–15] In Belgium, school closures were associated with a significant decline in the infection and mortality rates during the current pandemic.[16] On the other hand, another study reported that school closures did not contribute to controlling the epidemic, and that other social distancing measures were more important.[17] The present study did not provide a clear answer to this question because it was not concerned with addressing changes in the number of pediatric COVID cases. Of course, there are other factors involved as well, but public health interventions, including school closures, reduced the number of ED visits and were considered to have been very effective for creating the time needed for the redistribution of medical resources. This finding may be useful for preventing the further spread of COVID-19. However, their effectiveness against the transmission of COVID-19 has yet to be determined.

Global epidemics caused by emerging infectious diseases will continue to be a threat by virtue of increased international travel and the greater opportunities for zoonotic transmission due to more frequent contact with wildlife brought about by climate change. It is important to evaluate the effectiveness of various interventions and to be prepared for future emerging infectious diseases. It is hoped that the findings of the present study will be useful for these ends.

The present study has two limitations. First, this study was monocentric; thus, it may not be possible to extrapolate its findings to other countries or regions. Second, our database did not include information about diagnoses or patient dispositions; changes in the frequency of individual diseases and the prognosis of patients could not be determined.

### *Conclusions*

Public health interventions, including school closures, should be effective in reducing the number of ED visits to some degree, thereby allowing time to redistribute health-care resources. The findings of the present study will aid in formulating strategies for managing future emerging infectious disease outbreaks. Public health interventions are not sufficient to reduce the incidence of accidental injuries substantially, and medical resources need to be available continually for patients with these complaints even during a pandemic. We believe that further research into changes in pediatric emergency healthcare utilization is warranted.

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## Disclosure

The authors declare no conflict of interest.

## Author contributions

H.Y. conceptualized and designed the study, obtained the data, wrote the first draft, and reviewed and revised the manuscript. Y.M. and Y.H. contributed to the study conception and design and acquisition and interpretation of data, and revised the manuscript critically for important intellectual content. H.H. contributed to the study design and revised the manuscript critically for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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