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Association between the use of an app for providing healthcare information for parents and urgent emergency department visits for children: a cross-sectional study in Japan

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ABSTRACT

Objective To evaluate the association between the use of medical information applications and urgent emergency room consultation behaviour among parents who visited the emergency department (ED) of their children.

Design Cross-sectional survey.

Setting A primary-level paediatric emergency medical facility in Nagano Prefecture.

Participants Parents of children aged 8 years or younger who had visited the medical facility between December 2023 and March 2024.

Primary and secondary outcome measures The primary outcome was defined as an association between the urgency of ED visits and parental use of mobile applications. The secondary outcome was the association between the urgency of ED visits and app evaluations among parents using the app. The urgency of the ED visits was classified according to the Japan Triage and Acuity Scale.

Results In total, 386 parents participated in this study (response rate: 91%). Among these, 77% were mothers and the median age was 36.3 years. Of the ED visits by app users, 63.7% were classified as urgent, compared with 41.7% of visits by non-users (adjusted OR: 2.8, 95% CI: 1.7 to 4.7, p<0.001). Among the participants who used the app, 94.4% answered that they would recommend the app and 87.0% answered that the app made it easier to decide whether to visit the hospital. In addition, the proportion of children who revisited the ED within 6 months was higher for children with a medical history than for those without such a history. There were no significant associations between the urgency of ED visits and parental education, self-reported financial status, or whether the parent was a healthcare professional.

Conclusions The use of the medical information app was significantly associated with parental ED urgency. These findings suggest that such apps may support informed decision-making in paediatric emergency care. Future research should investigate the effect of this app on a broader population, including cases involving ambulance transport.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study used the Japan Triage and Acuity Scale to objectively evaluate the urgency of emergency room visits. This approach enhanced the validity and reliability of the results.
⇒ A high response rate (91%) achieved a robust sample size and minimised the risk of response bias.
⇒ The generalisability of the results of this study is limited because it was conducted in a single region during a specific season of the year.
⇒ As this was a cross-sectional study, it was not possible to prove a causal relationship. Furthermore, unmeasured confounding factors may have influenced the results.

INTRODUCTION

Emergency medical facilities are attractive to parents who want reassurance and convenience because they provide quick service and comprehensive diagnostic and treatment procedures.[1] The most frequent reason for parents to visit hospitals for non-urgent care is the perceived urgency by the parents.[1] It has been reported that 35% of 200 parents recognised their child's condition as urgent.[2] Unsatisfaction with general practitioners (GPs) is also cited as a reason for non-urgent visits. This is an issue that arises from complex problems within the healthcare system, such as difficulties in accessing primary care, distrust of GPs, a lack of enough medical advice and inconvenient service hours.[3]

On the other hand, visits to emergency medical institutions for non-urgent conditions can increase waiting times and reduce the time spent with each patient. As a result, there is a risk of lower quality and safety of medical care provided to patients, as well as disruption in the treatment of patients with serious conditions.[4]

There is also a risk that children may contract infectious diseases from other children through visiting medical facilities.[5] In addition, repeating visits to the emergency room can prevent the child from receiving

follow-up care, which is essential for effective medical management and may result in inadequate preventive medical measures.[6]

On the other hand, because parents are not experts, judging the urgency of the child's condition is difficult for them. Previous studies have reported that the competency of parents in assessing the severity of their sick child can be affected by their knowledge of the illness of children.[7] Therefore, tools that help parents determine the urgency of their child's condition will help to reassure them.

In recent years, digitised healthcare information has been accessed via mobile devices. In a cross-sectional survey conducted in Switzerland, over 90% of parents with children under the age of 2 years used digital media to obtain healthcare information about their children.[8] It is believed that creating an environment in which parents can access evidence-based healthcare information using Information and Communication Technology (ICT) will help reassure parents. In fact, in the field of injury prevention, it is reported that providing information to parents via an app has improved the safety behaviour of parents.[9] On the other hand, it is also noted that parents prefer booklets to apps for receiving information in emergency rooms.[10] In addition, a study showed that apps that are difficult to use do not help parents make decisions about emergency medical visits.[11]

In 2015, we launched the parent education programme 'Teach Me! Doctor' in Saku City, Nagano Prefecture, and developed an app that provides healthcare information to parents. A study conducted in Saku City in 2022 showed an association between app use and parents' competency in managing children's health.[12] In the field of health communication, there is insufficient evidence to support an association between the use of apps and urgent consultation behaviours in emergency rooms. We hypothesised that use of the app by parents would be associated with a higher rate of urgent emergency department (ED) visits for children. The purpose of this study was to retrospectively evaluate the urgency of emergency room visits for infants and young children and to analyse the association between the use of the app and urgent emergency room consultation behaviour of parents.

METHODS

Participants and data collection

This cross-sectional study was conducted at the Weekend and Holiday Pediatric Medical Center in Saku City, Nagano Prefecture, from 20 December 2023 to 31 March 2024. The Weekend and Holiday Pediatric Medical Center is the only medical institution in the Saku area (population: 230 000) that provides emergency medical care on holidays (excluding ambulance services). This study targeted parents of children aged 8 years or younger who visited our centre. Parents who received an explanation of the questionnaire survey from a nurse in the emergency room and those who consented to participate were included in the study. The questionnaire was administered by a nurse after consultation (online supplemental file). Participants were excluded if they were not the mother or father of the child, did not have a smartphone or had subsequent consultation during the survey period.

The sample size was calculated to be 349 cases when the effect size was 0.15, the α error probability was 0.05, the power (1−β) was 0.8 and the df was 1. Considering the possibility of collecting data within the survey period and the available resources, the possible sample size was estimated to be 400 cases.

Outcome, exposures and potential confounding factors

The primary outcome was defined as the association between urgency of ED visits and parental use of mobile applications. The secondary outcome was the association between the urgency of ED visits and app evaluations among parents using the app. Exposure was defined as the use of the 'Teach Me! Doctor' app. In the statistical analyses, factors considered potential confounders were parental education and economic status. Factors considered potential effect modifiers were parental age and the child's underlying disease.

Overview of the app

The 'Teach Me! Doctor' app was developed in 2016. The programme was provided free of charge with the support of Saku City to improve parents' competency in caring for their children. It provides information on five topics: indications for children to visit the hospital, explanations of children's illnesses, information on immunisation, information on child-rearing support groups, and disaster countermeasures for children (figure 1). The app has been downloaded more than 400 000 times with over 160 000 active users, making it one of the largest healthcare information apps in Japan.

MEASUREMENT

Information on consultations with medical institutions

Information on the child's symptoms, diagnosis, outcome (return home or hospitalisation) and the participants' self-assessment of the appropriateness of the visit was collected, and the physician's evaluation of the urgency for an emergency room visit was recorded. Influenza and COVID-19 diagnoses were made using standardised rapid antigen tests, but in some cases, if a family member living in the same household had already been diagnosed and had the same symptoms, they were diagnosed as presumptive positive. The respiratory infection group mainly included upper respiratory tract infections and pharyngitis and excluded influenza and COVID-19. Participants were asked to choose from the following options to determine whether their visit to the hospital was appropriate: "It was good that I visited the hospital," "I may not have needed to visit the hospital," and "I did not need to visit the hospital." The responses were classified as appropriate or inappropriate. Physician assessments of the urgency of

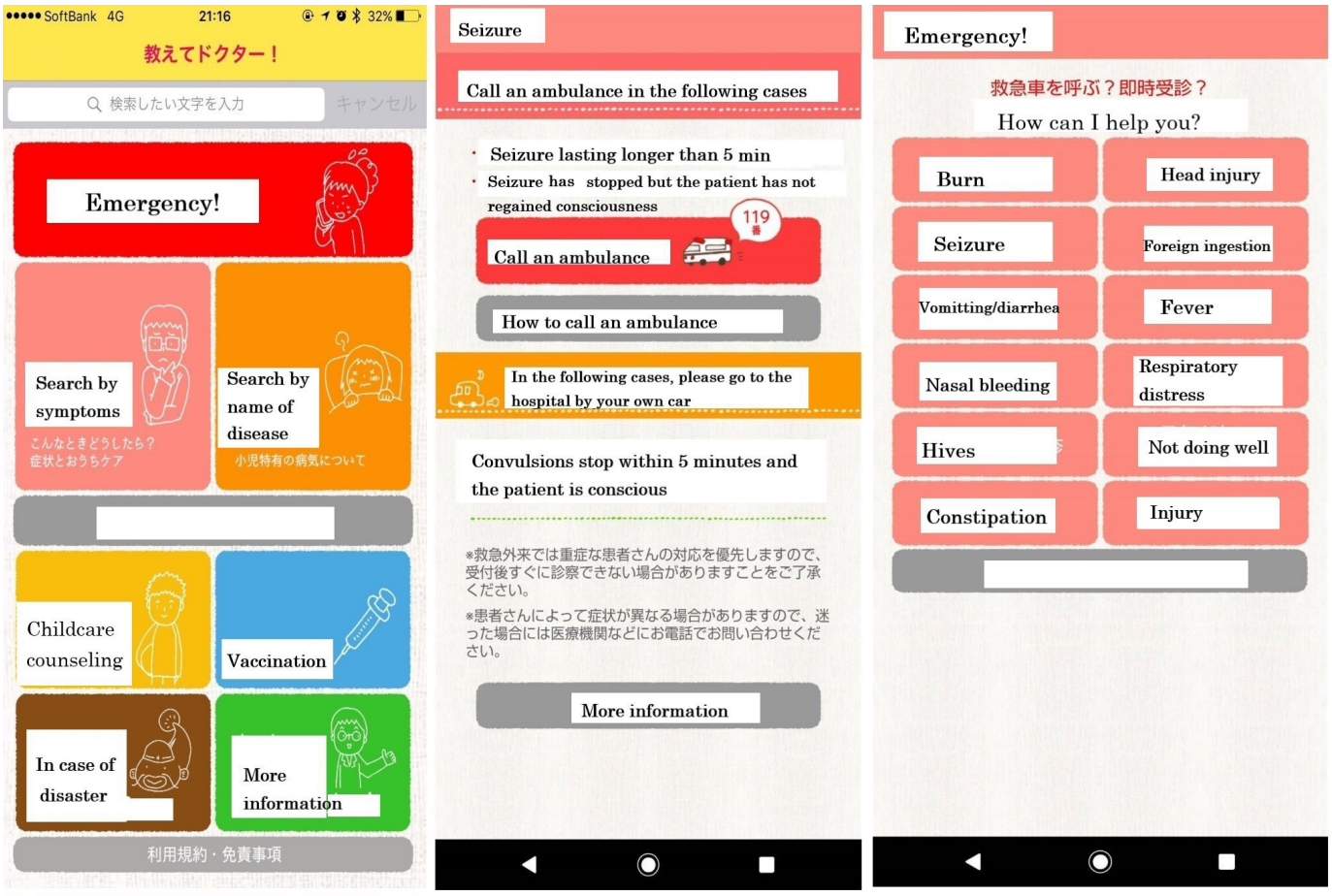

Figure 1 Examples of images of the main modules of the 'Teach Me! Doctor' App. Left: Top image of the app. Middle: Criteria to determine whether to call an ambulance when a seizure occurs. Right: Table of contents to determine the suitable response to the child's symptoms. The original app showed menu names in Japanese, which have been translated into English.

emergency room visits were conducted by the principal investigator, a paediatrician, using the Japan Triage and Acuity Scale (JTAS). This is a standardised triage system used in EDs and was developed by the Japanese Association for Acute Medicine and the Japanese Association of Emergency Nursing based on the Canadian Triage and Acuity Scale. The validity of this system has been evaluated in several previous studies.[13 14] It is used in medical facilities such as emergency rooms in Japan. It evaluates the level of patient emergency on a scale of 1 (resuscitation), 2 (emergency), 3 (semiemergency), 4 (low emergency) and 5 (non-emergency), based on vital signs, general condition, contents of vomit and the degree of bleeding, dehydration, pain and fever. In this study, we classified 1–3 as urgent emergency room visits and 4–5 as non-urgent emergency room visits. The physician was not informed of the parents' use of the app, and he was only given the electronic medical record ID described in the questionnaire and made his evaluation based solely on the content of the medical record.

Use of the 'Teach Me! Doctor' app and user evaluation

Participants were asked about the use of the app, frequency of use and their evaluation of the app (if they would recommend the app to others if they felt reassured by using the app, and if the app made it easier to make decisions about hospital visits). The question item regarding the evaluation of the app was "Would you recommend this app to others?" from the App subjective quality section of the User Version of the Mobile Application Rating Scale.[15] In addition, since the purpose of the app was to help parents make judgements about hospital visits, we added the question 'Is it a good guide for visiting the hospital?' Frequency of use was classified as '0 times' or '1 time or more' by selecting from 'none,' '1 time,' '2–3 times,' '4–10 times' and '10 times or more'. Regarding the evaluation of the app, respondents were asked to choose from four options: 'I agree,' 'I tend to agree,' 'I tend to disagree' and 'I disagree'. The answers were divided into two categories: 'I agree' and 'I tend to agree' were grouped as 'I agree', and 'I tend to disagree' and 'I disagree' were grouped as 'I disagree'.

Sociodemographic data

The participants' sex, age, educational background, self-assessed economic status, current occupation, age and sex of their children, birth order and medical history were recorded. Education was classified into having or not having a bachelor's degree. Regarding self-assessed economic status, participants reported their subjective

economic status on a 5-point scale: 'very good', 'good', 'normal', 'bad' and 'very bad'. This was then classified into three categories: 'very good–good' as 'good', 'normal' and 'bad–very bad' as 'bad'. Regarding healthcare professionals, those who answered that they were healthcare professionals were classified as 'yes', and those who answered that they were not healthcare professionals were classified as 'no'. Birth order was classified as either 'first child' or 'second or more children'. Regarding the child's medical history, those who answered that they had a medical history were classified as 'yes', and those who answered that they did not have a medical history were classified as 'no'.

Data analysis and statistics

Continuous variables were described as summary statistics (mean and SD or median and IQR), and categorical variables were expressed as frequencies and proportions. Participants were divided into two groups based on the assessment of the urgency of consultation. Sociodemographic characteristics, main symptoms and the use of the app were compared using the χ^2 test or t-test. Fisher's exact test with the Monte Carlo simulation (10 000 000 replicates) was used to compare the disease frequencies between the groups because of the large size of the contingency table.

We also conducted univariate (χ^2 or t-test) and multivariate (multiple logistic regression analysis) analyses to examine the association between participant characteristics and app use and evaluation. Statistical significance was set at $p<0.05$. We used Stata V.17 (StataCorp) to analyse the data.

Patient and public involvement

Although this study was conducted with the general public (parents), the subject of the study was medical triage, and the public was not involved in the research design or paper production process.

RESULTS

A flow diagram of the survey is shown in figure 1. A total of 386 cases responded to the questionnaire. The response rate was 91% (386/425). A total of 184 patients were classified as urgent, with 0 patients (0%) categorised as resuscitation (scale: 1), 5 patients (1.3%) as emergency (scale: 2) and 179 patients (46.4%) as semiemergency (scale: 3). Conversely, 202 patients were classified as non-urgent, including 195 patients (50.7%) in the low emergency category (scale: 4) and 7 patients (1.8%) in the non-emergency category (scale: 5). Table 1 presents the background characteristics of respondents in each group. Of the participants, 77% were mothers, 33% had graduated from university or higher and 17% were medical professionals. Of the participants, 95% lived in Nagano Prefecture, and 95% of participants felt that their emergency room visits were appropriate after consultations. There were no differences between the urgent and non-urgent emergency consultation groups regarding the parents' educational background, self-assessment of their consultation, residential area, or whether they were medical professionals. A total of 52% of the children were boys, and 50% were the first child. The proportion of children who had visited the emergency room more than twice in the past 6 months was higher in the group with a history of illness (36%) than in the group without a history of illness (23%) (p=0.045). The mean age of the children was 3.6 years. The average age of the children in the urgent consultation group was 3.2 years, which was lower than that in the non-urgent consultation group (4.0 years). The proportion of children with non-urgent medical visits was higher among those attending daycare or school than among those who did not. No differences were observed between the urgent and non-urgent medical visit groups in terms of birth order or medical history.

The diagnoses at the time of consultation are shown in table 2. The distribution of diagnoses at the time of consultation differed between the urgent and non-urgent emergency consultation groups (p<0.0001). The most frequent diagnoses were upper respiratory tract infection (excluding influenza and COVID-19) with 155 cases (40%), followed by influenza with 74 cases (19%), acute gastroenteritis with 49 cases (13%), bronchitis with 25 cases (7%), exanthematous diseases with 13 cases (3%) and COVID-19 with 13 cases (3%). Upper respiratory tract infections were often classified in the non-urgent consultation group, whereas gastroenteritis was more frequently included in the urgent consultation group. All patients with asthma and croup syndrome were categorised into urgent consultation groups.

Among children with a history of illnesses, there were 55 cases (15%), with asthma being the most common (21 cases), followed by non-asthmatic allergic diseases such as atopic dermatitis and rhinitis (8 cases), congenital heart disease (7 cases) and developmental disorders (5 cases) (figure 2).

Table 3 shows the association between the urgency of ED visits and parents' use of an application. A total of 26.5% (102/385) of guardians used the application. Among those who used the application, the rate of urgent visits was 63.7%, which was significantly higher than that of the non-user group (41.7%). This result remained significant even after adjusting for the attributes of the guardians and children.

Subsequently, among those who reported using the app, we investigated the association between the urgency of emergency outpatient visits and the evaluation of the application (table 4). Among respondents who indicated app usage, 94.4% (101/107) reported that they would recommend the app, 89.8% (97/108) indicated that the app provided a sense of reassurance, and 87.0% (94/108) stated that it assisted in their decision to visit the hospital. In addition, the proportion of respondents who recommended the application was significantly higher in the urgent consultation group than in the non-urgent

Table 1 Association between characteristics of parents and children and urgent emergency department visits

Characteristics	Non-urgent visits (n=202)	Urgent visits (n=184)	Total (n=386)	P value*
Parents				
Age (years)	36.3±6.3	36.3±6.0	36.3±6.2	0.996
Relationship to child				0.148
Father	52 (25.7%)	36 (19.6%)	88 (22.8%)	
Mother	150 (74.3%)	148 (80.4%)	298 (77.2%)	
Place of residence				0.830
Outside the prefecture	10 (4.9%)	10 (5.4%)	20 (5.2%)	
Within the prefecture	192 (95.1%)	174 (94.6%)	366 (94.8%)	
Medical professional				0.779
No	166 (83%)	153 (84.1%)	319 (83.5%)	
Yes	34 (17.0%)	29 (15.9%)	63 (16.5%)	
Education				0.756
Less than a university degree	137 (68.2%)	120 (66.7%)	257 (67.5%)	
University degree or higher	64 (31.8%)	60 (33.3%)	124 (32.6%)	
Self-evaluation on visit necessity				0.664
Unnecessary	9 (5.4%)	6 (4.3%)	15 (4.9%)	
Necessary	159 (94.6%)	134 (95.7%)	293 (95.1%)	
Child				
Age (years)	4.0±2.5	3.2±2.4	3.6±2.5	**0.003**
Sex of child				0.720
Male	105 (52.0%)	99 (53.8%)	204 (52.9%)	
Female	97 (48.0%)	85 (46.2%)	182 (47.2%)	
Birth order				0.283
First	106 (52.5%)	86 (47.0%)	192 (49.9%)	
Second or later	96 (47.5%)	97 (53.0%)	193 (50.1%)	
Medical history				0.930
None	173 (85.6%)	157 (85.3%)	330 (85.5%)	
Yes	29 (14.4%)	27 (14.7%)	56 (14.5%)	
Enrolment in daycare or school				**0.013**
None	40 (19.8%)	55 (29.9%)	95 (24.6%)	
Daycare/kindergarten	120 (61.2%)	103 (56.6%)	223 (57.8%)	
School	42 (21.4%)	26 (14.3%)	68 (17.6%)	
Outcome				0.068
Home	202 (100%)	181 (98.4%)	383 (99.2%)	
Hospitalised	0 (0%)	3 (1.6%)	3 (0.8%)	

*P values were generated using a t-test or χ^2 test. P values indicating statistically significant difference (p<0.05) are shown in bold.

consultation group. This result remained significant even after adjusting for the background characteristics of the parents and children.

DISCUSSION

In this study, we investigated the association between the urgency of ED visits by parents of children under 8 years old and the use of the parent-oriented app 'Teach Me! Doctor' developed in Japan. We found that emergency visits were significantly more urgent when parents used the app.

It is natural for parents to feel concerned about the illnesses of their children. The most common reason for parents to visit hospitals for non-urgent conditions is the perceived urgency among parents.[1]

Parents are not experts, and it is difficult for them to judge the urgency of their child's condition. Previous studies have reported that parents' competency in

Table 2 Comparison of disease frequency between the urgent consultation group and the non-urgent consultation group

Diagnosis	Non-urgent consultation group n (%)	Urgent consultation group n (%)	Total n (%)	P value*
Upper respiratory tract infection (excluding influenza and COVID-19)	100 (49.5)	55 (29.9)	155 (40.2)	
Influenza	38 (18.8)	36 (19.6)	74 (19.2)	
Gastroenteritis/vomiting syndrome	18 (8.9)	31 (16.8)	49 (12.7)	
Bronchitis	8 (4.0)	17 (9.2)	25 (6.5)	
Rash	8 (4.0)	5 (2.7)	13 (3.4)	
COVID-19	7 (3.5)	6 (3.3)	13 (3.4)	
Pharyngitis	6 (3.0)	5 (2.7)	11 (2.8)	
Streptococcal infection	5 (2.5)	5 (2.8)	10 (2.6)	
Asthma	0 (0.0)	5 (2.9)	5 (1.3)	
Croup	0 (0.0)	4 (2.2)	4 (1.0)	
Head injury	3 (1.5)	0 (0.0)	3 (0.8)	
Otitis media	0 (0.0)	3 (1.6)	3 (0.8)	
Constipation	2 (1.0)	3 (1.6)	5 (1.3)	
Others	7 (3.5)	9 (4.8)	16 (4.1)	
Total	202 (100)	184 (100)	386 (100)	**<0.0001**

*P-value was generated using Fischer's exact test. P value indicating statistically significant difference (p<0.05) is shown in bold.

evaluating the severity of the disease of their children can be affected by their knowledge of diseases.[7] Therefore, tools that help parents judge the urgency of their child's symptoms will reassure them. A systematic review reported a link between higher emergency room visits and inadequate parental health literacy, highlighting the significance of providing parents with access to relevant educational materials.[16]

Other factors that contribute to non-urgent visits by parents include difficulties accessing primary care, a lack of advice, and inconvenient service hours, which are issues for the healthcare system.[3] The apps can be accessed 24 hours a day, and this may reduce such complaints.

The current increase in health information dissemination applications has brought attention to how these resources can be used to educate parents and possibly affect their health-related behaviours. In 2022, we conducted a study in Saku City and found an association between app use and parental health literacy.[12] However, it is unclear how app use is related to urgent emergency visit behaviour. This study is significant because it suggests that the proportion of people who make urgent

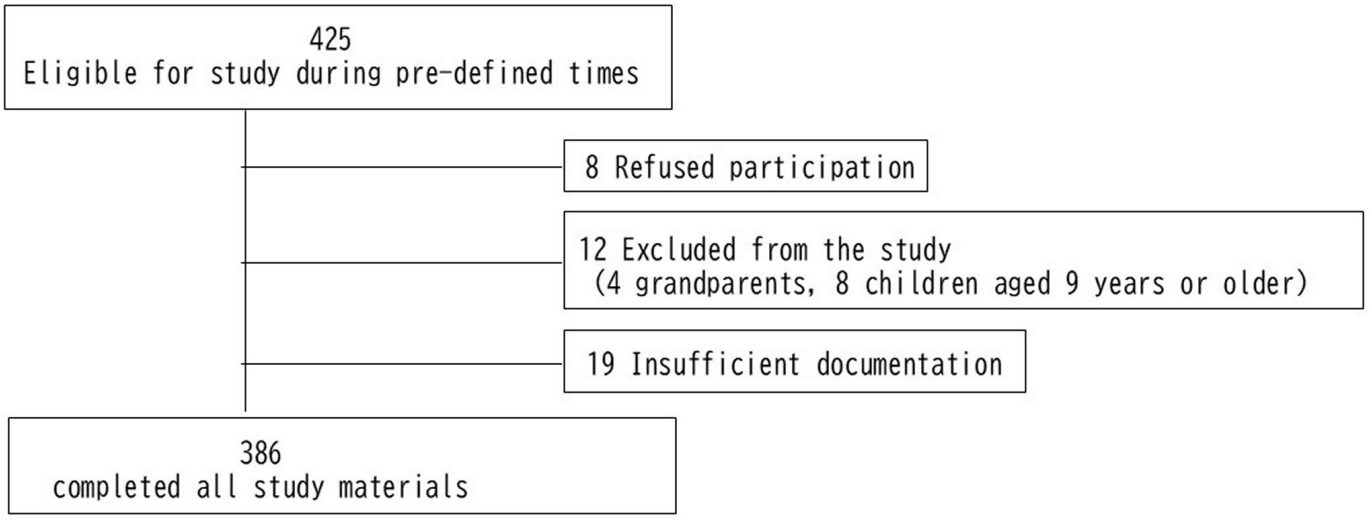

Figure 2 Flow diagram of the study. 386 valid participants were received from 425 eligible participants (response rate 91%).

Table 3 Association between urgency of emergency department visits and parental use of mobile applications (n=385)

	n	Urgent visit, n (%)	OR (95% CI)	P value	aOR* (95% CI)	P value
Application used	102	65 (63.7)	2.5 (1.5 to 3.9)	**<0.001**	2.8 (1.7 to 4.7)	**<0.001**
No application used	283	118 (41.7)	ref		ref	

P values indicating statistically significant differences (p<0.05) are shown in bold.
*Attributes of caregivers (age, relationship to the child (father/mother), education, economic status, healthcare worker status, residential area) and children (sex, age, birth order, status of childcare or school attendance and past medical history) were adjusted in the logistic regression analysis.
aOR, adjusted OR; CI, Confidence Interval; OR, Odds Ratio.

judgements to visit the emergency room is higher among those who use the app than among those who do not.

Additionally, the proportion of participants in the urgent consultation group who responded that they would recommend the app was significantly higher than that in the non-urgent consultation group, which remained significant even after adjusting for the background characteristics of parents and children. A positive attitude towards the app encourages its frequent use, which in turn leads to more urgent consultations. The positive elements of our app include that it displays guidelines for consultations in emergencies and has a built-in vaccination scheduler that makes it easy to keep track of when a child's vaccinations are scheduled. Bhandari *et al* reported that the design of an app can affect parents' first impressions of its quality and can also have a great impact on app downloads.[17] Similarly, we tried to design our app to be user-friendly and easy to understand so that people with low health literacy can use it. These features may encourage users to have a positive attitude towards the application and its frequent use.

There are many benefits to providing healthcare information to parents via mobile apps[18] but using apps can also lead to unintended consequences. For example, if the app's information leads to the judgement that a hospital visit is not necessary, parents may delay taking their children to the hospital, even though they should visit urgently. This risk may be particularly high when symptoms are temporarily under control. There may also be concerns that if parents depend too much on the app's judgement, their competency may decline in terms of observing and judging symptoms. It is important to recognise that the app is not a definitive judgement tool but rather a supplementary one. In addition, the content of the app also needs to be updated to reflect the latest medical findings. We update the evidence-based medical information every few months, but this process needs to be carried out as quickly and consistently as possible. Further research is needed regarding the impact of these unintended consequences.

We then considered the association between the urgent consultations and the background factors other than the app. The non-urgent consultation group had older children than the urgent consultation group, and this was significant even after adjusting for the background characteristics of the parents and children because illnesses in children typically manifest in younger age groups with more severe symptoms. Younger children are more likely to be recommended hospital visits and less likely to be judged as having non-urgent consultations. For example, respiratory diseases that are common in children, such as respiratory syncytial (RS) virus bronchiolitis and influenza, have more severe outcomes in younger children.[19]

Stevenson *et al* identified the key characteristics of patients with repeated emergency visits, including being an infant, enrolling in public insurance and having

Table 4 Association between the urgency of emergency outpatient visits and app evaluations among parents using the app (n=108)

Evaluation	n	Urgent visit, n (%)	OR (95% CI)	P value	aOR* (95% CI)	P value
Recommend	101	66 (65.4)	9.4 (1.1 to 83.9)	**0.017**	11.0 (1.1 to 110.1)	**0.041**
Do not recommend	6	1 (16.7)	Ref		Ref	
Felt reassured	97	61 (62.9)	1.4 (0.4 to 5.0)	0.59	1.3 (0.3 to 4.9)	0.694
Did not feel reassured	11	6 (54.5)	Ref		Ref	
Helpful for decision-making	94	60 (63.8)	1.8 (0.6 to 5.5)	0.32	1.5 (0.4 to 5.6)	0.529
Not helpful for decision-making	14	7 (50.0)	Ref		ref	

P values indicating statistically significant differences (p<0.05) are shown in bold.
*Attributes of caregivers (age, relationship to the child (father/mother), education, economic status, healthcare worker status, residential area) and children (sex, age, birth order, status of childcare or school attendance and medical history) were adjusted in the logistic regression analysis.
aOR, adjusted OR; CI, Confidence Interval; OR, Odds Ratio.

chronic conditions.[20] In our study, children with a medical history had a significantly higher rate of multiple visits to Weekend and Holiday Pediatric Medical Centers within the past 6 months compared with children without such a history (1.5 visits vs 1.3 visits; p<0.01). Children with chronic conditions are more susceptible to symptom exacerbation, and their associated family anxiety is higher. Consequently, emergency visits appear to serve as a crucial support mechanism for these families.

Previous studies have shown that the rate of emergency outpatient visits is higher for first-born children,[21] and increases as the parents' educational levels decrease.[22] Although these associations were not statistically significant in the present study, a similar trend was observed.

Limitations

This study had several limitations. First, because this was a cross-sectional study, causality cannot be discussed. Although we adjusted for environmental factors that were considered confounders in urgent emergency visits by parents using multivariate analysis, the influence of unknown confounding factors cannot be completely ruled out. Second, only one attending physician assessed whether the emergency visits were urgent, which could have influenced the outcomes with subjective judgement bias. The JTAS was used to ensure objectivity in these judgments, but it includes assessments of the patient's general condition and symptoms, so it is not possible to eliminate subjectivity.

Third, this study was conducted with parents who visited the Weekend and Holiday Pediatric Medical Center, a primary medical institution, and there were many patients with minor illnesses. Takahashi *et al* reported that the hospital admission rate for patients who visited the emergency room at tertiary medical facilities in Japan was 6.7%,[23] but the admission rate in this study was very low at 0.8%. As we do not have an ambulance service at this facility, we do not accept patients with serious conditions who require an ambulance. It is known that children's symptoms such as fever and asthma symptoms tend to worsen at night,[24 25] but our facility only accepts patients for consultation in the morning. These reasons may have affected the decrease in hospital admission rates. Therefore, the results of this study cannot be generalised to other medical institutions.

Fourth, increasing the frequency of app use is crucial to promote urgent visits to the ED. However, our app cannot track usage frequency. In a systematic review, Milne-Ives *et al* identified timely push notifications and reminders as contributing factors to behavioural changes in app users. They also reported that incorporating gamification and reward systems could effectively sustain user motivation.[26] Our app, however, is limited in these features. Enhancing the app with such elements in the future may increase the usage frequency.

Fifth, the study was conducted only in winter, from December to March. Paediatric illnesses often exhibit seasonality, and seasonal factors may influence the outcomes. However, winter is the period when EDs are most congested because of the prevalence of influenza and other seasonal illnesses. Therefore, evaluating this period is essential when considering measures to alleviate the burden on emergency services. Therefore, the selection of this season was deemed appropriate.

Sixth, in this study, parents were not included in the research team. As a result, the perspective of medical professionals was strongly reflected, and there is a possibility that the study design underestimated the anxiety of parents regarding the illness of their children.

Finally, this study only included cases in which parents took their children to the hospital by themselves; cases in which the children were taken by ambulance were excluded. Given that ambulance services in Japan are free of charge, the proper use of these services remains a significant issue. Future studies should include cases involving ambulance transportation.

Conclusions

This study demonstrated a significant association between parental use of healthcare information apps and urgent utilisation of emergency outpatient services. The use of these apps may enhance parental health literacy and contribute to more urgent use of emergency services. Future studies should include emergency transportation cases in their evaluation.

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