

Epidemiology of pediatric visits to the emergency department due to foreign body injuries in South Korea

Nationwide cross-sectional study

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Abstract

Foreign body (FB) injuries mainly occur in young children and may cause serious complications. The purpose of this study was to describe the epidemiological and clinical characteristics of FB injuries among children visiting the emergency department (ED) in South Korea and to compare the incidence and the ED results of FB injuries.

Using data from the National Emergency Department Information System, FB injury-related ED visits among children (<7 years) between January 2010 and December 2014 were included. Epidemiological characteristics were analyzed in different age groups, and metropolises were compared with provinces regarding the incidence of ED visits, admission, and transfer of patients with FB injuries.

In total, 51,406 pediatric patients with FB injuries visited 118 EDs over 5 years, and the annual incidence of FB injuries among children increased throughout the study period (215.1–436.5 per 100,000 population [<7 years], *P* for trend <.001). The most common anatomical site of the FB injury was the nose (18,479; 36.0%), followed by the pharynx (10,285; 20.0%). The most common age of patients was 1 year for alimentary tract, 2 years for nose, 1 year for respiratory tract, and 4 years for ear FB injuries. The overall admission rate was 1.8%, and the ICU admission rate was 0.04%. Four deaths occurred, and all of them were caused by respiratory FB injuries. The incidence of transfer of patients with FB injuries to other hospitals was higher in provinces than in metropolises.

The incidence of FB injury-related ED visits among children younger than 7 years old in South Korea has been high and has been increasing recently. In particular, the incidence of FB injuries of the alimentary and respiratory tracts was high, especially around the age of 1. Preventive measures should be taken to decrease FB injuries among young children in South Korea.

Abbreviations: ED = emergency department, EMS = emergency medical service, ESFBI = European Survey on Foreign Body Injuries, FB = foreign body, ICD-10 = International Classification of Diseases 10th, ICU = intensive care unit, KCD-6 = Korean Standard Classification of Diseases 6th Revision, NEDIS = National Emergency Department Information System, SPTF = small part test fixture.

Keywords: child, epidemiology, foreign bodies, pediatric emergency department, pediatric emergency medicine

1. Introduction

Foreign body (FB) injuries occur primarily in young children, who are intensely curious. Although most FBs in the ears and

nose can be easily removed, alimentary or respiratory FB injuries can have a fatal outcome. According to US statistics, 30 children per 100,000 people visit the emergency department (ED) with alimentary or respiratory FB injuries every year.^[1] If the diagnosis or treatment of a FB injury is delayed, subsequent serious complications, such as pneumonia or esophageal perforation, may lead to a longer hospital stay.^[2,3]

To improve clinical management of children with FB injuries and to develop strategies for prevention of pediatric FB injuries, it is crucial to understand the epidemiological characteristics of pediatric FB injuries.^[4] In South Korea, there are only a few reports on pediatric FB injuries, and these reports usually involve single-center studies.^[5,6] Additionally, there are no nationwide reports regarding pediatric patients with FB injuries visiting the ED. The purpose of this study was to investigate the epidemiological characteristics of children with FB injuries visiting the EDs in South Korea.

2. Methods

2.1. Study design and patients

This retrospective cohort study used data from the National Emergency Department Information System (NEDIS)

Editor: Shih-Min Wang.

The authors have no conflicts of interest to disclose.

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Medicine (2019) 98:22(e15838)

Received: 4 December 2018 / Received in final form: 1 April 2019 / Accepted: 3 May 2019

<http://dx.doi.org/10.1097/MD.00000000000015838>

in South Korea that were collected over a 5-year period of time from January 2010 to December 2014. We included patients with FB injuries who were <7 years old from 118 emergency centers in South Korea. The FB injuries were defined according to the Korean Standard Classification of Diseases 6th Revision (KCD-6), which is similar to the International Classification of Diseases 10th Revision (ICD-10).^[7,8] Cases with KCD-6 classifications of “FB in ear (T16),” “FB in respiratory tract (T17),” “FB in alimentary tract (T18),” “Inhalation and ingestion of food causing obstruction of respiratory tract (W79),” or “Inhalation and ingestion of other objects causing obstruction of respiratory tract (W80)” were selected as the study population.

2.2. Status of the NEDIS

The NEDIS collects information on the patients who visit EDs in South Korea in real time. The information system was released in June 2003, and data from >130 emergency medical centers in South Korea have been collected. At the end of December 2014, data from approximately 5,450,000 ED visits from 146 emergency medical centers, including all regional, specialized, and local emergency medical centers, had been collected and was being managed by the NEDIS.^[9] We used the data from only 118 emergency medical centers that registered the data during the study period without missing a year.

2.3. Data and variables

The analyzed variables included information regarding the patients' age, sex, anatomical site of injury, region of emergency medical center, route of ED entry, use of an ambulance, dates and times of the ED admission and discharge, ED disposition, length of hospitalization, and mortality. This study focused on children younger than 7 years old. To investigate the characteristics of FB injuries according to the children's developmental stages, they were divided into the following age groups: <1 year old (infant), 1 to 2 years old (toddler), 3 to 4 years old (early preschooler), and 5 to 6 years old (preschooler). The data regarding anatomical locations of the FB injury were collected from detailed diagnoses using KCD-6 classifications.^[8] The FB locations were classified as ear, respiratory tract, and alimentary tract. The respiratory tract was further divided into nose, pharynx, larynx, trachea, bronchus, and others, and the alimentary tract was further divided into mouth, esophagus, stomach, small intestine, colon, rectum, anus, and others. The KCD-6 combines FBs in the nose with FBs in the respiratory tract; however, in this study, FBs in the nose were separated from those in the respiratory tract because the entry of nasal FBs is different from that of other respiratory tract FBs. For alimentary tract FBs, the rectum and anus were grouped together. The regions of the emergency medical centers were classified into metropolises and provinces. The routes of admission to the ED were divided into direct visit, transferred, referred from an outpatient clinic, others, and unknown. The modes of transportation were classified into ambulance and non-ambulance. We also obtained data regarding the length of hospitalization. The ED visit times were divided into the following 2 groups: after hours and working hours. The ED disposition was classified as discharge, transfer, admission to ward, admission to intensive care unit (ICU), death, other, or unknown. We also obtained data regarding the length of hospitalization and mortality.

2.4. Outcomes

The primary outcome was the annual incidence of FB injuries among children visiting EDs in South Korea. The secondary outcome was the anatomical site of FB injuries according to age group and the rate of admission, transfer (in and out), and regional distribution of FB injuries.

2.5. Statistical analysis

Data were analyzed using STATA version 14.2 (StataCorp LP, College Station, TX). The annual incidence of FB injuries was defined as the number of FB injuries per 100,000 population (persons younger than 7 years). The resident population was based on the 2010 population data. The chi-square test was used to analyze the trend in the overall incidence by year. The continuous variables are presented as medians and interquartile ranges (IQRs, 25th and 75th percentiles). The categorical variables are presented as frequencies and proportions. For the descriptive variables, we calculated the number of observations in each outcome group and tested for significant differences between the groups with chi-square tests. For almost non-normally distributed continuous variables, we used the Wilcoxon rank sum test to identify significant differences between the outcome groups. $P < .05$ was considered statistically significant.

2.6. Ethics statement

The Institutional Review Board of Seoul Metropolitan Government Seoul National University (SMG-SNU) Boramae Medical Center waived the review of the present study.

3. Results

3.1. Demographics and clinical characteristics of patients with FB injuries

A total of 1,124,693 injured patients younger than 7 years old from 118 emergency centers in South Korea were registered in the NEDIS from 2010 to 2014. Among them, 51,406 (4.6%) patients were categorized as having FB injuries.

The annual incidence of FB injuries among children increased from 215.1 (2010), 266.1 (2011), 349.1 (2012), 390.3 (2013), to 436.5 (2014) per 100,000 population (age <7 years) throughout the study period (P for trend <.001) (Fig. 1).

The clinical characteristics of patients with FB injuries are presented in Table 1. The median age was 2 years (IQR 1–4), and 26,401 (51.4%) FB injuries occurred at age ≤ 2 years. The most common anatomical FB location was the nose (18,479; 36.0%), followed by the pharynx (10,285; 20.0%). After the ED treatments, most patients were discharged (50,158; 97.6%), 927 (1.8%) were hospitalized, and 1 (0.0%) patient died in the ED. The median length of hospitalization was 2 (IQR 2–4) days. Three children died after admission/during hospitalization (Table 1).

The median age of hospitalized patients was 1 year (IQR 1–3), and there were 583 boys (62.9%). With the exception of unspecified FB injury, stomach FB injury was the most common (182; 20.1%) injury, followed by esophageal FB injury (159; 17.6%), among the patients admitted to the general ward. Among the ICU patients, bronchial FB injuries were the most common (11; 47.8%), followed by tracheal FB injuries (4; 17.4%).

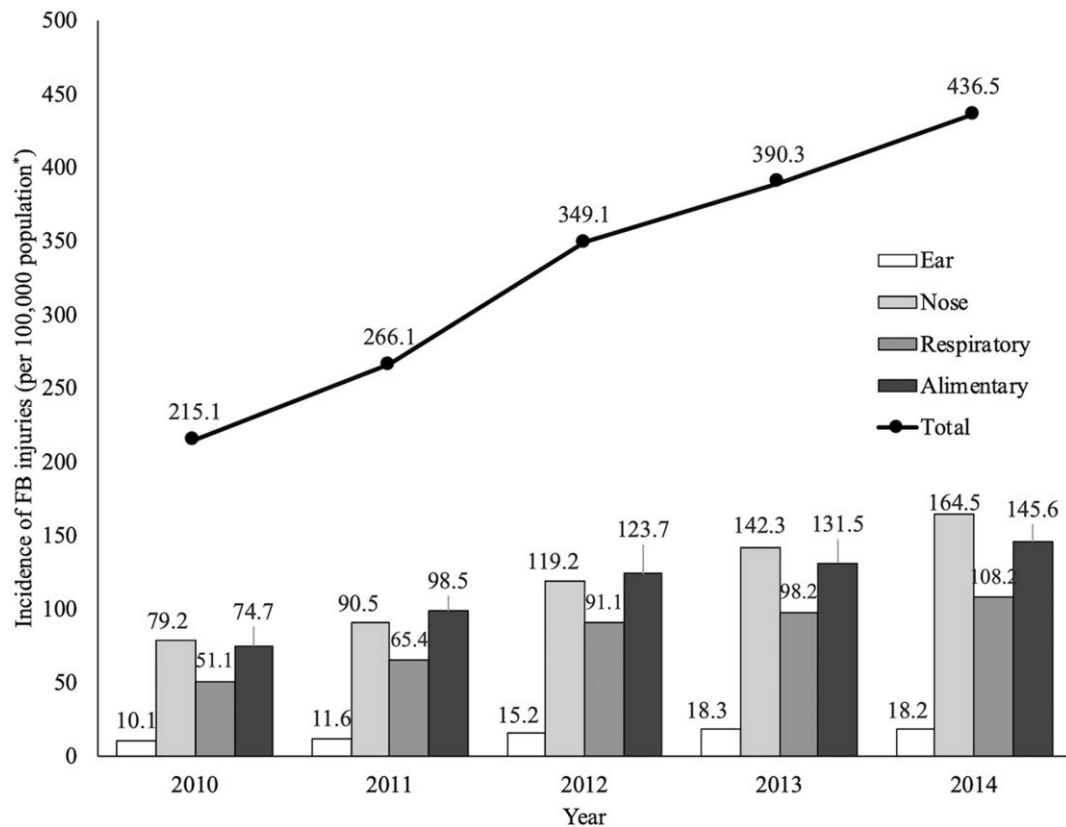


Figure 1. Annual incidence of foreign body injuries (per 100,000 population). * Resident population as of 2010 (<7 years old).

3.2. Characteristics of FB injuries according to age group

The clinical characteristics of FB injuries according to the pre-defined age groups are presented in Table 1. The incidence of FB injuries by age is plotted in Fig. 2. The incidence of FB injury to the alimentary system was highest at 0 to 1 year of age, followed by a rapid decrease, and the incidence of nasal FB injury was 2 to 3-fold higher than that in the 2 to 3-year age group. The incidence of respiratory FB injury was highest at 1 to 4 years and decreased thereafter. The incidence of ear injury was highest at 4 years and then decreased (Fig. 2). The mean ages of FB injuries were as follows: ear FB injuries, 3.7 years; nose, 2.7 years; alimentary system, 2.2 years; and respiratory system, 2.9 years.

The hospital admission rate was highest in patients aged 1 year or younger and decreased thereafter. All of the patients admitted to the intensive care unit (ICU) were younger than 2 years (Table 1). During the study period, 4 patients with FB injuries died, and all 4 children were under 2 years of age. The patients who died were a 1-month-old boy, a 2-month-old girl, a 1-year-old boy, and a 2-year-old girl, and all of them suffered from respiratory FB injuries. The details of the 4 mortality cases are presented in Table 2.

3.3. Characteristics of FB injuries according to regional distribution

The incidence of ED visits, admission, and transfer for FB injuries according to regional distribution are presented in Table 3. Compared with that in metropolitan/large cities, the incidences of

ED visits and admissions were lower but the incidence of transfer out to other hospitals was higher in provinces.

4. Discussion

This study is the first nationwide epidemiological report of pediatric FB injuries in South Korea. Despite the declining pediatric population, the number of patients with FB injuries (ear, nose, alimentary tract, and respiratory tract) visiting the ED has doubled in the last 5 years in South Korea. Most of the patients were discharged from the ED; however, during the 5 years of this study, there were 4 fatal outcomes among patients with airway FBs.

The incidence of FB injury was high in South Korea compared with the data reported in some countries.^[8–10] According to data released by the American Association of Poison Control Centers in the United States, there were 110,000 FB injuries in 2011, >85% of which occurred in children.^[10,11] Based on the European RPA (Risk & Policy Analysts Ltd.) report, the annual estimates of FB injuries among children aged 0 to 14 years in the EU were approximately 50,000, 10% of which were fatal.^[12] The incidence of nonfatal choking-related ED visits involving food among US children (0–14 years) was 20.4 people per 100,000 population, and the hospitalization rate was 10%.^[13]

The most common anatomical locations of FB injuries differed according to age. The mean ages of children with various FB injuries were as follows: ear FB injuries, 3.7 years; nose, 2.7 years; alimentary system, 2.2 years; and respiratory system, 2.9 years. A report on FB injuries in a pediatric ED in Italy indicated the

Table 1
The clinical characteristics of foreign body injuries in children younger than 7 years old by age group.

Characteristics	Total		Age groups in years							
			<1		1–2		3–4		5–6	
Total number of visits, No. (%)	51,406	(100.0)	5376	(10.5)	21,025	(40.9)	17,350	(33.8)	7655	(14.9)
Sex (boys), No. (%)	27,693	(53.9)	2684	(49.9)	10,732	(51.0)	9683	(55.8)	4594	(60.0)
Anatomical site, No. (%)										
Ear	2,277	(4.4)	43	(0.8)	443	(2.1)	1044	(6.0)	747	(9.8)
Nose	18,479	(36.0)	37	(0.7)	9345	(44.5)	7899	(45.5)	1198	(15.7)
Respiratory system										
Pharynx	10,285	(20.0)	945	(17.6)	3275	(15.6)	3494	(20.1)	2571	(33.6)
Larynx	1428	(2.8)	144	(2.7)	430	(2.1)	470	(2.7)	384	(5.0)
Trachea	139	(0.3)	35	(0.7)	64	(0.3)	25	(0.1)	15	(0.2)
Bronchus	210	(0.4)	53	(1.0)	119	(0.6)	26	(0.2)	12	(0.2)
Others or unspecified	781	(1.5)	158	(2.9)	347	(1.7)	195	(1.1)	81	(1.1)
Alimentary system										
Mouth	1386	(2.7)	296	(5.5)	547	(2.6)	319	(1.8)	224	(2.9)
Esophagus	4030	(7.8)	704	(13.1)	1449	(6.9)	1101	(6.4)	776	(10.1)
Stomach	3570	(6.9)	870	(16.2)	1469	(7.0)	794	(4.6)	437	(5.7)
Small intestine	298	(0.6)	45	(0.8)	125	(0.6)	80	(0.5)	48	(0.6)
Colon	144	(0.3)	19	(0.4)	72	(0.3)	27	(0.2)	26	(0.3)
Rectum and anus	47	(0.1)	13	(0.2)	10	(0.1)	13	(0.1)	11	(0.1)
Others or unspecified	8332	(16.2)	2014	(37.5)	3330	(15.8)	1863	(10.7)	1125	(14.7)
Region of emergency medical center, No. (%)										
Metropolis	23,952	(46.6)	2509	(46.7)	9880	(47.0)	8084	(46.6)	3479	(45.5)
Province	27,454	(53.4)	2867	(53.3)	11,145	(53.0)	9266	(53.4)	4176	(54.6)
Route of ED entry, No. (%)										
Direct visit	48,499	(94.4)	4983	(92.7)	19,762	(94.0)	16,512	(95.2)	7242	(94.6)
Transfer in	2787	(5.4)	379	(7.1)	1218	(5.8)	802	(4.6)	388	(5.1)
Referred from an outpatient clinic	87	(0.2)	10	(0.2)	31	(0.2)	28	(0.2)	18	(0.2)
Others or unknown	33	(0.1)	4	(0.1)	14	(0.1)	8	(0.1)	7	(0.1)
Use of an ambulance,* No. (%)	2,908	(5.7)	880	(16.4)	1146	(5.5)	631	(3.6)	251	(3.3)
Time of ED visit "after hours" [†] , No. (%)	45,495	(88.5)	3928	(73.1)	18,531	(88.1)	16,063	(92.6)	6973	(91.1)
ED disposition, No. (%)										
Discharge	50,158	(97.6)	5132	(95.5)	20,442	(97.2)	17,050	(98.3)	7534	(98.4)
Transfer	247	(0.5)	52	(1.0)	114	(0.5)	53	(0.3)	28	(0.4)
Admission (ward)	904	(1.8)	171	(3.2)	429	(2.0)	220	(1.3)	84	(1.1)
Admission (ICU)	23	(0.0)	5	(0.1)	18	(0.1)	0	(0.0)	0	(0.0)
Death	1	(0.0)	1	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Others or unknown	73	(0.1)	15	(0.3)	22	(0.1)	27	(0.2)	9	(0.1)
Length of hospitalization, d, median (IQR)	2	(2–4)	3	(2–4)	3	(2–4)	2	(2–3)	2	(2–3)
Mortality [‡] , No. (%)	4	(0.0)	2	(0.0)	2	(0.0)	0	(0.0)	0	(0.0)

ED=emergency department, ICU=intensive care unit, IQR=interquartile range, LOS=length of stay.

* Ambulance: 119 ambulance, hospital ambulance, private ambulance, or air transport.

[†] After hours: off time (18:00–next day 08:59) or holiday.

[‡] Mortality: death in the ED or during the hospitalization.

following mean patient ages: ear injuries, 5.4 years; nose, 3.8 years; pharynx, 5.5 years; trachea/bronchus/lung, 2.8 years; and mouth/esophagus/stomach, 2.6 years.^[14] Commonly, alimentary tract FB injuries occurred at the youngest age, and ear FB injuries occurred in children over 3 years of age.^[14] According to a report by the European Survey on Foreign Body Injuries (ESFBI), the mean age of pediatric patients with FB injuries in the ear was 6 (± 3.2), and the prevalence was higher in the group under 5 years old.^[15] Compared with the Italian and Europe reports,^[14,15] our study showed that ear and nose FB injury-related ED visits tend to occur at a younger age. Although there was no analysis of FB materials in this study, other studies have reported that beads, stationeries, foods, and nuts are common.^[14,15] Based on these results, it is necessary to educate parents and guardians on the ages at which children are more prone to suffer FB injuries.

In this study, the most common site of FB injuries was the nose (36.0%), followed by the pharynx (20.0%), esophagus (7.8%), and stomach (6.9%). The EU and other countries have built a "Susy Safe registry" and are collecting information on FB-related injuries. The analysis of Susy Safe registry data revealed that 74% of the injuries in patients under 14 years old were caused by non-food items (22%, pearls/balls/stones; 20%, coins; and 8%, others), as well as that 37% of the injuries occurred in the nose, 29% in the mouth/esophagus/stomach, 24% in the ears, and 4% in the trachea/bronchus/lung.^[16] Food FB injury accounted for 26% of cases, including bone (32%), nuts (22%), and others (21%). Of these cases, 50% of the FBs entered the organ/bronchus/lung, 19% entered the nose, 16% entered the pharynx/larynx, and 8% entered the mouth/esophagus/stomach.^[17] As shown in previous studies, most of the FB injuries in our study were not critical; however, there

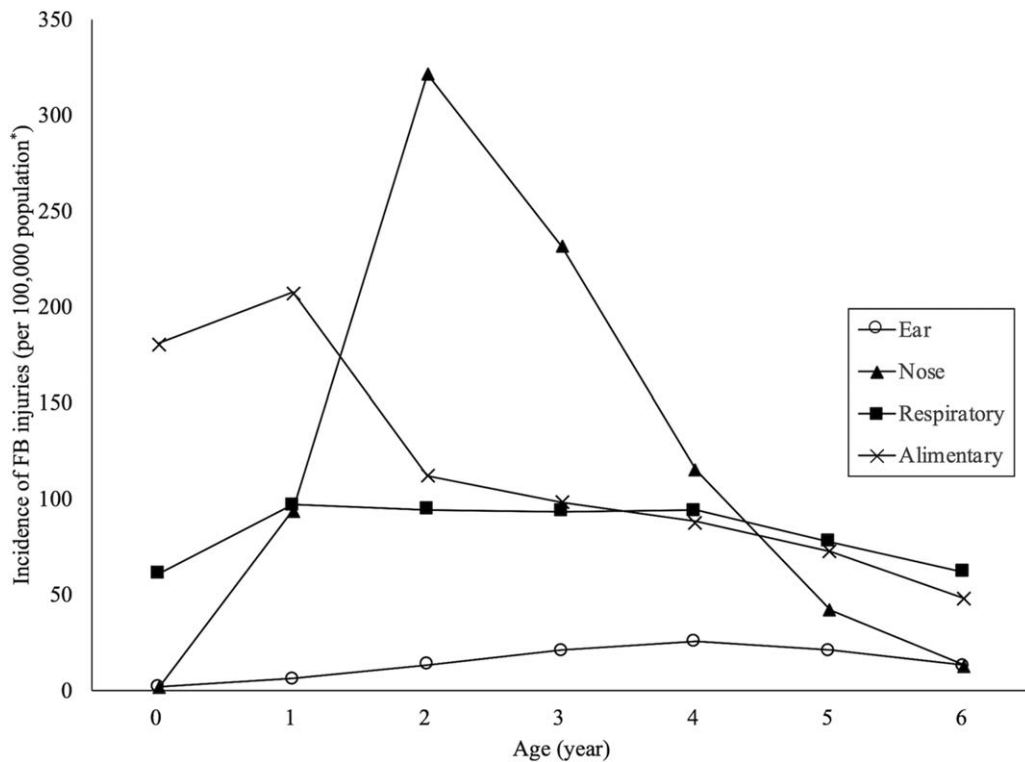


Figure 2. Incidence of foreign body injuries by age and anatomical site. * Resident population at each age as of 2010.

Table 2

Summary of 4 mortality cases of foreign body injuries in children younger than 7 years old.

	Mortality cases			
	Case 1	Case 2	Case 3	Case 4
Age	1 mo	2 mos	1 y	2 yrs
Sex	Female	Female	Male	Female
Anatomical site	Respiratory tract, unspecified	Respiratory tract, unspecified	Trachea	Bronchus
Location of ED	Metropolis	Province	Province	Metropolis
Route of entry	Direct visit via 119 ambulance	Direct visit via 119 ambulance	Direct visit via other car	Transferred via hospital ambulance
Chief complaint	Decreased mentality	Cyanosis	No response	Acute dyspnea
Onset to visit, min	10	152	118	413
Initial consciousness (AVPU)	U	U	U	A
Type of emergency center	Regional	Regional	Local	Regional
ED disposition	CA at ED admission and death after CPR in ED	ICU	ICU	OR, then ICU
Complications during hospitalization		Pneumonia, DIC, CA	Hemorrhage from respiratory tract, acute pulmonary edema, CA	Pneumonia, CA
Hospitalization period, day		3	4	43

AVPU = alert, verbal response, painful response, unresponsive, CA = cardiac arrest, CPR = cardiopulmonary resuscitation, DIC = disseminated intravascular coagulation, ED = emergency department, ICU = intensive care unit, OR = operating room.

were 4 deaths, and all the deaths occurred in patients with airway FB injuries.^[18,19] The prevention of pediatric injuries is important, and there have been many efforts to prevent injuries in children and adolescents.^[20] Some studies found that many parents were unaware of appropriate prevention strategies, particularly for asphyxia.^[21] In addition, a study showed that asphyxia in younger children is significantly associated with a lack of caregiver knowledge.^[22] Therefore, social efforts, such

as caregiver education, are important for the prevention of FB injuries. The results of this study also emphasize the importance and necessity of the prevention of pediatric FB injuries. It is also possible to consider prevention counselling performed by health care providers in some developed countries.^[23]

Despite the high incidence of FB injury in South Korea, there is a lack of effort to collect systematic data on FB and to promote publicity and campaigns to prevent FB-related injuries. It is

Table 3**Incidence of emergency department visits, admission and transfer for foreign body injuries in patients younger than 7 years old by regional distribution.**

	ED region [‡]			
	Metropolis /large city		Province/Rural area	
	No.	Rate [§]	No.	Rate [§]
Resident population*	1,324,985		1,777,252	
ED visit [†]	4,790	361.5	5,491	309.0
Admission [†]	98	7.4	87	4.9
Transfer in [†]	257	19.4	301	16.9
Transfer out [†]	17	1.3	32	1.8

* Resident population as of 2010 (<7 years old).

† Average value from 2010 to 2014.

‡ The ED regions were classified into 7 metropolitan areas and 9 provinces based on the administrative boundaries in the year 2010.

§ Per 100,000 population (<7 years old).

necessary to establish a data collection system for the high frequency of FB injuries, identify the specific materials constituting the FBs, and determine the specific risk group according to age and sex. In the United States, data are collected through poison control centers or the National Electronic Injury Surveillance System to monitor FB injuries.^[10,24] Small Parts Test Fixture (SPTF) is a device that can assess whether the size of an object poses a risk to toddlers. SPTF is available in some developed countries, but it has not yet been introduced in South Korea.^[25] Before its introduction and utilization, it is necessary to ascertain whether it is an appropriate tool to prevent FB injuries in South Korea.

In infants and young children, the treatment of FB injuries to the alimentary or respiratory tract is often difficult in small- and medium-sized hospitals. In some regions, due to limited resources, it may not be possible to provide appropriate treatment for FB injuries. Therefore, it is necessary to understand the ability of medical institutions to treat FB injuries. In this study, we analyzed the incidence, hospitalization rate, and transfer rate associated with FB injuries according to the regional distribution. As expected, the incidence of transfer of patients with FB injuries to other hospitals was higher in the provinces than in the metropolises.

This study has several limitations. First, the characteristics of the pediatric patients with FB injuries were analyzed based only on the pre-registered items in the NEDIS. Therefore, other potentially important data, such as the type and shape of the FB, were not available. Second, although a nationwide database was used, not all EDs in South Korea were included. However, even if small emergency room data are not included, data from emergency medical institutions of a certain size or larger are included, and it is presumed that patients usually visit NEDIS-registered emergency rooms due to the nature of FB treatment, which requires an otorhinolaryngologist. Therefore, we consider our data to be reasonably representative of the pediatric FB injuries in South Korea. Important data regarding patient management, such as endoscopy or bronchoscopy, were not available from the NEDIS dataset. Thus, along with multi-institutional studies, in-depth studies that consider all types of treatments should be conducted in the future.

In conclusion, the incidence of FB injury-related ED visits among children younger than 7 years old in South Korea was high and has been increasing recently. In particular, the incidence of FB injuries of the alimentary tract and respiratory system was

high around the age of 1. Preventive measures should be taken to decrease the incidence of FB injuries among young children in South Korea.

Author contributions

Conceptualization: Joong Wan Park, Jin Hee Jung.

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Writing - Review & Editing: Joong Wan Park, Jin Hee Jung, Young Ho Kwak, Jae Yun Jung.

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