Retrospective Cohort Study

Accidental ingestion of foreign bodies/harmful materials in children from Bahrain: A retrospective cohort study

Isa HM et al. Accidental ingestion in children
Abstract

BACKGROUND
Children like to discover their environment by putting substances in their mouths. This behavior puts them at risk of accidentally ingesting foreign bodies (FBs) or harmful materials, which can cause serious morbidities.

AIM
To study the clinical characteristics, diagnosis, complications, management, and outcomes of children with accidental ingestion of FB, caustics, and medications.

METHODS
We conducted a retrospective cohort study of all children admitted for accidental ingestion to the Department of Pediatric, Salmaniya Medical Complex, Bahrain, between 2011 and 2021. Demographic data, type of FB/harmful material ingested, and investigations used for diagnosis and management were recorded. The patients were divided into three groups based on the type of ingested material (FB, caustics, and medications). The three groups were compared based on patient demographics, socioeconomic status (SES), symptoms, ingestion scenario, endoscopic and surgical complications, management, and outcomes. The FB anatomical location was categorized as esophagus, stomach, and bowel and compared with respect to symptoms. The Fisher’s exact, Pearson’s $\chi^2$, Mann-Whitney $U$, and Kruskal-Wallis tests were used for comparison.

RESULTS
A total of 161 accidental ingestion episodes were documented in 153 children. Most children were boys ($n = 85, 55.6\%$), with a median age of 2.8 (interquartile range = 1.8-4.4) years. Most participants ingested FBs ($n = 108, 70.6\%$), 31 (20.3\%) ingested caustics, and the remaining 14 (9.2\%) ingested medications. Patients with caustic ingestion were younger at the time of presentation ($P < 0.001$) and were more symptomatic ($n = 26/31$, $P < 0.001$).
89.7%) than those who ingested medications \( (n = 8/14, 57.1\%) \) or FBs \( (n = 52/108, 48.6\%) \) \( (P < 0.001) \). The caustic group had more vomiting \( (P < 0.001) \) and coughing \( (P = 0.029) \) than the other groups. Most FB ingestions were asymptomatic \( (n = 55/108, 51.4\%) \). In terms of FB location, most esophageal FBs were symptomatic \( (n = 14/16, 87.5\%) \), whereas most gastric \( (n = 34/56, 60.7\%) \) and intestinal FBs \( (n = 19/32, 59.4\%) \) were asymptomatic \( (P = 0.002) \). Battery ingestion was the most common \( (n = 49, 32\%) \). Unsafe toys were the main source of batteries \( (n = 22/43, 51.2\%) \). Most episodes occurred while playing \( (n = 49/131, 37.4\%) \) or when they were unwitnessed \( (n = 78, 57.4\%) \). FBs were ingested more while playing \( (P < 0.001) \), caustic ingestion was mainly due to unsafe storage \( (P < 0.001) \), and medication ingestion was mostly due to a missing object \( (P < 0.001) \). Girls ingested more jewelry items than boys \( (P = 0.006) \). The stomach was the common location of FB lodgment, both radiologically \( (n = 54/123, 43.9\%) \) and endoscopically \( (n = 31/91, 34\%) \). Of 107/108 (99.1%) patients with FB ingestion, spontaneous passage was noted in 54 (35.5%), endoscopic removal in 46 (30.3%), laparotomy in 5 (3.3%) after magnet ingestion, and direct laryngoscopy in 2 (1.3%). Pharmacological therapy was required for 105 (70.9%) patients; 79/105 (75.2%) in FBs, 22/29 (75.9%) in caustics, and 4/14 (28.8%) in medications’ groups \( (P = 0.001) \). Omeprazole was the commonly used \( (n = 58; 37.9\%) \) and was used more in caustic \( (n = 19/28, 67.9\%) \) than that in other groups \( (P = 0.001) \). Endoscopic and surgical complications were detected in 39/148 (26.4%) patients. The caustics group had more complications than the other groups \( (P = 0.036) \). Gastrointestinal perforation developed in the FB group only \( (n = 5, 3.4\%) \) and was more with magnet ingestion \( (n = 4) \) than with other FBs \( (P < 0.001) \). In patients with FB ingestion, patients aged < 1 year \( (P = 0.042) \), those with middle or low SES \( (P = 0.028) \), and those with more symptoms at presentation \( (P = 0.027) \) had more complications. Patients with complications had longer hospital stays \( (P < 0.001) \) than those without.

CONCLUSION
Accidental ingestion in children is a serious condition. Symptomatic infants from middle or low SES families had the highest morbidity. Prevention through parental education and government legislation is crucial.

Key Words: Pediatric; Accidental ingestion; Foreign body; Caustic; Complication; Bahrain


Core Tip: Foreign body (FB) or harmful material ingestion is common in pediatric patients. These accidents occur more frequently among boys. Toddlers are at a higher risk of accidental ingestion because of their exploratory behavior. Batteries are the most commonly ingested FBs. Many ingestion incidents have occurred while playing and because of unsafe storage. The stomach is the most common anatomical location of FB loosening on radiography and endoscopy. Caregiver education regarding preventive methods and governmental execution of safe manufacturing of toys, magnets, and batteries is essential to prevent FB ingestion and the complications that might occur.

INTRODUCTION
Children like to discover their environment by putting substances into their mouth\textsuperscript{[1]}. Accidental ingestion of foreign bodies (FBs) or caustic materials is a common problem encountered by families with children. It is considered as one of the most common indications for emergency referral and hospital admission. There are diverse types of FBs or ingested materials that can be swallowed by children. Coins, toy parts, jewelry, button-type batteries, needles, and pins are the most frequently ingested materials\textsuperscript{[1]}.

Most ingested FBs pass spontaneously, and patients can be safely observed\textsuperscript{[2]}. Although most ingestion incidents are insignificant in terms of consequences, a few can
pose a challenging problem that may lead to serious life-threatening complications[2]. For example, numerous magnetic objects located at various sites in the bowel can attract one another, leading to pressure necrosis of the bowel wall and eventual perforation[1]. Furthermore, although batteries can pass easily through the digestive tract and are eliminated from the stool within a few days of ingestion, swallowing batteries is more dangerous than swallowing coins or other inert objects because of their electrochemical composition and high risk of local damage[3]. Moreover, batteries 20 mm or larger in size can affect the esophagus, especially in young children[3]. Strong exothermic reactions can lead to serious mucosal injuries that may appear as skin burns[3]. Caustic ingestion is also common in pediatric age groups, and most cases happen accidentally[4]. The seriousness of this ingestion is due to the tissue injury and necrosis[4]. Tissue damage can start from the mucosa and extend to the muscular layers, causing multiple complications, such as burns, strictures, and perforations[4].

Prompt diagnosis of accidental ingestion, appropriate management, and a decision on whether the patient necessitates intervention are crucial for reducing morbidity[2]. The type of FB, anatomic location in which the FB is lodged, and clinical picture of the patient determine the timing of endoscopic removal of the swallowed FB[2,3]. In children with caustic ingestion, postoperative treatment remains controversial and includes entities, such as antireflux therapy, antibiotic therapy, steroids, and interventions, such as esophageal stenting[3]. Nonetheless, the implementation of preventive methods and safe storage of caustic materials is essential to avoid these accidents and their related consequences[4].

Although many studies on accidental ingestion in children have been published in several countries, no studies have been published on this issue in Bahrain. The aim of this study was to review the incidence, demographics, different types of FB/harmful materials, diagnostic modalities, complications, and outcomes of accidental ingestion in a pediatric age group and compare patients with endoscopic or surgical complications with those without complications to identify the predicted risk factors.
MATERIALS AND METHODS

Study design, setting, and population
In this retrospective cohort study, all pediatric patients (aged < 18 years) who presented to the Department of Accident and Emergency with a history of accidental ingestion and were admitted to the Department of Pediatric, Salmaniya Medical Complex, Bahrain, from January, 2011 to August, 2021, were included. Patients who presented to the Department of Accident and Emergency and were subsequently discharged were excluded.

Data collection
Patient data were collected by reviewing electronic and paper-based medical records. Important missing data were retrieved through direct contact with the patients' parents or guardians via telephone. Demographic data, including year of admission, nationality, sex, age at presentation, and age at the time of the study, were collected. Data on families’ socioeconomic status (SES) were collected, including paternal and maternal educational levels, occupation, number of children, and total family income. Accordingly, families were categorized into low-, middle-, and high-SES groups. Data on symptoms at presentation, including vomiting, abdominal pain, passing tarry stool, choking, dysphagia, drooling of saliva, shortness of breath, and coughing, were collected. Details related to accidental ingestion of FB, including the type, number, and source of FB, were collected. Additionally, the presence of witnesses at the time of accidental ingestion, time to presentation to the Department of Accident and Emergency, and spontaneous passage times were outlined. More details regarding the type of battery were collected from the patients who ingested batteries.

Radiological imaging findings, endoscopic findings, and extraction methods were also reviewed. Urgent endoscopy was considered if it was performed within 48 h of ingestion, whereas a longer time was considered a delayed endoscopy. Data on the patients’ hospital management, including endoscopic removal and the use of medications, such as lactulose, enema, glycerin suppositories, and omeprazole, were
gathered. Furthermore, data on patient outcomes, including length of stay, morbidity, mortality, and follow-up period, were assessed.

**Statistical analysis**

Patient data were initially collected and entered into an Excel sheet and then transferred to and analyzed using the Statistical Package for the Social Sciences Statistics ver. 21.0 (IBM Corp., Armonk, NY, United States). Categorical variables were presented as numbers and percentages. Continuous variables were presented as mean and standard deviation or median and interquartile range (IQR), according to distribution normality using the Shapiro-Wilk test. To assess the trend of accidental ingestion episodes over the last 10-year period, the duration was divided into two periods of 5 years each (2012-2016 and 2017-2021), and the incidence of ingestion in both periods was compared. The incidence was calculated as the number of patients with accidental ingestion per year divided by the total pediatric population (less than 18 years), obtained from the Bahrain Health Statistics website (https://www.moh.gov.bh/Ministry/Statistics?lang=en). The patients were divided into three groups based on the type of ingested material (FB, caustic chemicals, and medications). The three groups were compared based on patient demographics, family SES, clinical presentations, ingestion scenario, endoscopic and surgical complications, management, and outcomes. Based on radiological and endoscopic findings, the anatomical location of the FB was categorized into esophageal, stomach, and bowel locations and compared with the presenting symptoms. Metallic FBs were divided into jewelry and other metal objects and compared based on sex. The Fisher’s exact test or Pearson’s chi-square test was used to compare categorical variables, while student t test, Mann-Whitney U test, or Kruskal-Wallis test was used to compare independent groups. Confidence interval (CI) was set to 95%. $P < 0.05$ was considered statistically significant.

**Ethical approval**
This study was conducted in accordance with the principles of Helsinki declaration, and it was ethically approved by the Secondary Health Care Research Committee, Salmaniya Medical Complex, Government Hospitals, Kingdom of Bahrain (IRB number: 88300719, July 30, 2019).

RESULTS
During the study period, 161 accidental ingestion episodes were documented in 153 children admitted to the hospital, all of whom were included in this study. Eight (5.0%) patients had another episode of accidental ingestion following the initial episode; one of them had three episodes in total, and two patients ingested the same object (battery or hard food) during the two episodes. Of the eight patients with multiple ingestions, three (37.5%) had neuropsychiatric disorders, including autism, demyelination, and mild intellectual disability. The latter had iron-deficiency anemia associated with pica. The patient with three episodes had disc battery ingestion, followed by two repeated FB ingestions and was referred to the child protection team because of suspected child neglect, as this patient also had repeated burn events.

The mean number of accidental ingestions was 13.9 ± 10.3 episodes per year. The annual incidence of accidental ingestion episodes is shown in Figure 1. The incidence of accidental ingestion increased during the study period. In 2012-2016, the mean incidence was 3.3 ± 2.8 compared to 4.2 ± 2.4 episodes in 2017-2021. However, this increase was not statistically significant ($P = 0.610, 95\% CI: -4.6 to 2.9$).

The demographic data and clinical presentations are shown in Table 1. Most of the patients ingested FBs ($n = 108, 70.6\%$), 31 (20.3%) ingested caustic chemicals, and the remaining 14 (9.2%) ingested medications. Most of the patients were boys ($n = 85, 55.6\%$). Most patients were Bahraini children ($n = 118, 77.1\%$), while non-Bahraini were accounted for 35 (22.9%) patients (10 from India, 5 from Saudi Arabia, 2 from Bangladesh and United States of America each, 1 from Egypt, Sri Lanka, Sudan, Yemen, Syria each, while 8 patients had unspecified nationalities). The median age at presentation was 2.8 (IQR = 1.8-4.4) years, and the most frequent age group was 2-3
years old, accounting for 43.5%. Patients with caustic ingestion were younger than those
who ingested medications or FB at the time of presentation (P < 0.001). Most patients (n = 119, 77.8%) ingested one item, and most were symptomatic (n = 86, 57.3%). The most
common symptom was vomiting (n = 44, 29.3%), followed by abdominal pain (n = 25,
16.7%). Patients with caustic ingestion (n = 26/31, 89.7%) were more symptomatic than
those who ingested medications (n = 8/14, 57.1%) or FB (n = 52/108, 48.6%) (P < 0.001).
The caustic group had more vomiting (P < 0.001) and coughing (P = 0.029) than the
other two groups. Most of patients with FB ingestion were asymptomatic (n = 55/108,
51.4%). Upon comparison of symptoms according to the location of FB (esophagus,
stomach, or bowel), most of the 16 patients with esophageal FB were found to be
symptomatic [14 (87.5%) vs 2 (12.5%)], while the majority of the 56 patients with gastric
FB [34 (60.7%) vs 22 (39.3%)] and the 32 patients with intestinal FB [19 (59.4%) patients
vs 13 (40.6%)] were asymptomatic (P = 0.002).

Five patients had underlying diseases that might have been related to accidental
ingestion. Esophageal strictures after tracheoesophageal fistula repair were found in
two patients with food bolus impaction; one patient had cerebral palsy with needle
ingestion, one had mental retardation with coin ingestion, and one had autism with disc
battery ingestion.

Out of 136 (88.9%) patients with available witness history, 58 (43.6%) were witnessed
and 78 (57.4%) were unwitnessed. Of those witnessed, 55 (94.8%) patients had a known
witness person, while 3 (5.2%) had an unknown witness. Three (5.2%) patients had
more than one witness person. First degree relatives were witnesses in 47 (85.5%)
patients, second degree relatives in 8 (14.6%), and unrelated people (teacher,
housemaid, and family friend) in 3 (5.5%). The mother was the most frequent witness (n =
27, 49.1%), followed by other siblings [n = 11 (20%); seven of them were sisters and
four were brothers] and fathers (n = 7, 12.7%). There were no significant differences
among the three groups with respect to sex, nationality, SES, maternal occupation,
number of siblings, time to presentation, length of stay, number of ingested materials,
or the presence of a witness.
The different types of ingested material are listed in Table 2. Battery ingestion was the most frequent FB type \((n = 49, 32\%)\); 48 of them were disc batteries, and 1 was a finger type. The sharp objects included earring, screw, nail/nail hanger \((n = 5\) each), key/keyring/keychain \((n = 4)\), needle \((n = 3)\), hair clip/pin and sharp pin \((n = 2\) each), gold chain, leg accessories, necklace, pepsi cap, and zipper piece \((n = 1\) each). The chemicals and corrosive solutions included alkaline corrosives \((n = 19)\); Clorox in 11 patients, detergents or disinfectants in 3 each, and nonspecific corrosives in 2 patients), acid corrosives \((n = 5)\); keratolytic agents in three and toilet cleaners in two patients), and other chemicals \((n = 6)\). The medications included paracetamol \((n = 4)\), antihypertensives \((n = 3)\); coversyl in two and angiotensin-converting enzyme inhibitor in one patient), antihistamines, hypoglycemic agents, oral contraceptives, nitrite, multivitamins, methylphenidate, and multiple medications \((n = 1\) each).

Even though there was no significant difference between boys and girls in terms of the type of FB ingested \((P = 0.217)\), in metal object ingestions, girls were found to ingest more jewelry items than boys, with seven \((70\%)\) vs three \((30\%)\), respectively \((P = 0.006)\). Of the 49 \((32\%)\) patients who ingested batteries, 43 \((87.8\%)\) patients had the source of battery data available. Unsafe toys were the main sources of batteries \((n = 22, 51.2\%)\), followed by light torches \((n = 10, 23.3\%)\), remote-control devices \((n = 2, 4.7\%)\), artificial candles, baskets, electronic walking aids, headphones, laser pens, on car seats, on tables, and from watches and weighing scales \((n = 1\) each, 2.3\%).

The accidental ingestion scenarios are presented in Table 3. Data regarding this scenario were available for 131 \((85.6\%)\) patients. Accidental ingestion mostly happened while the child was playing \((n = 53, 40.5\%)\). FBs were ingested more while playing \((P < 0.001)\), caustic chemical ingestion was mainly due to unsafe storage \((P < 0.001)\), and medication ingestion was mostly due to a missing object \((P < 0.001)\).

Results of radiological imaging, including chest and abdominal radiography, were available for 123 \((80.4\%)\) patients: 108 \((100\%)\) for FB, 8 \((25.8\%)\) for caustic, and 7 \((50\%)\) for medication ingestion \((P < 0.001)\) (Table 4). The remaining 30 \((24.6\%)\) patients with no radiological findings ingested either corrosives \((n = 23, 76.7\%)\) or medications \((n = 7,
23.3%). The most common location of the ingested object was the stomach both radiologically \((n = 54/123, 43.9\%)\) and endoscopically \((n = 31/91, 34\%)\).

Endoscopic procedures were performed in 91 (59.9\%) of the 152 (99.4\%) patients, 73/107 (68.2\%) for FB, 18/31 (58.1\%) for caustic ingestion, while no patient with medication ingestion underwent endoscopy \((P < 0.001)\) (Table 4). Ninety patients (59.2\%) underwent upper gastrointestinal endoscopy and one (0.7\%) underwent colonoscopy. The common endoscopic location of the ingested objects was also the stomach \((n = 31, 34\%)\). The time from presentation to endoscopy was available for 81 (89\%) patients; 78 (96.3\%) of them had an emergency endoscopy \((< 48 \text{ h})\), while 3 (3.7\%) were delayed after 48 h. The first delayed patient was a 4-year-old girl who was brought by her parents with a history of fainting and vomiting streaks of blood after accidental ingestion of Clorox stored in a small water bottle. The second patient was an 8-year-old boy who ingested two attached magnets while playing a game. X-ray imaging revealed that the magnets had passed down to the large intestine. He was administered laxatives for 2 d without any progress; therefore, the magnets were removed endoscopically. The third patient was a 7-year-old boy who ingested a coin while playing, which was found to be in the stomach radiologically and remained there for 3 mo.

Data about the method of extraction were available in 107/152 (70.4\%) patients with FB ingestion; spontaneous passage was noted in 54 (35.5\%), endoscopic removal in 46 (30.3\%), laparotomy in 5 (3.3\%) (all after magnets ingestion), and direct laryngoscopy in 2 (1.3\%); while in the remaining 45 (29.6\%) patients nothing was removed as they ingested chemicals \((n = 31, 20.4\%)\) or medications \((n = 14, 9.2\%)\). Among patients who passed the FB spontaneously, 34 (59.7\%) passed it within the first 24 h of admission, 13 (22.8\%) passed it between 1 and 2 d, 10 (17.5\%) passed it after 3 d, and one patient had missing data. Three patients underwent endoscopic removal of one FB and spontaneous passage of the other.

Pharmacological therapy was required for 105/148 (70.9\%) patients; 79/105 (75.2\%) in FB, 22/29 (75.9\%) in caustics, and 4/14 (28.8\%) in medication groups \((P = 0.001)\). The
commonest medication was omeprazole \((n = 58; 37.9\%)\), which was used more in caustic group \((n = 19/28, 67.9\%)\) than in the FB \((n = 37/104, 25.9\%)\) and medication \((n = 2/14, 14.3\%)\) groups \((P = 0.001)\). Phosphate/glycerin enemas, lactulose, and glycerin suppositories were used in 30 (19.6%), 28 (18.3%), and 24 (15.6%) patients, respectively. Laxatives and whole-bowel irrigation were administered to one patient who ingested mercury. Among the patients who ingested medication, two patients received gastric lavage, and two patients were given activated charcoal.

Seven types of endoscopic and surgical complications were detected in 39 (26.4%) patients out of 148 patients with available data (Table 5). Some patients experienced more than one complication. Overall, patients who ingested caustics had more complications than those in the other groups \((P = 0.036)\) in the form of mucosal erythema \((P = 0.005)\) and strictures \((P = 0.019)\). Gastrointestinal perforation developed in the FB group only \((n = 5, 3.4\%)\) and was more with magnet ingestion (4 patients) than with other FB types (one with battery and none with others) \((P < 0.001)\). Examples of complications caused by battery and magnet bead ingestion are shown in Figures 2 and 3, respectively. Patients who ingested the medications showed no endoscopic or surgical complications. Data from follow up out-patient visits were available for 49 (32%) patients. Median follow-up period was 2 (IQR = 1.7-6.2) wk.

A comparison between the FB and caustic groups with respect to the presence or absence of endoscopic and surgical complications is shown in Table 6. In patients with FB ingestion, patients aged < 1 year \((P = 0.042)\), those with middle or low SES \((P = 0.028)\), and those with more symptoms at presentation \((P = 0.027)\) had more complications. Both the FB and caustic groups with complication had longer hospital stays \((P < 0.001)\) than those without. There were no significant differences in sex, nationality, maternal occupation, number of siblings, presence of witnesses, time to presentation, number and type of ingested FBs, or anatomical location.

**DISCUSSION**

12 / 20
This study observed an increasing trend in the incidence of accidental ingestion among children. This may be attributed to the increasing number of battery-powered electronic devices and the increased incidence of disc battery ingestion over the past several years\cite{2,5}.

The present study showed a male predominance among children with accidental ingestions, where boys accounted for 55.7\%. Some accidental ingestion patterns may also be related to sex\cite{6}. In fact, there was a consensus among all the reviewed studies that boys form the majority of children with accidental ingestion (Table 7)\cite{2,4,6-17}. However, there were some variations in percentages. For instance, Dereci et al\cite{13} from Turkey showed that boys accounted for 56\%, which is similar to our study. However, Diaconescu et al\cite{14} reported a male predominance, but with a lower percentage (52.45\%). However, Chan et al\cite{9} reported higher proportion of boys (80\%). This finding may be explained by the fact that boys are more active and explore more\cite{16}. However, some FBs are more accessible to girls than to boys and vice versa\cite{6}. For instance, girls frequently consume jewelry and hair products\cite{6}. This finding was confirmed in the present study. In a study by Orsagh-Yentis et al\cite{6}, girls were 2.5 times more likely to swallow jewelry than boys. Speidel et al\cite{4} also found that girls were at higher risk of sharp object ingestion.

The current study found that the median age at presentation was 2.8 years, and the most frequent age group was between 2-3 years old, accounting for 43.4\%. This finding is consistent with several other studies that showed that the toddler age group is the most frequent risk factor for accidental ingestion\cite{2,4,6-10,14,17}. This high prevalence of accidental ingestion in younger age groups can be attributed to the exploratory habits of these children\cite{14}. Furthermore, children in the oral phase are prone to ingesting objects while crawling and playing\cite{7}. Several studies have attributed the high prevalence of FB ingestion to the accessibility of FBs in a child’s environment, especially because this age group has the desire to explore their surroundings\cite{1,6,16,18}. However, few studies have reported older age groups up to adulthood\cite{11,13,15,16,18}.
In the current study, we evaluated families’ SES as a risk factor for the increased incidence of accidental ingestion, as the child might be left alone at home unwitnessed by the parents/caregivers owing to their work obligations, as stated by Kalra et al.[16]. Despite that, we did not observe an overall significant difference between families of different SES. However, in patients who ingested FB, families with middle or low SES had more endoscopic and surgical complications than those with higher SES families (P = 0.028).

In this study, 57.3% (86/150) of the patients were symptomatic at presentation. This is comparable to the studies by Speidel et al.[4] and Khorana et al.[17], where the percentages of symptomatic patients were 51.6% and 55.67%, respectively. However, studies by Uba et al.[7] and Diaconescu et al.[14] reported higher percentages of symptomatic patients (85% and 70.5%, respectively). In contrast, Chan et al.[9] and Lee et al.[10] reported very low percentages of symptomatic patients, with 12% and 9.2%, respectively. This variation in the percentage of symptomatic patients who ingested FB or other materials can be attributed to the differences in the time from ingestion to presentation and the shape, type, location, and amount of the ingested object.[14,15,16].

Overall, the most frequent presenting symptom in our study was vomiting (29.3%). In the literature review, we found variations in the presenting symptoms depending on the type of FB/material ingested or the site of the FB impaction.[15]. In terms of the type of ingestion, caustic materials exhibited the highest percentage of symptoms (89.7%) in this study. A lower percentage of symptomatic patients who ingested cleansers was reported by Speidel et al.[4] (53.4%). In the FB group, 48.6% of our patients were symptomatic, and 21.9% had vomiting as the most common symptom. Khorana et al.[17] reported a higher percentage of symptomatic patients with FB ingestion (55.67%), and vomiting was also the commonest presenting symptom (23.2%). Moreover, Diaconescu et al.[14] reported symptoms in 70.5% of their patients with FB ingestion, yet they mainly presented with abdominal pain (55.73%), followed by vomiting (34.42%). Upon comparison of symptoms according to the lodgment site, most patients with esophageal FB were symptomatic in our study (87.5%). This was comparable to the percentage
reported by Uba et al[7] in patients with esophageal FB (85%). Drooling of saliva and dysphagia are the main symptoms in patients with esophageal FB[8,13], while the presence of abdominal pain and vomiting are the main symptoms in patients with FBs found in the stomach[14,15]. Diaconescu et al[14] explained the wide variation in presenting symptoms among different studies based on the shape of the FB, duration between the ingestion event and time to presentation, and age of the patient.

In the current study, 42.7% of the children who ingested FB, caustics, or medications were asymptomatic. This is comparable to the study by Speidel et al[4], who also included the three types of ingested materials, where the percentage of asymptomatic patients was 48.4%. Moreover, Lee et al[10] reported that most of the 76 patients with FB ingestions were asymptomatic (90.8%), which was also the case in our study, but at a lower rate (51.4%). Chan et al[9] also documented that most of the 25 patients with button battery ingestion were asymptomatic (88%). This high percentage of asymptomatic patients is of concern, as it may lead to delayed diagnosis in many cases, putting these children at risk of a higher rate of complications. Preventing complications and missed diagnoses, particularly in high-risk objects, such as batteries, is important. Early detection of an incident by parents leads to faster presentation, diagnosis, and intervention[3,19]. Nevertheless, doctors should consider FB ingestion scenarios in young patients who present with vague symptoms, such as abdominal pain and vomiting[3,19].

In this study, the majority of the ingestion scenarios were during the playing time (40.5%) and were unwitnessed (57.4%). Ingestion episodes while playing were also documented by Dereci et al[13] but at a higher rate (72%). Unwitnessed events were also found in other studies, such as those illustrated by Litovitz et al[19], who reported a comparable percentage to our study (56.2%). In contrast, most of accidental ingestion reported by Lin et al[15] were witnessed (89%). However, Kalra et al[16] found a low percentage of witnessed accidental ingestion (19%). The presence of a witness during the child’s play is important for the early detection of ingestion episodes and might hasten medical management.
In our study, the most frequently ingested FB were batteries (32%), followed by chemical solutions (20.3%). The main source of ingested batteries was unsafe toys (51.2%). Unsafe toys are a source of danger, particularly if their batteries are not locked. This may be due to the ease of swallowing these objects and/or being within reach of the children. However, our findings are not compatible with those of many other studies on the most commonly ingested FB. Most studies have reported that coins are the most common\textsuperscript{2,6-8,10,11,13,14}. This can be explained by the strict inclusion criteria of our study, in which patients were admitted to the hospital for observation and for the inclusion of possible endoscopic procedures. Most patients who ingested coins at our hospital were seen in the Department of Emergency, and if the coin was in the stomach or beyond, the patient was discharged if he or she was asymptomatic. Because a significant number of patients with accidental ingestion present to the hospital without any symptoms, the implementation of specific investigations and diagnostic modalities, such as erect chest radiography, technetium-labelled sucral fate scan, and early esophagogastroduodenoscopy, are important to establish any anatomical-internal injuries\textsuperscript{4}. The decision to perform an endoscopic procedure to remove a FB depends on the time since ingestion, FB location, size, and shape, as well as the patient’s age, symptoms, and complications\textsuperscript{10}. In our study, both radiologically and endoscopically, FBs were mostly found in the stomach, followed by the small bowel, and then esophagus, with 37.7%, 19.7%, and 14.7%, respectively. However, the study by Lin et al\textsuperscript{15}, which was conducted on 87 patients who underwent an endoscopic procedure, showed that the most common lodgment site of FB was the esophagus (51.4%), followed by the stomach (44.6%) and finally the duodenum (4%).

Fortunately, most of our patients did not develop complications (73.6%). However, 26.4% had endoscopic and surgical complications, 10.8 developed mucosal erythema, 9.5% had ulcer, 6.1% had erosions, and 3.4% had gastrointestinal perforation \((n = 5)\). Uba et al\textsuperscript{17} illustrated that the most common comorbidities were hemorrhage (15%), perforation (3.7%), and aspiration pneumonitis (2.8%).
In our study, 38.2% (n = 58) of the patients had a spontaneous passage of the FBs. However, higher rates of spontaneous passage have been documented. Chan et al[9] and Khorana et al[17] reported percentages of spontaneous passages that reached 92% and 60.31%, respectively. Accordingly, it was thought that the actual number of ingested FBs in children was higher than the documented number, since many cases had uneventful and symptomless spontaneous passage without the recognition and witnessing of the parents[13]. In our study, 30.3% of children underwent endoscopic procedures either to remove the FB or for the assessment/management of any complications. However, Dereci et al[13] reported a higher percentage of endoscopic procedures (n = 55, 85%). Fortunately, the overall need for surgical intervention reported in the literature is relatively low. In our study, five (3.3%) cases needed surgical intervention. Speidel et al[4] showed even lower percentage (n = 4; 0.3%).

**Limitations**

This study had several limitations. As this was a retrospective study, missing data, such as patient contact number, presence of a witness, and details of the ingestion scenario, were expected. One of the limitations of this study was that we included only those who had been admitted to the hospital, excluding those who attended the Departments of Accident and Emergency and were discharged home, especially asymptomatic patients and those who ingested metallic coins found in the stomach or beyond. Moreover, the ingestion scenario of some patients was gathered via telephone calls to the child’s parents/guardians after the ingestion episode, which was subject to recall bias. Some parents did not provide consent for endoscopy, especially for children who ingested corrosives, which made the assessment of local injury and gastrointestinal complications difficult. The ingestion of glass is a real challenge because it is radiolucent, and nothing was seen on the X-ray to determine the location. Despite these limitations, this study had many strengths. It is the first study from Bahrain to focus on accidental ingestion in children. This covered all types of accidental ingestion, unlike most other studies, which included the ingestion of only one type of hazardous
material. The findings of this study are particularly important for health care providers dealing with this group of patients. They are also valuable for policymakers as prevention guidelines, and legislation is crucial for protecting children from avoidable risks.

CONCLUSION
Accidental ingestion of FBs/harmful materials in children is a serious problem. Our study showed that boys and toddlers were at a higher risk. Most children are symptomatic at presentation, with vomiting being the predominant symptom. Batteries were the most commonly ingested materials, followed by metals and chemicals. Most accidents occur while playing games unwitnessed. Patients ingested chemicals had higher endoscopic morbidity than FB or drug groups. In patients with FB ingestion, younger age (less than 1 year), those from middle- and low-SES families, and those with more symptoms at presentation, were more prone to complications. Gastrointestinal perforation developed in the FB group only, and mainly after magnet ingestion. Further studies are required to assess the impact of parental education, government legislation, and ensuring a safe environment to prevent such serious accidents in children.

ARTICLE HIGHLIGHTS
Research background
Accidental ingestion of foreign bodies (FB) or harmful materials is a common problem in families with children because of their exploratory behavior. This behavior puts them at risk and can cause serious morbidities.

Research motivation
While many studies on accidental ingestion in children have been published from several countries worldwide, no study has been published on this issue in Bahrain. This knowledge gap motivated us to study this health problem in Bahrain.
Research objectives

To evaluate the incidence, demographics, types of FB/harmful materials ingested, diagnostic methods, management, complications, and outcomes of accidental ingestion in pediatric patients at the main tertiary hospital in Bahrain and compare patients with endoscopic or surgical complications with those without complications to identify the predicted risk factors.

Research methods

We retrospectively reviewed and collected the demographic data, clinical presentations, radiological and endoscopic findings, treatments, complications, and outcomes of children with accidental ingestions admitted to the Department of Pediatric at the Salmaniya Medical Complex, Kingdom of Bahrain, from medical records between 2011 and 2021.

Research results

In total, 161 accidental ingestion episodes were documented in 153 children. Male predominance was noted (n = 85, 55.6%). The median age at presentation was 2.8 (interquartile range = 1.8-4.4) years. Most participants ingested FBs (n = 108, 70.6%), followed by caustic chemicals (n = 31, 20.3%), or medications (n = 14, 9.2%). Most patients were symptomatic (n = 86, 57.3%); vomiting was the common symptom (n = 44, 29.3%), followed by abdominal pain (n = 25, 16.7%). Batteries were the most commonly ingested FBs (n = 49, 32%). Unsafe toys were the main source of batteries (n = 22/43, 51.2%). Most episodes occurred while playing (n = 49/131, 37.4%) or unwitnessed (n = 78, 57.4%). Stomach was the common location of FB lodgment, both radiologically (n = 54/123, 43.9%) and endoscopically (n = 31/91, 34%). Of 107/108 (99.1%) patients with FB ingestions, spontaneous passage was noted in 54 (35.5%), endoscopic removal in 46 (30.3%), laparotomy in 5 (3.3%), and direct laryngoscopy in 2 (1.3%). Pharmacological therapy was required in 105 (70.9%) patients. Complications were detected in 39 (26.4%) patients, five of whom had gastrointestinal perforation. Patients who ingested FB before
the year of age \( (P = 0.042) \), those with middle or low socioeconomic status \( (P = 0.028) \), and those with more symptoms at presentation \( (P = 0.027) \) had more complications.

**Research conclusions**

Accidental ingestion in children is a serious health problem. Symptomatic infants from families with middle or low families had the highest morbidity. Prevention through parental education and government legislation is crucial.

**Research perspectives**

Additional research is required to evaluate the influence of parental awareness, authority regulations, and the provision of safe environments to prevent such serious incidents.

Crossref