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# Toxic exposures among young children one year into the COVID-19 pandemic: a retrospective review of three San Francisco Bay Area emergency departments

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**Author contributions**

GD, AS, CCC, JGP, and AEK conceived the study and obtained research funding. GD managed the data. NA provided statistical advice on study design. GD and NA analyzed the data. GD drafted the manuscript, and all authors contributed substantially to its revision. GD and AEK take responsibility for the paper as a whole.

**Conflicts of interest**

None of the authors report any conflicts of interest.

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## ABSTRACT

*Background:* Daycare and school closures prompted by shelter-in-place may have increased opportunities for unintentional ingestions among young children.

*Objectives:* We examined emergency department (ED) presentations for toxic exposures among young children during the COVID-19 pandemic in the San Francisco Bay Area, which had some of the strictest and most prolonged shelter-in-place policies in the United States.

*Methods:* We performed a retrospective cross-sectional study of children aged 0-5 years old who presented with an ED ICD-10 diagnosis code of toxic exposure within a tertiary care hospital system from March 16, 2016, to March 15, 2021. We considered the period after March 16, 2020 to represent the pandemic.

*Results:* During the pandemic, the absolute number of poisonings among young children remained stable. Overall ED encounters within this cohort decreased by 55%, which doubled the relative toxic exposure rate per 1000 ED encounters from 4.99 (95% CI 3.19, 5.90) to 9.79 (95% CI 8.09-11.49). Rates of admission, severe medical complications, operating room case requests and length of stay were not significantly different. Shelter-in-place was associated with significantly higher odds of cannabis ingestion (OR = 2.70, 95% CI 1.60-4.49).

*Conclusion:* Despite dramatic decreases in overall ED patient volumes, the absolute number and severity of toxic exposures were similar during the pandemic compared to previous years.

Keywords: COVID-19, shelter-in-place, toxic exposures, poisonings, young children, San Francisco Bay Area, marijuana, cannabis

## INTRODUCTION

On March 16, 2020, six San Francisco Bay Area counties imposed shelter-in-place orders to mitigate the spread of COVID-19. Shelter-in-place orders are a public health strategy where governments restrict population movement to prevent communicable infectious diseases. Despite their intent, shelter-in-place may have unintentional societal consequences. For example, studies have identified associations between the COVID-19 pandemic and increases in firearm injuries[1] and eating disorders[2] among children.

Drug overdose and poisoning is the third leading cause of death among children and adolescents.[3] Furthermore, 90% of poisonings occur at home and 50% occur among children less than six years old.[4] We hypothesized that school and daycare closures prompted by shelter-in-place may have increased opportunities for unintentional ingestions among young children. A national study of poison control center data did not find an increase in pediatric toxic exposures among this age group during the pandemic, but it did not account for regional variation in COVID case counts and public health restrictions.[5] In order to more directly isolate the effect of shelter-in-place policies, we focused on the experience of the San Francisco Bay Area, where stay-at-home restrictions were among the strictest in the United States.[6]

## MATERIALS AND METHODS

### *Study design*

We performed a retrospective study of the electronic medical record using International Statistical Classification of Diseases and Related Health Problems Tenth Revision (ICD-10) codes.

*Study setting*

The electronic medical record includes a tertiary care hospital system that includes two pediatric and one general ED in the San Francisco Bay Area. We examined the period from March 16, 2016, to March 15, 2021. We considered the period after March 16, 2020, to represent the pandemic, as this was when six Bay Area counties announced shelter-in-place orders restricting all residents to their homes.

*Participants*

We identified all children aged 0-5 years old who presented to the ED during the study period. We only examined children aged 0-5 years old to focus on unintentional ingestions that occur at home (as opposed to toxic ingestions in older children from intentional self-harm). We excluded incomplete encounters (e.g., patient left before being seen by a provider, left against medical advice, or no medical discharge diagnosis documented).

*Variables*

For each encounter, we collected the patient's demographic variables (including age, sex, race, ethnicity, and health insurance), date of encounter, and associated International Statistical Classification of Diseases and Related Health Problems Tenth Revision (ICD-10) emergency and discharge diagnosis codes. We identified children with toxic exposures based on whether the encounter received an ED or discharge ICD-10 diagnosis code of poisoning or toxic effect per the Centers for Disease Control Injury Mortality Diagnosis Matrix (ICD-10 codes T36-65 and T96-97).[7] We also included children presenting with drug intoxication (F10-19), remapping

these diagnoses as outlined in Supplementary Table 1. We excluded children with a diagnosis of toxic exposure due to an adverse medication side effect (T35-50.XA or X5A), food poisoning (T61-62 and T64), venomous animals and plants (T63), and unspecified toxic effects (T65). To assess for patient severity among children presenting with toxic exposure, we extracted triage acuity level, disposition (intensive care unit [ICU] admission, non-ICU admission, discharge, transfer, or death), operating room case requests, and ED or discharge diagnosis codes for severe medical complications, including intubation, respiratory failure (J96), cardiac dysfunction and arrhythmias (I44-I52), renal failure (N17), liver failure (K71-72), encephalopathy and altered consciousness (R40-41), and seizure (R56).6

*Data sources and measurements*

We extracted all data directly from the electronic medical record and did not perform manual abstraction. We categorized toxic exposures per the original ICD-10 coding schema. We examined all other categorical variables per how they are stored within the electronic medical record.

*Bias*

To avoid bias, we obtained four years of pre-pandemic data to compare pandemic-era trends. We also examined year-by-year pre-pandemic trends to ensure pandemic-era trends were not just a continuation of secular trends. We compared pre- and post-pandemic demographic data to assess for selection bias. We chose the specific age range of 0-5 years old to align our study with the age cutoffs used by the American Association of Poison Control Centers.[8]

*Study size*

Our study size is based on a fixed sample.

*Statistical methods*

We calculated aggregate data from 2016-20 and 2020-21. We then examined differences in demographics and clinical outcomes using the test of equal or given proportions; differences in length of stay using the Kruskal-Wallis test; differences in the overall incidence of toxic exposures over time via linear regression; and differences in pharmacological etiologies of toxic exposures between 2016-20 and 2020-21 via logistic regression. We calculated all statistics using R software (R Foundation for Statistical Computing, Vienna, Austria). The study received approval from our organization's institutional review board.

**RESULTS**

During the 5-year study period, there were 140,648 ED encounters among children aged 0-5 years old, of which 770 (0.55%) were diagnosed with toxic exposure (Figure 1). Yearly demographic trends were similar from March 16, 2016, to March 15, 2021, including the pandemic era. Among children aged 0-5 years old, ED volume declined by 55% during the pandemic era, but the absolute number of toxic exposures decreased by only 13%. The toxic exposure rate per 1000 ED encounters among children 0-5 years old doubled from 4.99 (95% CI 3.19-5.90) during 2016-20 to 9.79 (95% CI 8.09-11.49) during 2020-21.

Comparing the COVID-19 pandemic era to 2016-20, we did not detect any differences in rates of level 1 triage acuity (7 vs 8%, p=0.98), hospital admission (31% vs 30%, p = 0.82), ICU admission (11 vs 9%, p=0.44), severe medical complications (14% vs 10%, p=0.22), and operating room case requests (2% vs 4%, p=0.36). The median length of stay was similar among all patients (5 vs. 5 hours, p=0.31), admitted patients (24 vs. 22 hours, p=0.32), and ICU-admitted patients (37 vs. 25 hours, p=0.48). There were no patient deaths in our cohort.

We examined changes in pharmacological etiologies of toxic exposures over time. Cannabis intoxication among young children increased by 11% (Figure 2, 95% CI 4-18%) and the COVID-19 pandemic was associated with higher odds of cannabis ingestion (OR = 2.70, 95% CI 1.60-4.49). Meanwhile, exposure to corrosive substances such as bleach within this cohort decreased by 6% (95% CI 1-10%), and the pandemic was associated with lower odds of toxic exposures due to corrosive substances (OR = 0.40, 95% CI 0.15-0.88). We did not detect any significant differences in other causes of toxic exposures during the pandemic (Supplementary Table 2).

## DISCUSSION

Our study found that the absolute number of toxic exposures among children 0-5 years old remained stable during the first year of the COVID-19 pandemic. Although toxic exposures accounted for a larger proportion of ED visits during the pandemic, this was principally due to decreases in overall ED patient volumes rather than an increase in toxic exposures. Our findings are consistent with national trends, in which ingestions managed at health care facilities decreased by 14.2% during the pandemic.[5] Despite early concerns that pediatric patients were delaying presentation to care and arriving in more critical condition during the COVID-19 pandemic,[9] our study did not detect changes in patient severity or resource utilization.

We also found that the composition of ED-related toxic exposures changed during the pandemic. Cannabis accounted for an increasing share of toxic exposures, conforming with national trends associated with expanding access to legal cannabis.[10] The surge in cannabis exposures buoyed the frequency of toxic exposures to baseline during the pandemic - excluding these exposures, the number of toxic exposures during the pandemic would have been the lowest within the 5-year study period.

We also detected a proportional decrease in toxic exposures due to corrosive substances, which coincided with a 50% decrease in the proportion of encounters associated with operating room case requests. Corrosive substances represent a large proportion of operating room cases related to toxic ingestion.[11] Therefore, our findings may reflect a decrease in the number of severe corrosive exposures requiring endoscopic evaluation in the operating room. However, the decrease was not statistically significant. The media widely reported a spike in bleach poisonings during the early months of the COVID-19 pandemic,[12] which may have increased parental vigilance during the remainder of the year. We did not detect increases in toxic exposures due to

hand sanitizer and melatonin as reported by the national United States poison control centers, likely because few of these patients required ED evaluation.

## LIMITATIONS

First, our findings may not reflect an actual decrease in exposure but the apprehension of in-person healthcare use, including exposure-related ED visits, during the COVID-19 pandemic. Furthermore, we only report on trends in emergency department visits and our results may not capture mild or asymptomatic toxic exposures that either did not require presentation to care or were evaluated in an ambulatory clinic setting. Future studies using California Poison Control System (CPCS) data may aid in validating our findings and in describing trends in toxic exposures that did not lead to an ED visit. Second, we only report trends within a single healthcare center which limits the generalizability of our findings. However, the study location serves as a tertiary referral center for the geographic area with strict shelter-in-place policies. Third, we do not report changes in antidotal therapies because our clinical dataset did not include this information.

## CONCLUSIONS

Strict and prolonged shelter-in-place policies did not coincide with an increase in the absolute number of exposure-related ED visits or patient severity among young children. Although we detected an increase in the relative incidence of toxic exposures, this change appeared to be more reflective of decreased ED use during the pandemic than an increase in the number of toxic exposures. Our study provides further evidence that contrary to expectations, shelter-in-place

policies did not cause alarming alterations in the incidence and severity of toxic exposures among young children.

## ARTICLE SUMMARY

### 1) Why is this topic important?

Shelter-in-place orders are a public health strategy to prevent the spread of infectious disease, but their far-reaching effects may have had unintended consequences. For example, prolonged daycare and school closures may have increased opportunities for unintentional ingestions among young children while they sheltered at home.

### 2) What does this study attempt to show?

In order to more directly measure the effects of shelter-in-place policies upon toxic exposures among young children, we examined the epidemiology of emergency department (ED) visits due to toxic exposures among children 0-5 years old in the San Francisco Bay Area, where public health restrictions were among the strictest in the United States.

### 3) What are the key findings?

The absolute number of young children presenting for toxic exposures remained stable. Overall ED volume decreased during the pandemic, doubling the proportion of ED visits for toxic exposures. A surge in cannabis ingestions buoyed the incidence of toxic exposures during the pandemic. Despite reports of bleach poisonings during the early months of the COVID-19 pandemic, poisonings due to corrosive substances were lower than in prior years.

**4) How is patient care impacted?**

Shelter-in-place orders did not coincide with alarming alterations in the absolute number of toxic exposures among young children. However, we detected a concerning increase in the number of cannabis ingestions, which aligns with national trends as more states decriminalize marijuana.

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**Figure 1 - Flow diagram of cohort selection**

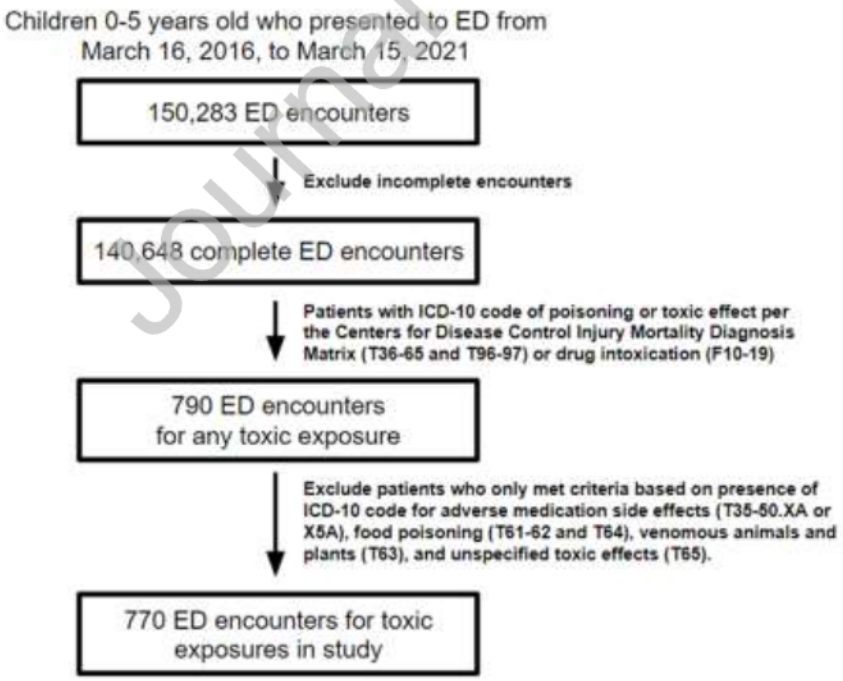
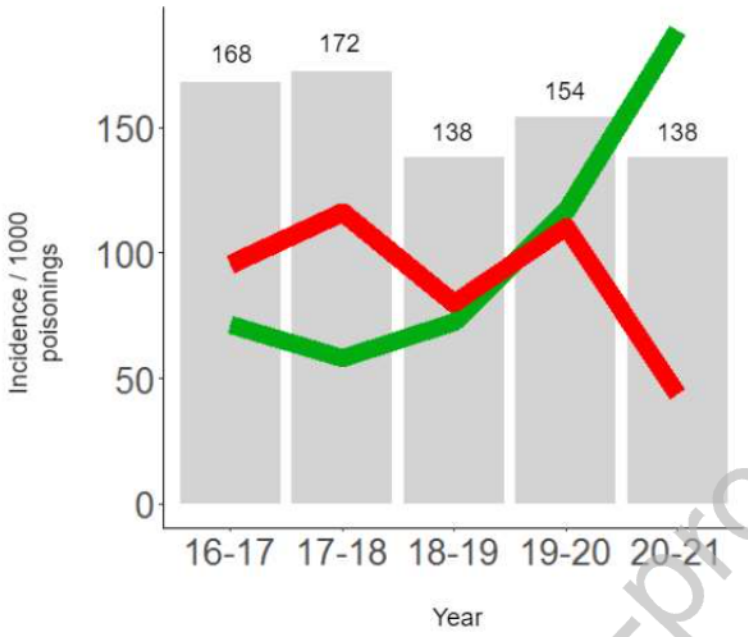


**Figure 2 - Causes of poisonings over time**




Bars (grey) show the absolute number of toxic exposures per year among patients aged 0-5 years old. Lines show the incidence of toxic exposures due to marijuana (green) and corrosive substances (red) per 1000 poisonings.