CLINICAL SCIENCE

CORROSIVE POISONINGS DURING THE COVID-19 PANDEMIC: TRENDS AND DEMOGRAPHIC SHIFTS IN THE PRE- AND EARLY VACCINATION PERIODS (2020–2021)

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Abstract

The COVID-19 pandemic significantly disrupted global healthcare and societal norms, leading to changes in poisoning patterns, particularly corrosive poisonings (CP). This study aimed to evaluate the impact of the pandemic on CP trends in North Macedonia by comparing observed data from 2020 and 2021 with predicted values (PV) based on a 10-year tren. A retrospective study was conducted using data from the Poisoning Registry at the Poison Information Center (PIC), University Clinic for Toxicology, Skopje. Patients with confirmed acute upper gastrointestinal corrosive injuries were included. A total of 1,668 CP cases were recorded in the period between 2010 and 2021. While an overall downward trend was observed ($y = -6.5x + 181.4$, $R^2 = 0.56$), CP cases declined by 1.5% in 2020 and by 25.5% in 2021 compared to PV. Female cases decreased by 27.5% in 2021; male cases declined by 16.6% in 2020 and 32.4% in 2021. Adolescent CP increased by 12.8% in 2020 and 80.0% in 2021; cases in those aged over 75 rose by 2.5% and 6.2%, respectively. The mean age of CP patients rose by 7.6% in 2020 and 11.0% in 2021. Suicidal poisonings increased by 9.9% in 2021. Disinfectant poisonings rose by 74.5% in 2020, while poisonings with hydrochloric acid (+6.2%), detergents (+3.4%), and degreasers (+32.0%) increased in 2021. Case fatality ratios were increased by 36.2% in 2020 and 44% in 2021. Although the overall number of cases declined, the increased severity, lethality, and demographic shifts—particularly among adolescents and the elderly—highlight the high-risk groups, mental health burden and toxicological risks associated with public health emergencies.

КЛИНИЧКИ ИСТРАЖУВАЊА

КОРОЗИВНИ ТРУЕЊА ЗА ВРЕМЕ НА ПАНДЕМИЈАТА СО COVID-19: ТРЕНДОВИ И ДЕМОГРАФСКИ ПРОМЕНИ ВО ПЕРИОДОТ ПРЕД И НА ПОЧЕТОКОТ НА ВАКЦИНАЦИЈАТА (2020–2021)

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Извадок

Пандемијата со COVID-19 значително го наруши глобалниот здравствен систем и општествените норми, што доведе до промени во моделите на труење, особено кај корозивните труења (КТ). Целта на оваа студија беше да се процени влијанието на пандемијата врз трендовите на КТ во Северна Македонија, споредувајќи ги податоците од 2020 и 2021 година со предвидени вредности (ПВ) базирани на 10-годишен тренд. Се спроведе ретроспективна студија користејќи податоци од Регистарот за труења при Токсиколошкиот информативниот центар (ТИЦ) на Универзитетската клиника за токсикологија во Скопје. Беа вклучени пациенти со потврдени акутни корозивни повреди на горниот гастроинтестинален тракт. Во периодот од 2010 до 2021 година беа евидентирани вкупно 1.668 случаи на КТ. И покрај општиот опаѓачки тренд ($y = -6.5x + 181.4$, $R^2 = 0.56$), бројот на случаи опадна за 1,5% во 2020 и за 25,5% во 2021 споредено со ПВ. Кај жените се забележа намалување од 27,5% во 2021, додека кај мажите опаѓање од 16,6% во 2020 и 32,4% во 2021. Кај адолесцентите се регистрира зголемување од 12,8% во 2020 и 80,0% во 2021, а кај лицата над 75 години пораст од 2,5% и 6,2%. Просечната возраст на пациентите со КТ се зголеми за 7,6% во 2020 и 11,0% во 2021. Самоубиствата со КТ се зголемија за 9,9% во 2021. Труењата со дезинфициенси се зголемија за 74,5% во 2020, додека труењата со хлороводородна киселина (+6,2%), детергенти (+3,4%) и одмастувачи (+32,0%) беа зголемени во 2021. Смртноста од КТ се зголеми за 36,2% во 2020 и 44% во 2021. Иако вкупниот број на случаи е намален, зголемената тежина, леталитетот и демографските промени – особено кај адолесцентите и постарите лица – ги истакнуваат ризичните групи, психолошкиот товар и токсиколошките закани поврзани со вонредни состојби во јавното здравство.

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Клучни зборови: корозивно труење, горен гастроинтестинален тракт, COVID-19, анализа на трендови, вонредни состојби во јавното здравство

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Introduction

The COVID-19 pandemic has significantly influenced global public health, not only through its direct morbidity and mortality but also by altering patterns of behavior and access to healthcare services. The extensive social restrictions, psychological stress, and heightened fear of infection, especially in the period prior to the availability of effective vaccines, have had far-reaching effects on mental health and healthcare utilization[1].

These disruptions also extended to the field of clinical toxicology. Several studies have reported shifts in the epidemiology of poisonings during the pandemic, including an increase in cases involving corrosive substances[2]. In adults, corrosive poisonings (CP) are frequently associated with suicidal intent, while in children, they are more often accidental exposures[3]. The psychological burden and social isolation during the pandemic further contributed to this pattern, increasing the frequency and severity of CP in certain populations.

Corrosive poisonings remain a major toxicological concern, particularly in developing countries where access to mental health services and public education may be limited. The lack of specific antidotes for upper gastrointestinal tract injuries caused by corrosive agents leads to high morbidity and mortality. Despite global trends showing a decline in CP in high-income countries, several reports have documented an increase in such poisonings during the COVID-19 period, especially those linked to suicidal behavior and developing countries [2,4–6].

The aim of this study was to evaluate the impact of the COVID-19 pandemic on the epidemiological characteristics of corrosive poisonings in North Macedonia by comparing data from the pandemic years (2020 and 2021) to predicted values (PV) derived from a trend analysis of the previous ten-year period.

Material and method

We conducted a retrospective observational study using data from the Poisoning Registry maintained by the Poison Information Center (PIC) at the University Clinic for Toxicology, covering the period from 2010 to 2021. The study included patients with confirmed corrosive injuries of the upper gastrointestinal tract who were treated at the University Clinic for Toxicology and the University Pediatric Clinic, and whose cases were reported to the PIC.

Study Variables

Data collected included:

- Demographics: Gender, age, and age group:
  - Children (<14 years)
  - Adolescents (15–19 years)
  - Adults (20–74 years)
  - Elderly (>75 years)
- Circumstances/intent of poisoning (suicide, accidental)
- Type of corrosive substance according chemical composition (hydrochloric acid, bleach, detergents, disinfectants, alkali degreasers, sodium hydroxide)
- Clinical outcome (Patients with documented clinical outcomes - survival, postcorrosive substenosis of upper gastrointestinal tract or death within the first 72 hours following admission or intervention)
- Diagnosis and Classification
  - Acute corrosive poisoning was confirmed by esophagogastroduodenoscopy (EGD) conducted

within 48 hours of exposure. Patients with a history of corrosive injury or with chronic post-corrosive complications were excluded from the study. Endoscopic findings were classified according to the Kikendall grading system.

From all 1,668 cases, 1,081 (64.8%) were females and 587 (35.2%) were males. Over the past 12 years, the incidence of corrosive poisonings (CP) declined in both genders, reaching an almost equal distribution between males and females by 2021. The decline was more pronounced in females, with a trend line of $y = -6.65x + 132$, $R^2 = 0.7$, compared to a slight decrease in males ($y = -0.045x + 49.5$, $R^2 = 0.0003$).

However, in 2020, there was a 7.7% increase in female cases, followed by a 27.5% decrease in 2021 compared to the predicted values (PV). In males, the number of cases steadily declined, with reductions of 16.6% in 2020 and 32.4% in 2021 relative to PV (Figure 2).

Statistical Analysis

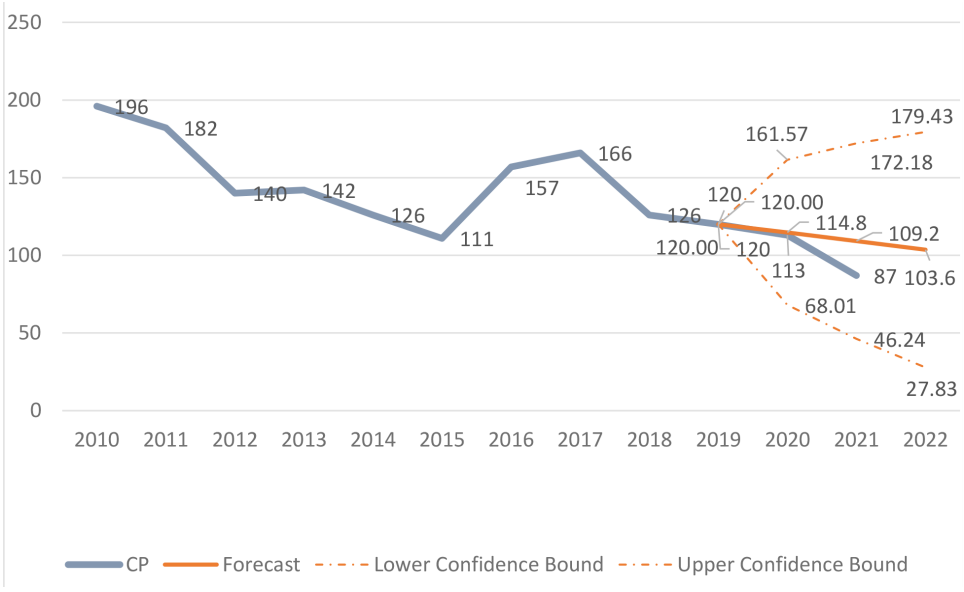
Descriptive statistics (frequencies and proportions) were used to summarize the demographic characteristics of the study population. To evaluate trends over time, linear regression analysis and linear forward trend forecasting were performed using Microsoft Excel (Microsoft Corp., Redmond, WA, USA). The mean absolute percentage error (MAPE) between actual and predicted values was calculated using the standard formula: MAPE = | (Actual − Predicted) / Actual| × 100. Case fatality ratio (CFR) was calculated with standard formula: Number of deaths due to a particular disease/ Total number of cases due to the same disease×100. A p-value of <0.05 was considered statistically significant.

Results

We registered 1668 acute CP from 2010 to the end of 2021. CP demonstrated a declining trend over the past 12 years, as indicated by the linear regression model ($y = -6.5x + 181.4$, $R^2 = 0.56$). The CP decreased by 1.5% during 2020 due to COVID-19 curfews, and by 25.5% in 2021, compared to PV (Figure 1).

From all 1,668 cases, 1,081 (64.8%)

Figure 1. CP during 2010-2021 with PV for 2020 and 2021



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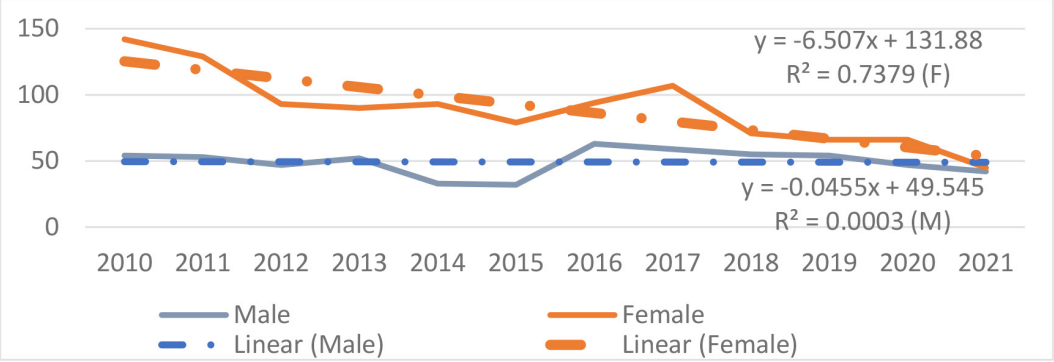
During 2020 and 2021, the incidence of corrosive poisonings (CP) increased among adolescents, with rises of 12.8% and 80.0%, respectively, compared to predicted values (PV). A similar upward trend was observed in individuals aged over 75, with increases of 2.5% in 2020 and 6.2% in 2021.

Figure 2. Gender distribution in CP

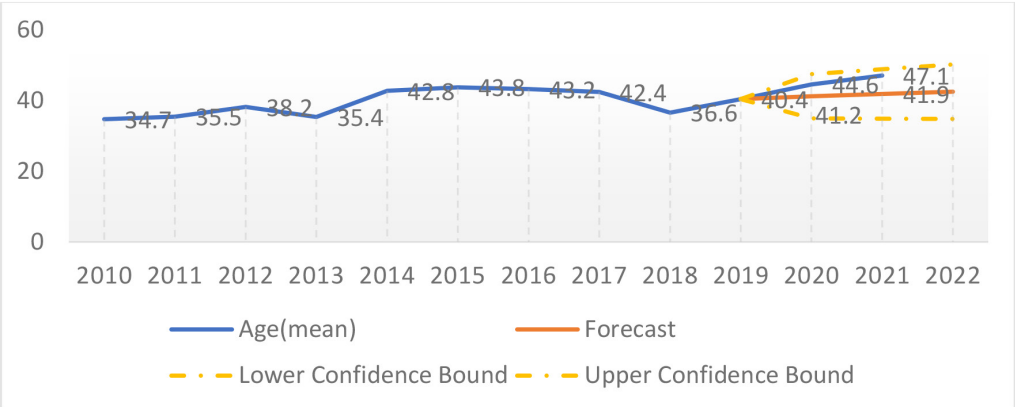


In contrast, the adult population experienced a 2.5% increase in 2020 and 6.15% in 2021, compared to PV.

The mean age of patients with corrosive poisoning (CP) exhibited a general upward trend over the study period, with two notable declines observed in 2013 and 2018. In comparison to predicted values, the mean age increased by 7.6% in 2020 and by 11.0% in 2021 (Figure 3).

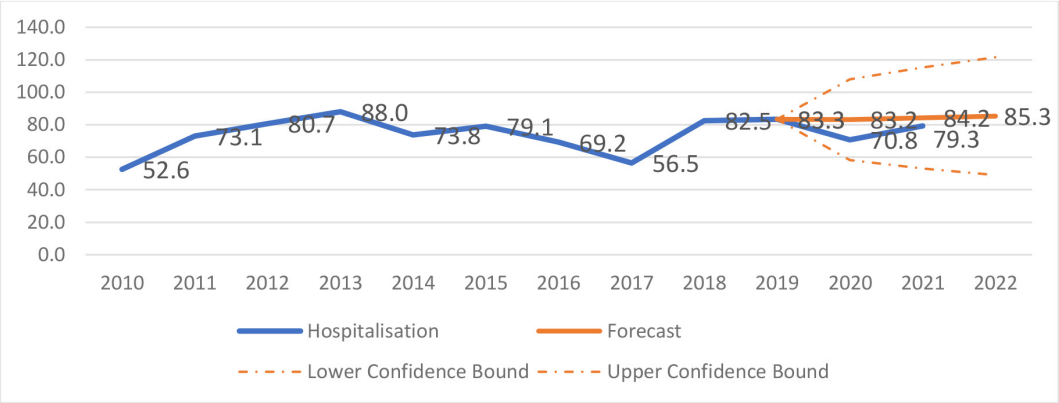
The proportion of hospitalizations followed a steady trend (y = 0.71x

Figure 3. Mean age of patients with CP and comparisons to PV for 2020 and 2021



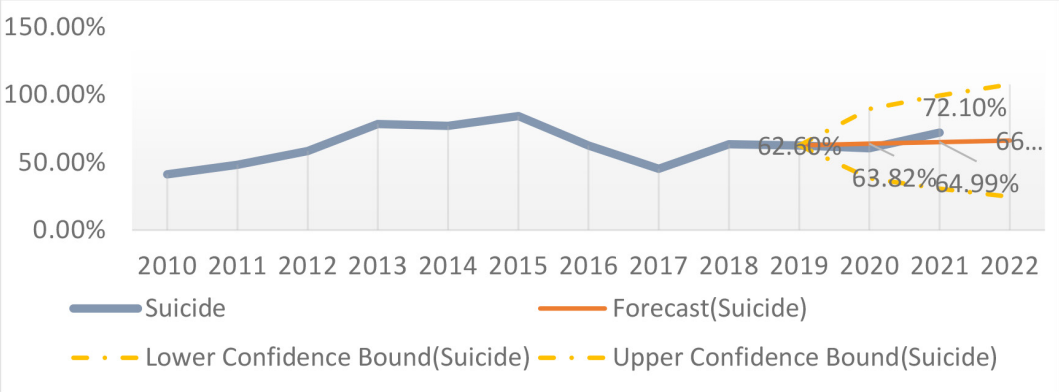
+ 69.47, R^2 = 0.058). This decrease was more pronounced in 2020, with a 17.5% reduction compared to PV, while in 2021, the decline was smaller, amounting to 6.2% (Figure 4).

Figure 4. Hospitalization (in proportion) and comparisons to PV for 2020 and 2021



The proportion of suicidal CP showed a slight upward trend over the 12-year period (y = 0.01x + 0.56, R^2 = 0.07). However, there was a 5.6% decrease in 2020, followed by a 9.9% increase in 2021, compared to predicted values (PV) (Figure 5).

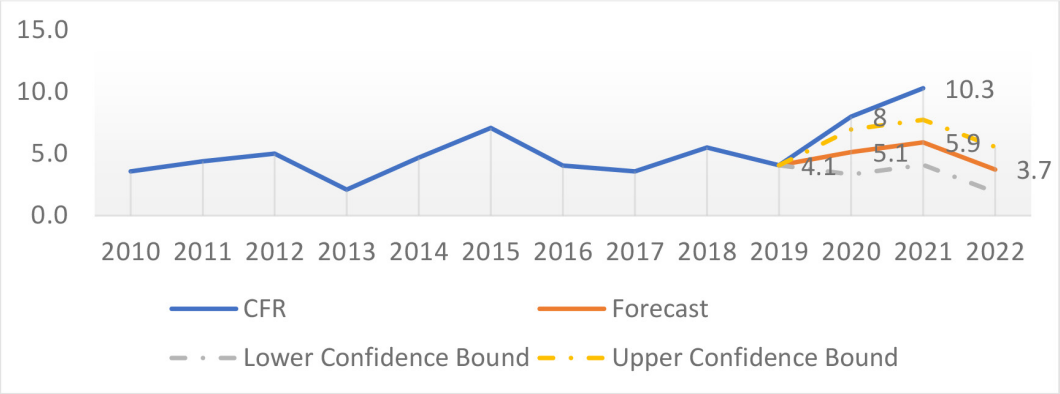
Figure 5. Suicidal CP: Observed values vs. predicted values for 2020 and 2021



Among all substances, poisonings involving bleach increased in both 2020 (by 16.0%) and 2021 (by 7.3%) compared to predicted values (PV). Additionally, disinfectant-related poisonings rose sharply by 74.5% in 2020. In 2021, there was a further increase in poisonings involving hydrochloric acid (HCl): +6.2%, detergents: +3.4%, degreasers: +32.0%, all compared to PV.

Regarding gender, mortality occurred in 22.1% of female cases and 26.4% of male cases. The case fatality ratio (CFR) for corrosive poisonings showed a substantial increase, rising by 36.2% in 2020 and 44% in 2021 compared to predicted values (Figure 6).

Figure 6. Case fatality ratio (CFR) in corrosive poisonings in 2020 and 2021, with comparisons to predicted values



Discussion

Our analysis highlights significant changes in the pattern of CP in North Macedonia during the COVID-19 pandemic, revealing distinct trends in 2020 and 2021. These shifts reflect broader societal, healthcare, and psychological impacts of the pandemic and offer context-specific insights into toxicovigilance during public health crises.

2020 – Pre-Vaccination Phase: Restricted Movement and Emergency Avoidance

In 2020, the number of CP cases decreased by 1.5% compared to predicted values, with a more prominent 17.5% reduction in hospitalizations. This decline coincided with strict lockdown measures, including prolonged curfews and restrictions on movement during national holidays. The reduced number of presentations may have stemmed from public fear of SARS-CoV-2 exposure and avoidance of emergency rooms (ERs), as previously noted in other healthcare settings[7].

Despite fewer cases, the case fatality ratio (CFR) increased by 36.2%, suggesting a higher severity among those who did seek treatment. The suicidal intent in CP was lower during this period, likely influenced by increased family presence, improved support systems, and potential links to mental health services during lockdowns[8]. However, some studies reported a higher incidence of accidental CP than suicidal poisonings in the same timeframe[5], supporting the hypothesis of more incidental exposures due to increased home disinfectant use.

Demographically, female CP cases slightly increased in 2020, in contrast to the overall downward trend in female involvement. This may reflect heightened psychosocial pressures on women during lockdown, such as increased domestic violence and economic instability[4,9]. CP incidence also rose among adolescents and the elderly, particularly those above 75 years, were highly vulnerable to pandemic-related stress. Adolescent neurodevelopmental vulnerabilities under pandemic stress have been well-documented[10] and influence on their behavior. The medical community became increasingly attentive to the mental health vulnerabilities of older adults during

the COVID-19 pandemic, recognizing their greater susceptibility to social isolation and severe illness. A survey conducted in July 2020 indicated that nearly half (46%) of individuals aged 65 and above reported that pandemic-related concerns had adversely affected their mental well-being11.

2021 – Early Vaccination Phase: Eased Restrictions, Rising Severity.

In 2021, the decline in CP cases became more pronounced, with a 25.5% decrease compared to predicted values, while hospitalizations reduced by 6.2%, a smaller reduction than the previous year. Nonetheless, the CFR rose even further by 44%, indicating sustained or worsening severity in CP cases.

Unlike 2020, suicidal CP cases increased in 2021, mirroring trends reported globally [12,13]. This rise may reflect accumulated psychological distress, prolonged isolation, and growing pandemic fatigue, all contributing to growing mental health deterioration and increased determination for self-harm[13].

The mean age of patients increased by 11.0% compared to projections, reflecting an aging CP population and more cases among those over 75 years. Adolescents also remained at elevated risk. The gender distribution continued to shift, with male prevalence remaining stable or slightly increasing, while female representation declined overall, despite the early 2020 spike.

In terms of substance use, poisonings with disinfectants increased, reflecting their widespread household availability during the pandemic[14]. Nevertheless, the most frequently used agents remained acids, followed by bleach and strong alkalis (degreasers) - a pattern consistent with other studies[5,12].

Comparison and Implications

Comparison between 2020 and 2021 revealed distinct phases in CP dynamics during the pandemic. While 2020 was marked by avoidance behavior and reduced emergency visits, 2021 saw a continuation of the case decline but a surge in suicidal intent and poisoning severity. The increasing CFR in both years (36.2% in 2020; 44% in 2021) highlights the pandemic lasting impact on the mental health and partially on quality of acute care and the timeliness of medical intervention[7,15].

Furthermore, most international reports indicated increased suicidal CP during the pandemic 2,4,5, —a trend mirrored in our findings for 2021 but not for 2020. Throughout 2020 and 2021, a stable or slightly increasing male prevalence was observed, reaching near gender parity. The evolving demographic patterns (older age, adolescent involvement, fluctuating gender distribution) call the need for targeted preventive strategies. As seen in our data, the indirect consequences of pandemics can manifest in severe, life-threatening patterns of behavior, such as CP, that require proactive healthcare planning and social support systems.

Conclusion

The COVID-19 pandemic influenced the epidemiology of corrosive poisonings in North Macedonia during 2020 and 2021. While the overall number of cases declined, the severity and lethality of CP increased, especially during the early vaccination phase.

Demographic shifts, including a rise in adolescent and elderly cases, along with gender-specific trends and substance use patterns, reflect the complex interplay between pandemic-related social changes and toxicological outcomes in CP.

Collectively, these findings underscore the importance of ensuring uninterrupted toxicological and mental health services during crises and highlight the need for integrated public health preparedness plans that include toxicovigilance, mental health support, and prevention strategies for high-risk groups.

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