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Special Report from the CDC: Suicide rates, sodium nitrite-related suicides, and online content, United States☆

Karin A. Mack[*], **Wojciech Kaczkowski**, **Steven Sumner**, **Royal Law**, **Amy Wolkin**

Centers for Disease Control & Prevention, National Center for Injury Prevention and Control, Atlanta, GA, United States

Abstract

Background: In 2022, suicide ranked as the 11th leading cause of death in the United States with 49,513 deaths. Provisional mortality data from 2022 indicate a 2.8% increase in the number of suicides compared to 2021. This paper examines overall suicide trends, sodium nitrite ingestion as an emerging suicide method, and the role that online forums play in sharing information about suicide methods (including sodium nitrite ingestion).

Methods: Suicides were identified from CDC's National Vital Statistics System (2018-July 2023 provisional) multiple cause-of-death mortality files using International Classification of Diseases (ICD), Tenth Revision underlying cause-of-death codes U03, X60–X84, and Y87.0 and T code T50.6 (antidotes and chelating agents). Google search popularity metrics were captured from January 2019 to January 2023. Case reports of sodium nitrite related suicide and suicide attempts (through February 2024) were identified in the medical and forensic literature.

Results: At least 768 suicides involving antidotes and chelating agents (including sodium nitrite) occurred between 2018 and July 2023, set in the context of 268,972 total suicides during that period. Overall, suicides involving antidotes and chelating agents (including sodium nitrite) represent <1% of all suicides, however, numbers are rising.

☆Special Report from the CDC: The Journal of Safety Research has partnered with the Office of the Associate Director for Science, Division of Injury Prevention, National Center for Injury Prevention and Control at the CDC in Atlanta, Georgia, USA, to briefly report on some of the latest findings in the research community. This report is the 78th in a series of "Special Report from the CDC" articles on injury prevention.

[*]Corresponding author at: Division of Injury Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention, Atlanta, GA 30341, United States. kmack@cdc.gov (K.A. Mack).

CRediT authorship contribution statement

Karin A. Mack: Conceptualization, Writing – original draft, Writing – review & editing, Data curation. **Wojciech Kaczkowski:** Conceptualization, Writing – original draft, Writing – review & editing. **Steven Sumner:** Conceptualization, Writing – original draft, Writing – review & editing. **Royal Law:** Conceptualization, Data curation, Visualization, Writing – original draft, Writing – review & editing. **Amy Wolkin:** Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Conclusions: Suicide methods are known to change over time. These changes can be influenced by, among other factors, online forums and means accessibility, such as internet purchase availability. CDC remains committed to prevention through comprehensive public health strategies that protect individuals, families, and communities.

Practical Applications: States and community partners might consider leveraging physicians, emergency responders, and other appropriate crisis response groups to disseminate information on sodium nitrite self-poisoning and its antidote, methylene blue. Efforts should be part of a comprehensive public health approach to suicide prevention.

1. Introduction

Suicide is a major public health challenge, both in the United States and worldwide. In recent years, the COVID-19 pandemic has taken a significant mental, physical, and economic toll on individuals, families, and communities, further exacerbating suicide risk factors (Bledsoe et al., 2021; Centers for Disease Control and Prevention, 2022). In 2022, suicide ranked as the 11th leading cause of death in the United States, with 49,513 deaths, and about 136 people per day die by suicide in the United States (Centers for Disease Control and Prevention, 2023b).

Deaths represent a fraction of the problem as the number of people who think about or attempt suicide is considerably higher. In 2021, the number of hospitalizations for self-harm was approximately four times higher than the number of suicides (Healthcare Cost and Utilization Project, 2022) and the number of emergency department (ED) visits related to suicide was around eight times higher (Centers for Disease Control and Prevention, 2023c). In 2022, an estimated 13.2 million American adults seriously thought about suicide, 3.8 million planned a suicide attempt, and 1.6 million attempted suicide (Substance Abuse and Mental Health Services Administration, 2023).

1.1. Suicide methods

Firearms are the most common suicide method in the United States, used in more than half of suicides in 2022 (Kaczkowski et al., 2023). The other common methods are suffocation and poisoning, including drug overdose (Centers for Disease Control and Prevention, 2023b). Suicide methods vary considerably by age, sex, race/ethnicity, and other population characteristics. Suicide methods are also known to change over time. This paper examines sodium nitrite ingestion as an emerging suicide method, and discusses the role that online forums play in sharing information about suicide methods, including sodium nitrite ingestion.

Sodium Nitrite ($NaNO_2$) is used to preserve and cure meat, fish, and certain cheeses because of its antimicrobial effects and because it is a relatively available substance. Sodium nitrite is an inexpensive, odorless, white powder that can easily be confused with table salt and has high water solubility. It is sold online for the purpose of curing meat and can be purchased in large quantities and high concentrations. Acute acquired methemoglobinemia is the most important adverse health effect caused by excessive nitrate or nitrite exposure (Centers for Disease Control and Prevention & Agency for Toxic

Substances and Disease Registry, 2014). There can be a rapid onset of symptoms once nitrite is ingested. Methemoglobinemia is an unusual and potentially fatal condition in which hemoglobin is oxidized to methemoglobin and loses its ability to bind and transport oxygen (Centers for Disease Control and Prevention, 2002). Methylene blue is used as a medication for the treatment of methemoglobinemia (Ludlow et al., 2023).

1.2. Online forums and health discussions

There are many online forums dedicated to discussion of suicidal thoughts, general mental health, as well as specific conditions such as schizophrenia, depression, and bipolar disorder, among others. Forums and their discussions often weave topics of suicide, mental health, depression, and health conditions. Although research on the role of online forums on suicidality is somewhat limited relative to the broader suicide prevention literature, studies have explored both benefits and potential harms associated with forums (Daine et al., 2013; Marchant et al., 2017; Sumner et al., 2021). Online forums also post content about suicide methods. One study reviewed the content of posts in an online community and found that sodium nitrite was the most popular means of suicide discussed and the frequency of mentions of sodium nitrite increased from 2018 through 2022 (Das et al., preprint).

Online forums, also sometimes called internet forums or message boards, are communication spaces typically characterized by the ability of users to post questions or messages and then for others to respond to or answer those messages/questions in a structured conversation “thread.” Benefits of online forums include the ability of patients to share information about treatments, assist in finding social support, and improve knowledge particularly for conditions that may be rare or stigmatized in general discourse. Online forums and social media can be sources of evidence-based prevention information and can be used during crises or suicide clusters to share messages of help and hope (e.g., the five action steps of https://www.bethe1to.com/).

While online health-related forums have served as a source of positive educational and emotional support, forums also evolved to take on new meanings of support, where risk behavior is accepted or promoted. Individuals with suicidal thoughts may visit online forums seeking support and instead be unintentionally exposed to content that may increase their risk of suicide. Other individuals intentionally seek out content that may increase their risk of suicide. Other print and online resources (e.g., *Final Exit* or *Peaceful Pill*) provide method specific information and are often viewed as controversial.

Considering concerns stated above, many leading forum sites have developed explicit policies around what type of content may be discussed on their site. For example, Reddit, which hosts the largest forums globally, including forums discussing suicidality, includes an extensive list of community guidelines for SuicideWatch (a peer support forum for anyone struggling with suicidal thoughts). This includes a prohibition against “pro-suicide posts or comments, or any explicit discussion of suicide methods” and “trolling or incitement to suicide or any type of self-harm or violence.” The forum guidelines indicate that moderators should be alerted to any message “that’s not a direct, personal, supportive response” (https://www.reddit.com/r/SuicideWatch/). Although it is generally recognized that exposure to harmful suicide-related content can increase risk of suicide (Niederkrotenthaler et al., 2010),

it is particularly difficult to restrict access to such content under current frameworks. As noted above, online content and engagement can be supportive and beneficial and it can be challenging to disentangle support and harm. While some websites promoting suicide-related content have been banned in certain countries, laws governing suicide-related content online in the United States are scarce (Phillips et al., 2019). It should also be noted that forums can be hosted on websites/domains based in other nations, and then be accessed from the United States.

In the context then of examining emerging methods of suicide and the nature of information sharing online, we sought to provide a brief overview of suicide in the United States and characterize trends in suicides involving chelating agents. We also reviewed Google trend searches for sodium nitrite and present a synopsis of case studies of sodium nitrite reported in published literature to provide additional contextual information.

2. Methods

Suicides were identified from CDC's National Vital Statistics System multiple cause-of-death mortality files (NVSS) using International Classification of Diseases (ICD), Tenth Revision underlying cause-of-death codes U03, X60–X84, and Y87.0 (Centers for Disease Control and Prevention, 2023b) from 2018 through July 2023. Data from 2022 and 2023 are provisional. The T code T50.6 was used as a surrogate for sodium nitrite as there is not a separate T code in the ICD-10 coding system specific to sodium nitrite. T50.6 includes 26 antidotes, chelating agents, cholinesterase reactivators, and alcohol deterrents and includes both sodium nitrite as well as methylene blue. Thus, counts of deaths involving this code may overestimate the number of sodium nitrite related deaths. Age-adjusted rates (suicides per 100,000 population) were calculated using the direct method and the 2000 U.S. Census Bureau standard population. Hispanic and unknown ethnicity included persons of any race. Racial groups excluded persons of Hispanic or unknown ethnicity. Rates are not provided for non-Hispanic Native Hawaiian or other Pacific Islander persons because of unstable rates in most strata resulting from small numbers of deaths. While all ages are captured, rates are not provided for some age/race strata because of unstable estimates resulting from small numbers of deaths.

Google search popularity metrics measure the relative popularity of key search terms over time on the Google platform, normalized between 0 (lowest relative search popularity) and 100 (highest relative search popularity). Monthly national search popularity for the terms 'sodium nitrite' and 'sodium nitrate' were queried for January 2019 through January 2023.

Finally, case reports of sodium nitrite related suicide and suicide attempts were identified in the medical and forensic literature (PubMed search using related terms and citation review; open beginning date through February 2024) and are summarized.

3. Results

3.1. Overall suicide by age and race

Suicide rates (per 100,000 population) generally increased for most age groups between 1999 and 2022 (Fig. 1) Adults aged 24–44 accounted for just over one-third (34.1%) of all suicides in the United States in 2022, and adults 45–64 just under one-third (31.6%) (Centers for Disease Control and Prevention, 2023b). The suicide rate for those aged 5 to 14 years was 1.2 per 100,000 population in 2022 (503 suicides), and suicide was the 4th leading cause of death in this age group.

Suicide rates also vary by racial and ethnic groups. Non-Hispanic American Indian and Alaska Native persons (27.2 deaths per 100,000 population) and non-Hispanic White persons (17.6 deaths per 100,000 population) had the highest age adjusted suicide rates in 2022 (Centers for Disease Control and Prevention, 2023b). Suicide rates are also markedly different by age group when you consider race and ethnicity. For example, there were relatively higher rates among younger versus older non-Hispanic American Indian and Alaska Native persons, which contrasts with non-Hispanic White persons where rates across adult age groups are very similar (Fig. 2).

3.2. Antidotes and chelating agent related suicides

At least 768 suicides involving antidotes and chelating agents occurred between 2018 and July 2023, set in the context of 268,972 total suicides during that period (Centers for Disease Control and Prevention, 2023b). There were 22 suicides involving antidotes and chelating agents in 2018, rising to 65 in 2019 and 169 in 2020, then declining in 2021 to 152, with provisionally 229 in 2022 and 131 in 2023 (through July; data Feb. 9, 2024; Centers for Disease Control and Prevention, 2023b). Case counts were lowest in 2018 and notably accelerated in March of 2020 (Fig. 3).

Age-adjusted rates (per 100,000 population) of suicides involving antidotes and chelating agents were <0.1 per 100,000 population in 2018–2021 and 0.01 in 2022. Antidotes and chelating agents were involved in <1% of all suicides during the time period of the analysis. By age group, 36.5% of suicides involving T50.6 were persons under age 25 years and males accounted for nearly two-thirds (64.2%) of the suicides involving antidotes and chelating agents between 2018 and 2023 (Table 1). During these years, 63.8% of the number of suicides involving antidotes and chelating agents were non-Hispanic White persons. Eighteen deaths involving antidotes and chelating agents were coded as undetermined between 2018 and 2023 (case counts prior to 2018 are suppressed because of small numbers) (data not shown). At least 68 deaths involving antidotes and chelating agents were coded as unintentional in the last 10 years (Centers for Disease Control and Prevention, 2023b).

3.3. Sodium nitrite-related search metrics through Google trends

Google search popularity for sodium nitrite stayed relatively stable over the study period with the exception of a large influx of searches for sodium nitrite in August 2022, which

could be a result of the autopsy release of a well-known public figure, which occurred in August 2022 and showed sodium nitrite was involved in the suicide (Fig. 4).

3.4. Sodium nitrite literature case studies

Case reports of sodium nitrite related suicide and suicide attempts come from across the globe in the medical and forensic literature, including the United States (Cruz et al., 2018; Dean et al., 2021; Khan et al., 2024; McCann et al., 2021; Mudan et al., 2020; Neth et al., 2021; Pires et al., 2022; Sedhai et al., 2022; Wettstein et al., 2022), Australia (Stephenson et al., 2022), Belgium (Andelhofs et al., 2023), Canada (Hickey et al., 2021; Sajko et al., 2022; Saleh et al., 2022), France (Loiseau et al., 2023; Vodovar et al., 2022), Italy (Barranco et al., 2021; Bugelli et al., 2022; Zerbo et al., 2023), Japan (Katabami et al., 2016), Korea (Hwang et al., 2021; Mun et al., 2022; Nishiguchi et al., 2015; Park et al., 2020; Yoon & Kim, 2022), New Zealand (Harvey et al., 2010), Poland (Tomsia et al., 2021; Tusiewicz et al., 2023), Portugal (Durão et al., 2020, 2021), Slovakia (Szórádová et al., 2024), and the United Kingdom (Hikin et al., 2023; Huntington & Pennington, 2021). Emergency Medical Service (EMS) and hospital treated cases detail treatments and outcomes, including survival (Cruz et al., 2018; Matin et al., 2022; McCann et al., 2021; Mudan et al., 2020). A review of cases in the U.S. National Violent Death Reporting system reported an age range of 13–80 years (Khan et al., 2024). The youngest case report found in the literature in the United States was age 16 years and the oldest was 39 years (mean = 24.5) (Dean et al., 2021; Mudan et al., 2020). These reports provide important case notes. For example, they confirm that sodium nitrite was obtained in some cases via online order, and that patients gathered information about sodium nitrite ingestion as a manner of suicide through online communities (McCann et al., 2021; Mudan et al., 2020). Case reports also provide lessons learned in treating cases. Early notification of the poisoning by the patient or person on the scene allows for timely methylene blue administration (Tong et al., 2020; Wettstein et al., 2022). For example, in one case, a friend of the victim called emergency medical services and told them that the patient had ingested approximately one tablespoon of sodium nitrite. Medical personnel were then prepared to treat with methylene blue and a transfusion of red blood cells (Neth et al., 2021).

4. Discussion

Sodium nitrite-related suicides have increased in recent years, however, they currently represent less than 1% of all suicides. Additionally, information about, and discussions of, sodium nitrite online have increased over time. While this report focused on information from death certificates, Google trends data, and published case reports, other existing data systems can also be used to monitor trends related to ED visits, calls to hotlines, and social media and online forum content. Information from treated cases and deaths is already being used by localities, for example, to provide notice to emergency service personnel about signs, symptoms, and treatments (Colorado Department of Public Health and Environment, 2023; Illinois Department of Public Health, 2019; University of Maryland School of Pharmacy, 2022).

While understanding emerging health concerns remains a persistent challenge, new surveillance systems based on near real-time ED, EMS, and syndromic data can potentially help in early detection of such emerging health threats. Used as early warning notification systems, these sources can inform local prevention and identify emerging methods of suicide and suicide attempt clusters. Furthermore, combining information from multiple data systems can enhance the accuracy of information. For example, ensemble modeling (combining multiple data streams through machine learning) has been shown to provide fairly accurate estimates of suicide fatalities in a near–real-time fashion and is less prone to the underlying biases, idiosyncrasies, and unique characteristics of any single data source (Choi et al., 2020). Information from online, big-data sources and use of data science processes can also aid in rapid exploration of emerging trends in suicidal thoughts and behaviors. This information, however, only provides a snapshot of a point in time. It does not give us, for example, information on contributors to or viewers of social forum exchanges. The demographic characteristics of individuals or biopsychosocial factors cannot be fully realized through captures of social media/forums posts, which include individuals who reside outside the United States. Further, these methods must be nimble enough to capture changes in use patterns, sites, norms, and key word changes in real-time. Models attempting to harness information from novel data sources will need to be adaptive, free of bias, and incorporate new and changing data sources that emerge as leading proxy signals for suicide (Choi et al., 2020; National Academies of Sciences, 2022).

Despite robust statistics on suicides, gaps remain in established systems as noted above, and not enough is known about the people who visit online forums seeking information related to suicide. A focus should remain on monitoring social media dissemination and promotion of suicide mechanisms. Generally, there remains a paucity of high-quality studies that fully evaluate the benefits and risks of engagement with online forums, specifically for suicide-related content. We know little about individual risk and protective factors prior to online engagement, and thus we know little about how encounters with online content modifies those factors. Understanding how individuals engage, adapt, and combine (such as professional counseling and online forum engagement) prevention resources may help identify the influence of different resources and inform prevention strategies.

Public messaging and media can influence suicide risk (Niederkrotenthaler et al., 2010). Suicide prevention-related media campaigns can promote resiliency and encourage help-seeking behaviors. Safe media reporting following a suicide is critical. Results from a meta-analysis found that increases in suicides were associated with 2019–2020 media reporting of a celebrity suicide and stories featuring glorification or romanticized portrayals of suicide (Niederkrotenthaler et al., 2022). Stories with a focus on suicide prevention, community suicide clusters, and healing stories were associated with more help-seeking (Niederkrotenthaler et al., 2022). Research suggests that media reports following a suicide that include exposure to sensationalized or otherwise uninformed reporting can inadvertently contribute to suicide contagion (Gould et al., 2014). One sodium nitrite case report noted that the suicide occurred four days after news reports covered a celebrity sodium nitrite ingestion suicide (Matin et al., 2022). Although the case could not be directly linked to the media reports, the case study noted that the celebrity death was covered by news outlets

where it was reported that instructions on how to ingest a lethal dose of sodium nitrite was found in online forums and the substance was purchased online.

Importantly, prevention focused messaging can enhance engagement. Improved adherence to safe-reporting guidelines about suicide can improve article sharing (reach and engagement) on social media, generating evidence that incentivizes publishers to report on suicide in safe ways (Sumner et al., 2020). In response to research (Sumner et al., 2020), Facebook introduced a ranking signal to demote news articles that describe suicide in unsafe ways per guidelines from major health organizations.

CDC's Comprehensive Suicide Prevention program funds activities in 24 programs to implement and evaluate a comprehensive public health approach to suicide prevention (Centers for Disease Control and Prevention, 2023a). CDC's comprehensive approach to suicide includes: having strong leadership to convene and connect multi-sectoral partnerships; using data to identify disproportionately affected populations with increased risk of suicide; understanding contributors to suicide and suicidal behaviors; tracking trends in suicide deaths and suicidal behavior; identifying and assessing gaps in existing programs in the jurisdiction; implementing and evaluating complementary strategies with the best available evidence from the Suicide Prevention Resource for Action; and developing, implementing, and evaluating a communication and dissemination plan to communicate trends, progress, successes, and lessons learned to partners (Centers for Disease Control and Prevention, 2023a).

4.1. Limitations

NVSS Mortality data are available more rapidly than in the past with provisional data posted on CDC WONDER. However, the process of death determination for suicides results in a lag for the release of these counts. We used full years of data for charts (through 2022; provisional), but included death counts that were available (July 2023; provisional) at the time of writing this report for Table 1. Further, while we have information from ICD cause-of-death codes and literal text descriptions written on death certificates, the circumstances of the death and related factors are generally not available in National Vital Statistics System. Finally, these results may over or underestimate the number of sodium nitrite related suicides. The T code used also include the antidote for sodium nitrite poisoning which might overestimate cases, but the involvement of specific substances might also not be included in the case record, which would underestimate cases. The Google trend search used information available to us at the time of analysis and does not match the time frame of NVSS. The literature review was updated to be current at the time of writing.

5. Conclusion

Results confirm that sodium nitrite ingestion is an emerging suicide method. However, sodium nitrite-related suicides represent <1% of all suicides. Other data sources confirm that social media and online forums share information about suicide methods, including sodium nitrite ingestion, and the level of online content has increased.

6. Practical Applications

States and community partners can leverage physicians, emergency responders, and other appropriate crisis response groups, such as crisis text line and mobile crisis teams, to distribute information broadly on suicide prevention, and specifically on treating sodium nitrite ingestions. Distribution of information on sodium nitrite and its antidote, methylene blue, to healthcare workers who may encounter individuals who attempt suicide by this method is a prudent public health action. Factsheets and other easily disseminated information spread through mediums that reach emergency healthcare professionals may be important (Federal Bureau of Investigation, 2023; Illinois Department of Public Health, 2019; Neth et al., 2021; University of Maryland School of Pharmacy, 2022).

Call or text 988 Suicide and Crisis Lifeline if you are experiencing mental health-related distress or are worried about a loved one who may need crisis support. 988lifeline.org Connect with a trained crisis counselor. 988 is confidential, free, and available 24/7/365. Visit (or chat) the 988 Suicide and Crisis Lifeline for more information at 988lifeline.org.

7 Disclaimer

The findings and conclusions in this publication are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Biographies

Karin A. Mack, PhD is the Associate Director for Science in the Division of Injury Prevention, National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. Her current projects include research on preventing suicide, drowning, and overdoses. Dr. Mack earned her PhD in Sociology/Demography/Survey Research at the University of Maryland, and a Bachelor's degree in Socioeconomics from James Madison College of Michigan State University. She is Adjunct Faculty at Emory University (Sociology Department).

Wojciech Kaczkowski, PhD is a Health Scientist (Data Scientist) on the Suicide Prevention Team in the CDC's Division of Injury Prevention. He completed his PhD in Community Psychology at Georgia State University, followed by PPEO Evaluation Fellowship at CDC's Division of Adolescent and School Health. His work focuses on youth suicide prevention and data collection and optimization in suicide research.

Royal Law PhD MPH is the Team Lead for the CDC Data Science Team in the Data Analytics Branch, Division of Injury Prevention, National Center for Injury Prevention and Control. He leads a multidisciplinary team of data scientists, statisticians, and health scientists in applying data science techniques to critical injury topics including opioids, adverse childhood experiences, and suicide prevention. He received his Doctorate in Epidemiology at Georgia State University, Masters of Public Health at Emory University, and Bachelors of Science in Biomedical Engineering at Georgia Tech.

AmyWolkin,DrPH, MSPH is the Chief of the Data Analytics Branch, Division of Injury Prevention at the National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. Her research experience includes data analytics, surveillance, injury research and prevention, environmental epidemiology, and emergency preparedness and response. Dr. Wolkin received her Doctorate of Public Health from the University of North Carolina and her Masters of Science in Public Health from Emory University. Dr. Wolkin joined the CDC in 2002.

Steven A. Sumner, MD is Senior Advisor in the Division of Violence Prevention, National Center for Injury Prevention and Control, at the Centers for Disease Control and Prevention. His research interests include violence and injury prevention, the application of machine learning to health data, and use of novel real-time data sources for public health. He completed medical school at the Medical College of Wisconsin and an Internal Medicine residency at Duke University.

References

Andelhofs D, Van Den Bogaert W, Lepla B, Croes K, & Van de Voorde W (2023). Suicidal sodium nitrite intoxication: A case report focusing on the postmortem findings and toxicological analyses-review of the literature. Forensic Science, Medicine, and Pathology. 10.1007/s12024-023-00664-9

Barranco R, Frigiolini FME, Orcioni GF, Malandrino M, Salomone A, & Ventura F (2021). A Rare case of fatal self-poisoning with sodium nitrite: Autopsy and toxicological findings. The American Journal of Forensic Medicine and Pathology, 42(4), 379–382. 10.1097/PAF.0000000000000697 [PubMed: 34310360]

Bledsoe M, Captanian A, & Somji A (2021). Special report from the CDC: Strengthening social connections to prevent suicide and adverse childhood experiences (ACEs): Actions and opportunities during the COVID-19 pandemic. Journal of Safety Research, 77, 328–333. 10.1016/j.jsr.2021.03.014 [PubMed: 34092325]

Bugelli V, Tarozzi I, Manetti AC, Stefanelli F, Di Paolo M, & Chericoni S (2022). Four cases of sodium nitrite suicidal ingestion: A new trend and a relevant forensic pathology and toxicology challenge. Legal Medicine (Tokyo, Japan), 59, Article 102146. 10.1016/j.legalmed.2022.102146

Centers for Disease Control and Prevention. (2002). Methemoglobinemia following unintentional ingestion of sodium nitrite–New York, 2002. MMWR Morbidity and Mortality Weekly Report, 51(29), 639–642. [PubMed: 12186221]

Centers for Disease Control and Prevention. (2022). Suicide prevention resource for action: A compilation of the best available evidence. https://www.cdc.gov/suicide/pdf/preventionresource.pdf.

Centers for Disease Control and Prevention. (2023a). Comprehensive suicide prevention. Retrieved 3 March 2023 from https://www.cdc.gov/suicide/programs/csp/index.html.

Centers for Disease Control and Prevention. (2023b). National Vital Statistics System, Mortality on CDC WONDER Online Database, released in 2023. Data are from the Multiple Cause of Death Files.

Centers for Disease Control and Prevention. (2023c). Web-based Injury Statistics Query and Reporting System (WISQARS).

Centers for Disease Control and Prevention, & Agency for Toxic Substances and Disease Registry. (2014). What Are the Health Effects from Exposure to Nitrates and Nitrites?. Retrieved March 12 from https://www.atsdr.cdc.gov/csem/nitrate-nitrite/health_effects.html.

Choi D, Sumner SA, Holland KM, Draper J, Murphy S, Bowen DA, & De Choudhury M (2020). Development of a machine Learning model using multiple, heterogeneous data sources to estimate weekly US suicide fatalities. JAMA Network Open, 3(12), e2030932.

Colorado Department of Public Health and Environment. (2023). HEALTH ADVISORY | Recent suicide attempts with sodium nitrite. Retrieved from https://cdphe.colorado.gov/health-alert-network.

Cruz MD, Glick J, Merker SH, & Vearrier D (2018). Survival after severe methemoglobinemia secondary to sodium nitrate ingestion. Toxicology Communications, 2(1), 21–23. 10.1080/24734306.2018.1467532

Daine K, Hawton K, Singaravelu V, Stewart A, Simkin S, & Montgomery P (2013). The power of the web: A systematic review of studies of the influence of the internet on self-harm and suicide in young people. PLoS One1, 8(10), e77555.

Das S, Walker D, Rajwal S, Lakamana S, Sumner S, Mack K, … Sarker A (preprint). Emerging trends in self-harm: Sodium nitrite and an online suicide community. JMIR. doi: 10.2196/preprints.53730.

Dean DE, Looman KB, & Topmiller RG (2021). Fatal methemoglobinemia in three suicidal sodium nitrite poisonings. Journal of Forensic Sciences, 66(4), 1570–1576. 10.1111/1556-4029.14689 [PubMed: 33598944]

Durão C, Pedrosa F, & Dinis-Oliveira RJ (2020). A fatal case by a suicide kit containing sodium nitrite ordered on the internet. Journal of Forensic and Legal Medicine, 73, Article 101989. 10.1016/j.jflm.2020.101989

Durão C, Pedrosa F, & Dinis-Oliveira RJ (2021). Another suicide by sodium nitrite and multiple drugs: An alarming trend for “exit”? Forensic Science, Medicine, and Pathology, 17(2), 362–366. 10.1007/s12024-020-00340-2 [PubMed: 33247411]

Federal Bureau of Investigation. (2023). Sodium Nitrite Abuse Poses a Risk to Public Health. Public Safety Awareness Report.

Gould MS, Kleinman MH, Lake AM, Forman J, & Midle JB (2014). Newspaper coverage of suicide and initiation of suicide clusters in teenagers in the USA, 1988–96: A retrospective, population-based, case-control study. Lancet Psychiatry, 1 (1), 34–43. 10.1016/S2215-0366(14)70225-1 [PubMed: 26360401]

Harvey M, Cave G, & Chanwai G (2010). Fatal methaemoglobinaemia induced by self-poisoning with sodium nitrite. Emergency Medicine Australasia, 22(5), 463–465. 10.1111/j.1742-6723.2010.01335.x [PubMed: 21040485]

Healthcare Cost and Utilization Project. (2022). National Inpatient Sample (NIS). https://www.hcup-us.ahrq.gov/news/announcements/nis2020.jsp.

Hickey TBM, MacNeil JA, Hansmeyer C, & Pickup MJ (2021). Fatal methemoglobinemia: A case series highlighting a new trend in intentional sodium nitrite or sodium nitrate ingestion as a method of suicide. Forensic Science International, 326, Article 110907. 10.1016/j.forsciint.2021.110907

Hikin LJ, Ho J, Morley SR, Ahluwalia A, & Smith PR (2023). Sodium nitrite poisoning: A series of 20 fatalities in which post-mortem blood nitrite and nitrate concentrations are reported. Forensic Science International, 345, Article 111610. 10.1016/j.forsciint.2023.111610

Huntington GR, & Pennington JM (2021). Fatal methaemoglobinaemia due to intentional sodium nitrite poisoning. Acute Medicine, 20(2), 148–150. [PubMed: 34190743]

Hwang C, Yeon SH, Jung J, & Na JY (2021). An autopsy case of sodium nitrite-induced methemoglobinemia with various post-mortem analyses. Forensic Science, Medicine, and Pathology, 17(3), 475–480. 10.1007/s12024-021-00378-w [PubMed: 33961276]

Illinois Department of Public Health. (2019). Health Alert. https://www.dhs.state.il.us/OneNetLibrary/27896/documents/By_Division/MentalHealth/2020/CommunityAlerts/12132019-CommAlert-HealthAlert_sodiumNitrite.pdf.

Kaczkowski W, Kegler SR, Chen MS, Zwald ML, Stone DM, & Sumner SA (2023). Notes from the field: Firearm suicide rates, by race and ethnicity - United States, 2019–2022. MMWR. Morbidity and Mortality Weekly Report, 72(48), 1307–1308. 10.15585/mmwr.mm7248a3 [PubMed: 38032829]

Katabami K, Hayakawa M, & Gando S (2016). Severe methemoglobinemia due to sodium nitrite poisoning. Case Reports in Emergency Medicine, 2016, 9013816. 10.1155/2016/9013816

Khan H, Barber C, & Azrael D (2024). Suicide by sodium nitrite poisoning: Findings from the National Violent Death Reporting System, 2018–2020. Suicide & Life-Threatening Behavior. 10.1111/sltb.13043

Loiseau M, Matheux A, Sabini S, Cavard S, Advenier AS, Pasquet A, & Guerard P (2023). Suicide of an adolescent girl with sodium nitrite ordered on the internet. Journal of Forensic Sciences, 68(6), 2200–2204. 10.1111/1556-4029.15350 [PubMed: 37526251]

Ludlow J, Wilkerson J, & Nappe T (2023). Methemoglobinemia. StatPearls; https://www.ncbi.nlm.nih.gov/pubmed/30726002. https://doi.org/NBK537317.

Marchant A, Hawton K, Stewart A, Montgomery P, Singaravelu V, Lloyd K, & John A (2017). A systematic review of the relationship between internet use, self-harm and suicidal behaviour in young people: The good, the bad and the unknown. PLoS One, 12(8), e0181722.

Matin AM, Boie ET, & Moore GP (2022). Survival after self-poisoning with sodium nitrite: A case report. Journal of the American College of Emergency Physicians Open, 3 (2), e12702. [PubMed: 35342896]

McCann SD, Kennedy JM, Tweet MS, & Bryant SM (2021). Sodium nitrite ingestion: An Emerging trend in suicide attempts shared via online communities. The Journal of Emergency Medicine, 60(3), 409–412. 10.1016/j.jemermed.2020.10.021

Mudan A, Repplinger D, Lebin J, Lewis J, Vohra R, & Smollin C (2020). Severe methemoglobinemia and death from intentional sodium nitrite ingestions. The Journal of Emergency Medicine, 59(3), e85–e88. 10.1016/j.jemermed.2020.06.031 [PubMed: 32713620]

Mun SH, Park GJ, Lee JH, Kim YM, Chai HS, & Kim SC (2022). Two cases of fatal methemoglobinemia caused by self-poisoning with sodium nitrite: A case report. Medicine (Baltimore), 101(7), e28810. [PubMed: 35363170]

National Academies of Sciences, E., and Medicine. (2022). Innovative data science approaches to identify individuals, populations, and communities at high risk for suicide: Proceedings of a workshop. doi: 10.17226/26752.

Neth MR, Love JS, Horowitz BZ, Shertz MD, Sahni R, & Daya MR (2021). Fatal sodium nitrite poisoning: Key considerations for prehospital providers. Prehospital Emergency Care, 25(6), 844–850. 10.1080/10903127.2020.1838009 [PubMed: 33074043]

Niederkrotenthaler T, Laido Z, Gould M, Lake AM, Sinyor M, Kirchner S, & Till B (2022). Associations of suicide-related media reporting characteristics with help-seeking and suicide in Oregon and Washington. Australian and New Zealand Journal of Psychiatry, 57(7), Article 48674221146474. 10.1177/00048674221146474

Niederkrotenthaler T, Voracek M, Herberth A, Till B, Strauss M, Etzersdorfer E, & Sonneck G (2010). Role of media reports in completed and prevented suicide: Werther v. Papageno effects. The British Journal of Psychiatry, 197(3), 234–243. 10.1192/bjp.bp.109.074633 [PubMed: 20807970]

Nishiguchi M, Nushida H, Okudaira N, & Nishio H (2015). An autopsy case of fatal methemoglobinemia due to ingestion of sodium nitrite. Journal of Forensic Research, 6(1). 10.4172/2157-7145.1000262

Park MJ, Kim O, & Ha H (2020). Death by nitrite intoxication: Report of 14 cases. Korean J Leg Med, 44, 96–101.

Phillips JG, Diesfeld K, & Mann L (2019). Instances of online suicide, the law and potential solutions. Psychiatry, Psychology and Law, 26(3), 423–440. 10.1080/13218719.2018.1506719

Pires KD, Hart K, & Tomassoni AJ (2022). Internet-assisted suicide by nitrite poisoning - a case report and increase in reported intentional nitrite/nitrate exposures in U.S. Poison Center data. Clinical Toxicology (Philadelphia, Pa.), 60(2), 271–272. 10.1080/15563650.2021.1926474 [PubMed: 34034611]

Sajko N, Finn K, Hill J, Khaira GK, Duff JP, Jiwani F, & Oliva MA (2022). Near-fatal pediatric methemoglobinemia secondary to intentional sodium nitrite ingestion. The American Journal of Emergency Medicine, 59, 215.e211–215.e215. 10.1016/j.ajem.2022.05.051

Saleh D, Lucyk S, & McGillis E (2022). Methemoglobinemia caused by sodium nitrite overdose. CMAJ, 194(30), E1066–E1067. 10.1503/cmaj.220434 [PubMed: 35940618]

Sedhai YR, Atreya A, Basnyat S, Phuyal P, & Pokhrel S (2022). The use of sodium nitrite for deliberate self-harm, and the online suicide market: Should we care? The Medico-Legal Journal, 90(2), 79–80. 10.1177/0025817221998119 [PubMed: 33906496]

Stephenson L, Wills S, van den Heuvel C, Humphries M, & Byard RW (2022). Increasing use of sodium nitrite in suicides-an emerging trend. Forensic Science, Medicine, and Pathology, 18(3), 311–318. 10.1007/s12024-022-00471-8 [PubMed: 35334075]

Substance Abuse and Mental Health Services Administration. (2023). Key substance use and mental health indicators in the United States: Results from the 2022 National Survey on Drug Use and Health (HHS Publication No. PEP22-07-01-005, NSDUH Series H-57. https://www.samhsa.gov/data/sites/default/files/reports/rpt42731/2022-nsduh-nnr.pdf.

Sumner SA, Burke M, & Kooti F (2020). Adherence to suicide reporting guidelines by news shared on a social networking platform. Proceedings of the National Academy of Sciences of the United States of America, 117(28), 16267–16272. 10.1073/pnas.2001230117 [PubMed: 32631982]

Sumner SA, Ferguson B, Bason B, Dink J, Yard E, Hertz M, & Jones CM (2021). Association of online risk factors with subsequent youth suicide-related behaviors in the US. JAMA Network Open, 4(9), e2125860.

Szórádová A, Hojsík D, Zdarílek M, Valent D, Nižnanský Ľ, Kovács A, & Šidlo J (2024). Modern suicide trend from internet. Legal Medicine (Tokyo, Japan), 67, Article 102384. 10.1016/j.legalmed.2023.102384

Tomsia M, Głaz M, Nowicka J, & Szczepański M (2021). Sodium nitrite detection in costal cartilage and vitreous humor - case report of fatal poisoning with sodium nitrite. Journal of Forensic and Legal Medicine, 81, Article 102186. 10.1016/j.jflm.2021.102186

Tong LK, Lee HM, & Graudins A (2020). Survival from severe methemoglobinemia after intentional ingestion of sodium nitrite. Is this an emerging method for suicide? Journal of Medical Toxicology, 16, 129.

Tusiewicz K, Kuropka P, Workiewicz E, Wachełko O, Szpot P, & Zawadzki M (2023). Nitrites: An old poison or a current Hazard? epidemiology of intoxications covering the last 100 years and evaluation of analytical methods. Toxics, 11(10). 10.3390/toxics11100832

University of Maryland School of Pharmacy. (2022). Sodium nitrite poisoning. https://www.mdpoison.com/media/SOP/mdpoisoncom/ToxTidbits/2022/SodiumNitrite-Dec-2022.pdf.

Vodovar D, Tournoud C, Boltz P, Paradis C, & Puskarczyk E (2022). Severe intentional sodium nitrite poisoning is also being seen in France. Clinical Toxicology (Philadelphia, Pa.), 60(2), 272–274. 10.1080/15563650.2021.1919695 [PubMed: 33988068]

Wettstein ZS, Yarid NA, & Shah S (2022). Fatal methaemoglobinemia due to intentional sodium nitrite ingestion. BML Case Reports, 15(12). 10.1136/bcr-2022-252954

Yoon JC, & Kim SE (2022). Suicide attempt using sodium nitrite ordered on the internet: Two case reports. Medicine (Baltimore), 101(28), e29355. [PubMed: 35839015]

Zerbo S, Spanò M, Albano GD, Buscemi R, Malta G, & Argo A (2023). A fatal suicidal sodium nitrite ingestion determined six days after death. Journal of Forensic and Legal Medicine, 98, Article 102576. 10.1016/j.jflm.2023.102576

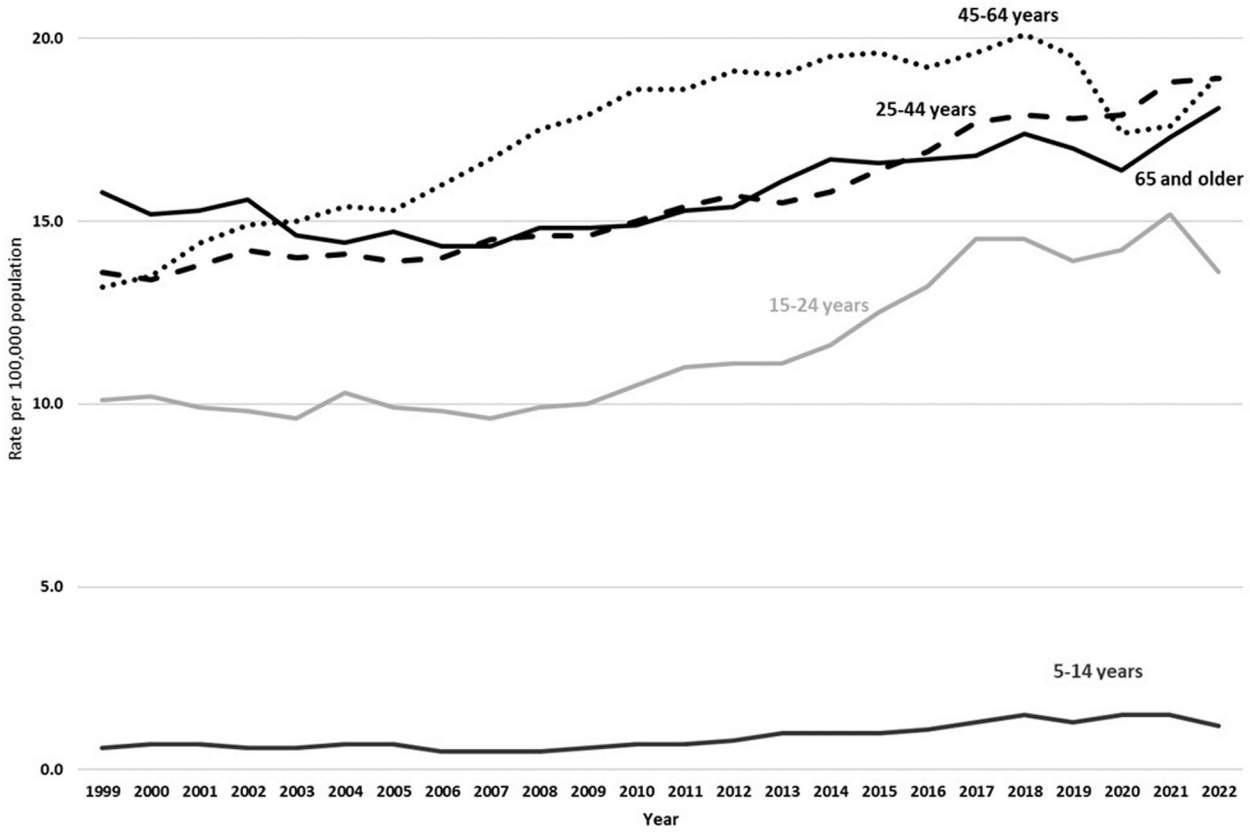

Fig. 1. Rate (per 100,000 population) of suicide by age group — National Vital Statistics System - Mortality, United States, 1999–2022.

Suicide deaths were identified by using International Classification of Diseases, Tenth Revision underlying cause-of-death codes U03, X60–X84, and Y87.0. 2022 data are provisional. Source: CDC Wonder Accessed at http://wonder.cdc.gov/mcd-icd10-provisional.html on Feb 9, 2024.

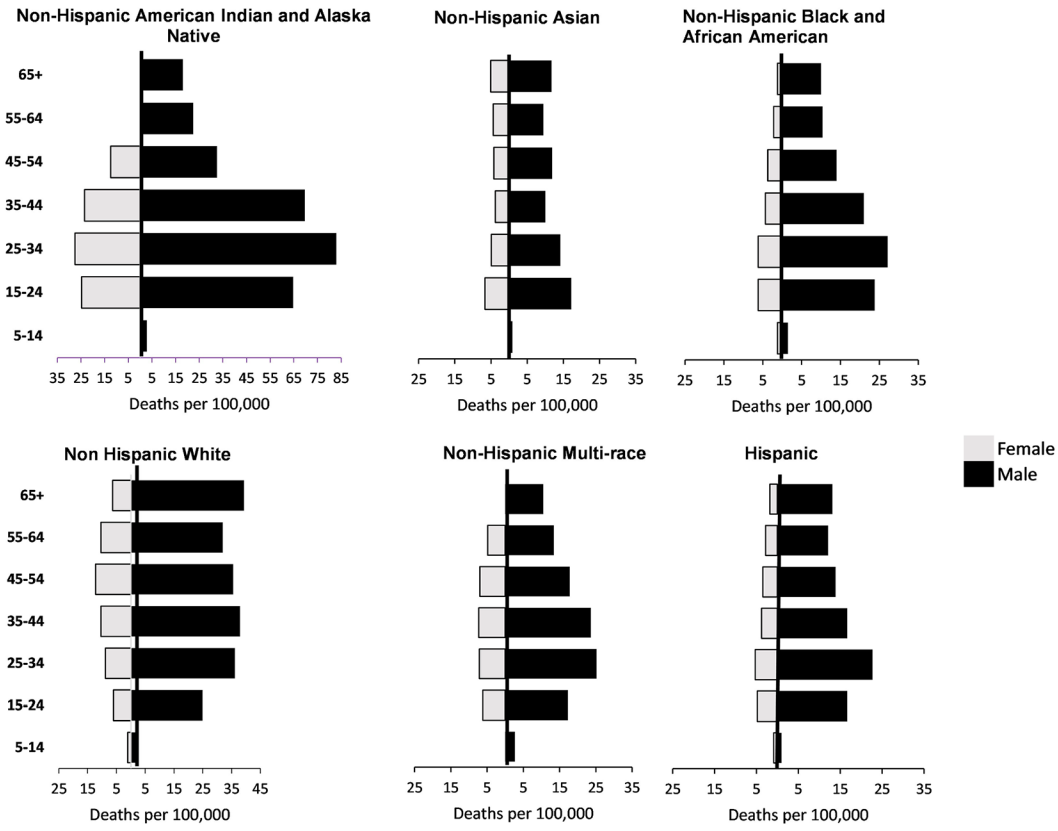

Fig. 2. Crude rate (per 100,000 population) of suicide, stratified by race/ethnicity, sex, and age group — National Vital Statistics System - Mortality, United States, 2021–2022.

Suicide deaths were identified by using International Classification of Diseases, Tenth Revision underlying cause-of-death codes U03, X60–X84, and Y87.0. 2022 data are provisional. Data for Hispanic or Latino (Hispanic) origin should be interpreted with caution; studies comparing Hispanic origin on death certificates and on U.S. Census Bureau surveys have shown inconsistent reporting on Hispanic ethnicity. Potential racial misclassification might lead to underestimates for certain categories, primarily American Indian, Alaska Native, Asian, and other Pacific Islander decedents. Hispanic ethnicity includes persons of any race. Racial groups exclude persons of Hispanic ethnicity. Source: CDC WONDER Accessed at http://wonder.cdc.gov/mcd-icd10-provisional.html on Feb 9, 2024.

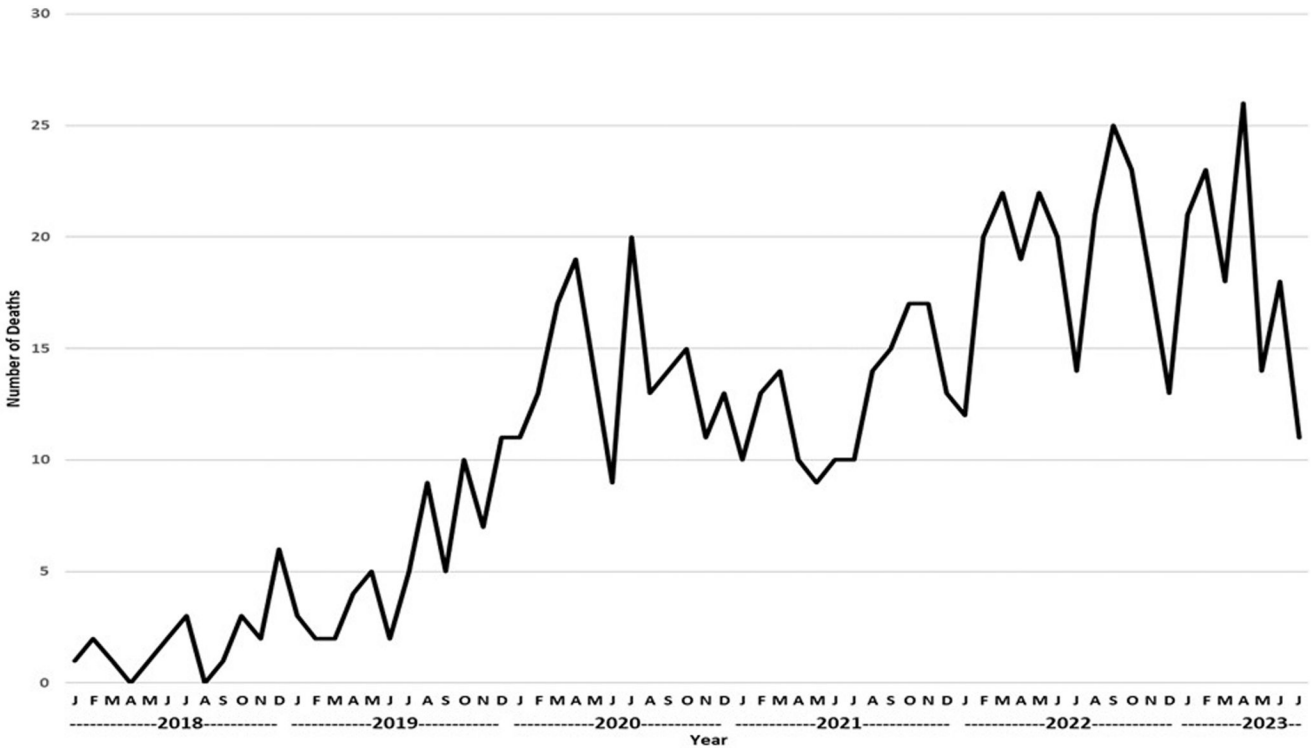

Fig. 3. Number of chelating agent-related suicides by month and year, National Vital Statistics System - Mortality, United States, January 2018- July 2023.

Months are abbreviated to first letter. Suicide deaths involving chelating agents were identified by using International Classification of Diseases, Tenth Revision underlying cause-of-death codes U03, X60–X84, and Y87.0 and T code T50.6. 2022 and 2023 data are provisional. Source: CDC WONDER Accessed at http://wonder.cdc.gov/mcd-icd10-provisional.html on Feb 9, 2024.

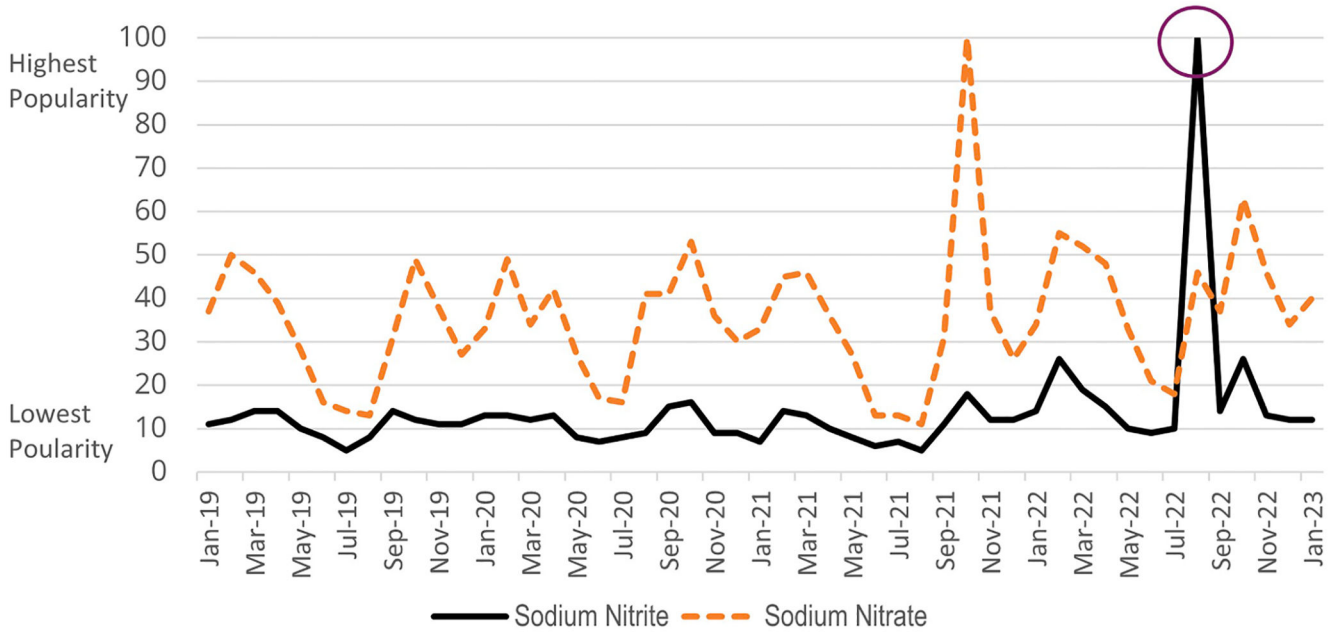

Fig. 4.

Relative search popularity metrics for sodium nitrite-related terms in Google, January 2019 through January 2023.

Table 1

Chelating agent-related suicides by age, gender and race/ethnicity, January 2018- July 2023, National Vital Statistics System - Mortality, United States.

	Number of Deaths	Percent
Total	768	
Age group *		
15–24 years	280	36.5%
25–34 years	241	31.4%
35–44 years	109	14.2%
45–54 years	78	10.2%
55–64 years	32	4.2%
65–74 years	17	2.2%
Gender		
Female	275	35.8%
Male	493	64.2%
Race or Ethnicity *		
Non-Hispanic Asian	102	13.3%
Non-Hispanic Black or African American	70	9.1%
Non-Hispanic White	490	63.8%
Non-Hispanic Multi-race	22	2.9%
Hispanic	79	10.3%

Suicide deaths involving chelating agents were identified by using International Classification of Diseases, Tenth Revision underlying cause-of-death codes U03, X60–X84, and Y87.0 and T code T50.6. 2022 and 2023 data are provisional. Hispanic ethnicity includes persons of any race. Racial groups exclude persons of Hispanic ethnicity. Source: CDC WONDER Accessed at https://wonder.cdc.gov/mcd-icd10-provisional.html on Feb 9, 2024.

* Number of deaths for some groups were suppressed due to low counts and are not included in Table rows.