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ORIGINAL RESEARCH

Main Causes of Death from Poisoning or Intoxication Among Individuals Under 20 Years of Age and Their Geographic Distribution in Mexico, 2000–2022

Principales causas de mortalidad en menores de 20 años por intoxicación o envenenamiento y su distribución geográfica en México, entre los años 2000-2022

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Abstract

Poisoning and intoxication represent a complex public health problem, due to the wide range of substances involved, with mechanisms of exposure that vary by age and geographic region. This study aims to describe the main causes of death due to poisoning or intoxication among individuals under 20 years old in Mexico, as well as their geographic distribution between 2000 and 2022. Methodology: This is an ecological, observational, retrospective, and longitudinal study based on data from the Health Information System (SIS). Results: A total of 7,377 deaths were recorded in the population studied. Conclusion: On average, six deaths occurred per week, with no significant difference between sexes.
Keywords: mortality, poisoning, individuals under 20 years, geographic distribution.

Resumen

El envenenamiento y las intoxicaciones representan un problema complejo debido a la diversidad de compuestos involucrados, cuyos mecanismos de exposición varían según la edad y la región geográfica. Este estudio tiene como objetivo describir las principales causas de mortalidad por intoxicación o envenenamiento en menores de 20 años en México, así como su distribución geográfica entre 2000 y 2022. Metodología: se trata de un estudio ecológico, observacional, retrospectivo y longitudinal, basado en datos del Sistema de Información en Salud (SIS). Resultados: se registraron 7377 muertes en el grupo etario estudiado. Conclusión: en promedio, ocurrieron seis muertes semanales sin distinción de sexo.
Palabras clave: mortalidad, envenenamiento, menores de 20 años, distribución geográfica.

Introduction

Infant and youth mortality is one of the main indicators of a population's health [1]. Over the past few decades, its reduction has represented a significant achievement for many countries. However, deaths related to poisoning and intoxication remain a serious concern, particularly among minors.

In 2019, the United Nations Children's Fund (UNICEF) reported 6.1 million deaths among children and adolescents, of which 5.2 million were under the age of five, and nearly half were newborns [2]. By 2015, 7.3 million deaths among individuals under 20 years of age were recorded in low- and middle-income countries [3]. These figures highlight the magnitude of the problem, with millions of deaths each year from such causes—many of them preventable.

Globally, more than one million children die from poisoning or intoxication, most often in rural areas. In the United States alone, 87 people die every day and around 2,277 receive medical treatment as a result of poisoning [4]. In 2007, accidental poisoning ranked between sixth and ninth place among causes of death across different age groups [5].

Between 2013 and 2019, hospitalizations due to poisoning were reported alongside those caused by trauma, placing poisoning as the third leading cause in that category [6].

Between 2016 and 2020, 459 children under the age of 16 were admitted to emergency departments due to some form of poisoning, representing a prevalence of 3.16% out of a total of 14,539 emergency admissions. It is estimated that one out of every 100 hospitalized patients is admitted due to intoxication, and eight out of every 100 autopsies performed worldwide are attributed to toxic deaths [7,8].

Poisoning or intoxication occurs when a toxic (poisonous) substance is ingested, inhaled, or comes into contact with the skin. The source may be botanical, chemical, or derived from the secretions of venomous animals [9]. Depending on the concentration reached in the body, such exposure can cause injury, illness, or even death [10].

In Mexico, both historical and contemporary studies indicate that accidental poisoning has been a persistent cause of death among children and adolescents. Between 1979 and 1994, a total of 11,272 accidental poisoning deaths were recorded among individuals under 15 years of age. Of these, 93% (10,511 deaths) were due to accidental poisoning by antipyretics, analgesics, drugs, chemical preparations (used in agriculture and horticulture), carbon monoxide, and domestic gas, while 56% were related to toxic reactions caused by poisonous plants and animals [11].

These data demonstrate that mortality among minors remains a significant problem, raising the question, "What were the main causes of death by poisoning or intoxication among minors?" Therefore, the objective of this study is to describe the main causes of death due to poisoning or intoxication among individuals under 20 years of age, and their geographic distribution in Mexico.

Methodology

This was an ecological, observational, descriptive, retrospective, and longitudinal study [12]. Mortality databases recorded in the Health Information System (SIS) were analyzed for the period 2000–2022 [13], following the criteria established in the International Classification of Diseases, 10th Revision (ICD-10) [14]. Cases were examined across 64 available categories**,** identifying the seven main causes of death**,** which were classified for analysis.

The variable "causes" was categorized as follows: Other chemical products and harmful or unspecified substances (X49, X69, Y19); Pesticides (X48, X68, Y18); Carbon monoxide, other gases, and vapors (X47, X67, Y17); Traumatic contact with venomous animals and plants (X20–X29); Drugs, medications, and biological substances (X40–X44, X60–X64, Y10–Y14); Alcohol (X45, X65, Y15); Organic solvents, halogenated hydrocarbons, and their vapors (X46, X66, Y16).
The demographic variables analyzed were as follows; Sex: All cases recorded as male or female

were included, excluding those marked as unspecified. Age: Data were grouped in five-year intervals**,** following the INEGI methodology [15], using the following categories: 0–4, 5–9, 10–14, and 15–19 years. Place of death: All deaths recorded under these causes were included for each federal entity, in order to analyze their geographic distribution**.**

The data were organized by frequency, ranking causes in descending order. As part of the exploratory analysis**,** frequencies of the variables of interest and their corresponding percentages were calculated, using the total number of cases for each cause as the denominator, disaggregated by sex.

Results

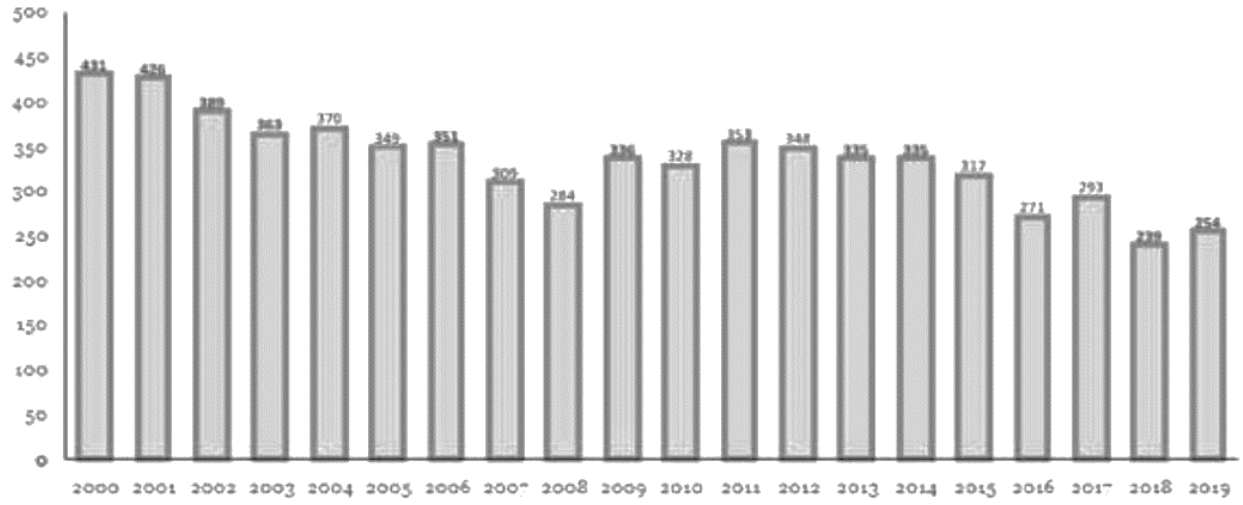
In Mexico, between 2000 and 2022, a total of 7,377 deaths due to poisoning or intoxication were recorded among individuals under 20 years of age. Of these, 83% (6,171 deaths) corresponded to only four main causes: other chemical products and harmful or unspecified substances; pesticides; carbon monoxide and other gases and vapors; and traumatic contact with venomous animals and plants. This indicates that eight out of every ten deaths were concentrated in these four categories (Table 1).

Table 1. Causes of poisoning by sex among individuals under 20 years of age in Mexico, 2000–2022

ICD-10 Code*	Cause	Sex		Total
		Female	*Male*	
X49, X69, Y-19	Other chemical products and harmful or unspecified substances	928	860	1788
X48, X68, Y-18	Pesticides	962	610	1572
X47, X67, Y-17	Carbon monoxide and other gases and vapors	713	847	1560
X20-X29	Traumatic contact with venomous animals and plants	538	713	1251
X40-X44; X60-X64; Y10-Y14	Drugs, medications, and biological substances	526	418	944
X45, X65, Y-15	Alcohol	26	122	148
X46, X66, Y-16	Organic solvents, halogenated hydrocarbons, and their vapors	40	74	114
Total		3733	3644	7377

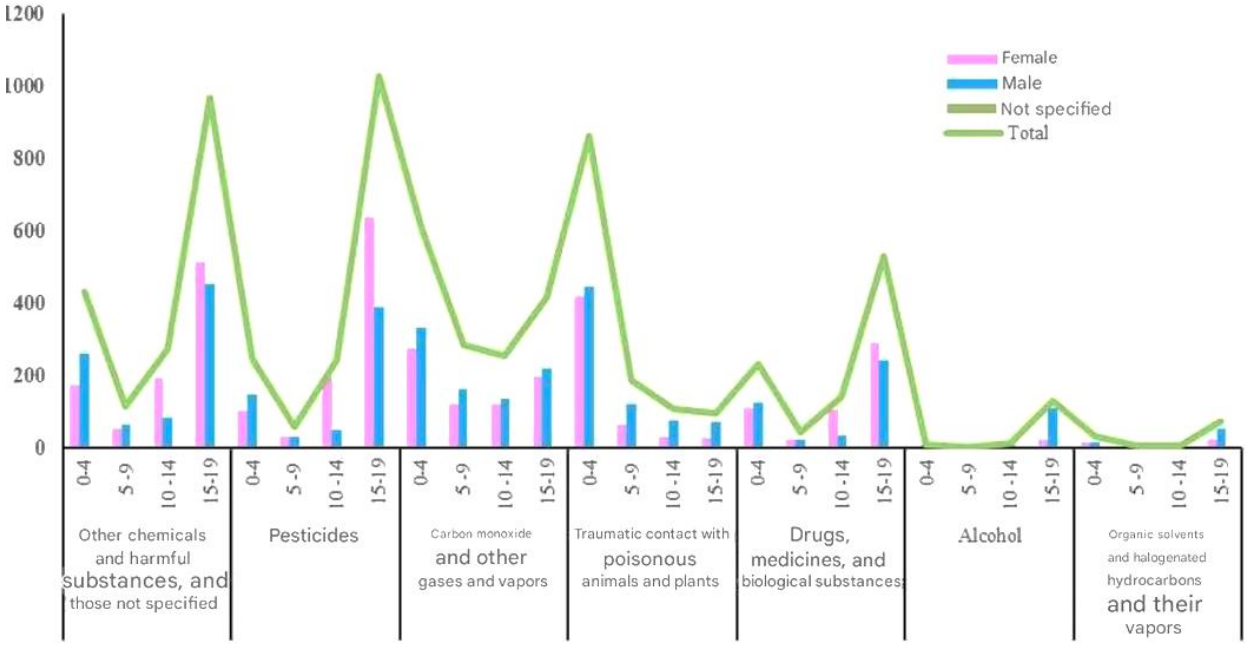
Source: Author's calculations based on mortality data from SIS-DGIS, 2000–2022.
*Includes all cases classified as accidental, by exposure, or self-inflicted.
Note: Two cases were excluded for unspecified sex (one in Chiapas due to pesticides, and one in Puebla due to carbon monoxide and other gases and vapors).

Figure 1. Annual distribution of poisoning cases in children under 20 years of age in Mexico, 2000-2019



ource: Prepared by the author using mortality data from SINAIS 2000-2019

Table 2. Causes of poisoning by sex and age group, among individuals under 20 years of age in Mexico, 2000-2022



Source: Prepared by the authors using mortality data from the SIS-DGIS 2000-2022.
Note: Two cases are excluded due to unspecified sex (one in the 0-4 age group due to carbon monoxide and other gases and vapors; and another in Chiapas in the 15-19 age group due to pesticides). All cases classified as accidental, exposure-related, and self-inflicted are included.

The annual distribution shows a gradual decrease in deaths, from 431 in 2000 to 225 in 2022, representing a 48% reduction. The years with the highest number of deaths were 2000, 2001, and 2002 (Figure 1).

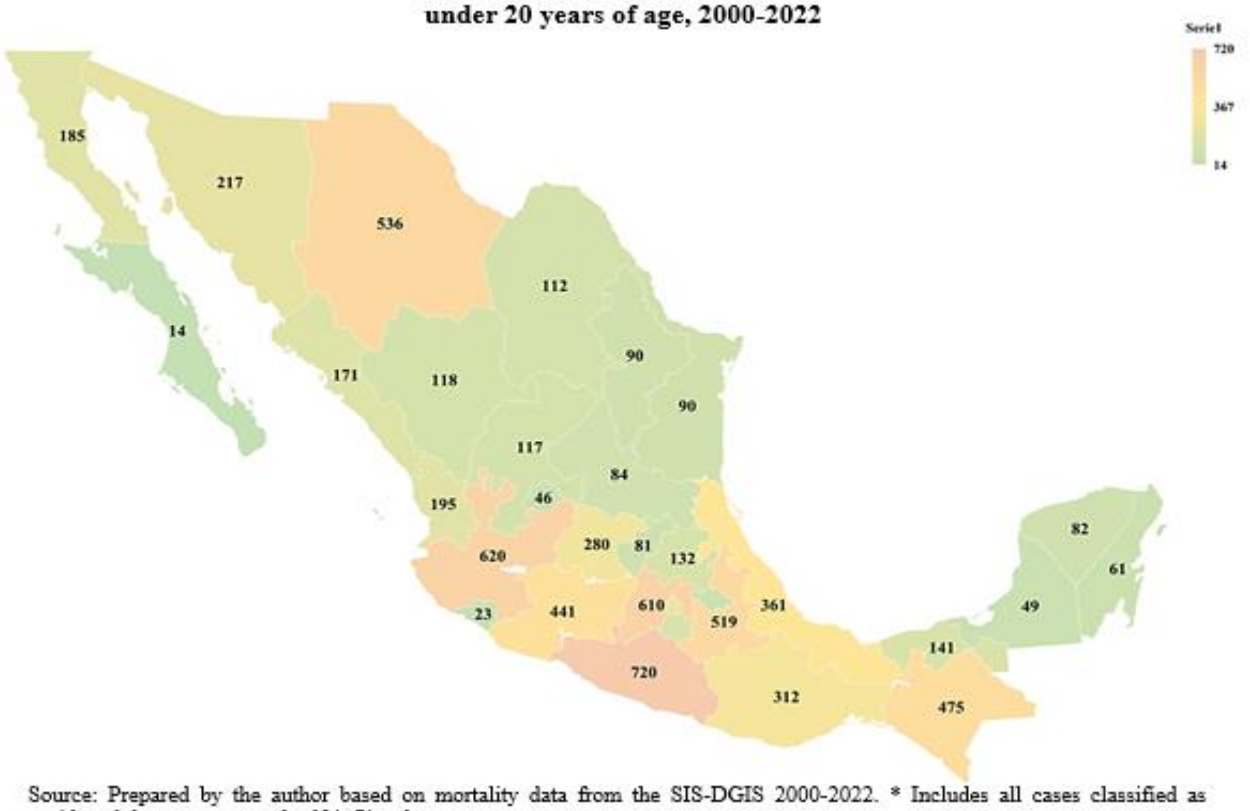
Data by five-year age group and cause of death indicate that, among children aged 0 to 4 years, the leading cause of death was *traumatic contact with venomous animals and plants*, with a total of 863 deaths. This was followed by *carbon monoxide and other vapors* (608 deaths) and *other chemical products and harmful or unspecified substances* (432 deaths). It is noteworthy that in this age group, seven deaths were attributed to alcohol.

In the 5–9 year age group, the highest number of deaths resulted from *carbon monoxide and other gases and vapors* (282 cases), followed by *traumatic contact with venomous animals and plants* (186 deaths) and *other chemical products and harmful or unspecified substances* (115 deaths).

Among adolescents aged 10 to 14 years, the main cause of death was *other chemical products and harmful or unspecified substances* (273 deaths), followed by *carbon monoxide and other gases and vapors* (254 deaths) and *pesticides* (241 deaths).

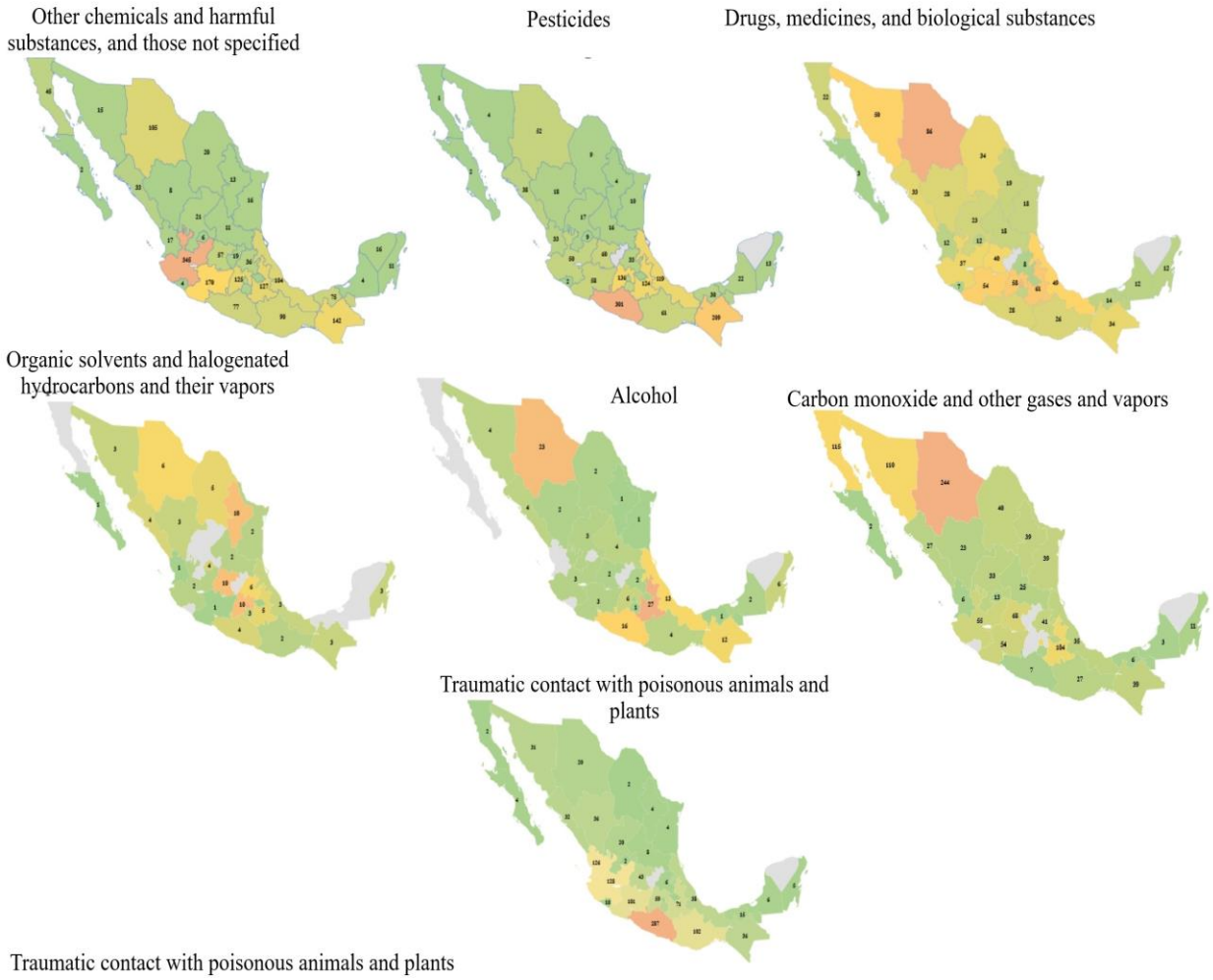
Finally, in the 15–19 year age group, *pesticides* accounted for 1,026 deaths, followed by *other chemical products and harmful or unspecified substances* (968 deaths) and *drugs, medications, and biological substances* (530 deaths) (Figure 2).

Figure 1. Distribution by federal entity of deaths from poisoning in children under 20 years of age, 2000-2022



Source: Prepared by the author based on mortality data from the SIS-DGIS 2000-2022. * Includes all cases classified as accidental, by exposure, and self-inflicted

Figure 2. Geographic distribution of the causes of poisoning in children under 20 year



Regarding geographic distribution, the ten states with the highest number of poisoning or intoxication cases, in descending order, were Guerrero (720), Jalisco (620), State of Mexico (610), Chihuahua (536), Puebla (519), Chiapas (475), Michoacán de Ocampo (441), Veracruz (361), Oaxaca (312), and Guanajuato (280). Together, these accounted for 66.05% of deaths in this age group (Figure 1).

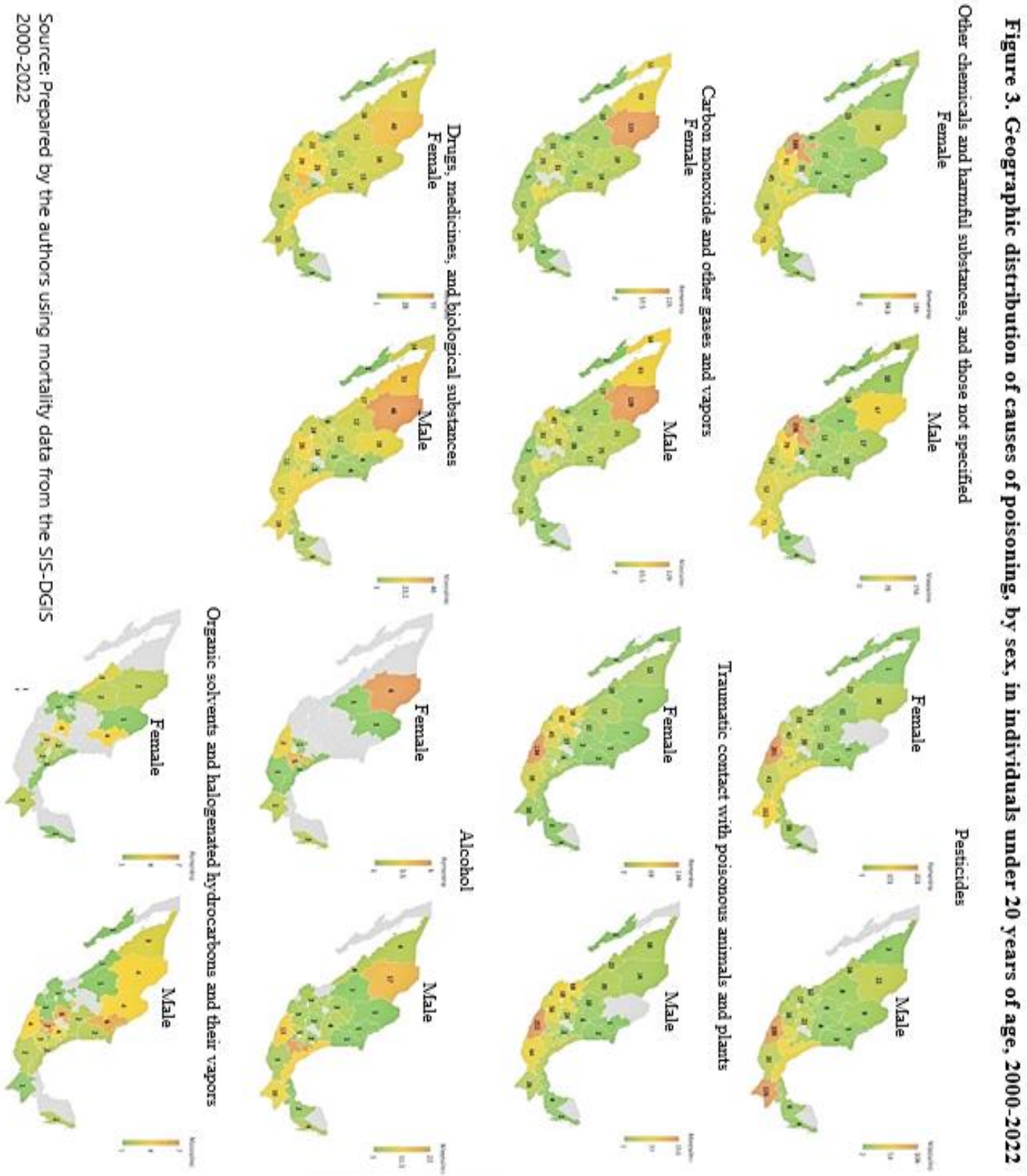
When analyzing by geographic area, we identified that the three states with the highest mortality from other chemical products and harmful substances, unspecified, were Jalisco with 345 deaths, Michoacán de Ocampo with 170, and Chiapas with 142.

Regarding pesticides, Guerrero recorded 301 deaths, Chiapas 208, and the State of Mexico 136. The state with the lowest number of deaths was Baja California, with only one.

For carbon monoxide and other gases and vapors, Chihuahua reported 244 deaths, the State of Mexico 216, and Baja California 115. The state with the fewest deaths was Baja California Sur, with two.

In the case of traumatic contact with poisonous animals and plants, Guerrero reported 287 deaths, Jalisco 128, and Nayarit 126, while Aguascalientes, Baja California, Coahuila de Zaragoza, and Tlaxcala each had two. question: what are these states doing differently to prevent such deaths?

Figure 3. Geographic distribution of causes of poisoning, by sex, in individuals under 20 years of age, 2000-2022



Source: Prepared by the authors using mortality data from the SIS-DGIS 2000-2022

With respect to drugs, medications, and biological substances, Chihuahua reported 86 deaths, Mexico City 79, and Puebla 61, while Baja California Sur recorded the fewest, with three.

As for alcohol, Puebla recorded 27 deaths, Chihuahua 23, and Guerrero 16, while Mexico City, Morelos, and Nuevo León, among others, reported only one death each.

Finally, deaths caused by organic solvents, halogenated hydrocarbons, and their vapors included 12 in Mexico City, and 10 each in Guanajuato, the State of Mexico, and Nuevo León. A small number of deaths, between one and two, were documented in Baja California Sur, Jalisco, Michoacán de Ocampo, Oaxaca, and Tlaxcala, among others (Figure 2).

Within this framework, when reviewing the geographic distribution of causes by sex, we found that deaths due to other chemical products and harmful substances, accounted for the largest number of cases, with a total of 1,788 deaths. Females were the most affected, representing 51.9% (928), while males accounted for 48% (860). The most affected state for both sexes was Jalisco.

These were followed by pesticide-related deaths, totaling 1,572, with females again showing a higher proportion—61% (962)—compared to males, who accounted for 38.7% (610). The state with the highest number of female deaths was Guerrero, while for males it was Chiapas.
For carbon monoxide and other gases and vapors, 1,560 deaths were recorded, with males being the most affected, representing 54.3% (847) of cases, and females 45.7% (713). Chihuahua stood out in this category for both sexes.

Of the 1,251 deaths caused by traumatic contact with poisonous animals and plants, males were the most affected with 57% (713), while females accounted for 43% (538). The state of Guerrero reported the highest number of cases for both sexes.

Regarding drugs, medications, and biological substances, a total of 944 deaths were recorded, with females being the most affected at 55.7% (526) and males at 44.3% (418). The state with the highest number of female deaths was Mexico City, while Chihuahua reported the highest number among males.

For alcohol consumption, there were a total of 148 deaths. Males were the most affected, accounting for 82.4% (122) of cases, while females represented 17.6% (26). Chihuahua had the highest number of female cases, and Puebla the highest number among males.

Finally, organic solvents, halogenated hydrocarbons, and their vapors accounted for a total of 114 deaths. Males represented 64.9% (74) and females 35.1% (40). Mexico City reported the highest number of female deaths, while the State of Mexico had the highest number among males (Figure 3).

Discussion

The results show that deaths among individuals under 20 years of age, regardless of sex, occurred at an average rate of approximately six per week due to these causes. Although the geographic distribution is scattered, it is notable that around eight out of every ten deaths were concentrated in ten states. With the exception of Chihuahua and Chiapas—located at opposite latitudes—most cases were clustered from east to west across central Mexico. States such as Chiapas and Guerrero stand out for having higher levels of
social inequality and marginalization, lower human development indices, and limited access to quality medical care [16]. In contrast, states such as Baja California Sur reported few or no deaths, appearing with the lowest mortality in four of the seven categories. This raises an important

We also observed a reduction of nearly 50% in deaths caused by poisoning or intoxication; however, it is noteworthy that the 15–19-year-old age group continues to be the most affected. In this case, the issue is even more concerning, as adolescents are especially vulnerable to addiction and to the use of toxic substances commonly associated with suicidal behavior.

Deaths caused by pesticides in 2001 surpassed those resulting from the ingestion of drugs and medications [4]. We observe this same pattern in our data, with slightly more than 1.5 times as many deaths attributed to pesticides, particularly in the states of Guerrero, Chiapas, and the State of Mexico. These findings align with those of Moreno et al., who reported high pesticide-related death rates among individuals aged 15 to 19 in two of these states [16]. García et al. emphasize that most acute poisonings are caused by organophosphate, carbamate, and bipyridyl (paraquat) pesticides [17].

In the case of alcohol-related deaths, we found higher mortality among men—especially in Puebla—while for women, the highest mortality occurred in Chihuahua. It is important to note that there were also isolated cases among children aged 0–4 and 5–9 years. We assume that these rare incidents may be linked to a lack of milk or limited economic resources, although no definitive explanation for this phenomenon was identified. In the Americas, in 2016, 46.1% of the population over the age of 15 reported consuming alcohol in the previous year [18]. Mexico ranks among the leading countries in mortality due to liver cirrhosis, with a rate of 22 deaths per 10,000 inhabitants [19].

Poisonings caused by drugs, medications, and biological substances are generally due to improper administration. A study conducted at the Hospital Español of Mexico among individuals under 17 years of age between 2014 and 2021 found that of 120 patients, 21.6% (26 cases) involved intentional poisoning and 11 were accidental. The most commonly used substances were analgesics (such as aspirin), with a higher prevalence among females than males [20]. In our study, out of 944 deaths, females were the most affected.

In the case of death caused by traumatic contact with poisonous animals and plants, the subject is broad, but most cases are treated symptomatically; therapy generally involves the intravenous administration of antivenoms [21]. Scorpion stings alone have shown an incidence of 233.64 per 100,000 inhabitants, with the highest rates reported in Nayarit, Guerrero, and Morelos [22]. Ramírez et al. reported 195 cases of mushroom poisoning in Mexico between 2004 and 2014, 74 of which resulted in death. The states with the highest incidence were Hidalgo and Chiapas. In our analysis, we found that Guerrero, Jalisco, Nayarit, Hidalgo, and Chiapas continue to report cases within this classification [23].

Regarding poisonings caused by carbon monoxide and other gases and vapors, both incidence and mortality are high. The main chemical contaminants are carbon monoxide (CO) and cyanide, among others. In Mexico, these causes account for approximately 13,600 hospital discharges, 34,900 hospital days, and 1,400 deaths annually—13% of which occur in children. Of these, 72% are accidental and 28% are suicides [24]. In our analysis, this category ranks among the leading causes of death for the 0–14 age group, with Chihuahua reporting the highest number of cases, likely due to the use of indoor heaters to maintain warmth.

Poisonings from other chemical products and harmful substances, including unspecified agents, are significant causes of morbidity and disability. In our study, this category represented one of the main causes of death across all age groups, particularly in Jalisco, Michoacán de Ocampo, and Chiapas. Ospina et al. note that there is limited information available to provide a clear picture of the risks these substances pose, estimating 4.9 million deaths globally (8.3% of the total disease burden) due to environmental exposure and the handling of certain chemicals [4].

Finally, in the case of organic solvents, halogenated hydrocarbons, and their vapors, although the literature does not provide specific data on mortality in children, our analysis shows that cases were recorded in at least some states across the country. Males were the most affected group, and seven states reported no deaths from this cause. The World Health Organization (WHO) notes that exposure to air pollution causes seven million premature deaths each year. In children, it leads to stunted growth and impaired lung function, and increases susceptibility to respiratory infections and asthma [25].

When analyzing data from secondary sources, it becomes impossible to make a deeper observation of the causal characteristics of poisoning in this age group—particularly those related to health and social factors—which can be seen as one of the main limitations of this study. Moreover, the problem may be even greater because not all deaths are accounted for, as underreporting of poisoning-related deaths likely exists across all age groups, especially among children. In our research, we found two cases where the cause of death and the state where it occurred were recorded, but the sex of the deceased was missing. A related study examining external causes of death among children under five found that, of eleven comparable causes classified as either accidents or homicides, three were related to some type of poisoning [18, 26, 27].

During the period from 2013 to 2019, emergency departments treated 1,604,529 adolescents; 80.03% had a defined primary cause, while 19.96% were classified under "ill-defined" or "other causes" [26]. This aligns with the findings of Louise et al., who observed that many childhood deaths are categorized under infectious, neonatal, and nutritional causes, while others are grouped as "other" [6].

Conclusion

Death due to poisoning, caused by various substances, is a preventable problem—particularly among minors and in states where prevalence is highest. This population is especially vulnerable, and it is essential to establish response mechanisms that enable early identification and intervention. It is also important to note that the lack of complete records in such cases limits our understanding of the phenomenon as a whole.

Regulating the sale of over-the-counter medications and preventing access to hazardous or improperly labeled substances in the home are both necessary measures. Likewise, strengthening epidemiological surveillance, promoting health education, and improving access to healthcare services—including public awareness campaignns and the creation of specialized centers—are fundamental steps toward prevention and protection.

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