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Statistical Analysis for Infections of Chemical Intoxication in Saudi Arabia (2019–2023)

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KEYWORDS

Chemical Intoxication, Infections, ANOVA, Welch's ANOVA, Chi-square, General trend

ABSTRACT:

The aim of this study was to conduct a statistical analysis of chemical poisoning cases in Saudi Arabia for the years 2019 to 2023, using official data from the Saudi Ministry of Health (Statistical Yearbook). The study found significant differences in the number of cases between health regions in Saudi Arabia (20 regions), and no significant differences between cases over the five study years. The study also found that the number of cases in the regions of Riyadh, Jeddah, Al-Qurayyat, the Northern Borders, and Hail constitute 50% of the total cases in Saudi Arabia. Therefore, the study recommended focusing on these regions to reduce the incidence rate. The highest number of cases was recorded in the Riyadh region over the five years, while the lowest number of cases was recorded in Al-Baha region. The study also found that cases were completely independent of health regions, and that predictions of cases in the coming years are increasing.

1. Introduction

Intoxication is the harmful effect that occurs when a toxic substance is swallowed, inhaled, or comes in contact with the skin, eyes, or mucous membranes, such as those of the mouth or nose (Malley, 2025).

Chemical pollutants are among the most important, most dangerous and dangerous types of pollutants because the possibility of chemical intoxication has increased recently. Chemical pollutants may result from industrial sources as a result of the use of unscientific methods of production or occur as a result of activity related to life and production, in addition to the waste emitted by industries and what comes out of means of transportation and the transfer of gases and vapors, as well as the products of incomplete combustion of petroleum derivatives and the residues of agricultural chemicals that accumulate in the rural environment, which include agricultural fertilizers and agricultural and household pesticides.[1]

According to a World Health Organization report, more than 600 million cases of food intoxication occur worldwide each year, with approximately 420,000 associated deaths. It's worth noting that a third of these cases affect children under the age of five. The World Health Organization estimates that 1 in 10 people worldwide will develop intoxication in food each year if they consume contaminated food. This can cause acute illness and symptoms (such as fever, diarrhea, abdominal pain) or can lead to chronic illnesses (such as kidney failure, hepatitis, or even complete paralysis) [2] Mortality rate in 2024 from unintentional intoxication per 100 000 population is 0.7 (Organization, 2024).

In Saudi Arabia, intoxication cases have been reported in 2021, 2022, and 2023, 1367, 1525 and 1629 respectively. This is alarming, as the numbers are on the rise, which underscores the importance of this research, so the research aims to determine whether these differences in infections between years and between health regions are significant or not, in addition to deducing some other statistical indicators.

Material and Methods:

Descriptive measures and graphic representations will be used to describe the data. Since the data relates to more than two variables, an analysis of variance (ANOVA) will be applied to test whether there is a significant difference between infections across study

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years and between health districts. ANOVA requires that the data be normally distributed, which will be tested using Kolmogorov-Smirnov and Shapiro-Wilk test "The Shapiro–Wilk test is more appropriate method for small sample sizes (<50 samples) although it can also be handling on larger sample size while Kolmogorov–Smirnov test is used for $n \geq 50$. For both of the above tests, null hypothesis states that data are taken from normal distributed population. When $P > 0.05$, null hypothesis accepted and data are called as normally distributed. (Pradesh, 2019), and that there be homogeneity of variances, which will be tested using Levene's test "Levene's Test is a statistical procedure used to assess the equality (or homogeneity) of variance across different groups" (Lee, 2025). If the ANOVA assumptions are not met, Welch's ANOVA will be used, "Welch's ANOVA is an alternative to the typical one-way ANOVA when the assumption of equal variances is violated" (BOBBITT, 2021). The chi-square test will be used to test whether infections are independent of districts, and the general trend equation will be used to make forecasts for future years.

Data and data description:

This study is based on data obtained from the official statistical yearbooks issued by the Saudi Ministry of Health, covering the years 2019 to 2023 and encompassing 20 health regions.

Table1: Reported Cases of Chemical Intoxication by Health Regions in Saudi Arabia (2019–2023) [3]

Health Region	Chemical Intoxications					Total	Average
	2019	2020	2021	2022	2023		
Riyadh	196	297	331	141	260	1225	257
Holy Capital	16	8	75	73	35	207	41
Jeddah	185	90	85	152	171	683	137
Ta'if	46	38	47	65	64	260	52
Medinah	33	14	9	30	55	141	28
Qaseem	40	20	20	20	16	116	23
Eastern	100	71	60	109	116	456	91
AL-Ahsa	98	40	63	85	145	431	86
Hafr AL-Baten	33	28	21	6	6	94	19
Aseer	54	60	55	52	104	325	65
Bishah	52	44	76	66	35	273	55
Tabouk	29	28	35	58	82	232	46
Ha'il	165	91	113	94	77	540	108
Nourth Borders	118	98	67	144	114	541	108
Jazan	30	6	12	6	55	109	22
Najran	137	80	47	78	47	389	78
Al Bahaha	19	12	7	8	4	50	10
Al-Jouf	8	56	158	148	49	419	84
Qurayyat	131	154	82	168	180	715	143
Qunfudah	34	11	4	22	14	85	17
Total	1524	1246	1367	1525	1629	7291	1458
Average	76	62	68	76	81		

*Source: Statistical Yearbooks, issued by ministry of health in Saudi Arabia (2019-2023).

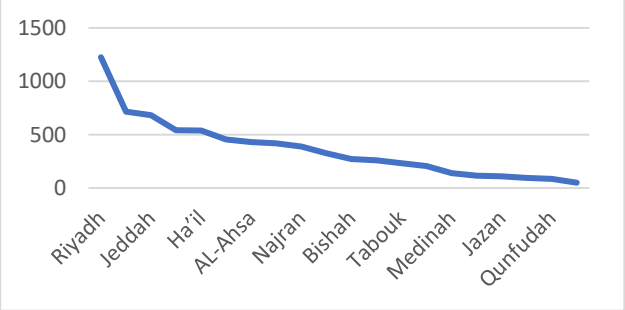

Figure1: Total Cases of Chemical Intoxication by Health Regions in descending arrange Saudi Arabia (2019–2023)

From Table 1. and Figure 1, the top five regions that recorded more than 500 cases over the five years are Riyadh, where 1,252 cases were recorded, with an

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average of 257 cases per year; Al-Qurayyat, where 715 cases were recorded, with an average of 143 cases per year; Jeddah, where 683 cases were recorded, with an average of 137 cases per year; the Northern Borders, where 541 cases were recorded, with an average of 108 cases per year; and Hail, where 540 cases were recorded, with an average of 108 cases per year, the infection rate in these five regions was 50% of the total infections in Saudi Arabia, while the infections in the other 15 regions were 50%.. The areas with the lowest number of infections, less than 100, over the five years were Hafr Al-Batin, where 94 infections were recorded, with an average of 17 infections per year; Qunfudah, where 85 infections were recorded, with an average of 17 infections per year; and Al-Baha, where 50 infections were recorded, with an average of 10 infections per year. The rest of the regions, the infections range between 100 and 500 infections over the five years.

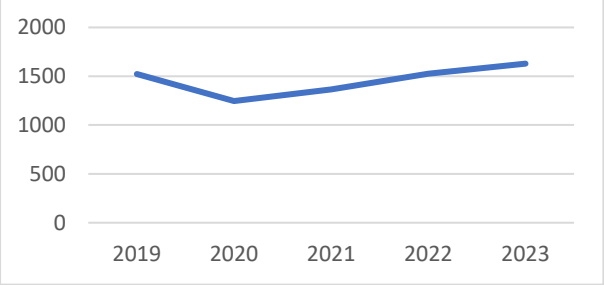

Figure2: Total Cases of Chemical Intoxication in Saudi Arabia (2019–2023)

From Table 1 and Figure 2, over the years, the number of infections is slowly increasing, as the rate of increase in the year 2023 compared to the year 2019 reached 7%.

Analysis:

To use ANOVA to test whether there is a significant difference between the number of infections during the five years, it is necessary to ensure that the data meets its conditions. The data were tested for normality using two tests Kolmogorov-Smirnov and Shapiro-Wilk, and they showed a significant value of zero for all years, which is less than 0.05, indicating that the data are not normally distributed and therefore ANOVA cannot be used. Therefore, Welch's ANOVA test was used, and it showed a significant value of 0.09, which is greater than 0.05, indicating that there is no significant difference between the infections during the five years. That is, the differences between the number of infections during the five years are not considered significant, and therefore the number of infections during the five years can be considered equal.

To use ANOVA to test if there is a significant difference between the number of infections in the health districts (20 districts), the data were tested for normality using two tests, which showed a significant value greater than 0.05 for all districts, indicating that the data is normally distributed. Therefore, the second condition, which is data homogeneity, was tested. The test was done using Levene's test, which showed a significant value of zero, which is less than 0.05, indicating that the variance is not homogeneous for the districts. Therefore, ANOVA cannot be used. Therefore, Welch's ANOVA test was used, and it showed a significant value of zero, which is less than 0.05, indicating that there is a significant difference between infections in the health districts. That is, the differences in the number of infections between different health regions are considered significant, and therefore attention must be paid to regions with high infections.

To test whether the region had an effect on the number of infections, the Chi-square test was used, which showed a significant value of 0.316, which is greater than 0.05, indicating the independence of infections from health regions, meaning that the number of infections differed for reasons other than the region, which may be represented by human behavior towards chemicals.

The general trend equation for predicting chemical intoxication infections is Y=1310+48.9x

Where, y represents the number of infections and x represents the time period. According to the equation, the prediction for the next five years is 2024, 2025, 2026, 2027 and 2028 are 1603, 1652, 1701, 1750 and 1799 respectively, these predictions indicate that the function is increasing, which requires more precautions.

Findings:

1. The highest number of cases was recorded in the Riyadh region, while the lowest number of cases was recorded in Al-Baha region.
2. The number of cases in the regions of Riyadh, Jeddah, Al-Qurayyat, the Northern Borders, and

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Hail constitute 50% of the total cases in Saudi Arabia.

3. Infections were completely independent of health regions, and they may be for other reasons such as human behavior.
4. Predictions of cases in the coming years are increasing.

Recommendations:

1. Focus on Riyadh, Jeddah, Al-Qurayyat, the Northern Borders, and Hail regions to reduce the number of infections through health awareness and by taking the necessary precautions**.**
2. Study the causes that led to chemical intoxication and monitor them in detail to facilitate the treatment process.

References:

[1]. Al-Shahat Hassan Abdel Latif Nashi, 2011. "*Chemical Pollutants and Their Effects on Health and the Environment: The Problem and the Solution*" Egypt, Cairo: University Publishing House.

[2] Maha Al-Maneef and Alaa El-Din Brada. (2024). "*Intoxication and its impact on the reputation of the food sector: A complementary comparison*". Paper presented to the Aspar Forum, Report No. 409.

[3] Statistical Yearbooks, issued by ministry of health in Saudi Arabia (2019, 2020, 2021, 2022, 2023)