Original article

Epidemiology of suspected typhoid fever cases from 2020 to 2022

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Abstract
Introducción. Typhoid fever is a potentially fatal infectious disease caused by the bacterium Salmonella typhi, transmitted through contaminated food or water. Symptoms include fever, fatigue, headache, nausea, abdominal pain, and constipation or diarrhea. **Objetive.** Characterize epidemiologically the suspected cases of typhoid fever in the years 2020 to 2022. **Methodology.** A descriptive cross-sectional design was used with data from the National Epidemiological Surveillance System of El Salvador, considering epidemiological variables such as sex, age, area, department, municipality, incidence rate, and case notification. Absolute frequencies, ratios, and cumulative incidence per 100 thousand inhabitants were used, and tables and graphs were generated. **Results.** Twenty-six percent of the cases were registered in 2020, 38 % in 2021, and 37 % in 2022. Fifty-one percent were male. The median age was 23 years. The highest incidence rate in age groups was found from 20 to 29 years, with 25 cases per 100 thousand inhabitants in 2021. The urban/rural ratio was 3:1. The incidence rate in 2022 was 11.6 cases per 100 thousand population, that for 2021 was 12.1 cases, and that for 2020 was eight cases. **Conclusion.** The highest notification was in the capital city in age groups 19 to 29 years of age in the male gende.

Palabras clave
Salmonella typhi, Typhoid Fever, Disease Notification.

Resumen
Introducción. Typhoid fever is a potentially fatal infectious disease caused by the bacterium Salmonella typhi, transmitted through contaminated food or water. Symptoms include fever, fatigue, headache, nausea, abdominal pain and constipation or diarrhea. Objectivo. To characterize epidemiologically the suspected cases of typhoid fever in the years 2020 to 2022. **Metodología.** Se utilizó un diseño transversal descriptivo con datos del Sistema Nacional de Vigilancia Epidemiológica de El Salvador, se tomaron en cuenta variables epidemiológicas como sexo, edad, área, departamento, municipio, tasa de incidencia y notificación de casos. Se utilizaron frecuencias absolutas, razones e incidencia acumulada por cada 100 mil habitantes y se generaron tablas y gráficos. **Resultados.** El 26 % de los casos se registró en el 2020, para 2021 el 38 % y 2022 el 37 %. El 51% fue del sexo masculino. La mediana de edad fue de 23 años. La mayor tasa de incidencia en grupos de edad se encontró de 20 a 29 años con 25 casos por 100 mil habitantes para el año 2021. La razón urbana/rural fue de 3:1. La tasa de incidencia del año 2022 fue de 11.6 casos por 100 mil habitantes, la del 2021 fue de 12.1 casos y la del 2020 fue de ocho casos. **Conclusión.** La mayor notificación fue en la capital en grupos de edad de 19 a 29 años del género masculino.

Palabras clave
Salmonella typhi, Fiebre Tifoidea, Notificación de Enfermedad.

Introduction

Typhoid fever (TF) is an infectious disease caused by *Salmonella typhi*, transmitted mainly through contaminated food or water.[i,ii] Symptoms include persistent fever, fatigue, headache, nausea, abdominal pain, and gastrointestinal problems. The disease can be fatal and is difficult to treat due to antibiotic resistance; confirmatory diagnosis is through PCR or cultures.[iii,iv] In industrialized countries, TF has declined due to better living conditions and antibiotics; however, it remains a problem in Africa and Southeast Asia[v] The global burden of disease is approximately nine million cases and 110 000 deaths annually.[vi]

People without access to clean water and adequate sanitation are most at risk, mainly affecting children.[vii-ix]

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Epidemiología de casos sospechosos de fiebre tifoidea de 2020 a 2022

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In Latin America, the incidence of TF varies from ten to 120 cases per 100 000 inhabitants per year, with low mortality. In the United States and other industrialized countries, cases are rare and generally imported.[x] El Salvador recorded about 866 cases per year from 2011 to 2019, with a decrease in the trend from 2018. During this period, epidemiological surveillance of this disease allowed only a general analysis of this disease, as information was only collected on the number of cases per epidemiological week, age groups, and stratified by department.[xi,xii] The need was identified to collect more information on TF cases in order to determine the probable source of infection and conduct a timely investigation of the case. For this reason, in 2020, individual surveillance was implemented, which involves adding other variables of epidemiological interest and reporting suspected cases within the first 24 hours, thus guiding prevention and control strategies.[xi]

Surveillance of the disease aims to detect acute changes in the occurrence of the disease that help to identify, quantify and monitor the occurrence of the disease.[xi] Therefore, the objective of the present study is to characterize epidemiologically the suspected cases of typhoid fever in the years 2020 to 2022.

Methodology

The study design was descriptive cross-sectional with data from the National Epidemiological Surveillance System of El Salvador (VIGEPES), where patients who met the definition of a suspected case of TF were registered: "any person with fever of more than seven days and two or more of the following symptoms: headache, abdominal pain, diarrhea, vomiting, anorexia, nausea, progressive worsening of the general condition, or any case epidemiologically linked to a confirmed case of typhoid fever, regardless of the time of onset of symptoms."[xi] Inclusion criteria were cases with symptom onset dates from January 2020 to December 2022; cases of patients residing in foreign countries were taken as exclusion criteria.

The data were obtained from the VIGEPES digital platform and downloaded to a Microsoft Excel spreadsheet; subsequently, quality control of the information was performed to eliminate duplicate cases and those that did not meet the selection criteria. The variables used were sex, age, area, department, municipality, incidence rate, case notification, and clinical management. Quantitative variables that had an alphanumeric format were changed to numeric. The variable age was reclassified into the variable age groups. The variable "year" was created from the variable "date of symptom onset." The variable "difference between the date of consultation and date of notification" was created, and the variable "notification greater than, equal to, or less than 24 hours" was created from this new variable.

Microsoft Excel 365 in its 2019 version with the Real Statistics add-in was used for data processing and analysis. Absolute and relative frequencies, ratios and cumulative incidence expressed per 100 thousand inhabitants were calculated; tables and graphs were also made. Descriptive statistics, measures of central tendency, dispersion and the Kolmogorov Smirnov normality test were performed on the continuous quantitative variables in the RStudio program in version 14.1106.[xiii] For the geospatial analysis, the QGIS program version 3.26.0 was used to construct maps of notification of typhoid fever cases according to the date of symptom onset and two color palettes were used to express notification and non-notification in the municipalities; and the nonparametric Mann Whitney U test was used to look for differences in medians between two independent groups such as sex and age.[xiv]

The study was approved by the Ethics Committee of the Instituto National Institute of Health of El Salvador (CEINS/2024/002). The research team adhered to the Declaration of Helsinki as ethical principles for medical research in humans.

Results

In the initial database, 2195 cases were registered, 16 duplicates, two cases with a symptom onset date in 2019, and one case from abroad were eliminated. Of the 2176 cases included in the study, 26 % of the cases were registered in 2020, 38 % in 2021 and 37 % in 2022. The series showed annual cyclicity and slight seasonal variations by epidemiological week (EW), the ascendancy of cases was mainly reflected between EW 10 to 20 (Figure 1).

Fifty-one percent of the cases were male. The median age of the patients was 23 years (interquartile range [IR]: 15-33). The median age in men was 24.90 (IR: 15-31.5), and in women was 26.94 (IR: 16-34). The Mann-Whitney U test comparing age by gender resulted in a p-value of < 0.05, indicating that there was a significant difference between the two medians.

From 2020 to 2022, 89 % of the cases attended a educational center. Seventy-three percent of the cases belonged to the urban area. The urban/rural ratio is 3:1.

A total of 2 % of the cases were referred, 58 % were managed on an outpatient basis, and 40 % were hospitalized. Seventy percent of the cases have a difference between the date of consultation and the date of notification less than or equal to 24 hours. Thirty percent were notified more than 24 hours after providing the consultation.

The age group with the highest rate in 2020 was 20-29 years old (16 cases per 100 000 population), in 2021 the age group with the highest rate was 20-29 years old (25 cases per 100 000 population) and in 2022 the age group with the highest rate was 10-19 years old with 21 cases per 100 000 population (Table 1).

In 2020, the highest rate was recorded in the department of San Salvador with 24 cases per 100 000 inhabitants, followed by La Libertad with seven cases per 100 000 inhabitants. The cities with the highest rates were Santa Tecla (127 cases per 100 000 inhabitants) and Quezaltepeque (55 cases per 100 000 inhabitants) (Figure 2).

In 2021, the highest rate was recorded in the department of San Salvador, with 35 cases per 100 000 inhabitants, and La Libertad, with ten cases per 100 000 inhabitants. The cities with the highest rates were Santa Tecla (department of La Libertad), with 162 cases per 100 000 inhabitants, followed by San Vicente (department of San Vicente) with 87 cases per 100 000 inhabitants (Figure 2).

In 2022, the highest rate was also in San Salvador, with 35 cases per 100 000 inhabitants, followed by La Libertad, with seven cases per 100 000 inhabitants. In the same year, the cities with the highest rates were Ayutuxtepeque (department of San Salvador), with 93 cases per 100 000 inhabitants, followed by Santa Tecla with 90 cases per 100 000 inhabitants (Figure 2).

The incidence rate for 2022 was 11.6 cases per 100 000 inhabitants, which, compared to 2021 with 12.1 cases per 100 000 inhabitants, shows a difference in rates of approximately one case per 100 000 inhabitants. In 2020, the incidence rate was eight cases per 100 000 inhabitants, making a difference between 2020 and 2022 of three cases per 100 000 inhabitants.

Regarding the health institution, during the three years of the analysis, 2170 (99.69 %) of cases consulted a public health institution and six cases (0.28 %) consulted on a private health center.

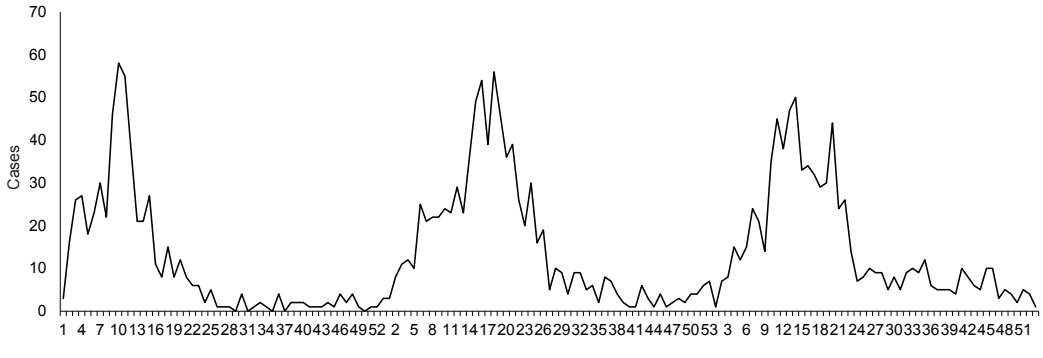

Figure 1. Trend of typhoid fever cases distributed by epidemiological week in the years 2020 to 2022 in El Salvador.

Table 1. Rates by age group of typhoid fever in the years 2020 to 2022 in El Salvador

Age groups	Rate per 100 000 inhabitants		
	2020	2021	2022
Under 1	7	2	5
1 to 4	2	6	7
5 to 9	6	15	13
10 to 19	11	15	21
20 to 29	16	25	18
30 to 39	10	15	13
40 to 49	6	9	8
50 to 59	5	5	5
Over 60	3	4	5
Total	9	13	13

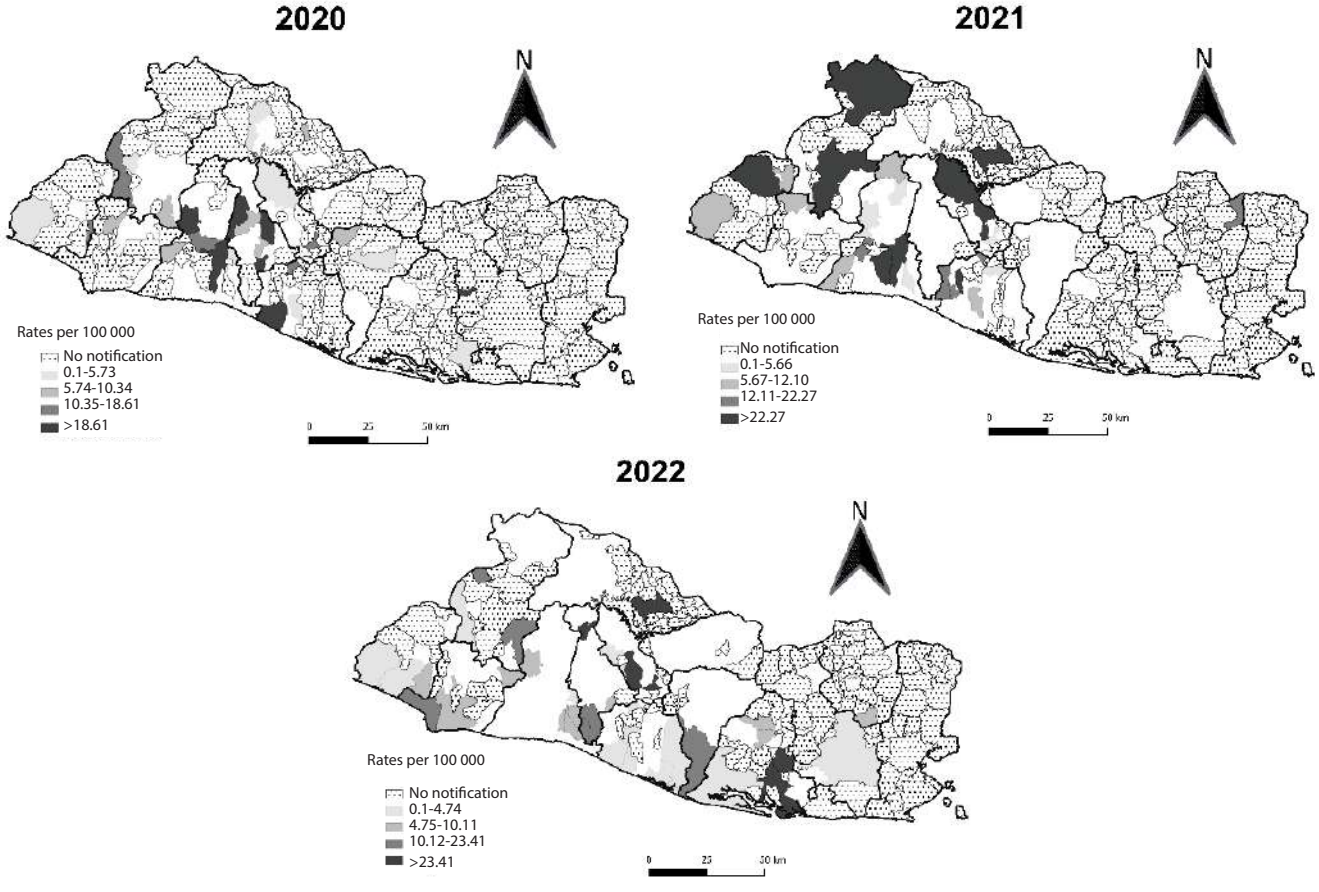

Figure 2. Distribution of typhoid fever rates by city, 2020 to 2022, El Salvador.

Discussion

In this investigation, the highest notification was in San Salvador in the 19 to 29 year-old male age group. This disease is classified based on its incidence per 100 000 inhabitants per year as: low (less than ten cases), moderate (10 to 100 cases), high (more than 100 cases) and very high (more than 500 cases).[xv] The country remained in a low risk category of having the disease during the three years of the study; however, it was above the expected for the Americas region, which is between three to four cases per 100 000 population.[vi]

Worldwide, the highest incidence of the disease is observed in children and adolescents between one and 14 years of age.[vi] The data from El Salvador were concentrated in a wider range and at a higher age than expected, similar to that reported by a study in Colombia, in which the highest percentage of cases was concentrated between ten and 29 years of age[xvi].

Regarding the sex variable, some research has shown that El Salvador has data similar to those reported in Colombia and some European and African countries, where the proportions for each sex are close to 50%.[xvi-xviii.]

Most cases were reported in urban areas, similar to studies in Asia, where typhoid fever was found to be concentrated in impoverished and densely populated urban areas, contrary to those reported from countries in sub-Saharan Africa, where the incidence was found to be higher in rural areas.[xviii] In a study conducted in England, the proportion of cases in urban areas was 96.1 % of the cases of typhoid and paratyphoid fever, a proportion much higher than that reported in this study, although this may be because, in these countries, cases are generally imported and have a history of travel to endemic areas.[xvii]

In El Salvador, the annual variation appears to be small, with the highest incidence occurring at almost the same time each year, between the months of March and May, which correspond to the end of the dry season and the beginning of the rainy season in El Salvador;[xix] this is congruent with other research that reports an association of rainfall and humidity with infectious diseases.[xx]

During the study period, suspected cases of typhoid fever were reported to the surveillance system. In 2024, the surveillance guidelines for El Salvador were updated. Currently, only cases that are confirmed by stool culture, blood culture, or myeloculture are reported. Additionally, the definition of a

suspected case has been modified, and the time for evolution has been extended from seven to ten days.[xxi]

Current epidemiological surveillance in the country is similar to that carried out in Colombia[xvi] and several Asian and African countries,[xxii,xxiii] as it includes passive surveillance focused on health facilities for typhoid fever cases with laboratory confirmation. Other research on the incidence and burden of typhoid fever disease complemented passive surveillance data with serologic surveys and health service utilization surveys.[xxii,xxiii]

Changes in the surveillance system limit the ability to compare case reporting in this research with records outside the study period. In addition, because suspicious cases were recorded in the system during the period analyzed, reporting rates may be overestimated.

Because *Salmonella typhi* is excreted in feces, there is evidence that searching for this agent in sewage or surface water contaminated with sewage in outbreaks or areas of endemic transmission could strengthen surveillance by providing information on the burden of disease in the population and facilitating the identification of TF outbreaks.[xxiv-xxvi] Therefore, its implementation in El Salvador could be a complementary surveillance of the disease, since the patient's environment would be studied more exhaustively for future analyses, especially in San Salvador and La Libertad, which were the most affected departments.

Conclusion

The incidence of TF established by the VIGEPES system data for the years 2020 to 2022 does not vary considerably by year, and its behavior is cyclical at a certain time of the year. The department with the highest notification of the disease is San Salvador, and the age groups with the highest risk, as evidenced by rates, are 19 to 29 years of age, affecting the male gender in greater proportion.

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