Vital Surveillances

# Epidemiological Characteristics of Sporadic Foodborne Diseases Caused by *Vibrio parahaemolyticus* — China, 2013–2022

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## ABSTRACT

**Introduction**: *Vibrio parahaemolyticus* (*V. parahaemolyticus*) is a common foodborne pathogen in coastal areas of China. Most epidemiological studies on *V. parahaemolyticus* have focused on foodborne disease outbreaks, with fewer studies based on long-term, continuous, and systematic sentinel surveillance.

**Methods**: Data were collected from the national foodborne disease active surveillance program in 31 provincial-level administrative divisions (PLADs) in China from 2013 to 2022. *V. parahaemolyticus*-positive cases were collected for further analysis in this study.

**Results**: From 2013 to 2022, the National Foodborne Disease Case Surveillance System identified 23,818 cases of *V. parahaemolyticus* foodborne infection in China. Patient ages ranged from 2 months to 100 years, with an average age of 38.41 years. These cases primarily occurred in coastal areas during summer. A new serotype, O10:K4, emerged in 2020 and has become the dominant serotype over O3:K6.

**Conclusions**: *V. parahaemolyticus* infection is common in the eastern coastal areas of China and is strongly associated with aquatic food consumption. This study recommends that food regulatory authorities increase routine surveillance and inspection during high-risk periods and in high-risk areas. Authorities should also use social media platforms to conduct extensive public education campaigns on the prevention and control of *V. parahaemolyticus*-associated foodborne disease.

*Vibrio parahaemolyticus* (*V. parahaemolyticus*) is a Gram-negative, halophilic bacterium found globally in environments such as oceans, rivers, and seabed sediments (*1*). Infections with *V. parahaemolyticus* are caused by diverse serotypes, with O3:K6 reported as the most dominant (*2–5*). In China, *V. parahaemolyticus* is the most common foodborne pathogen causing sporadic foodborne disease in coastal areas and the leading etiologic agent of foodborne disease outbreaks (*6*). However, most epidemiological studies on *V. parahaemolyticus* have focused on foodborne disease outbreaks (*7–9*), with few studies based on long-term, continuous, and systematic sentinel active surveillance.

## METHODS

This study was conducted from 2013 to 2022 under the framework of the national foodborne disease active surveillance program in 31 provincial-level administrative divisions (PLADs) in China. The China National Center for Food Safety Risk Assessment (CFSA) maintains and manages all national foodborne disease surveillance data and systems. According to the national foodborne disease surveillance plan, sentinel hospitals are responsible for collecting epidemiological information, clinical signs and symptoms, suspected food exposure information, and stool specimens from patients with diarrhea to test for *Salmonella*, *Shigella*, *V. parahaemolyticus*, diarrheagenic *Escherichia coli*, and norovirus, and to undertake identification and serotyping of positive strains. Cases positive for *V. parahaemolyticus* were selected for further analysis in this study. Data cleaning and database creation were performed using Microsoft Office (version 2010, Microsoft, Washington, USA), and SPSS (version 22.0, SPSS Inc, Chicago, USA) was used for statistical analysis. All variables were presented as counts or percentages. All procedures involving human participants followed the ethical standards of the ethics committee of Ningbo Municipal Center for Disease Control and Prevention and were in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards (Approval No.: 202204).

## RESULTS

From 2013 to 2022, the National Foodborne Disease Case Surveillance System documented 23,818 cases of *V. parahaemolyticus* diarrhea. Patient ages ranged from 2 months to 100 years (mean: 38.41 years), with 12,126 cases (50.91%) occurring in individuals aged 24–44 years. The most common symptoms were watery diarrhea (22,642 cases, 95.06%), abdominal pain (16,381 cases, 68.78%), nausea (11,158 cases, 46.85%), vomiting (9,593 cases, 40.28%), and fever (3,281 cases, 13.78%).

Analysis of the overall *V. parahaemolyticus* detection rate in sporadic diarrhea cases in China revealed a rate of 1.83% (23,818/1,298,516). Among the top 5 PLADs with the highest detection rates, Shanghai had the highest rate at 5.50% (2,352/42,759), followed by Zhejiang (3.45%, 11,751/340,354), Liaoning (3.43%, 1,054/30,711), Beijing (3.26%, 1,693/51,900), and Hainan (3.14%, 503/16,030). The 5 PLADs with the highest number of cases were Zhejiang (11,751 cases), Jiangsu (2,471 cases), Shanghai (2,352 cases), Beijing (1,693 cases), and Liaoning (1,054 cases), respectively. These PLADs accounted for 49.34% (11,751/23,818), 10.37% (2,471/23,818), 9.87% (2,352/23,818), 7.11% (1,693/23,818), and 4.43% (1,054/23,818) of the total cases. The distribution of detection rates and case numbers across these regions is illustrated in Figure 1.

Of the 23,818 foodborne disease cases caused by *V. parahaemolyticus*, 78.20% occurred between July and September. Using the circular distribution test (*10*), the peak occurrence of *V. parahaemolyticus*-induced foodborne disease in China from 2013 to 2022 was determined to be August 12, with a peak period from July 3 to September 21. Analysis of the peak disease periods in 12 coastal PLADs with high disease incidence revealed a distinct pattern. Regions with higher latitudes and lower temperatures tended to have peak periods that started later, ended earlier, and were shorter in duration. Conversely, regions with lower latitudes and higher temperatures exhibited peak periods that started earlier, ended later, and lasted longer. Among the 12 coastal PLADs, Liaoning Province experienced the shortest peak period for *V. parahaemolyticus*-related diseases, from July 13 to

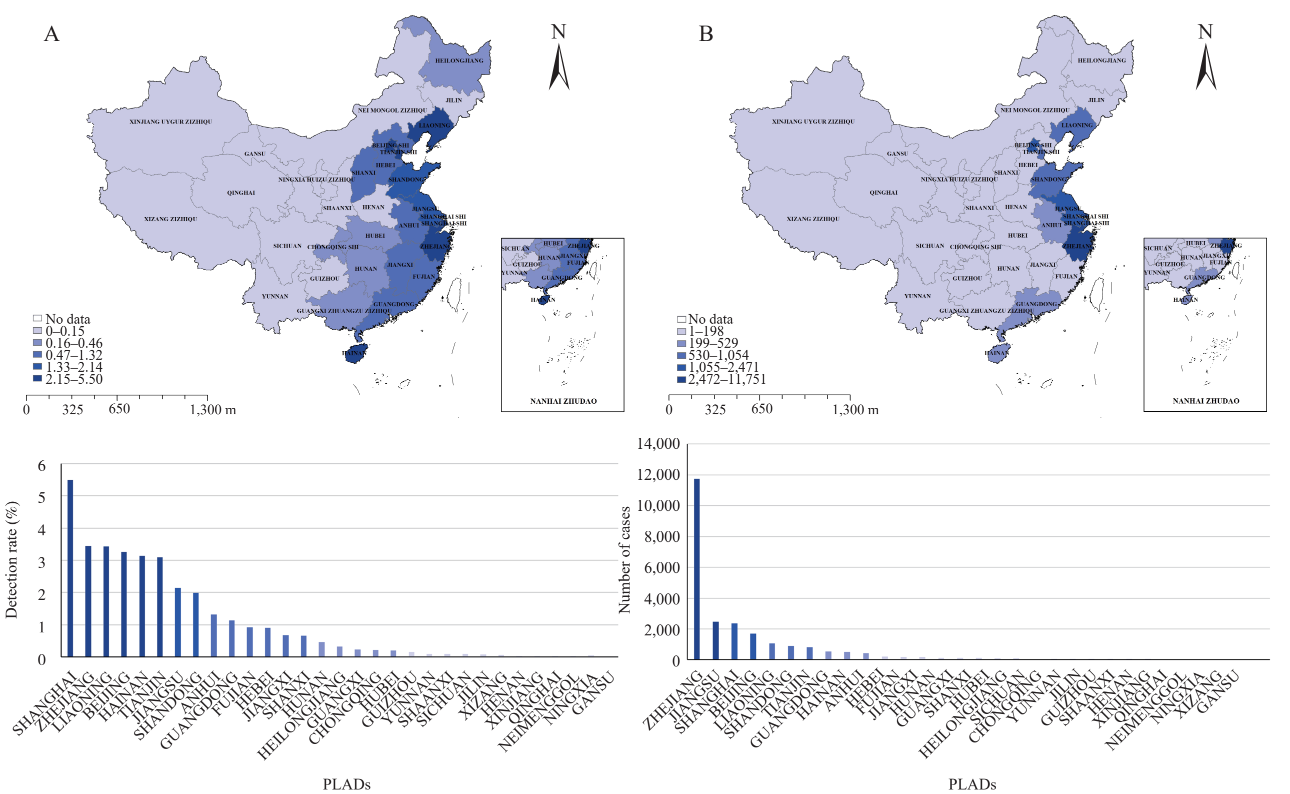



FIGURE 1. Detection rate and number of cases of foodborne disease caused by *V. parahaemolyticus* in China from 2013 to 2022. (A) Detection rate; (B) Case number.
Note: Map approval number: GS 京 (2024)1947 号.

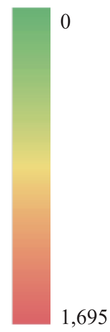
August 24. In contrast, Hainan Province recorded the longest peak period, extending from June 14 to October 20. The time distribution and peak periods of cases from 2013 to 2022 are shown in Figure 2.

A total of 81.88% of patients reported consuming suspicious foods, primarily aquatic animals and their derivatives (34.37%, 6,704/19,503). Meat and meat products were the second most common category (17.99%, 3,509/19,503), followed by various other foods (9.24%, 1,802/19,503).

Among the 23,818 isolates from 2013 to 2022, 11,987 strains of *V. parahaemolyticus* were serotyped for somatic (O) antigen, achieving a serotyping rate of 50.33%. The major serotypes identified were O3 and O4, comprising 49.59% and 23.25%, respectively. Table 1 revealed that 7,342 strains were further serotyped for both somatic (O) and capsular (K) antigens, accounting for a serotyping rate of 30.83%. Among these, the most prevalent serotypes were O3:K6 and O10:K4, representing 55.03% and 23.86%, respectively. Serotype O10:K4 emerged only in 2020 and became dominant in China in 2021–2022.

A

| Month | Number | | | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | |
| 1 | 0 | 1 | 1 | 9 | 5 | 5 | 0 | 3 | 3 | 2 | 29 |
| 2 | 0 | 0 | 1 | 5 | 1 | 12 | 4 | 0 | 12 | 1 | 36 |
| 3 | 2 | 5 | 4 | 10 | 8 | 18 | 9 | 2 | 9 | 10 | 77 |
| 4 | 6 | 15 | 23 | 27 | 23 | 30 | 18 | 6 | 36 | 15 | 199 |
| 5 | 48 | 68 | 133 | 182 | 125 | 135 | 125 | 62 | 167 | 43 | 1,088 |
| 6 | 89 | 155 | 223 | 343 | 130 | 193 | 185 | 106 | 165 | 112 | 1,701 |
| 7 | 261 | 361 | 353 | 949 | 768 | 500 | 724 | 153 | 345 | 352 | 4,766 |
| 8 | 409 | 674 | 822 | 1,695 | 1,347 | 1,379 | 1,133 | 515 | 665 | 859 | 9,498 |
| 9 | 144 | 390 | 335 | 581 | 478 | 564 | 519 | 430 | 628 | 293 | 4,362 |
| 10 | 43 | 116 | 160 | 244 | 216 | 128 | 190 | 223 | 272 | 112 | 1,704 |
| 11 | 9 | 28 | 32 | 39 | 16 | 28 | 48 | 30 | 38 | 30 | 298 |
| 12 | 2 | 4 | 10 | 10 | 3 | 4 | 8 | 12 | 7 | 0 | 60 |
| Total | 1,013 | 1,817 | 2,097 | 4,094 | 3,120 | 2,996 | 2,963 | 1,542 | 2,347 | 1,829 | 23,818 |




B

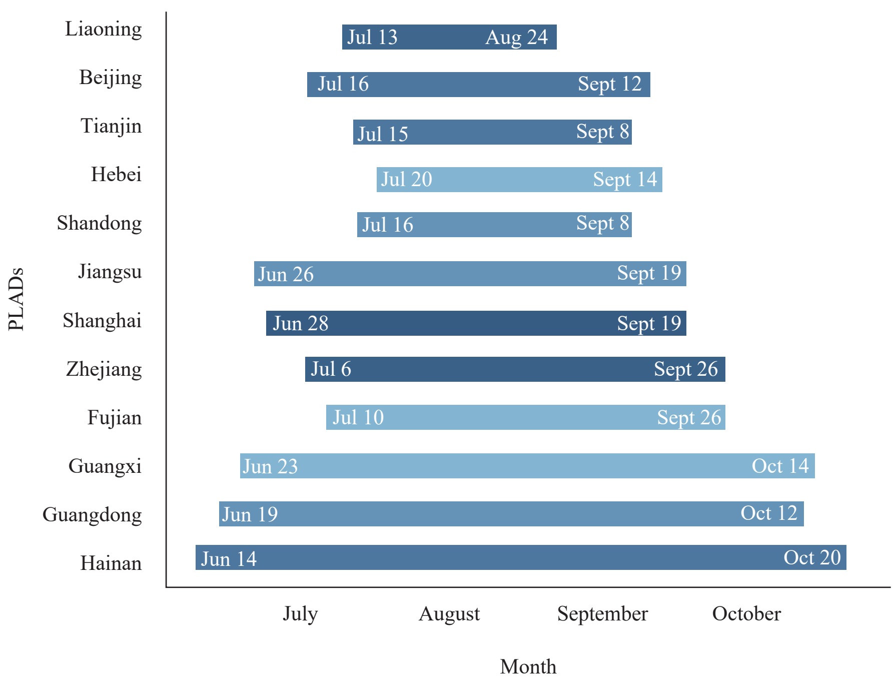



FIGURE 2. Time distribution and peak periods of foodborne disease caused by *V. parahaemolyticus* in China from 2013 to 2022. (A) Time distribution; (B) Peak periods.

TABLE 1. Distribution of main serotypes of *V. parahaemolyticus* from 2013 to 2022.

| Serotype | Number (%) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | Total |
| O3:K6 | 104 (69.33) | 410 (79.77) | 425 (83.66) | 925 (74.96) | 225 (74.26) | 150 (79.37) | 957 (79.95) | 401 (58.37) | 209 (13.91) | 234 (22.12) | 4040 (55.03) |
| O10:K4 | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 139 (20.23) | 1039 (69.17) | 574 (54.25) | 1752 (23.86) |
| O4:K8 | 37 (24.67) | 56 (10.89) | 61 (12.01) | 164 (13.29) | 45 (14.85) | 18 (9.52) | 117 (9.77) | 44 (6.40) | 31 (2.06) | 20 (1.89) | 593 (8.08) |
| O4:K4 | 8 (5.33) | 1 (0.19) | 0 (0) | 0 (0) | 7 (2.31) | 7 (3.70) | 1 (0.08) | 8 (1.16) | 64 (4.26) | 68 (6.43) | 164 (2.23) |
| O3:K4 | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 3 (1.59) | 1 (0.08) | 24 (3.49) | 43 (2.86) | 21 (1.98) | 92 (1.25) |
| O1:K1 | 0 (0) | 1 (0.19) | 1 (0.20) | 14 (1.13) | 0 (0) | 1 (0.53) | 29 (2.42) | 6 (0.87) | 11 (0.73) | 18 (1.70) | 81 (1.10) |
| O4:K6 | 0 (0) | 1 (0.19) | 8 (1.57) | 46 (3.73) | 4 (1.32) | 0 (0) | 1 (0.08) | 4 (0.58) | 0 (0) | 2 (0.19) | 66 (0.90) |
| O1:K4 | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 2 (0.66) | 0 (0) | 0 (0) | 0 (0) | 7 (0.47) | 23 (2.17) | 32 (0.44) |
| O10:K60 | 0 (0) | 17 (3.31) | 2 (0.39) | 6 (0.49) | 0 (0) | 1 (0.53) | 0 (0) | 0 (0) | 4 (0.27) | 1 (0.09) | 31 (0.42) |
| O10:K24 | 0 (0) | 0 (0) | 0 (0) | 1 (0.08) | 0 (0) | 0 (0) | 0 (0) | 9 (1.31) | 15 (1.00) | 1 (0.09) | 26 (0.35) |
| O1:K56 | 0 (0) | 2 (0.39) | 1 (0.20) | 4 (0.32) | 1 (0.33) | 0 (0) | 4 (0.33) | 2 (0.29) | 6 (0.40) | 5 (0.47) | 25 (0.34) |
| O2:K5 | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 15 (1.25) | 9 (1.31) | 1 (0.07) | 0 (0) | 25 (0.34) |
| O1:K3 | 1 (0.67) | 0 (0) | 2 (0.39) | 1 (0.08) | 4 (1.32) | 0 (0) | 6 (0.50) | 1 (0.15) | 2 (0.13) | 3 (0.28) | 20 (0.27) |
| O1:K6 | 0 (0) | 1 (0.19) | 0 (0) | 5 (0.41) | 1 (0.33) | 0 (0) | 4 (0.33) | 4 (0.58) | 0 (0) | 5 (0.47) | 20 (0.27) |
| O1:K36 | 0 (0) | 7 (1.36) | 0 (0) | 5 (0.41) | 0 (0) | 0 (0) | 3 (0.25) | 2 (0.29) | 1 (0.07) | 1 (0.09) | 19 (0.26) |
| O1:K25 | 0 (0) | 0 (0) | 1 (0.20) | 0 (0) | 0 (0) | 0 (0) | 13 (1.09) | 2 (0.29) | 1 (0.07) | 0 (0) | 17 (0.23) |
| O4:K68 | 0 (0) | 0 (0) | 1 (0.20) | 1 (0.08) | 0 (0) | 0 (0) | 7 (0.58) | 0 (0) | 8 (0.53) | 0 (0) | 17 (0.23) |
| O2:K3 | 0 (0) | 0 (0) | 0 (0) | 5 (0.41) | 0 (0) | 3 (1.59) | 6 (0.50) | 0 (0) | 0 (0) | 2 (0.19) | 16 (0.22) |
| O1:K5 | 0 (0) | 1 (0.19) | 1 (0.20) | 1 (0.08) | 2 (0.66) | 0 (0) | 0 (0) | 2 (0.29) | 3 (0.20) | 5 (0.47) | 15 (0.20) |
| O4:K9 | 0 (0) | 0 (0) | 1 (0.20) | 0 (0) | 0 (0) | 2 (1.06) | 2 (0.17) | 2 (0.29) | 3 (0.20) | 1 (0.09) | 11 (0.15) |
| O3:K8 | 0 (0) | 1 (0.19) | 1 (0.20) | 4 (0.32) | 3 (0.99) | 0 (0) | 1 (0.08) | 0 (0) | 0 (0) | 0 (0) | 10 (0.14) |
| O4:K55 | 0 (0) | 2 (0.39) | 0 (0) | 2 (0.16) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 4 (0.27) | 2 (0.19) | 10 (0.14) |
| O8:K4 | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 0 (0) | 1 (0.07) | 9 (0.85) | 10 (0.14) |
| Others | 0 (0) | 14 (2.72) | 3 (0.59) | 50 (4.05) | 9 (2.97) | 4 (2.12) | 30 (2.51) | 28 (4.08) | 49 (3.26) | 63 (5.95) | 250 (3.41) |
| Total | 150 (100.00) | 514 (100.00) | 508 (100.00) | 1,234 (100.00) | 303 (100.00) | 189 (100.00) | 1,197 (100.00) | 687 (100.00) | 1,502 (100.00) | 1,058 (100) | 7,342 (100) |

## DISCUSSION

This study examined the epidemiological characteristics of foodborne diseases caused by *V. parahaemolyticus* in China using active surveillance data from 2013 to 2022. A total of 23,818 cases of *V. parahaemolyticus* foodborne illness were identified and collated through the national foodborne disease surveillance system. Distinct monthly peaks in cases were observed during warmer months, particularly from July to September. Coastal regions accounted for most cases, with a significantly higher detection rate of *V. parahaemolyticus* than inland areas. Analysis of the 23 serotypes detected revealed the diversity of *V. parahaemolyticus*, with serotypes O3:K6 and O10:K4 being the most prevalent. Notably, serotype O10:K4 has become increasingly prominent, surpassing O3:K6 as the dominant serotype in China since 2021.

This seasonality and coastal distribution of *V.*

*parahaemolyticus* infection have also been observed in other countries. This phenomenon is thought to be associated with the thermophilic nature of *V. parahaemolyticus*, as coastal residents have a higher risk of consuming raw, undercooked, or mishandled seafood (*11*). The duration of the disease peak varies by region, mainly related to latitude and local temperature conditions, which may affect the growth and reproduction of *V. parahaemolyticus*. Recent studies have also shown a link between the appearance of *Vibrio* epidemic outbreaks and environmental factors, such as the oceanic transport of warm waters, providing a possible mechanism for the global dispersion of *Vibrio* diseases. In general, younger patients, particularly those under 5 years of age, tend to experience a higher frequency and variety of viral infections, while adults aged 18 to 45 are more susceptible to bacterial pathogens (*12*). This study agreed with this trend, as more than half of the *V. parahaemolyticus* cases occurred in the 24-44-year-old age group. This age distribution pattern could indicate a natural evolution in host immunity and/or dietary preferences that correlate with age. This study also revealed that the incidence of foodborne illnesses declined significantly during the COVID-19 pandemic. This decline may be attributed to policies, restrictions, and environmental and behavioral changes.

Frequent recombination events around the O- and K-antigen coding gene cluster in *V. parahaemolyticus* can lead to serotype transformation (*13*–*15*). In recent years, the serotype O10:K4 has become increasingly prevalent, surpassing O3:K6 as the dominant serotype in China. This suggests that new *V. parahaemolyticus* antigens may emerge and spread in the future.

This study was subject to some limitations. First, due to differing detection capabilities in sentinel hospitals, this study may not fully reflect the real-world epidemiological characteristics of foodborne disease caused by *V. parahaemolyticus*. Second, the actual number of foodborne disease cases may be larger than the number of monitored cases. This discrepancy may arise because foodborne disease often self-resolves, receives limited patient attention, and is prone to underreporting in the monitoring network. Third, the serotyping rate for both O and K antigens is relatively low and may not represent the true prevalence of *V. parahaemolyticus* serotypes. Fourth, this study did not investigate the virulence factors of *V. parahaemolyticus*.

Based on the study results, food regulatory authorities should intensify routine surveillance and inspections targeting high-risk periods and locations. Oversight of production, marketing enterprises, and catering services should be strengthened, with a focus on crucial steps such as raw seafood processing and storage. Additionally, relevant departments should leverage social media to promote public awareness and education on preventing and controlling *V. parahaemolyticus*-related foodborne illnesses. This will improve public knowledge and self-protection regarding these illnesses.

**Conflicts of interest**: No conflicts of interest.

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