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Risk Factors for *Vibrio parahaemolyticus* Infection in a Southern Coastal Region of China

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Abstract

Objectives—The objectives of the study were to identify dietary and medical risk factors for *Vibrio parahaemolyticus* (VP) infection in the coastal city Shenzhen in China.

Methods—In April–October 2012, we conducted a case–control study in two hospitals in Shenzhen, China. Laboratory-confirmed VP cases ($N = 83$) were matched on age, sex, and other social factors to healthy controls ($N = 249$). Subjects were interviewed using a questionnaire on medical history; contact with seawater; clinical symptoms and outcome; travel history over the past week; and dietary history 3 days prior to onset. Laboratory tests were used to culture, serotype, and genotype VP strains. We used logistic regression to calculate the odds ratios for the association of VP infection with potential risk factors.

Results—In multivariate analysis, VP infection was associated with having pre-existing chronic disease (adjusted odds ratio [aOR], 6.0; 95% confidence interval [CI], 1.5–23.7), eating undercooked seafood (aOR, 8.0; 95% CI, 1.3–50.4), eating undercooked meat (aOR, 29.1; 95%

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CI, 3.0–278.2), eating food from a street food vendor (aOR, 7.6; 95% CI, 3.3–17.6), and eating vegetable salad (aOR, 12.1; 95% CI, 5.2–28.2).

Conclusions—Eating raw (undercooked) seafood and meat is an important source of VP infection among the study population. Cross-contamination of VP in other food (e.g., vegetables and undercooked meat) likely plays a more important role. Intervention should be taken to lower the risks of cross-contamination with undercooked seafood/meat, especially targeted at people with low income, transient workers, and people with medical risk factors.

Introduction

Vibrio parahaemolyticus (VP) is a Gram-negative organism that thrives in water with a high salt content. This bacterium is a human pathogen that occurs naturally in the marine environments and is frequently isolated from a variety of seafood (Joseph *et al*., 1982; Ma *et al*., 2013). It is recognized as the leading cause of human gastroenteritis associated with seafood consumption in the United States and many Asian countries, including Thailand, Japan, and China. As reported in these countries, raw or improperly prepared oysters are a common vehicle; other implicated sources include clams, crayfish, crabs, lobster, mussels, and shrimp (Daniels *et al*., 2000; Vuddhakul *et al*., 2000; Hara-Kudo and Kumagai, 2014; Wu *et al*., 2014). During the last two decades in China, VP has become the most common cause of bacterial foodborne infection, especially in coastal regions (Wang *et al*., 2007; Ma *et al*., 2013; Yan *et al*., 2015). Although gastroenteritis caused by VP infection is usually self-limited and of moderate severity, both local (wound) and systemic (sepsis) illness can occur and cause severe outcomes (Daniels *et al*., 2000). The risk of sepsis increased in persons with underlying chronic illnesses, particularly in persons with pre-existing liver disease (Hlady and Klontz, 1996).

Even though VP infection is common and serious, most studies in China have focused on laboratory characterization of VP strains obtained from humans or foods, while few studies to date have systematically analyzed dietary or medical risk factors. A previous epidemiological study suggested that frequent eating out and shellfish consumption were two risk factors associated with VP infection (Yan *et al*., 2015). Another national analysis has indicated that meat and meat products are the most common vehicle of VP infection (responsible for 18% of outbreaks) in 322 reported VP outbreaks in China during 2003–2008, followed by aquatic products (responsible for 16% of outbreaks) (Wu *et al*., 2014). This is in contrast with data from other developed countries, where seafood products, mostly shellfish, are considered the food most associated with VP infection (McLaughlin *et al*, 2005; Su and Liu, 2007; Hara-Kudo and Kumagai, 2014).

Shenzhen is a city of 13 million people located in Guangdong Province along the southern coast of China. Shenzhen has one of China's largest transient populations due to its emergence as a major economic free-trade zone. In 2007, Shenzhen began conducting enhanced surveillance for acute infectious diarrhea at selected hospitals. VP has been found to be the most frequently isolated pathogen; more than 80% of cases occur from April to October (Li *et al*., 2014). To identify possible dietary and medical risk factors for VP infections, and to determine whether there are unique risk factors in China compared with other countries, we conducted a case–control study in Shenzhen.

Materials and Methods

Study population

From April to October 2012, study participants were recruited from two hospitals that accounted for the largest proportion of VP cases in Shenzhen. Local public health workers used a standardized questionnaire to interview out-patients with diarrhea who submitted stool specimens for testing. We enrolled all eligible case patients with VP infection confirmed by stool culture from the two hospitals. A case-patient was defined as any outpatient when VP was isolated from the stool.

Controls

For each VP case, we attempted to enroll at least three healthy controls among people who presented for an annual medical check-up in the community health care centers and excluded those with diarrhea and gastroenteritis. The criteria for a healthy control were no diarrhea, vomiting, or abdominal pain within 1 week before the survey. Controls were matched for gender, age (within 2 years), education level, and location of living quarters. All cases and controls resided in Shenzhen for >6 months. Controls were interviewed in person or over the phone using the same questionnaire during the same week of the enrollment of the cases. Among enrolled case and control patients, 10% were randomly selected for follow-up interviews for quality assurance.

Questionnaire

The questionnaire included information about demographics; medical history of the patient including liver, kidney, hematologic, immunologic, splenectomy, diabetes, or other conditions known to be risk factors for *Vibrio* sepsis; contact with sea water; clinical symptoms and outcome; and travel history over the preceding week. Dietary history over the preceding 3 days was also collected, including approximately 100 potential exposures and extensive questions about the type, quantity, and frequency of consumption of meat, seafood, and vegetable items and where the item was prepared or consumed. This research was approved by the Institutional Review Board at the Center for Disease Control and Prevention (CDC) of Shenzhen. Verbal informed consent was obtained from all respondents before the interview.

Laboratory testing

VP isolates were obtained from clinical laboratories and forwarded to Shenzhen CDC for confirmation and further identification. Serotyping was conducted by slide agglutination using a commercial serum (Denka-Seiken Ltd., Tokyo, Japan). Polymerase chain reaction was conducted to detect virulence genes including the thermostable direct hemolysin (*tdh*) and TDH-related hemolysin (*trh*). Molecular subtyping (pulsed-field gel electrophoresis [PFGE]) was performed using *Not*I restriction enzyme according to a protocol developed by the United States Centers for Disease Control and Prevention (US CDC) (Parsons *et al*., 2007).

Statistical analysis

Data was managed using Epidata software 3.2, and analyzed using SPSS software, version 16.0 (SPSS Institute Inc., Chicago, IL). A descriptive analysis was performed to describe the characteristics of the case-patients and controls. The association between study variables and VP infection was explored using univariate analysis. Individual exposure variables were introduced sequentially into an unconditional logistic regression model to determine adjusted, univariate odds ratios (ORs). Multivariable logistic regression models were used to estimate ORs and 95% confidence intervals (CIs) for variables significant in univariate analysis (ORs >1) and variables of *a priori* interest based on previous studies of VP infection. We excluded from the models those variables that had ORs <1 in univariate analysis. Automated forward selection was employed to derive a final multivariable model. A subset analysis was performed among patients infected with the most common VP serotypes, among patients with unique PFGE patterns. Statistical significance was defined as a p value < 0.05.

Results

From April to October 2012, 500 patients with diarrhea were interviewed. VP was recovered from 83 patient stool cultures out of the 500 patients. No case-patients were from the same family unit and none reported eating at the same institution within the same exposure period, suggesting they were not part of any recognizable outbreak.

Isolates for serotyping and molecular typing were available for 76 (92%) of the 83 VP patients. Serotype O3:K6 was found to be the most common serotype, accounting for 88% (67/76) of the serotyped strains. The remaining serotypes were O4:K8 (N = 4), O3:KUT (N = 1), O1:K6 (N = 1), O1:K41 (N = 1), O1:KUT (N = 1), and O2:K3 (N = 1) (Table 1). Among isolates expressing the O3:K6 serotype, PFGE subtyping with NotI showed eight different patterns; 81% (55/67) of the isolates with O3:K6 serotype expressed a single pattern. All but one of the VP isolates was *tdh+trh−*; the exception expressed tdh+trh+ and was serotype O1: KUT.

Case–control study

Controls (n = 249) were demographically similar to enrolled case-patients in terms of age, sex, and other social factors. Compared with controls, case-patients were more likely to have a lower monthly income and lower educational level, and less likely to have national medical insurance (Table 2).

The univariate analysis showed that eight exposure factors were associated with an increased likelihood of VP infection (Table 3). These were having a pre-existing chronic disease (OR 5.2; 95% CI 1.7–16.4), having exposure to other diarrhea patients (OR 3.7; 95% CI 1.7–8.1), having contact with sea water (OR 9.6; 95% CI 1.9–48.7), eating raw (undercooked) seafood (OR 11.0; 95% CI 2.2–55.8), eating raw (undercooked) meat (OR 36.7; 95% CI 4.6–291.9), eating food from a street food vendor (OR 10.3; 95% CI 5.0–21.0), eating vegetable salad (OR 10.4; 95% CI 4.9–22.3), and eating ice cream (OR 3.3; 95% CI 1.4–7.8). Among cases, 6 (7%) ate raw (undercooked) seafood (including fish, oysters, squid) and 10 (12%) ate raw (undercooked) meat (duck, pork, beef and chicken) in the 3 days preceding illness onset. Among controls, three (1%) ate raw (undercooked) food, including salmon, shrimp, fish, and pork. No one in the cases and controls reported eating both raw (undercooked) seafood and meat. The separate analysis for eating raw (undercooked) seafood and raw (undercooked) meat showed the two factors are both significantly associated with VP infection. For VP cases reported eating vegetable salad, only two (7%) also reported eating undercooked seafood, and none of the controls eating vegetable salad also ate raw (undercooked) seafood. Therefore, the OR and 95% CI of eating vegetable salad in Table 3 present the true association with VP infection.

The final multivariate model included eight exposures, five of which were strongly associated with VP infection. These exposures were as follows: (1) having a pre-existing chronic disease (adjusted OR [aOR], 6.0; 95% CI, 1.5–23.7); (2) eating raw (undercooked) seafood (aOR, 8.0; 95% CI, 1.3–50.4); (3) eating raw (undercooked) meat (aOR, 29.1; 95% CI, 3.0–278.2); (4) eating food from a street food vendor (aOR, 7.6; 95% CI, 3.3–17.6); and (5) eating vegetable salad (aOR, 12.1; 95% CI, 5.2–28.2) in the 3 days before illness onset (Table 4).

When univariate analysis was restricted to the serotype O3:K6 isolates, three additional exposures were associated with risk of VP infection: eating take-away food, eating in a canteen, and eating shellfish. One factor was protective: eating seaweed (OR 0.5; 95% CI 0.25–0.98). In the multivariate analysis restricted to serotype O3:K6-expressing isolates, five exposures showed strong association with VP infection. These were as follows: (1) having a pre-existing chronic disease, (2) eating raw (undercooked) seafood, (3) eating raw (undercooked) meat, (4) eating food from a street food vendor, and (5) eating vegetable salad. The analysis between O3:K6 cases and non-O3:K6 cases did not show significant difference for the risk factors. Further analysis for the 55 VP cases with a common NotI PFGE pattern showed no appreciable change in measures of association for the five exposures that were already included for serotype O3:K6 (data not shown).

Discussion

Our study suggests that eating undercooked seafood and meat are risk factors of VP infection. Previous studies have recognized eating raw or undercooked seafood (particularly shellfish) is a risk factor of VP infection in developed countries (Daniels *et al*., 2000; Vuddhakul *et al*., 2000; McLaughlin *et al*., 2005; Su *et al*., 2007; Hara-Kudo and Kumagai, 2014). In China, surveillance has indicated that seafood products had high concentrations of VP contamination (Yang *et al*., 2008; Chen *et al*., 2012; Zhang *et al*., 2013). However, our study did not indicate shellfish (e.g., oysters) as a predominant food item associated with VP infection. Only 2 VP case-patients and 1 control out of the 332 people interviewed reported eating oysters in the preceding 3 days, including 2 that had consumed cooked and 1 that had undercooked oysters. This is consistent with other studies (Yeung and Boor, 2004; McLaughlin *et al*., 2005; Ma *et al*., 2013), and probably reflects Chinese dietary habits (i.e., their habits do not often entail eating oysters, and when they eat them, these are often cooked).

A previous study showed that there is an association between VP infections and frequent eating out (Yan *et al*., 2015). Outbreaks of VP are also frequently traced to food served in restaurants or other commercial food settings (Wang *et al*., 2007; Wu *et al*., 2014). Our study has also suggested that eating out, particularly eating from a street food vendor, is a risk factor of VP infection in this study. In Shenzhen, it is popular for street vendors to sell roasted food (i.e., meat, seafood) and salted food (often made from duck, or viscera of pigs and cattle), especially in the summer. The hygienic standard of these foods is often insufficient, and the food is often undercooked. In this study, some case-patients reported not eating any seafood in the 3 days preceding illness onset, but they did report eating salted meat. Salted meat has previously been reported as a source of VP in outbreaks in China (Ma *et al*., 2013). In southern China, where Shenzhen is located, salted meat is often cooked with liberal salt and other spices, cooled to room temperature, and then sliced. Molecular subtyping has shown that VP cross-contamination can occur between salted foods and seafood at the point of food preparation (Ma *et al*., 2013). Once contaminated by VP, the salinity in the salted food allows for microbial proliferation and survival (Yeung and Boor, 2004).

Another interesting finding is that eating vegetable salad was a strong risk factor of VP infection (aOR 12.1; 95% CI 5.2–28.2). In this study, 30 out of the 83 VP case-patients reported eating food from a street vendor, and 27 reported eating vegetable salad; 8 reported both. Notably, many VP-infected case-patients were found to be transient residents in Shenzhen possessing low income and low educational levels. This population seldom consumes seafood, partially because of the cost. It is common for transient workers to purchase food from street vendors as a group in the evening, especially in the summer. Although it is hard to predict whether the patients ate vegetable salad from a street vendor, it is possible that VP infection among those patients is associated with poor hygiene and cross-contamination in food processing by street food vendors. Additionally, only 2 out of the 27 cases eating vegetable salad also reported eating undercooked seafood, indicating eating vegetable salad is a true risk factor of VP infection in the study. Vegetable salad can be cross-contaminated with VP in other commercial or household kitchens: VP can easily be transferred from meat or seafood to the ready-to-eat vegetables through a cutting board, knife, or table (Yeung and Boor, 2004).

This study revealed that having a pre-existing chronic disease is associated with VP infection (aOR 6.0; 95% CI 1.5–23.7). It has been documented that a population at increased risk for development of severe VP infection is people with chronic medical conditions including liver disease, immunodeficiency, peptic ulcer disease, diabetes, hematological disease, gastric surgery, cancer or malignancy, and transplant recipients (U.S. Food and Drug Administration, 2005). The most common pre-existing chronic disease associated with VP cases in this study was hepatitis, especially hepatitis B.

Serotype O3:K6 (*tdh*+*trh*−) was the most common serotype among VP patients identified in this study, consistent with other studies (Chao *et al*., 2009; Ma *et al*., 2013; Li *et al*., 2014). Risk factors associated with infection with serotype O3:K6 were the following: having pre-existing chronic disease, eating raw (undercooked) seafood and meat, eating food from a street food vendor, and eating vegetable salad. We have also compared risk factors between

O3:K6 cases and non-O3:K6 cases, but no significant difference was found, possibly because of the limited number of non-O3:K6 cases.

There were some limitations associated with this study. Firstly, the retrospective nature of the survey may have led to recall bias. Although we attempted to interview patients before stool culture as they presented to the hospital to minimize recall bias and ensure an interview, it is still possible that people may not remember a single food item consumed 3 days before symptom onset. Secondly, although the questionnaire was designed to examine many food items and pre-existing chronic disease as dietary and medical history, the number of cases with specific food exposure or chronic disease, such as oyster or hepatitis, was small, limiting the power to detect the association with infection. Thirdly, although our analysis has shown an association between eating vegetable salad and VP infection, our study was unable to identify the preliminary source of the VP contamination, as vegetable is not the natural reservoir for VP. We could only speculate the cross-contamination based on other studies.

The findings of this study suggest possible intervention measures to control VP infection. Consumer behavior represents an important aspect that affects numbers of VP infections. As VP is very sensitive to heat, the risk of VP infections can be reduced through thorough cooking of raw meat/seafood. Application of other hygienic food-handling techniques is also important to reduce the risk of VP infection at the consumer level (Yeung and Boor, 2004). Specific measures include educating the public about risks of undercooked seafood/meat and the risks of cross-contamination, especially targeted at people with low income, transient workers, and people with medical risk factors. Additionally, it is important to increase the awareness of health care professionals responsible for people with chronic illnesses about the risks of undercooked seafood and meat. Clear guidelines should be provided for hand hygiene, adequate cooking procedures, and ways to prevent cross-contamination of ready-to-eat foods with uncooked seafood in the kitchen. Finally, improving and enforcing restaurant inspection procedures, including monitoring for cross-contamination and cooking temperature of food, especially prepared by street food vendors, should reduce VP infections.

Conclusions

In conclusion, this case–control study suggested that undercooked seafood and meat is a source for VP infection among the study population. Cross-contamination of VP in other food (e.g., vegetables and undercooked meat) likely plays a more important role. Intervention should be taken to lower the risks of cross-contamination with undercooked seafood/meat, especially targeted at people with low income, transient workers, and people with medical risk factors.

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Table 1

Serotype Distribution of the *Vibrio parahaemolyticus* Isolates from the Patients Enrolled in This Study

Serotype	No. of isolates	%
O3:K6	67	80.7
O3:KUT	1	1.2
O4:K8	4	4.8
O1:K6	1	1.2
O1:K41	1	1.2
O1:KUT	1	1.2
O2:K3	1	1.2
Untypable	3	3.6
Missing isolates	4	4.8
Total	83	100

Table 2

Demographic Characteristics of Patients and Controls Participating in a Case–Control Study of *Vibrio parahaemolyticus* Infection, Shenzhen, China, 2012

Characteristic	***Patients* (n = *83*) No. (%)**	***Controls* (n = *249*) No. (%)**	**p *Value***
Female sex	42 (50.6)	139 (55.8)	0.408
Age median y (range)	27 (10–79)	30 (15–78)	0.066[a]
Local residence	8 (9.6)	45 (18.1)	0.069
Monthly income[b]			
<322 USD	22 (26.5)	33 (13.3)	0.035
322–966 USD	49 (59.0)	166 (66.7)	
≥966 USD	10 (12.0)	37 (14.9)	
Unknown	2 (2.4)	13 (5.2)	
Educational level			
Less than high school	37 (44.5)	79 (31.7)	0.025
High school	30 (36.1)	108 (43.4)	
College graduate	14 (16.9)	60 (24.1)	
Higher than college	2 (2.4)	2 (0.8)	
Covered by national medical insurance	32 (38.6)	187 (75.1)	<0.001

Chi-square test used except when noted.

[a] Wilcoxon rank-sum test.

[b] 322 U.S. dollars (USD) = 2000 renminbi (RMB), 966 USD = 6000 RMB.

Table 3

Univariate Analysis of Risk Factor for *Vibrio parahaemolyticus* Infection in Shenzhen, China, 2012, Including Subgroup Analysis of Serotype O3:K6

		Case-patient					
Characteristic	***Control* (n = *249*)**	***All* (*n* = *83*)**	**OR (95% CI)**	**p**	***Serotype O3:K6* (n =*67*)**	***OR (95% CI)***	**p**
Having pre-existing chronic disease[a]	5	8	**5.2 (1.7–16.4)**	0.005	8	**6.5 (2.1–20.6)**	0.001
Exposure to other diarrhea patients	14	15	**3.7 (1.7–8.1)**	0.001	10	**2.9 (1.2–6.9)**	0.016
Job involving sea contact	2	6	**9.6 (1.9–48.7)**	0.006	5	**9.8 (1.9–51.7)**	0.007
Eating raw (undercooked) seafood or meat	3	16	**19.6 (5.5–69.2)**	<0.001	15	**23.2 (6.5–83.0)**	<0.001
Eating raw (undercooked) seafood[b]	2	6	**11.0 (2.2–55.8)**	<0.001	6	**13.2 (2.6–67.0)**	<0.001
Eating raw (undercooked) meat[c]	1	10	**36.7 (4.6–291.9)**	<0.001	9	**39.5 (4.9–318.5)**	<0.001
Dining out	73	67	**10.1 (5.5–18.6)**	<0.001	57	**12.5 (6.2–25.2)**	<0.001
Restaurant	22	12	1.7 (0.8–3.7)	0.147	10	1.8 (0.8–4.0)	0.159
Take away	25	15	2.0 (1.0–4.0)	0.055	14	**2.3 (1.1–4.8)**	0.022
Canteen	32	18	1.9 (1.0–3.6)	0.054	16	**2.1 (1.1–4.1)**	0.032
Street food vendor[d]	13	30	**10.3 (5.0–21.0)**	<0.001	25	**10.6 (5.0–22.2)**	<0.001
Eating cooked meat							
Pork	227	70	0.5 (0.3–1.1)	0.083	60	0.7 (0.3–1.7)	0.466
Beef	93	29	0.9 (0.5–1.5)	0.693	24	0.9 (0.5–1.6)	0.756
Mutton	7	4	1.8 (0.5–6.1)	0.382	2	1.1 (0.2–5.2)	0.954
Chicken	181	57	0.8 (0.5–1.4)	0.482	47	0.8 (0.5–1.5)	0.561
Duck	89	21	0.6 (0.4–1.1)	0.082	19	0.7 (0.4–1.3)	0.230
Eating cooked seafood							
Fresh water fish	165	48	0.7 (0.4–1.2)	0.698	38	0.7 (0.4–1.1)	0.115
Sea water fish	94	32	1.0 (0.6–1.7)	0.896	29	1.2 (0.7–2.1)	0.463
Shrimp	45	14	0.9 (0.5–1.8)	0.804	12	1.0 (0.5–2.0)	0.936
Crab	6	2	1.0 (0.2–5.1)	1.000	1	0.6 (0.1–5.1)	0.644
Shellfish	17	11	2.1 (0.9–4.7)	0.073	10	**2.4 (1.0–5.4)**	0.044
Eating seaweed	75	17	0.6 (0.3–1.1)	0.091	12	0.5 (0.3–1.0)	0.044
Eating egg	178	55	0.8 (0.5–1.3)	0.368	48	1.0 (0.5–1.7)	0.885
Eating vegetable	231	77	1.0 (0.4–2.6)	1.000	63	1.0 (0.4–2.8)	0.972
Fried vegetable	224	72	0.7 (0.3–1.6)	0.416	59	0.7 (0.3–1.7)	0.452
Pickled vegetable	90	32	1.1 (0.7–1.9)	0.693	28	1.2 (0.7–2.1)	0.447
Vegetable salad[e]	11	27	**10.4 (4.9–22.3)**	<0.001	21	**9.7 (4.4–21.4)**	<0.001
Eating fruit	221	70	0.7 (0.3–1.4)	0.292	56	0.6 (0.3–1.2)	0.162
Having drinks	183	53	0.6 (0.4–1.1)	0.095	43	0.6 (0.4–1.1)	0.099
Ice cream	12	12	**3.3 (1.4–7.8)**	0.005	9	**3.0 (1.2–7.5)**	0.018
Having a pet	12	4	1.0 (0.3–3.2)	1.000	3	0.9 (0.3–3.3)	0.888

Significant OR values are in bold.

OR, odds ratio; CI, confidence interval.

[a]Among the *Vibrio parahaemolyticus* (VP) cases, 5 had hepatitis (4 hepatitis B and 1 other hepatitis), 1 diabetes, 1 hypertension, 1 stomach disease. Among the controls, 2 had hepatitis B, 1 diabetes, 1 hypertension, 1 heart disease, 1 cancer.

[b]Among the VP cases, including fish (4), oysters (1), and squid (1); among controls, including raw salmon (1) and shrimp and fish (1).

[c]Among the VP cases, including duck (4), pork (3), beef (2) and chicken (1); among controls, including chicken (1).

[d]Defined as sitting down and eating in a street food vendor but not taking food away.

[e]Among the 27 VP cases, 2 had both vegetable salad and undercooked seafood, 2 had both vegetable salad and undercooked meat. All controls did not have either undercooked seafood or meat.

Table 4

Multivariable Analysis of Risk Factors for *Vibrio parahaemolyticus* Infection in Shenzhen, China, 2012

Characteristics, by serotype	*Adjusted OR*	*95% CI*	p
All serotypes			
Having pre-existing chronic disease	**6.0**	**1.5–23.7**	0.010
Exposure to a diarrhea patient	2.3	0.9–6.1	0.081
Job involving sea contact	2.8	0.3–31.1	0.399
Eating raw (undercooked) seafood	**8.0**	**1.3–50.4**	0.027
Eating raw (undercooked) meat	**29.1**	**3.0–278.2**	0.003
Eating from a street food vendor	**7.6**	**3.3–17.6**	<0.001
Eating vegetable salad	**12.1**	**5.2–28.2**	<0.001
Eating ice cream	2.3	0.8–6.8	0.119
Serotype O3:K6			
Having pre-existing chronic disease	**7.9**	**1.9–32.4**	0.004
Exposure to a diarrhea patient	1.9	0.7–5.4	0.225
Job involving sea contact	1.0	0.1–11.1	0.983
Eating raw (undercooked) seafood	**11.2**	**1.7–72.5**	0.011
Eating raw (undercooked) meat	**36.6**	**3.2–422.4**	0.004
Eating in a street food vendor	**7.0**	**2.8–17.6**	<0.001
Eating vegetable salad	**10.5**	**4.3–25.5**	<0.001
Eating ice cream	2.2	0.7–6.9	0.376
Eating take-away food	1.5	0.6–3.9	0.376
Eating in a canteen	2.0	0.8–4.8	0.123
Eating shell fish	1.4	0.5–4.3	0.508

Significant odds ratio (OR) values are in bold.

CI, confidence interval.