Student's name: KEY

PHR 250
Final Exam
June 6–13, 2007
80 total points

1. Multi-state Outbreak of Gastroenteritis (25 points)

In November 1999, the Fresno County Health Department reported five cases of *Pathogen X* among children (all under 18 years of age) with gastroenteritis to the state health department. At that time, Fresno County normally reported one or fewer cases of *Pathogen X* per month. One of the children was hospitalized with kidney failure. The county noted that all patients had been diagnosed at a large local Children's Hospital, which had recently begun routine screening of stools from children with unexplained bloody diarrhea using an appropriate culture medium for identification of *Pathogen X*.

1-1. What is *Pathogen X*? Why is the agar medium used to selectively isolate this pathogen important? (4 pts)
***E. coli* O157:H7 or enterohemorrhagic *E. coli* (EHEC). Unlike typical *E. coli*, isolates of O157:H7 do not ferment sorbitol and are negative with the MUG assay; therefore, these criteria are commonly used for selective isolation. Sorbitol-MacConkey agar (SMAC) is used most commonly to isolate this organism from clinical specimens (or Sorbitol-MacConkey medium containing potassium tellurite and Cefixime).**

The state immediately sends an alert about the possible outbreak to surrounding counties in the Central Valley and Bay Area of California. Five nearby counties report 1-2 patients recently diagnosed with *Pathogen X*, but this is not necessarily more than would be expected in their county during that time period.

1-2. What laboratory procedure can be performed to identify whether or not the cases in the nearby counties are related? (2 pts)
PFGE (DNA "fingerprinting")

1-3. What is the name of the national database used to compare bacterial isolates from different patients? What government agency maintains this database? (2 pts)
CDC's PulseNet

Using the technique and database above, a total of 20 patients are identified as cases (part of the outbreak) including 12 from California, 5 from Nevada, and 3 from Arizona. The median age of the patients was 9 years (range 3-90 years). Fourteen (70%) of the 20 patients were under 20 years of age.

Initial interviews with the patients or their parents revealed that several had eaten at the same fast-food restaurant chain (but at different franchises in the different counties and states) during the week before illness onset. To determine whether or not eating at this restaurant was statistically associated with illness, a case-control study was conducted. A control was defined as a person without diarrheal illness during the first two weeks of November. Controls were

enrolled by telephone using computer-assisted random digit dialing in the same area codes as the patient's residences. Controls were matched to cases by age group (0-9 years; 10-19 years; over 20 years). Interviews were conducted over the telephone using a standardized questionnaire. Patients and controls were both asked if they had eaten at any of 10 national fast-food restaurant chains during the first two weeks of November.

1-4. Why did the epidemiologist match by age for this case-control study? (3 pts)
Because many cases were children—matching is used to equalize the frequency of the confounding variable in the two groups being compared.

The case-control study implicates a Mexican-style fast-food restaurant chain hereafter referred to as Chain A (Matched Odds Ratio = infinity; Confidence Interval = 2.33 – infinity; p = 0.002). The epidemiologist conducts a second case-control study to determine the food item on the menu associated with illness.

Table 1-1. Food consumption histories from the case-control study.

Meal item or ingredient	Cases		Controls		Odds ratio
	Yes	No	Yes	No	
Burrito – bean	2	18	2	18	1.00
Burrito – beef	1	19	2	18	0.47
Chalupa – beef	0	19	4	16	XX
Mexican pizza	2	18	5	15	0.33
Nachos	4	16	6	14	0.58
Taco, beef, hard shell	14	6	10	10	2.33
Taco, beef, soft shell	1	19	3	17	0.30

1-5. Calculate odds ratios, enter them in the table, and determine the implicated food item. Explain why you chose this item. (12 pts)
Taco, beef, hard shell: with a representative portion of the sample population among cases and controls, the odds ratio was the only one >1.00.

A traceback of the ingredients in the suspect food item implicated ground beef that was pre-seasoned and packaged by a processor in Idaho. The beef had been purchased from a slaughterhouse also located in Idaho. An inspection of the out-of-state processing facility and slaughterhouse was conducted.

1-6. What government agency was responsible for the inspection? (2 pts)
USDA (FSIS)

2. Illnesses from Spanish Cheese (20 points)

From January to March, 2002, four similar illnesses were recorded among residents of three rural municipalities (Lucena, Benameji, and Palenciana) in Andalucía, Spain. An epidemiological investigation was conducted to identify additional cases, to identify a vehicle, and to enact control measures.

Eleven cases (2 laboratory-confirmed and 9 suspect) were identified. The mean age was 33 years, and the most frequent symptoms were: fever (100%), chills (100%), nocturnal sweating (91%), general malaise (91%), arthralgia (82%), weight loss (64%), and headache (64%). Three cases were hospitalized for median of 4 days. All responded promptly to antibiotic treatment, except one person who had an abnormal reaction.

The onset of the first case was on January 1 and the last on March 20. a duration of 79 days. Cases were aggregated in seven families; eight cases occurred in five families in Lucena, whereas two individual cases occurred in Benameji and one in Palenciana (Fig. 1). All cases were interviewed, but only one case was randomly selected from each family to be included in the analyses regarding risk factors. Controls (a total of 26) were included on the basis that they resided in the territory, did not display similar symptoms, and had the same probability of exposure to the risk as did the cases.

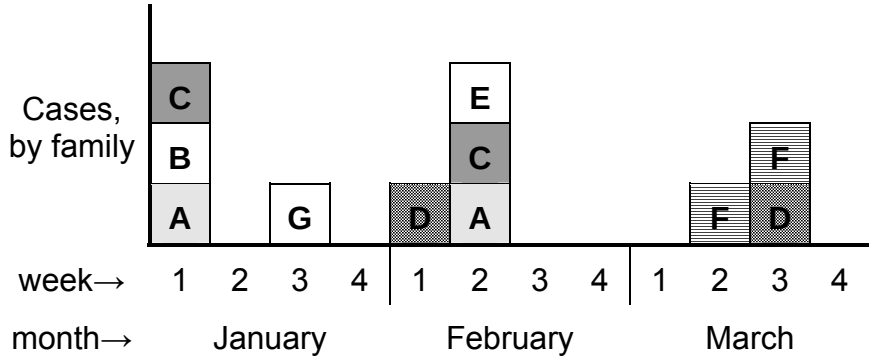


Fig. 2-1. Temporal distribution of cases among families.

There was no recent or earlier occupational exposure risk from animals (mainly goats and sheep) among cases or controls. Neither was there any previous contact with risk animals, so that was excluded as a possible risk factor in the outbreak. Persons who had eaten cheese made from raw goat's milk were at higher risk than those who had not, and the association was especially strong for cheese produced in farmhouse A. As Table 1 shows, one case had not eaten cheese made from raw goat's milk. In addition to the known cases, 10 asymptomatic persons were determined to have eaten the suspect cheeses. Three of these were found to be infected and were treated.

Table 2-1. Case-control study results

Variable	Cases		Controls		Odds ratio
	Yes	No	Yes	No	
Eating unpasteurized goat's milk cheese	6	1	3	23	**46**
Eating unpasteurized goat's milk cheese from farmhouse A	3	4	0	26	XX
Acquaintance with other buyers of unpasteurized goat's milk cheese	4	3	3	23	**10.2**

2-1. What is your diagnosis? (2 pts)
***Brucella melitensis* infection**

2-2. Calculate the first and third odds ratios in Table 1 and write them into the table. (4 pts)

2-3. Because the numbers of cases are small, the significance of the association (first row of the table) must be determined by Fisher's exact test. Do your calculations on the form at the end of the exam, showing all work. You can photocopy this form or download extras from the course web site, as you prefer. If your calculator cannot do the factorials, add papers that show how you did the cancellations. You can download additional forms from the course web site for trial runs. If minus signs (–) do not translate into the PDF format (a problem encountered in the past), you will have to put these where they belong by comparison with the form in your textbook. (10 pts)

2-4. Assuming that cheese made from pasteurized goat's milk is not gastronomically acceptable, what alternate means might have been used to prevent these illnesses? (4 pts)
Immunize the goats against *Brucella.*

From: Eurosurveillance Monthly 8(7-8):164-168, July&August 2003

3. An Easter outbreak of *Salmonella* Typhimurium DT 104A in Italy (20 points)

As in other European countries, most *S.* Typhimurium strains in Italy belong to the phage type DT104. Within this phage type there are numerous distinguishable subtypes, identified as A,B,C,H,L. In Italy, most human strains isolated between 2001 and 2006 were 104L and H. We describe the investigation of an outbreak of *S.* Typhimurium DT104A, a subtype never observed before in Italy, which occurred in Rome during spring 2004.

Methods

In June 2004, ISS typed 22 human isolates of *S.* Typhimurium as phage type DT104A. The strains were sent by the Lazio regional reference laboratory, and all were isolated by the laboratory of the Bambino Gesù Paediatric Hospital in Rome.

In order to verify if other cases related to the same serotype had occurred, in July 2004 ISS requested that laboratories participating in Enter-net Italy send all the strains of *S.* Typhimurium isolated between 1 March and 1 June 2004. A request for information on DT104A *S.* Typhimurium strains eventually isolated in animals or food of animal origin was also sent to veterinary laboratories participating in Enter-vet.

Salmonella characterization

Serotyping based on O and H antigens was performed according to the Kauffmann-White scheme; phage-typing was performed in accordance with the methods of the UK's Health Protection Agency. Susceptibility to 11 antimicrobial agents was assessed using the National Committee for Clinical Laboratory Standards (NCCLS) agar disk diffusion method. Pulsed-field gel electrophoresis (PFGE) was performed after digestion of the DNA with XbaI according to a standardized protocol.

Matched case control study

In order to investigate risk factors for DT104A *S.* Typhimurium, a matched case control study was conducted between 24 July and 9 September 2004.

A case was defined as a person with a *S.* Typhimurium DT 104A infection, laboratory-confirmed between 1 March and 1 June 2004 in Rome. Demographic information on all cases was obtained from the Enter-net Italy database. We selected up to four matched controls for each case (assuming 25% exposure among controls, 80% power to detect a minimum Odds Ratio of 3.9, alpha error of 5%). We randomly selected controls from each case's general practitioner resident list matched for age (± 2 years), sex, and district of residence. Controls were excluded if they reported that they or any of their household members had experienced an episode of gastrointestinal illness (three or more loose stools in a 24-hour period, or vomiting, or abdominal pain) in the seven days prior to the onset of illness in the matched case.

Trained interviewers collected data using a structured questionnaire administered by telephone. The questionnaire collected information on clinical symptoms, food consumption

during April 2004 (Easter month, with Easter falling on 11 April), travel (abroad and within Italy), contact with animals, and restaurants and food vendors visited. Interviewers made three attempts at different times of day to contact each case and the corresponding controls. If cases or controls were under 16 years old, parents or guardians were interviewed.

Statistical Analysis

All questionnaires were mailed to ISS, where the data were entered into an MSAccess 2000 (Microsoft, Redmond, Wash) database. Categorical variables were compared using the Chi-square test; continuous variables were compared using the Wilcoxon Mann-Whitney test.

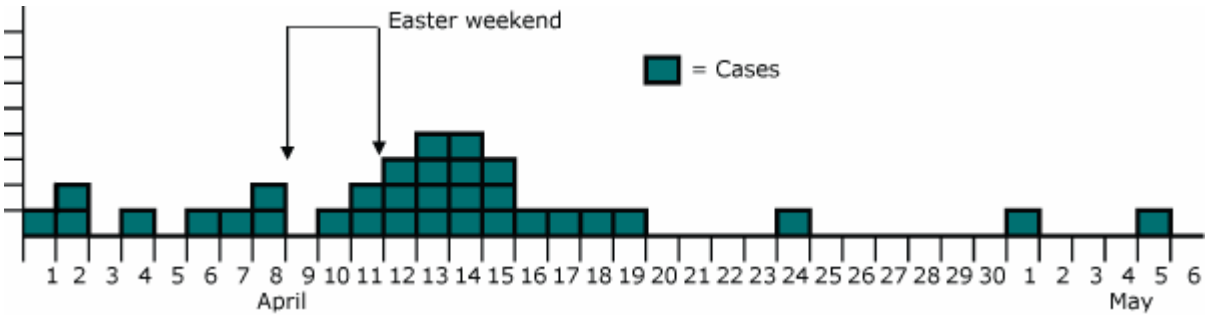
Results

Description of cases

A total of 242 *S.* Typhimurium strains were isolated from 1 March to 1 June 2004, and were collected by the Lazio regional reference laboratory in June 2004. Sixty-three (26%) of these strains belonged to DT104A; all were sensitive to the 11 antimicrobial agents tested.

Sixty-one isolates were from residents of Rome and two were residents of a neighbouring region (Umbria). All cases from Rome were distributed within the five districts of the municipality. Of the 63 patient with isolates of *S.* Typhimurium, 34 (54%) were male; the median age, available for 61 cases, was 7 years (range 1-78). Date of onset of symptoms was available for 32 patients (Figure 3-1) and ranged from April 1 to May 5 with a duration of symptoms of 1-30 days. The cases reported diarrhoea (93%), abdominal pain (73%), and fever (75%).

Figure 3-1. Cases of *Salmonella* Typhimurium DT104a, by day of onset of symptom, Rome, 2004



Matched Case Control Study

Of 61 cases identified in Rome, 35 (57%) could not be included in the case control study: 11 refused to participate, 10 could not be found because interviews took place over the summer period, and for 14 interviewed cases no controls could be identified. In total, 26 cases and 63 controls were enrolled in the study. The 26 cases included in the study did not statistically differ from the 35 cases who did not participate, in terms of sex (P=0.87), median age (7.5 years;

P=0.16) and district of residence (P=0.32). The matched univariate analysis revealed that cases were more likely than controls to have eaten "corallina," a fermented pork salami traditionally consumed during Easter in the Rome region. They were less likely to have eaten at a restaurant, to have eaten sausages or snacks, and to have consumed cow milk (Table 3-1).

Veterinary data

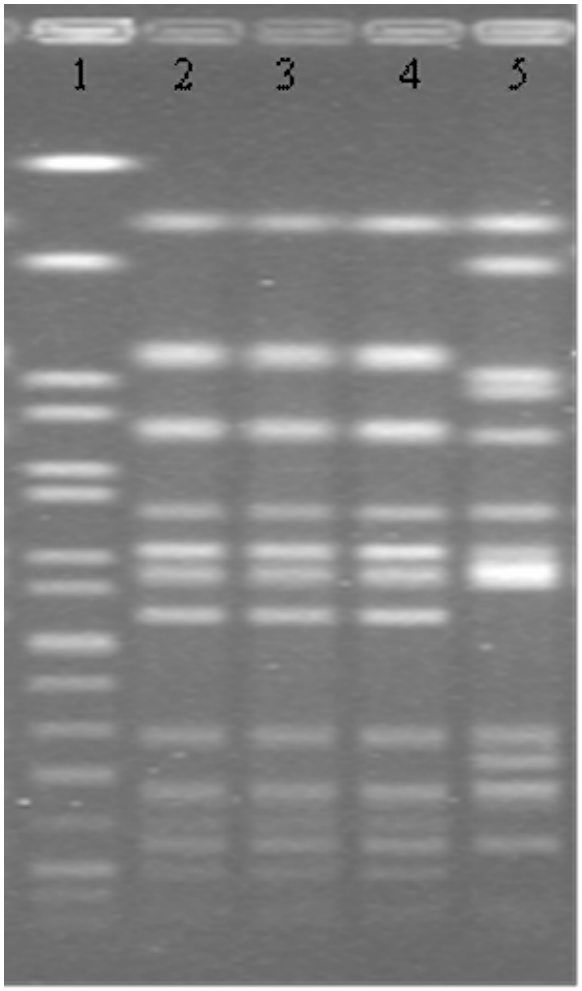
Two months prior to the outbreak, the veterinary surveillance system Enter-vet identified the first isolation of *S.* Typhimurium DT104A in a pig isolate, among 1021 animal and food *S.* Typhimurium isolates. This strain came from the intestinal content of a pig slaughtered in north-eastern Italy (Veneto region) in January 2004 during a monitoring program on the presence of Salmonella in swine herds. Both human and pig isolates showed indistinguishable PFGE patterns (Figure 3-2). It was not possible to trace the pig after the sample was taken at slaughter.

Table 3-1. Matched univariate analysis (odds ratio: OR). Cases of *Salmonella* Typhimurium DT104A infection (n=26) and Controls (n=63) according to investigated risk factors, April-May 2004, Rome, Italy

Consumption of	Cases			Controls			OR	*p*
	ate	total	% ill	ate	total	% ill		
Raw eggs	5	26	19	3	63	5	3.4	0.1
Sausage	7	25	28	33	63	52	**0.4**	**>0.05**
Ham	3	25	12	1	63	2	8.9	0.06
“Corallina” salami	14	23	61	16	63	28	**4.6**	**<0.01**
Snacks	12	26	46	39	63	62	0.3	0.05
Cow milk	12	26	46	57	63	91	0.1	<0.01

**In the univariate analysis, only risk factors with p-value<0.20 are reported.*

Figure 3-2. Pulsed-field gel electrophoresis profiles of 3 strains (two from patients and one from a pig) of *S.* Typhimurium DT104A after digestion with *Xba*I (Line 1:Molecular reference marker ‘*S.* Braenderup strain H9812’; Lines 2,3: *S.* Typhimurium DT104A human isolates; Line 4: *S.* Typhimurium DT104A pig isolate; Line 5: *S.* Typhimurium DT104L with the common penta-resistance pattern)



3-1. Fill in the univariate analysis blanks in Table 3-1. (8 pts)

3-2. The OR for ham is greater than for "corallina" salamis. Why is the *p* value for ham so low? (4 pts)
Only a small proportion of the sample population at ham, so the sample is at best marginally representative.

3-3. What is the significance of the PFGE patterns shown in Figure 3-2? (4 pts)
It certainly shows that at least one Italian pig carried the outbreak strain of *S.* Typhimurium DT104A. However, this pig may well have had no relationship to the present outbreak.

3-4. What preventive measures are indicated in this situation? (4 pts)
The sausage is described as fermented. It may or may not have been cooked before serving. If cooking was not an option, irradiation could have been a critical control point. Beyond this, the only alternative would have been to exercise extreme sanitary precautions to ensure that nothing from the pig's digestive tract got into the sausage batter (or the casings, if these were natural).

From: Eurosurveillance 12(4), April 2007

4. Botulism, fermented soybean curd, California (10 points)

In December 2006, the Orange County Health Care Agency (OCHCA) and the California Department of Health Services (CDHS) were notified of 2 potential cases of foodborne botulism in an older Asian couple. This report summarizes the subsequent investigation, which identified home-prepared fermented tofu (soybean curd) as the source. The public should be aware of the risk for botulism when preparing fermented tofu at home.

On Tue 28 Nov 2006, a 67-year-old woman had onset of double vision, followed the next day by bilateral ptosis [drooping of the upper eyelid]. An ophthalmologist attributed these symptoms to long-standing diabetes mellitus. On Mon 4 Dec 2006, she visited her primary-care physician because of double vision, ptosis, dizziness, difficulty swallowing, slurred speech, drooling, and right arm weakness. Physical examination revealed limitation of upward gaze, bilateral ptosis, sluggish tongue movement, and mild right upper extremity weakness.

The woman's husband, aged 75 years, reported 3 days of worsening double vision, dizziness, and difficulty swallowing. On physical examination, he also had mild right ptosis and sluggish tongue movement.

Both patients were admitted to an intensive care unit. On Tue 5 Dec 2006, physicians suspected foodborne botulism, notified OCHCA, and collected clinical specimens for testing. CDHS dispatched botulinum antitoxin to the hospital, and it was administered to the couple. Both patients were hospitalized for more than one week with no further symptom progression. Botulinum toxin was not detected in serum or stool samples from the patients. However, *Clostridium botulinum* type A was detected in enrichment cultures of the stool samples of both patients. Both patients have some blurred vision but otherwise have recovered.

On Tue 5 Dec 2006, OCHCA visited the couple's home and identified multiple potential sources of intoxication. OCHCA interviewed the patients using photos of home-prepared food items to overcome the language barrier and identify the most suspect food. The patients reported they recently had been eating a new batch of home-prepared fermented tofu. Although both had eaten fermented tofu from this batch every day, the woman ate more than her husband. CDHS Microbial Diseases Laboratory found both *C. botulinum* type A and botulinum toxin type A in the fermented tofu samples, which had a pH of 6.8.

The tofu was a commercially packaged product purchased at a retail market. In the home, the tofu was boiled, towel dried, and cut into cubes. The cubes were placed in a bowl, covered with plastic wrap, and stored at room temperature for 10-15 days. The tofu was then transferred to glass jars with chili powder, salt, white cooking wine, vegetable oil, and chicken bouillon to marinate at room temperature for 2-3 more days. Finally, the fermented tofu was stored and eaten at room temperature.

The woman reported she has lived in the USA for more than 25 years and, during this time, has prepared fermented tofu using the same recipe she learned as a student in Taiwan. Preparation of this batch was not notably different, and the reason for contamination this time is not clear.

This is the first American report of botulism caused by eating home-prepared fermented tofu. Historically, most foodborne botulism cases in the USA result from consumption of improperly prepared home-canned foods. However, fermented foods, including fish, seal, and whale, also have been associated with botulism. Fermented tofu is popular in Asia, and homemade fermented bean products, including tofu, are the most common foods causing botulism in China. During 1958-1989, home-fermented bean products were associated with 63

percent of approximately 2000 cases of botulism in China. Clinicians, public health workers, and the public should be advised that home preparation of fermented tofu can result in foodborne botulism.

4-1. Is this a "home-fermented" product? (2 pts)
The tofu was produced commercially, but the modifications were definitely from "home."

4-2. List four risk factors that probably played a role in this event. (8 pts)
Boiling (heat shock for "bot" spores); covered with plastic wrap (anaerobic conditions?); stored at room temperature 10–15 days (permissive for Group I); added salt insufficient to lower a_w below permissive range for "bot"; added wine insufficient to lower pH below permissive range for "bot"; vegetable oil may have prolonged anaerobic conditions; further storage at room temperature; eaten without heating

From: Morbid. Mortal. Weekly Rept. 56(05):96–97, Feb. 9, 2007.

5. Illness from a Hot Dog (5 points)

Early in 2004, four people from a village in Tulskaya Oblast, Russia — including a 4-year-old child — were hospitalized after eating the farm dog. Symptoms included sore muscles, edema of the upper eyelids, fever, thirst, profuse sweating, chills, and weakness.

5-1. What is the disease? (2 pts)
trichinosis

5-2. Other than not eating the dog, how could these illnesses have been prevented? (3 pts)
Thorough cooking (freezing might not work in this instance, as *Trichinella nativa* is enzootic in Russia, along with *Trichinella spiralis*).

From: ProMED-mail, 27 Mar 2004

NOTE: This is an open-book, take-home examination. Use any resources you need to solve these problems, except your PHR 250 classmates. All of these outbreaks are probably accessible on the Internet if you look hard enough — I ask that you not do so.

The statistical calculations are not theoretical — all you need is entry-level, high-school algebra and close attention to directions. Please be very careful, do each calculation at least twice, and show all of your work so that part credit can be given in the event of an arithmetic error. Additional copies of the forms can be downloaded from the course web site.

Completed papers are to be returned to me not later than 5 p.m. on Wednesday, June 13, 2004, either at my office (1019 Haring Hall) or in my mailbox in 1024 Haring Hall. If you have questions, you can try to reach me at my office (754-9120; leave a voice mail if I'm not there) or by e-mail <docliver@ucdavis.edu>.

Plan to submit an on-line course evaluation. I sent you instructions by e-mail earlier and will try to remember to send them again before the finals are returned. Good luck!

CALCULATION OF FISHER=S EXACT TEST
Form L2

Complaint no.	Place of outbreak	Vehicle
Q. 3-2	Spain	Cheese

Step5 (Consider only if steps 3 and 4 are not performed on Form L1)

Formula for calculation = $\frac{(a+b)!\,(c+d)!\,(a+c)!\,(b+d)!}{(n!)\,(a!)\,(b!)\,(c!)\,(d!)}$

One-tailed test
*p*1.1 Observed table

Exposure	Ill	Well	Attack Rate
Ate/drank	a **6**	b **3**	a+b*(i)* **9**
Did not eat/drink	c **1**	d **23**	c+d*(ii)* **24**
Total	a+c*(iii)* **7**	b+d*(iv)* **26**	n*(v)* **33**

vi $p1.1 = \frac{(\mathbf{9})!\,(\mathbf{24})!\,(\mathbf{7})!\,(\mathbf{26})!}{(\mathbf{33}!)\,(\mathbf{6}!)\,(\mathbf{3}!)\,(\mathbf{1}!)\,(\mathbf{23}!)}$

vii Cancel any possible factorial (!) values
List individual values from factorials

viii Cancel any possible remaining values

ix Calculate *p*1.1 from the remaining values
0.000472

*p*1.2 Table

Exposure	Ill	Well	Attack Rate
Ate/drank	a+1 **7**	b!1 **2**	a+b*(i)* **9**
Did not eat/drink	c!1 **0**	d+1 **24**	c+d*(ii)* **24**
Total	a+c*(iii)* **7**	b+d*(iv)* **26**	n*(v)* **33**

vi $p1.2 = \frac{(\mathbf{9})!\,(\mathbf{24})!\,(\mathbf{7})!\,(\mathbf{26})!}{(\mathbf{33}!)\,(\mathbf{7}!)\,(\mathbf{2}!)\,(\mathbf{9}!)\,(\mathbf{24}!)}$

vii Cancel any possible factorial (!) values
List individual values from factorials

viii Cancel any possible remaining values

ix Calculate *p*1.2 from the remaining values
0.00000843

*p*1.3 Table

Exposure	Ill	Well	Attack Rate
Ate/drank	a+2	b!2	a+b*(i)*
Did not eat/drink	c!2	d+2	c+d*(ii)*
Total	a+c*(iii)*	b+d*(iv)*	n*(v)*

vi $p1.3 = \frac{(\quad)!\,(\quad)!\,(\quad)!\,(\quad)!}{(\quad!)\,(\quad!)\,(\quad!)\,(\quad!)\,(\quad!)}$

vii Cancel any possible factorial (!) values
List individual values from factorials

viii Cancel any possible remaining values

ix Calculate *p*1.3 from the remaining values

Etc. continue for all other *p*-value needed

x *p*1-value = *p*1.1 + *p*1.2 + *p*1.3 + *p*1.x for one-tailed test **0.000472**
+0.000008
0.000480

Interpretation: If the *p*-value is less than or equal to 0.05, then there is evidence to suggest that the food/beverage under investigation is related to the observed illness; if it is 0.005 or less, there is strong evidence for this relationship.

CALCULATION OF CHI SQUARE TEST, RELATIVE RISK AND ODDS RATIO
Form L1

Complaint no. **Q. 3-1** | Place of outbreak **Rome** | Vehicle **sausage**

Outbreak table (Step 1)

	Ill	Well	Total
Ate/drank	a **7**	b **33**	a+b **40**
Did not eat/drink	c **18**	d **30**	c+d **48**
Total	a+c **25**	b+d **63**	n **88**

Expected table (Step2)

	Ill	Well	Total
Ate/drank	a_e **11**	b_e **29**	a_e+b_e **40**
Did not eat/drink	c_e **14**	d_e **34**	c_e+d_e 48
Total	a_e+c_e **25**	b_e+d_e **63**	n **88**

Explanation

Step1
Fill in the outbreak table and calculate the marginal totals (a+b, c+d, a+c, b+d) and the sum of these totals (n) from Form K1 or K2. If any of the marginal totals are less than 10, skip steps 2 through 4 and use Fisher=s exact test (Form L2).

Step2
Fill in the marginal totals in the expected table; copy from those in outbreak table. Calculate the expected frequencies a_e, b_e, c_e, and d_e and fill in the cells of the expected table. If a_e, b_e, c_e, or d_e are less than 5, skip steps 3 and 4 and use Fisher=s exact test (Form L2).

Step3
If vi, vii, viii, and ix are greater than 5, calculate the chi square statistic

$$X^2 = \frac{n\,(*aHd!bHc*!n/2)^2}{(a+b)(c+d)(a+c)(b+d)}$$

Step4
Compare X^2 to probability (*p*-value) critical values for the chi square distribution:

X^2 !values [1,2]	*p*-value
2.71	0.1
3.84	0.05
6.64	0.01
7.88	0.005
10.83	0.001
15.14	0.0001
19.51	0.00001
23.93	0.000001

Calculation

Step1
i) a+bH = **40** H
ii) c+dH = **48** H
iii) a+c = **25**
iv) b+d = **63**
v) n = **88**

Step2
vi) a_e = iHiii/v = **11**
vii) b_e = i ! vi = **29**
viii) c_e = iii ! vi = **14**
ix) d_e = ii ! viii = **34**

Step3
x)* aHd = **210** *
xi)* bHc = **594** *
xii) x!xi = **384**
xiii) n/2 = **44**
xiv) xii!xiii = **340**
xv) xivHxiv = **115600**
xvi) xvHn = **10172800**
xvii) iHiiHiiiHiv = **3024000**
xviii) X^2 = xvi/xvii = **3.36**

Step4
(xviii) = X^2 = **3.36**
(xix) = *p*-value = **> 0.05**

Calculate relative risk
HRR = a/i / c/ii = _____

Calculate odds ratio
*OR = x / xi = **0.35**

[1] X^2 value of 3.84 or greater ($p<0.05$) indicates that there is evidence to suggest a difference between the outbreak table and the expected table, and thus the exposure food/beverage under investigation is related to the observed illness.
[2] X^2 value of 7.88 or greater ($p<0.005$) indicates that there is strong evidence to suggest a difference between the outbreak table and the expected table, and thus the exposure food/beverage under investigation is related to the observed illness.

CALCULATION OF CHI SQUARE TEST, RELATIVE RISK AND ODDS RATIO
Form L1

Complaint no.	Place of outbreak	Vehicle
Q. 3-1	**Rome**	**corallina salami**

Outbreak table (Step 1)

	Ill	Well	Total
Ate/drank	a **14**	b **16**	a+b **30**
Did not eat/drink	c **9**	d **47**	c+d **56**
Total	a+c **23**	b+d **63**	n **86**

Expected table (Step2)

	Ill	Well	Total
Ate/drank	a_e **8**	b_e **22**	a_e+b_e 30
Did not eat/drink	c_e **15**	d_e **41**	c_e+d_e **56**
Total	a_e+c_e **23**	b_e+d_e **63**	n **86**

Explanation

Step1
Fill in the outbreak table and calculate the marginal totals (a+b, c+d, a+c, b+d) and the sum of these totals (n) from Form K1 or K2. If any of the marginal totals are less than 10, skip steps 2 through 4 and use Fisher=s exact test (Form L2).

Step2
Fill in the marginal totals in the expected table; copy from those in outbreak table. Calculate the expected frequencies a_e, b_e, c_e, and d_e and fill in the cells of the expected table. If a_e, b_e, c_e, or d_e are less than 5, skip steps 3 and 4 and use Fisher=s exact test (Form L2).

Step3
If vi, vii, viii, and ix are greater than 5, calculate the chi square statistic

$$X^2 = \frac{n\,(*aHd!bHc*!n/2)^2}{(a+b)(c+d)(a+c)(b+d)}$$

Step4
Compare X^2 to probability (*p*-value) critical values for the chi square distribution:

X^2 !values [1,2]	*p*-value
2.71	0.1
3.84	0.05
6.64	0.01
7.88	0.005
10.83	0.001
15.14	0.0001
19.51	0.00001
23.93	0.000001

Calculation

Step1
vi) a+bH = **30** H
vii) c+dH = **56** H
viii) a+c = **23**
ix) b+d = **63**
x) n = **86**

Step2
vi) a_e = iHiii/v = **8**
vii) b_e = i ! vi = **22**
viii) c_e = iii ! vi = **15**
ix) d_e = ii ! viii = **41**

Step3
x)* aHd = **658** *
xi)* bHc = **144** *
xii) x!xi = **514**
xiii) n/2 = **43**
xiv) xii!xiii = **471**
xv) xivHxiv = **221841**
xvi) xvHn = **19078326**
xvii) iHiiHiiiHiv = **2434320**
xviii) X^2 = xvi/xvii = **7.837**

Step4
(xviii) = X^2 = **7.837**
(xix) = *p*-value = **<0.01**

Calculate relative risk
HRR = a/i / c/ii =

Calculate odds ratio
*OR = x / xi = **4.57**

[1] X^2 value of 3.84 or greater ($p<0.05$) indicates that there is evidence to suggest a difference between the outbreak table and the expected table, and thus the exposure food/beverage under investigation is related to the observed illness.
[2] X^2 value of 7.88 or greater ($p<0.005$) indicates that there is strong evidence to suggest a difference between the outbreak table and the expected table, and thus the exposure food/beverage under investigation is related to the observed illness.