Example of an outbreak investigation report

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| **Learning objectives**  The student should be able to reproduce the basic descriptive analysis section of an outbreak or surveillance report. Here is a sample outbreak report (“Guidelines for writing outbreak investigation reports” shared by Dr. Kostas Danis on October, 6, 2023). The student will be engaged in complete the Results section. |

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| **Date:** | 25 September 1996 |
| **To:** | Director of Public Health, Eastern Health Board |
| **From:** | Thomas Grein, EPIET Fellow, EHB |
| **Supervisor:** | Darina O'Flanagan |
| **Subject:** | Salmonella typhimurium outbreak |
| **Location:** | Malahide, Country Fingal |
| **Date of Departure:** | N/A |
| **Date of return:** | N/A |

1. Define a tibble table in a “natural” way by rows.

## Analyses

### Import, clean, and manage data

### Compute tables

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| Table three is way too difficult in this shape; we need to investigate for a cleaner solutions! |

1. This is needed because in the tbl\_ar variables’ levels are treated as variable *per se*, i.e. not as level; we need to recreate the var/levels hierarchy in the table, and we can take that from the tbl\_rr.
2. We look at each row independently to substitute the relevant table field using the tbl\_rr corresponding ones.
3. This is a usefull pattern to add grouping variable. Another one is to create a summary per group and then stack together the table. See [this](https://stackoverflow.com/a/65668806/4434088) post.

### Compute figures

1. Simple solution, but not exactly the same as in the guidelines, i.e. it is composed by bars and not by unit-tiles
2. Theming will be showed but not teached deeply in the details of time formats, code will be provided as an example template
3. This is a more complex graph that reproduce more as-is the prototype graph. The added skills to learn are: cut variables into intervals (keeping intervals progressive number only), slide timepoints to a midrange position, produce progressive id by levels of a variable (using mutate(..., .by = ...)), and use geom\_tile()
4. For plots, ggsave require the path as first argument
5. Note: if plot is not provided, it will be saved the last printed one

## Abstract

An outbreak of salmonellosis occurred among 127 persons attending a wedding reception on 21 August 1996. Of 115 interviewed guests, 57 (50%) met the case definition (diarrhoea within three days after having eaten at the reception). Thirty-eight cases visited their GP, seven were admitted to hospital. Forty-six cases submitted stool samples, of which 39 were culture positive for Salmonella typhimurium. Turkey was identified as the most likely vehicle for this outbreak (relative risk). Environmental investigations at the catering facilities showed deficiencies in food hygiene practices. Eight of 17 asymptomatic kitchen workers carried S. typhimurium in their stool.

We recommended: to exclude all symptomatic food handlers from work in the hotel kitchen for 48 hours after their first normal stool; to educate food handlers and other personnel in the hygienic preparation and serving of food; and to immediately address the structural and operational deficiencies in the hotel kitchen. Introduction

On 26 August 1996 the Eastern Health Board (EHB) was informed of an outbreak of gastrointestinal illness among guests of a wedding party that was held in a large hotel in Malahide on 21 August 1996.

Many guests had fallen ill since the reception and some had required hospitalisation. Malahide is a popular seaside town approximately twenty kilometres north of Dublin City.

The same day the EHB started an investigation to assess the extent of the outbreak, identify the mode and the vehicle of transmission, and initiate appropriate control measures.

Dr. Darina O’Flanagan, Specialist in Public Health Medicine at the EHB, led the epidemiological investigations. She was assisted by Dr. Thomas Grein, Fellow of the European Programme for Intervention Epidemiology Training. Mr. Tom McCarthy, Principal Environmental Health Officer for food hygiene North Dublin City with special responsibility for communicable disease, and Mr. Derek Bauer, Principal Environmental Health Officer for County Fingal, led the environmental investigations and supervised the implementation of control measures.

## Materials and Methods

### Case definition

We defined a case as a person who had consumed food at the wedding reception on 21 August 1996 and developed diarrhoea (three or more loose stools in 24 hours) within the next 72 hours.

### Case Finding

We obtained the addresses and telephone numbers of all 127 attendees of the wedding reception. Hotel management provided a copy of the menu and a list of all food items served during the reception.

Starting 27 August 1996, Environmental Health Officers (EHOs) conducted personal interviews at the homes of all wedding guests. Hospitalised cases were interviewed after discharge from hospital. Information was obtained on demographic details, symptoms of gastrointestinal illness three days prior to and after the wedding reception, the time of onset and the duration of symptoms, contact with ill persons not related to the wedding party, secondary spread among family members, foods consumed during the reception, whether the family doctor was contacted because of the illness, whether hospitalisation was required, and length of hospital stay if admitted.

### Analytical study design

We conducted a retrospective cohort study to identify the potential vehicle of the outbreak. The retrospective cohort design was chosen because information could be obtained on a clearly identifiable risk group.

Definition of exposure. The outbreak occurred among 127 guests who attended the wedding reception in the hotel on 21 August 1996. The main meal was served to 108 guests at 1800 hours on 21 August 1996. The meal consisted of honeydew melon, roast turkey, baked Irish gammon (ham steak), a selection of vegetables and potatoes, and chocolate eclairs for dessert. At 2200 hours sandwiches (turkey, ham, chicken, salad, savoury, egg, cheese) were offered to the guests and consumed by 58 individuals. Hotel staff prepared all dishes and sandwiches in a kitchen on the premises except for a home-made birthday cake and a home-made wedding cake. Both cakes were brought into the hotel by guests and consumed throughout the evening. To identify potential risk factors for illness, all guests were asked if they had consumed any of these food items

The restaurant of the hotel caters for hotel guests and a large number of visitors. No other functions were held on the day of the wedding reception. The number of persons who attended the restaurant on 21 August 1996 is unknown.

Analysis of the data was performed with Epi Info software, version 6.041. Food specific attack rates (AR), relative risks (RR) and 95% confidence intervals (95% CI) were calculated for the consumption of food items. The c2 test was used to compare proportions between groups.

### Laboratory investigations

All interviewed persons who reported an illness were asked to provide a stool sample. Stool samples were also collected from some individuals who attended the wedding reception but did not become ill. Most specimens from non-cases were obtained from household members of cases. All specimens were submitted to the Public Health Laboratory for culture. Faecal specimens were also obtained from the 17 kitchen workers who were on duty during the week of the wedding reception, regardless of their symptoms.

### Environmental investigations

Starting 26 August, EHOs inspected the restaurant and the hotel kitchen on several occasions, investigated food handling practices and interviewed all food handlers for illness one week prior to and after the wedding. They examined transport, storage and preparation processes for the foods served at the wedding reception, and reviewed order and delivery books of the restaurant. The ingredients of incriminated foods were identified and traced to their sources.

Food specimens from the day of the wedding were no longer available when investigations commenced. EHOs sampled the same type of food items which were mentioned on the wedding reception menu and submitted them for culture on 27 August 1996.

## Results

### Descriptive findings

Of the 127 wedding guests, four individuals had not eaten at the wedding reception and were excluded from the study. None of them reported an illness. Five guests refused to participate in the study and three guests could no longer be contacted. The remaining 115 (93%) individuals were interviewed ([Table 1](#tbl-one)). Sixty-two (54%) of them were female, 100 (87%) between 15 and 64 years of age ([Table 2](#tbl-two)).

Sixty-eight guests reported an illness during the interview. The case definition could be applied to 57 individuals. The overall attack rate among guests was 50%.

Dates and times of onset of illness for the 57 cases are shown in [Figure 1](#fig-one). There was a steady increase in the number of cases, starting in the night of 21 August, peaking during 22 August and declining over the next 48 hours. Two individuals developed diarrhoea on 25 August 1996 but were not included as cases. The median time (range) between the main meal and onset of illness in cases was 24 (5-72) hours.

Males were 1.3 times (95% CI 0.9 - 1.9) more likely to be a case than females. Guests older than 65 years had the highest attack rate (100%) and were 2.3 times (95% CI 1.7 - 3.2) more likely to become ill than guests 45- 64 years who had the lowest attack rate with 43%.

The main symptoms of cases were diarrhoea (case definition, 100%), feeling feverish (89%), general malaise (88%) and nausea (81%). Vomiting was reported less frequently (47%). The duration of illness ranged from two hours to 13 days with a median of five days ([Table 4](#tbl-four)).

Individuals who ate only during the late meal had a 1.7 times (95% CI 1.0 - 2.6) higher risk of illness than individuals who only ate during the main meal. The attack rates for guests seated at different tables varied between 25% and 80% (c2 = 11.3, p = 0.42). The age and sex distribution of guests seated at tables with higher attack rates ([Table 5](#tbl-five) and 11) was not different from the distribution of guests seated at tables with lower attack rates ([Table 3](#tbl-three)).

Forty-six (81%) cases provided stool samples. Thirty-nine (85%) samples were culture positive for Salmonella typhimurium. All isolates showed the same resistance pattern to Ampicillin, Amoxycillin, Chloramphenicol and Sulphonamides. One culture was phage typed at CDSC London (Definitive Type 104). An increase in the number of S. typhimurium isolates unrelated to the outbreak was not observed by hospital laboratories in the EHB area during this period.

The rapid increase and decline in the number of cases, the single peak, the common exposure to food consumed at the wedding reception and the absence of an increase in other laboratory-detected cases of S typhimurium suggested a foodborne point source outbreak among the wedding guests (figure).

Food specific attack rates, relative risks and percentage of cases exposed to the food items consumed at the wedding reception are given in [Table 5](#tbl-five).

For seven food items, cases had higher attack rates than non-cases: turkey (RR ¥), savoury sandwich (RR 1.85), birthday cake (RR 1.61), egg sandwich (RR 1.56), chicken sandwich (RR 1.43), ham (RR 1.22) and turkey sandwich (RR 1.12).

There were no cases among guests who had not eaten turkey during the main meal. Of the 57 cases, 52 (91%) had consumed turkey during the main meal

### Environmental investigations

EHOs noted 23 violations of the food hygiene regulations during the kitchen inspections. Relevant findings with regard to the wedding outbreak were that frozen food was thawed in hot water, cooked meats cooled down at room temperature for indeterminate times and that storage practices in the cold room allowed for possible cross-contamination of raw meat.

Food items from hotel kitchen and bar buffet were sent to the laboratory on 27 August 1996. The only positive microbiological finding was found for a sample of cooked turkey (Salmonella agona).

The examination of the kitchen delivery dockets revealed that ten turkeys were delivered to the hotel on 19 August. Six of the ten turkeys were used for the wedding reception. Each of them weighted 20-24 lb. and were cooked on 20 August at 250oC for thirty minutes and at 180oC for two and a half hours. After cooking they were put into a non-refrigerated holding cabinet, left at room temperature to cool down, and later removed to the cold room. We could not determine how long the turkeys were left in the non-refrigerated holding cabinet. Other turkeys, cooked at midday on 21 August, were left overnight in the holding cabinet before being removed to the cold room.

Seventeen kitchen workers were interviewed and stool samples obtained from them. None reported an illness but eight (47%) stool samples were culture positive for S. typhimurium. Antibiotic resistance was determined for some isolates and matched that of the cases (resistant to Ampicillin, Amoxycillin, Chloramphenicol, Sulphonamides).

## Discussion

The primary objectives of our study were to identify the mode of transmission, the vehicle of the outbreak and to initiate appropriate control measures. Our data suggest that the vehicle of the outbreak was turkey served during the wedding reception on 21 August, and the infecting agent S. typhimurium DT104.

The relative risk for the consumption of turkey was infinite. There were no cases among guests who had not eaten turkey during the main meal. Of the 57 cases, 52 (91%) had consumed turkey during the main meal. Six other food items showed statistically significant relative risk estimates greater than. However, all of these food items were consumed by a small number of cases which makes them implausible vehicles for this outbreak. Thus epidemiologically turkey appears to be the most likely vehicle for this outbreak. Isolation of S. typhimurium from the stool of cases supports this finding as the pathogen is frequently found in poultry. Eighty-five percent of the stool cultures available for the cases were positive for this organism.

As the epidemiological data were obtained from a non-controlled, observational study some limitations apply to our results. All data were collected by personal interviews and could not be verified. Some information bias is likely to have existed, particularly after interviewees learned through the media about legal proceedings and compensation claims. Although most interviews were conducted within a week following the outbreak recall bias may have led to wrong exposure status. Selection bias is unlikely to have influenced our findings as the participation in the study was high (93%). As most guests ate the same foods stratification for possible confounding could not be performed for most food items. As we did not enquire about the amounts of food consumed we were unable to calculate dose response.

The environmental investigations support our epidemiological findings and revealed severe deficiencies in food handling practices in the hotel kitchen. Stool samples from eight of the 17 kitchen staff on duty during the week of the outbreak were also positive for S. typhimurium suggesting that the infective food was prepared and consumed in the hotel kitchen.

Six turkeys were identically prepared on the same day and served at 12 tables. We could not determine if the meat of a whole turkey was served to specific tables or if the meat of all six birds was cut into pieces and then distributed randomly to all 12 tables. Attack rates for the tables vary between 25% and 80% without statistically significant differences. As every table had at least two cases it is more likely that meat of one or more infected birds was served to all tables. The mode of contamination remains unknown. Poor foodhandling practices may have allowed for one infective turkey to cross contaminate others, or contamination may have occurred by an asymptomatic, culture positive food handler.

Our findings are consistent with other foodborne outbreaks related to the consumption of turkey. It is also a biologically plausible vehicle for the aetiological agent, S. typhimurium. The implicated exposure preceded illness. Consumption of

turkey was positively associated with illness and this association was stronger than for other food items.

More cases, unrelated to the wedding reception, came to our attention. Of five golfers lunching in the same hotel on the day of the wedding reception three fell ill within the next 24 hours. Interviews were conducted with the group. The main symptoms of the three ill individuals were diarrhoea and general malaise lasting between four and ten days. All three had consumed turkey salad sandwiches, the other two unaffected golfers cheese sandwiches. A stool sample was available for one ill individual which was culture positive for S. typhimurium (no definite type available). These additional cases strongly support the hypothesis that turkey was the vehicle of the outbreak and S. typhimurium the infecting agent.

The Department of Agriculture was informed about the outbreak and subsequently investigated the poultry farm where the turkeys originated. S. typhimurium was detected in the dust of one of six turkey houses examined. According to a spokesperson of the Department this is a rare finding on Irish poultry farms. Further investigations are pending.

## Recommendations, actions

We recommended excluding all symptomatic food handlers from work in the hotel kitchen for 48 hours after their first normal stool. We also advised to educate food handlers and other personnel in the hygienic preparation and serving of food and to implement the National Standard Authority of Ireland (NSAI) guideline 340:1994 - Hygiene in the Catering Sector4. The structural and operational deficiencies in the hotel kitchen were outlined in a detailed report and hotel management was urged to correct these deficiencies immediately.

## Acknowledgements

The members of the outbreak control team would like to thank the staff of the EHB, in particular the Environmental Health Officers involved in the investigation and the laboratory staff of Cherry Orchard hospital, for their indispensable help. We would also like to thank Dr Alain Moren and Dr Mike Rowland, EPIET/EUPHEM, for reviewing the manuscript of this report.

## References

## Tables

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| Table 1: Study characteristics. Wedding reception, Malahide, 21 August 1996   |  | **N** | **N = 127**1 | | --- | --- | --- | | **Wedding cohort** | 127 | 127 (100%) | | **Eligible** | 127 | 121 (95%) | | **Refused to participate** | 127 | 1 (0.8%) | | **Unable to locate** | 127 | 6 (4.7%) | | **Interviewed** | 127 | 123 (97%) | | 1n (%) | | | |

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| Table 2: Demographic details of cohort. Wedding reception, Malahide, 21 August 1996   |  | **N** | **N = 127**1 | | --- | --- | --- | | **Age class** | 117 |  | | 5 - 14 |  | 2 (1.7%) | | 15 - 44 |  | 67 (57%) | | 45 - 64 |  | 42 (36%) | | 65+ |  | 6 (5.1%) | | Unknown |  | 10 | | **Female** | 127 | 76 (60%) | | 1n (%) | | | |

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| Table 3: Characteristics of cases with attack rates, relative risks (RR) and 95% confidence intervals (95% CI). Wedding reception, Malahide, 21 August 1996.   |  | Attack Rate | Relative Risks | | | | | --- | --- | --- | --- | --- | --- | |  | **N = 127**1 | **N** | **RR**2 | **95% CI**2 | **p-value** | | **Gender** |  | 127 |  |  |  | | Female | 29/76 (38%) |  | — | — |  | | Male | 14/51 (27%) |  | 0.72 | 0.41, 1.19 | 0.2 | | **Age class** |  | 117 |  |  |  | | 5 - 14 | 1/2 (50%) |  | — | — |  | | 15 - 44 | 20/67 (30%) |  | 0.60 | 0.14, 2.50 | 0.5 | | 45 - 64 | 18/42 (43%) |  | 0.86 | 0.21, 3.58 | 0.8 | | 65+ | 1/6 (17%) |  | 0.33 | 0.03, 3.20 | 0.3 | | (Missing age\_class) | 3/10 (30%) |  |  |  |  | | **Meals** |  | 127 |  |  |  | | Late night meal only | 22/61 (36%) |  | — | — |  | | Main meal only | 21/66 (32%) |  | 0.88 | 0.54, 1.44 | 0.6 | | **Seating arrangements** |  | 64 |  |  |  | | Table 1 | 1/5 (20%) |  | — | — |  | | Table 2 | 0/4 (0%) |  | 0.00 | 0.00, Inf | >0.9 | | Table 3 | 2/4 (50%) |  | 2.50 | 0.34, 18.6 | 0.4 | | Table 4 | 0/1 (0%) |  | 0.00 | 0.00, Inf | >0.9 | | Table 5 | 2/8 (25%) |  | 1.25 | 0.15, 10.5 | 0.8 | | Table 6 | 1/6 (17%) |  | 0.83 | 0.07, 10.2 | 0.9 | | Table 7 | 3/8 (38%) |  | 1.88 | 0.26, 13.4 | 0.5 | | Table 8 | 0/2 (0%) |  | 0.00 | 0.00, Inf | >0.9 | | Table 9 | 2/3 (67%) |  | 3.33 | 0.49, 22.9 | 0.2 | | Table 10 | 1/2 (50%) |  | 2.50 | 0.27, 23.4 | 0.4 | | Table 11 | 7/15 (47%) |  | 2.33 | 0.37, 14.6 | 0.4 | | Table 12 | 1/6 (17%) |  | 0.83 | 0.07, 10.2 | 0.9 | | (Missing seating\_arrangements) | 23/63 (37%) |  |  |  |  | | **Illness** | 43.00/127 (34.00%) |  |  |  |  | | 1Sum/N (p\_attack%) | | | | | | | 2RR = Relative Risk, CI = Confidence Interval | | | | | | |

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| Table 4: Clinical and laboratory details of cases. Wedding reception, Malahide, 21 August 1996.   |  | **Characteristic**1 | **N = 43** | | --- | --- | --- | | **Symptoms** | Diarrhoea | 43 (100%) | |  | Feeling faverish | 20 (47%) | |  | Aches and pains | 24 (56%) | |  | Nausea | 21 (49%) | |  | Abdominal cramps | 13 (30%) | |  | Vomiting | 13 (30%) | |  | Headaches | 7 (16%) | |  | Blood seen in / on stool | 2 (4.7%) | | **Other clinical** | Gp visit | 25 (58%) | |  | Hospitalization | 3 (7.0%) | | **Laboratory** | Stool samples obtained | 37 (86%) | |  | Stool sample +ve for salmonella typhimurium | 28 (65%) | | 1n (%) | | | |

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| Table 5: Duration of illness and hospitalisation of cases. Wedding reception, Malahide, 21 August 1996.   |  | **N = 43**1 | | --- | --- | | **Time in hospital** | 201 (60, 251) | | **Duration of illness** | 160 (63, 218) | | **Incubation period** | 30 (18, 45) | | 1Median (IQR) | | |

## Figures

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| |  | | --- | | (a) *This data are simulated.* |   Figure 1: Date and time of onset of diarrhoeal illness among cases. Wedding reception, Malahide, 21 August 1996 |

## Simulated Data

# A tibble: 127 × 13  
 guest\_id wedding\_cohort eligible interviewed not\_eaten refused\_to\_participate  
 <int> <lgl> <lgl> <lgl> <lgl> <lgl>   
 1 1 TRUE TRUE TRUE TRUE FALSE   
 2 2 TRUE TRUE TRUE TRUE FALSE   
 3 3 TRUE TRUE TRUE FALSE FALSE   
 4 4 TRUE TRUE TRUE FALSE FALSE   
 5 5 TRUE TRUE TRUE FALSE FALSE   
 6 6 TRUE TRUE TRUE FALSE FALSE   
 7 7 TRUE TRUE TRUE FALSE FALSE   
 8 8 TRUE TRUE TRUE FALSE FALSE   
 9 9 TRUE TRUE TRUE TRUE FALSE   
10 10 TRUE TRUE TRUE FALSE FALSE   
# ℹ 117 more rows  
# ℹ 7 more variables: unable\_to\_locate <lgl>, age\_class <chr>, gender <chr>,  
# illness <lgl>, meals <fct>, date\_of\_illness <dttm>,  
# seating\_arrangements <fct>

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| Table 6: Simulated “1996s wedding” data, used for the analyses on this report |

# A tibble: 43 × 16  
 guest\_id diarrhoea feeling\_faverish aches\_and\_pains nausea abdominal\_cramps  
 <int> <lgl> <lgl> <lgl> <lgl> <lgl>   
 1 1 TRUE FALSE TRUE FALSE FALSE   
 2 13 TRUE TRUE FALSE TRUE FALSE   
 3 15 TRUE TRUE TRUE TRUE FALSE   
 4 16 TRUE TRUE FALSE FALSE FALSE   
 5 21 TRUE FALSE TRUE FALSE FALSE   
 6 22 TRUE TRUE FALSE TRUE FALSE   
 7 34 TRUE FALSE TRUE FALSE TRUE   
 8 36 TRUE FALSE FALSE FALSE FALSE   
 9 38 TRUE TRUE TRUE FALSE FALSE   
10 44 TRUE TRUE TRUE FALSE TRUE   
# ℹ 33 more rows  
# ℹ 10 more variables: vomiting <lgl>, headaches <lgl>,  
# blood\_seen\_in\_on\_stool <lgl>, gp\_visit <lgl>, hospitalization <lgl>,  
# stool\_samples\_obtained <lgl>,  
# stool\_sample\_plus\_ve\_for\_salmonella\_typhimurium <lgl>,  
# time\_in\_hospital <int>, duration\_of\_illness <int>, incubation\_period <int>

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| Table 7: Simulated “1996s wedding” clinical and laboratory data, used for the analyses on this report |