# South Island VTEC/STEC infection

## An analysis of notifications (2000-2014)
## Incidence 2015-2017 (Appendix)

Canterbury District Health Board
Te Poari Hauora ō Waitaha

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## Foreword

This report on VTEC/STEC has been produced to improve understanding of its local epidemiology in order to assist with its public health management.

## Document availability

This document is available on the Community and Public Health website: www.cph.co.nz

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## Contents

# Summary points

## Main findings

- Verotoxin- or Shiga toxin-producing *E. coli* (VTEC/STEC) infection is a notifiable disease that can cause severe enteritis with bloody diarrhoea. It is associated with high rates of hospitalisation and high-level care including dialysis. The major complication, most common in children, is haemolytic uraemic syndrome.

- Between 2000 and 2014 there were 1,785 VTEC/STEC notifications nationwide. In the South Island there were 501 notified cases, 18 percent of which were hospitalised, and one death. VTEC/STEC incidence rates rose between 2000 and 2014 both nationally and in the South Island.

- In the Community and Public Health (C&PH) region (i.e. Canterbury, South Canterbury and West Coast DHBs), 13 percent of children aged 1-4 years who were notified with VTEC/STEC developed haemolytic uraemic syndrome.

- The majority of *E. coli* isolates from samples of VTEC/STEC notifications in the C&PH region were the O157 serogroup, which is similar to national findings.

- In the C&PH region the average annual VTEC/STEC notification and hospitalisation rates were highest among children less than 4 years of age, females, and those living in rural locations. Although notification rates were highest in the least deprived areas, hospitalisation rates were similar across the deprivation deciles. For adults aged 50 years and over, one in three were hospitalised.

- Notification rates were similar for Māori and non-Māori. However, because of the small sample size for Māori, the comparison is not conclusive.

- For adults, the highest VTEC/STEC notification rates were among those who were labourers (e.g. farm worker, meat process worker) and community and personal service workers (e.g. caregiver, teachers' aide).

- It was not possible to determine specific risk factors that were associated with VTEC/STEC due to the lack of a control group. However, across New Zealand, areas with high dairy cattle density tended to have high VTEC/STEC notification rates.

- The seasonality of VTEC/STEC notifications in the South Island and New Zealand shows a bimodal pattern, with low rates of notifications occurring in July and high rates in autumn and late winter-spring.

- There were six VTEC/STEC outbreaks in the C&PH region reported in EpiSurv between 2000 and 2014. The largest outbreaks involved only six cases. However an analysis by household revealed an additional 45 household clusters of between 2-5 cases. The omission of these cases from the definition of an outbreak was due to a coding policy until 2010.

## Recommendations

VTEC/STEC is a potentially serious illness and its incidence is increasing. Public health staff can respond to this challenge by:

- Raising public awareness of the disease and its key risk factors.
- Promoting hygiene messages, especially to do with hand-washing, to the following (or their caregivers) known to be at higher risk of acquiring the infection:
    - young children, especially preschoolers, exposed to risk factors in the rural environment
    - those in contact with cattle/dairy cows, and
    - caregivers of children with diarrhoeal illnesses.
- Promoting notification on suspicion and investigating cases thoroughly to identify and mitigate risks where possible.
- Ensuring that water supplies (particularly public supplies) are adequately maintained and monitored.
- Highlighting the potential for food to become contaminated by VTEC/STEC bacteria when processed, and advocating for safety and quality assurance programmes of the highest standard.

# Introduction

*Escherichia coli* (*E. coli*) is a common cause of infections, including cholecystitis, cholangitis, neonatal meningitis, urinary tract infection, and traveller's diarrhoea (1). Disease caused by Verotoxin- or Shiga toxin-producing *E. coli* (VTEC/STEC) is notifiable. VTEC/STEC is a heterogenous group of bacteria that express potent cytotoxins called Shiga toxins, one of which is essentially identical to the toxin produced by *Shigella dysenteriae*. There are numerous serogroups, the commonest being 0157, which accounts for 80-90 percent of VTEC/STEC isolates in New Zealand (2).

VTEC/STEC causes an enteritis often associated with severe abdominal cramps, diarrhoea that can be severe and bloody, and a hospital admission rate of up to 40 percent. The most significant complication is haemolytic uraemic syndrome (HUS), a condition characterised by haemolytic uraemia, thrombocytopaenia and acute renal dysfunction. It most commonly affects children aged less than 5 years. In children with VTEC/STEC, 8-10 percent will develop HUS and of these, 12–30 percent will have severe sequelae, including renal and cerebral impairment. Elderly patients with VTEC/STEC may suffer thrombotic thrombocytopenic purpura, which is similar to HUS but with greater neurological involvement (1, 3, 4).

VTEC/STEC disease is a significant problem in the United States of America, Europe, Japan, Australia, New Zealand and southern South America but its significance in the rest of the world is less well-established (3). Cattle are the most common reservoir, but sheep, goats, deer, water buffalo, turkeys and wild migrating birds also harbour the organism (3, 5, 6). Contaminated foods, including hamburger and other meat products, unpasteurised milk, apple cider, and produce (including melons, lettuce, coleslaw, and alfalfa sprouts) have been implicated in outbreaks resulting at times in significant mortality. A breakdown in hygiene is responsible for person-to-person transmission (7, 8). In New Zealand, environmental and ruminant animal contact have been implicated as the predominant exposure pathways (9).

VTEC/STEC became notifiable in 1997 as one of the specific causes of acute gastroenteritis. It was gazetted as a notifiable disease in 2012 (10). Since 1997 the incidence has gradually increased, although this may have been partly due to changes in laboratory testing practices, with increasingly sensitive assays and algorithms used for the detection of the bacteria (11). VTEC/STEC is of significance because of the potential severity of the disease and its complications, especially in young children, and because of the potential for food- and waterborne outbreaks.

# Methods

## Data

VTEC/STEC data were retrieved from EpiSurv[1] for the 15 years from 2000 to 2014 (inclusive). Notification data were retrieved for all five South Island district health boards (DHBs). Demographic, risk exposure and outbreak data were retrieved for the Community and Public Health (C&PH) region (i.e. Canterbury, South Canterbury and West Coast DHBs).

## Incidence and rates

Population estimates based on the 2001, 2006 and 2013 New Zealand Censes were used to calculate incidence rates over time. The 2006 Census usually resident population counts were used to calculate average annual rates. Regression analysis was conducted to detect time trends in incidence rates using SPSS (Version 22.0. Armonk, NY: IBM Corp).

## Demographic characteristics

To calculate rates of VTEC/STEC notification and hospitalisation among the different demographic groups, population count data from the 2006 Census were used, as this was deemed to be a suitable estimate for the mid-point of the time period.

Due to small sample sizes for some ethnic groups, prioritised ethnicity (Māori, Pacific, Asian, Other, European) was recoded so that any person of Māori ethnicity was categorised as Māori, and people of all other ethnicities were categorised as non-Māori. Ethnicity data were analysed only for the time period 2010-2014 (inclusive), and 2013 Census population count data were used to estimate rates, as DHB-level prioritised ethnicity data were only available for the 2013 Census.

Cases were categorised as residing in either urban or rural locations using the Urban/Rural Profile 2006 (12), where urban areas consisted of main urban areas, satellite urban communities and independent urban communities; and rural areas consisted of rural areas with high urban influence, rural areas with moderate urban influence, rural areas with low urban influence, and highly rural/remote areas. In addition, the neighbourhood deprivation (NZDep2006) of the area where cases lived was categorised into quintiles (13). NZDep2006 is a small-area-based relative deprivation index based on nine socioeconomic variables from the 2006 Census. NZDep2006 scores are usually categorised into tenths (deciles), numbered from 1 (least deprived) to 10 (most deprived). NZDep2006 describes the deprivation experienced by groups of people in small areas and describes the general socio-economic deprivation of an area. It does not describe the deprivation of an individual.

The occupation of each case (where recorded) was coded according to the Australian and New Zealand Standard Classification of Occupations (ANZSCO v1.2, Level 1)[2]. Children and young people less than 17 years of age and/or school students (n=195), and tourists (n=1) were not included in the analyses. It is important to note that the level at which occupation data is collected and coded in this dataset may not

[1] EpiSurv is the national notifiable disease surveillance database operated by the Institute of Environmental Science & Research Ltd (ESR) on behalf of the Ministry of Health.

[2] For a description of the occupations included in each category, see: http://www.stats.govt.nz/tools_and_services/ClassificationCodeFinder/ClassificationCodeHierarchy.aspx?classification=3781

be consistent, and results should be interpreted with this in mind. Rates were calculated using population counts for each occupation category for people 15 years of age and older, from the 2006 Census. Population counts for those not in paid employment (e.g. at-home parent, homemaker, retiree, unemployed, tertiary student, volunteer) were estimated by adding those not in the labour force and those who were unemployed, also from the 2006 Census.

## Risk exposures

Data on dairy cattle density was sourced from DairyNZ's publication New Zealand Dairy Statistics 2013-2014 (14). Areas of each Territorial Authority (in $km^2$) were derived from the Geographic Information System shapefiles of Territorial Authority boundaries produced by Statistics New Zealand (15). VTEC/STEC notification data for all DHBs in New Zealand were retrieved from EpiSurv for the 5 years from 2010 to 2014 (inclusive). The 2013 Census usually resident population counts were used to calculate average annual rates for each DHB in New Zealand. Maps of cattle density by Territorial Authority and notification rates by DHB were generated using ArcGIS (Version 10.0. Redlands, CA: Environmental Systems Research Institute, Inc).

## Seasonality

Seasonality was investigated by calculating the mean monthly VTEC/STEC notification rate (n=15 instances of each month for the period 2000 to 2014) for the whole of New Zealand, the South Island, and for each of the three South Island Public Health Unit areas - Nelson Marlborough Public Health Service (Nelson Marlborough DHB), Public Health South (Southern DHB), and C&PH (Canterbury, South Canterbury and West Coast DHBs combined). The mean monthly notification rate was not calculated for individual DHB areas, as smaller DHBs had too few notifications to allow meaningful calculations. In addition, 95 percent confidence intervals were calculated for the whole of New Zealand.

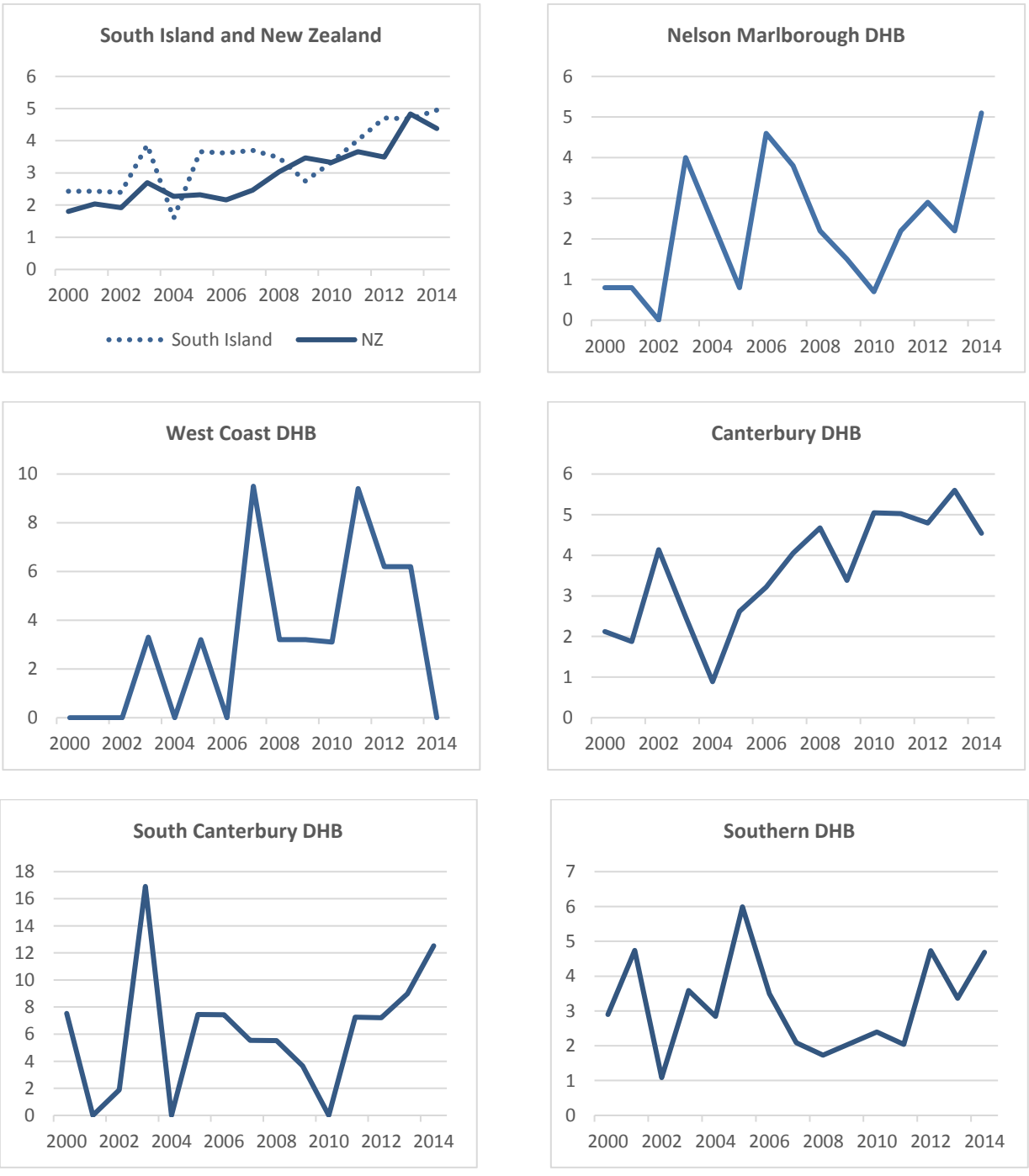
## Outbreaks and clusters

Household clusters not included in reported outbreaks were identified for the C&PH region by examining surnames, contact addresses, and report dates of VTEC/STEC notifications. Cases were classified as a household cluster when two or more notifications had the same surname and contact address and the notification dates were no more than 21 days apart.

## Incidence and rates

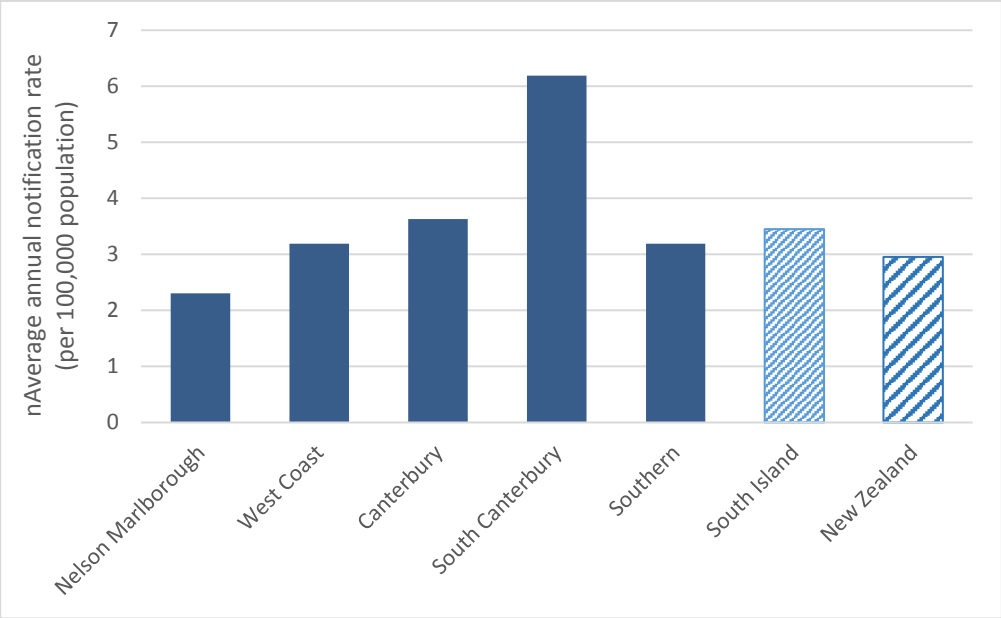
From 2000 to 2014 there were 1,785 VTEC/STEC notifications nationwide and 501 in the South Island. Incidence rates rose over the past 15 years both nationally and in the South Island ($p<0.001$ and $p=0.001$ for trend for New Zealand and the South Island, respectively) (**Figure 1**). A similar trend could also be seen in Canterbury ($p=0.001$ for trend). Rates for Nelson Marlborough, West Coast, South Canterbury and Southern DHBs were based on small numbers with differences of one or two cases resulting in wide annual fluctuations. This made it difficult to identify trends over time with any certainty in these DHBs.

**Figure 1. Annual VTEC/STEC notification rates per 100,000 population for New Zealand, the South Island, and each South Island DHB (2000-2014)**



The average annual VTEC/STEC notification rates for 2000-2014 varied little between DHBs with the exception of South Canterbury that had almost double the rate of other DHBs (**Figure 2**).

**Figure 2. Average annual VTEC/STEC notification rates for South Island DHBs, South Island, and New Zealand (2000-2014)**




## Hospitalisations, haemolytic uraemic syndrome, and mortality

There were 501 cases notified in the South Island between 2000 and 2014, of which 90 (18%) were hospitalised. There was one death. This is a substantially lower percentage hospitalisation than for the whole of New Zealand, where 517 of 1,785 notifications (29%) were hospitalised, with two deaths. Hospitalisation rates were comparable across the South Island DHBs. On average, all but South Canterbury had less than one hospitalisation per 100,000 population per year.

In the C&PH region there were 21 cases (6.6%) of VTEC/STEC-associated HUS of which 18 were children, all aged 1 to 4 years. This equated to 13.3 percent of all children in that age group who were notified and 9.2 percent of all children notified. In addition there were two reported cases, one a child, with thrombotic thrombocyptopenic purpura without HUS.

## Isolates

The majority of *E. coli* isolates (94%) from samples of notified VTEC/STEC cases in the C&PH region were of the O157 serogroup (**Table 1**). This serogroup is also the most common nationally (9, 11, 16-18).

**Table 1. *Escherichia coli* isolates of VTEC/STEC notifications, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| *Escherichia coli* isolates | Number of notifications (n) | Percentage of notifications (%) |
|---|---|---|
| **O157** | 275 | 93.9 |
| **Non-O157** | 18 | 6.1 |

No laboratory results were recorded for 23 notifications, and incomplete/illegible results were recorded for 3 notifications.

# Demographic characteristics

The demographic characteristics of VTEC/STEC notifications from the C&PH region are described in the following section for 2000-2014 (except for ethnicity, which is presented for 2010-2014).

## Age

The VTEC/STEC notification rate was highest among children less than 10 years of age, and this age group contributed more than half of all VTEC/STEC notifications between 2000 and 2014 (**Table 2, Figure 3**). This was driven by higher rates among those in the 0-4 year age group (30.7 notifications per 100,000 population per year, n=158), rather than those in the 5-9 year age group (5.6 notifications per 100,000 population per year, n=30). In particular, the number of notifications was highest among 1 and 2 year olds (60 and 31 notifications, respectively) (**Figure 4**). These findings are consistent with recent national figures (11, 16-18), and other New Zealand epidemiological information (9). While the rates for those aged 10-29 and 40-49 years were approximately 1.5 notifications per 100,000 population per year, the rates for those aged 30-39 years and 60-69 years were higher (**Table 2, Figure 3**).

The average annual hospitalisation rate was highest among children 0-9 years of age (**Table 2**), and 25 of the 29 hospitalisations were for those 0-4 years of age (data not shown). The next highest hospitalisation rate was in the 60-69 years age group. Approximately one in three cases aged 50 years and over were admitted to hospital (**Table 2**).

**Table 2. VTEC/STEC notification and hospitalisation rates by age group, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| | 0-9 years | 10-19 years | 20-29 years | 30-39 years | 40-49 years | 50-59 years | 60-69 years | 70+ years | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Number of notifications** | 188 | 18 | 16 | 28 | 18 | 15 | 21 | 14 | 319 |
| **Mean annual number of notifications** | 12.5 | 1.2 | 1.1 | 1.9 | 1.2 | 1.0 | 1.4 | 0.9 | 21.3 |
| **Mean annual notification rate per 100,000 population** | 17.9 | 1.5 | 1.6 | 2.4 | 1.4 | 1.4 | 2.9 | 1.7 | 3.9 |
| **Percentage of notifications (%)** | 58.9 | 5.6 | 5.0 | 8.8 | 5.6 | 4.7 | 6.6 | 4.4 | NA |
| **Number hospitalised** | 29 | 4 | 1 | 3 | 3 | 4 | 8 | 5 | 57 |
| **Mean annual number hospitalised** | 1.9 | 0.3 | 0.1 | 0.2 | 0.2 | 0.3 | 0.5 | 0.3 | 3.8 |
| **Mean annual hospitalisation rate per 100,000 population** | 2.8 | 0.3 | 0.1 | 0.3 | 0.2 | 0.4 | 1.1 | 0.6 | 0.7 |
| **Percentage of notifications hospitalised (%)** | 15.4 | 22.2 | 6.3 | 10.7 | 16.7 | 26.7 | 38.1 | 35.7 | 17.9 |

The age of one case was unknown.

**Figure 3. Mean annual rate of VTEC/STEC notifications, by age group, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

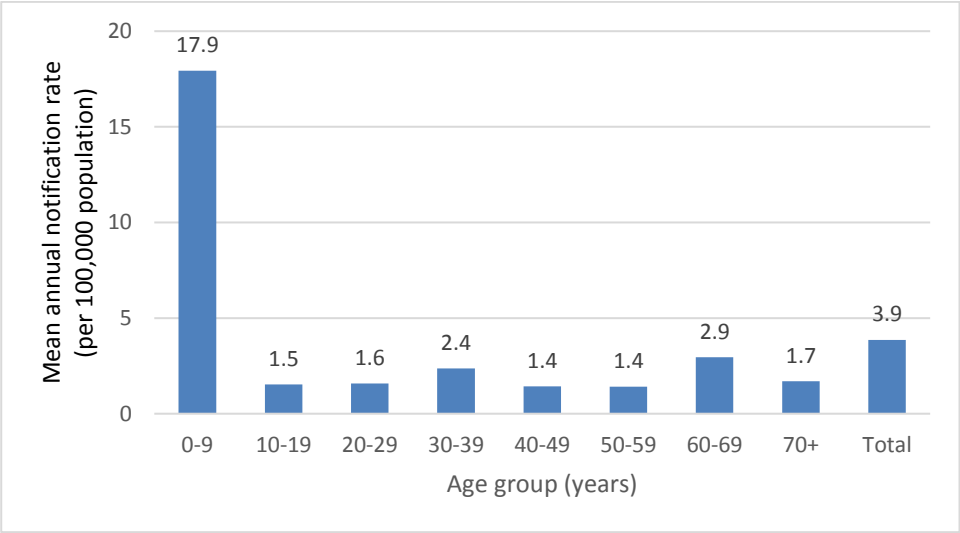
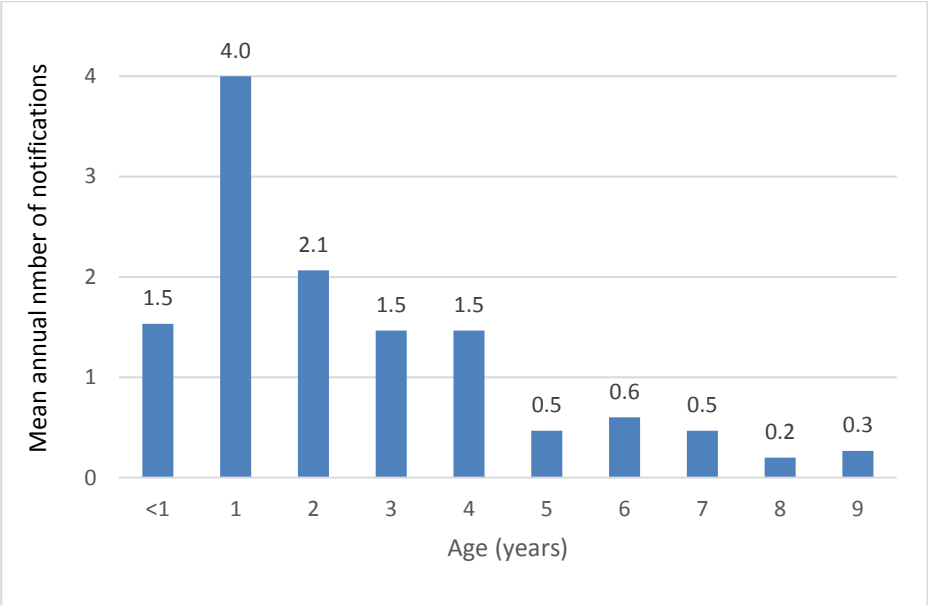



**Figure 4. Mean annual number of VTEC/STEC notifications for children less than 10 years of age, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**




## Sex

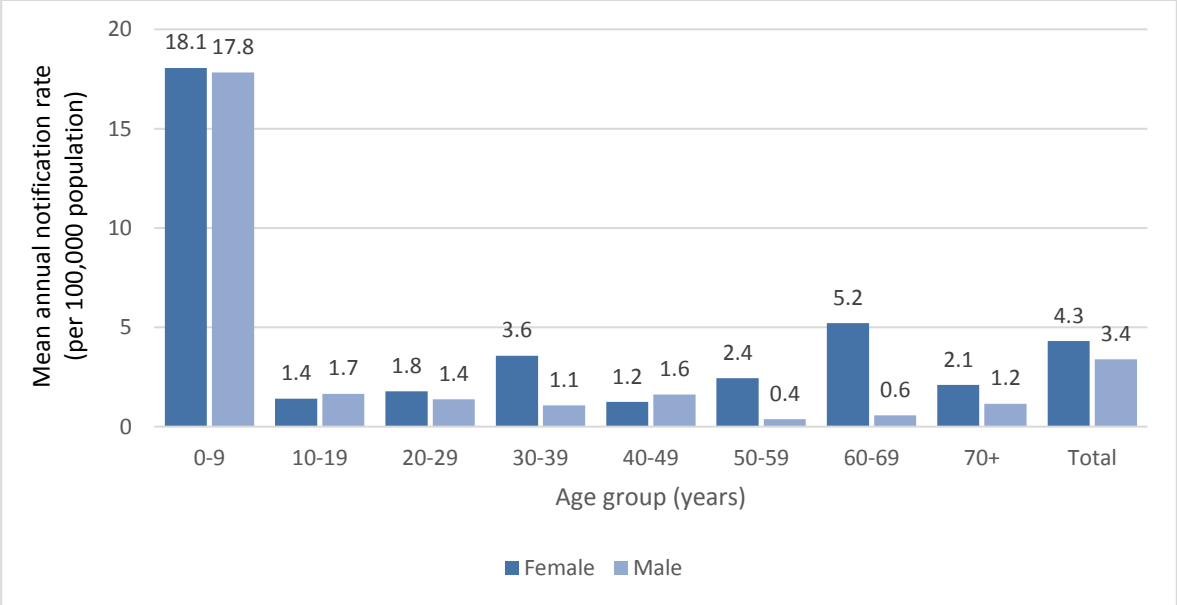
Mean annual VTEC/STEC notification rates were higher among females than males, as was the rate of hospitalisations (**Table 3**). These findings are consistent with national figures (11, 16-18). Notification rates were higher in females 30-39 years of age and those 50 years and over, but similar between females and males for other age groups (**Figure 5**).

| Table 3. VTEC/STEC notification and hospitalisation rates by sex, in Canterbury, South Canterbury and West Coast DHBs (2000-2014) | | |
|---|---|---|
| | **Male** | **Female** |
| **Number of notifications** | 137 | 182 |
| **Mean annual number of notifications** | 9.1 | 12.1 |
| **Mean annual notification rate per 100,000 population** | 3.4 | 4.3 |
| **Percentage of notifications (%)** | 42.9 | 57.1 |
| **Number hospitalised** | 20 | 37 |
| **Mean annual number hospitalised** | 1.3 | 2.5 |
| **Mean annual hospitalisation rate per 100,000 population** | 0.5 | 0.9 |
| **Percentage of notifications hospitalised (%)** | 14.6 | 20.3 |

The female:male notification ratio is 1: 1.3.

The female:male hospitalisation ratio is 1: 1.8.

**Figure 5. Mean annual rate of VTEC/STEC notifications, by age group and sex, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**




## Ethnicity

Between 2010 and 2014, the mean annual VTEC/STEC notification rates were similar for Māori and non-Māori (**Table 4**). However, because of the small sample size for Māori this finding is not conclusive. Nationally for 2010-2014, the mean annual notification rate of people of European/Other ethnicity was twice that of Māori (11, 16-18).

**Table 4. VTEC/STEC notification and hospitalisation rates for Māori and non-Māori, in Canterbury, South Canterbury and West Coast DHBs (2010-2014)**

| | Māori | Non-Māori |
|---|---|---|
| **Number of notifications** | 12 | 135 |
| **Mean annual number of notifications** | 2.4 | 27.0 |
| **Mean annual notification rate per 100,000 population** | 5.3 | 5.4 |
| **Percentage of notifications (%)** | 8.2 | 91.8 |
| **Number hospitalised** | 2 | 32 |
| **Mean annual number hospitalised** | 0.1 | 1.8 |
| **Mean annual hospitalisation rate per 100,000 population** | 0.9 | 1.3 |
| **Percentage of notifications hospitalised (%)** | 16.7 | 23.7 |

All persons of Māori ethnicity were categorised as Māori, and persons of all other ethnicities were categorised as non-Māori (i.e. 128 European, 3 Pacific, 3 Asian and 1 Other, using prioritised ethnicity: Māori, Pacific, Asian, Other, European).
Rates have been calculated using population counts from the 2013 Census.
The ethnicity of 1 case was unknown.

## Urban-rural location

Although almost two thirds of notifications lived in urban areas the rate of VTEC/STEC notifications in rural areas was three times higher (**Table 5**). The hospitalisation rate of those in rural areas was more than twice that of urban areas.

**Table 5. VTEC/STEC notification and hospitalisation rates by rural/urban location of residence, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| | Urban | Rural |
|---|---|---|
| **Number of notifications** | 185 | 107 |
| **Mean annual number of notifications** | 12.3 | 7.1 |
| **Mean annual notification rate per 100,000 population** | 2.7 | 8.0 |
| **Percentage of notifications (%)** | 63.4 | 36.6 |
| **Number hospitalised** | 36 | 15 |
| **Mean annual number hospitalised** | 2.4 | 1.0 |
| **Mean annual hospitalisation rate per 100,000 population** | 0.5 | 1.1 |
| **Percentage of notifications hospitalised (%)** | 19.5 | 14.0 |

Cases were categorised using the Urban/Rural Profile 2006.
Rates have been calculated using population counts from the Urban/Rural 2006 categories.
The Urban/Rural profile of 27 cases was unknown.

## Neighbourhood deprivation

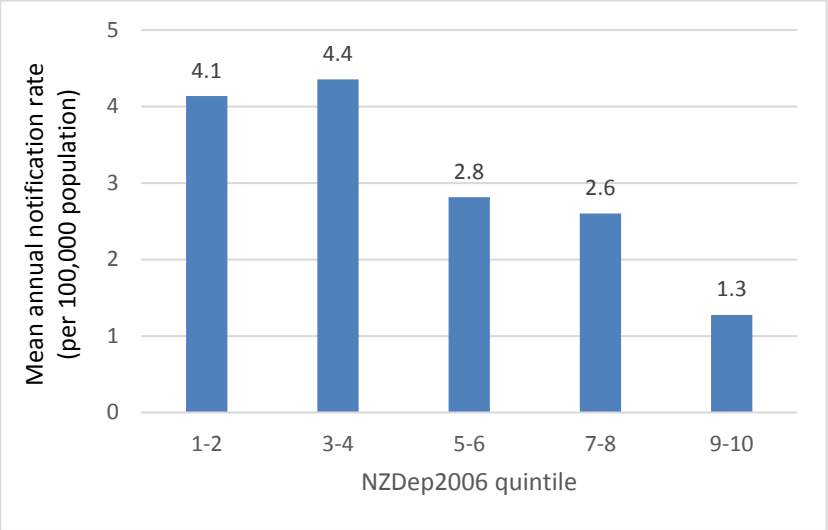
Mean annual VTEC/STEC notification rates were highest in the least deprived neighbourhoods, and lowest in the most deprived neighbourhoods (**Table 6, Figure 6**). Hospitalisation rates were similar across the five deprivation quintiles. More than one quarter (27.9 %) of cases who lived in the most deprived neighbourhoods were hospitalised, compared with 15 percent of those in the least deprived areas.

**Table 6. VTEC/STEC notification and hospitalisation rates by neighbourhood deprivation, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| | Deciles 1-2 | Deciles 3-4 | Deciles 5-6 | Deciles 7-8 | Deciles 9-10 |
|---|---|---|---|---|---|
| **Number of notifications** | 85 | 82 | 50 | 40 | 13 |
| **Mean annual number of notifications** | 5.7 | 5.5 | 3.3 | 2.7 | 0.9 |
| **Mean annual notification rate per 100,000 population** | 4.1 | 4.4 | 2.8 | 2.6 | 1.3 |
| **Percentage of notifications (%)** | 31.5 | 30.4 | 18.5 | 14.8 | 4.8 |
| **Number hospitalised** | 13 | 12 | 8 | 10 | 4 |
| **Mean annual number hospitalised** | 0.9 | 0.8 | 0.5 | 0.7 | 0.3 |
| **Mean annual hospitalisation rate per 100,000 population** | 0.6 | 0.6 | 0.5 | 0.6 | 0.4 |
| **Percentage of notifications hospitalised (%)** | 15.3 | 14.6 | 16.0 | 25.0 | 30.8 |

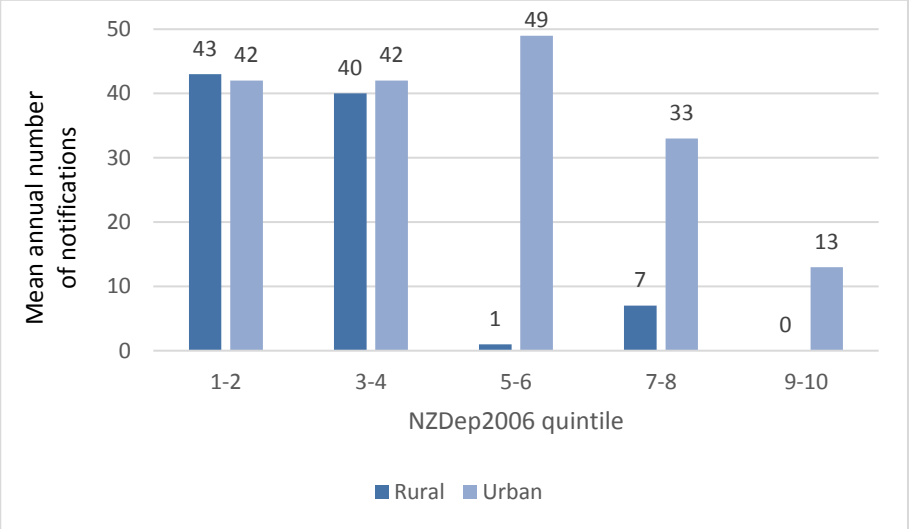
Cases were categorised using NZDep2006 as a measure of neighbourhood deprivation.
Population counts use data from the NZDep2006 categories.
The NZDep2006 of 49 cases was unknown.

**Figure 6. Mean annual rate of VTEC/STEC notifications, by neighbourhood deprivation, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**




When these neighbourhood deprivation findings were explored in relation to urban/rural location of the notification, the majority of notifications from those living in rural areas were in neighbourhoods with lower deprivations scores (i.e. deciles 1-4) (**Figure 7**). It was not possible to calculate VTEC/STEC notification rates for urban/rural deprivation sub-groups as the population count data was not readily available.

**Figure 7. Mean annual number of VTEC/STEC notifications, by neighbourhood deprivation and urban/rural location of residence, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**




## Occupation

Among the relatively small number of adults in paid employment with a VTEC/STEC notification (n=63), the highest rates were among those who were labourers (e.g. farm worker, meat process worker) and community and personal service workers (e.g. caregiver, teachers' aide) (**Table 7, Figure 8**). Ten cases mentioned a farm-based occupation – three managers and seven labourers. Of these 10, seven explicitly mentioned dairy/cattle/calves. However, the level at which occupation data is collected and coded in this dataset may be inconsistent, and may not provide sufficient detail to identify other specific cases with cattle/dairy farm-based occupations. Rates were also relatively high among those not in paid employment, which included at-home parents and retirees.

**Figure 8. Mean annual rate of VTEC/STEC notifications, by occupation, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

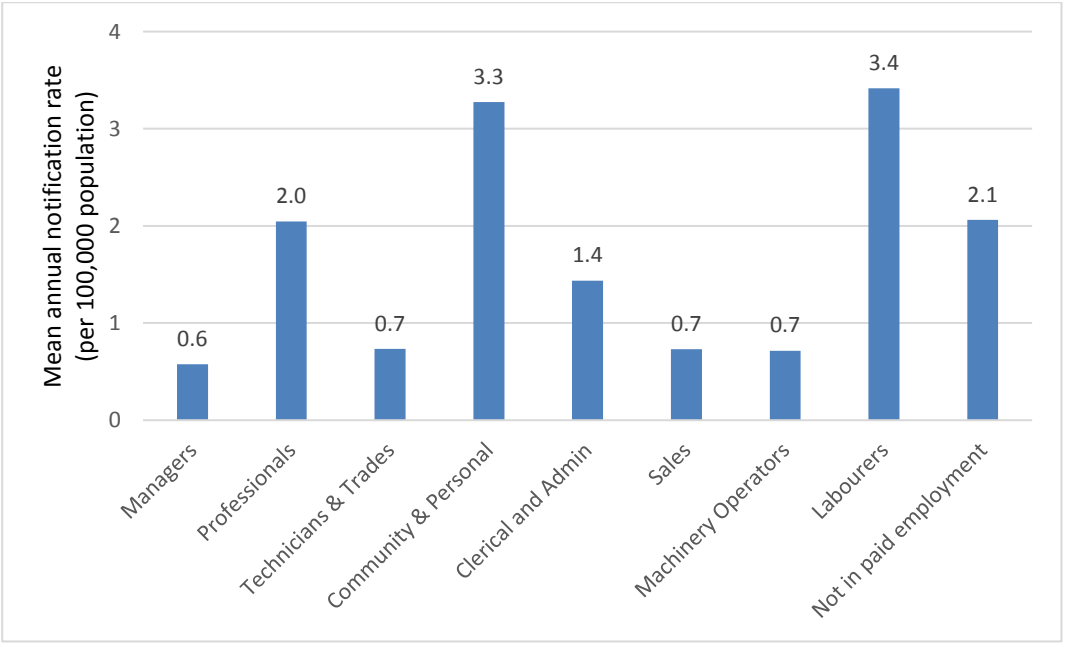


**Table 7. VTEC/STEC notification and hospitalisation rates by occupation, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| | Manager | Professional | Technician & Trades Worker | Community & Personal Service | Clerical & Administrative | Sales Worker | Machinery Operator & Driver | Labourer | Not in paid employment* |
|---|---|---|---|---|---|---|---|---|---|
| **Number of notifications** | 4 | 15 | 4 | 12 | 7 | 3 | 2 | 18 | 46 |
| **Mean annual number of notifications** | 0.3 | 1.0 | 0.3 | 0.8 | 0.5 | 0.2 | 0.1 | 1.2 | 3.1 |
| **Mean annual notification rate per 100,000 population** | 0.6 | 2.0 | 0.7 | 3.3 | 1.4 | 0.7 | 0.7 | 3.4 | 2.1 |
| **Percentage of notifications (%)** | 3.6 | 13.5 | 3.6 | 10.8 | 6.3 | 2.7 | 1.8 | 16.2 | 41.4 |
| **Number hospitalised** | 0 | 4 | 1 | 3 | 1 | 0 | 1 | 1 | 14 |
| **Mean annual number hospitalised** | 0.0 | 0.2 | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 | 0.1 | 0.8 |
| **Mean annual hospitalisation rate per 100,000 population** | 0.0 | 0.5 | 0.2 | 0.8 | 0.2 | 0.0 | 0.4 | 0.2 | 0.6 |
| **Percentage of notifications hospitalised (%)** | 0.0 | 26.7 | 25.0 | 25.0 | 14.3 | 0.0 | 50.0 | 5.6 | 30.4 |

*Not in paid employment includes: at-home parent, homemaker, retiree, unemployed, tertiary student and volunteer.
This table does not include those who were: Children and young people less than 17 years of age and/or school student (n=195), a tourist (n=1), or had an unknown occupation (n=12).
Rates have been calculated using population counts from the 2006 Census.

# Risk exposures

A prospective case-control study conducted in New Zealand in 2011/2012 found that the following factors were associated with a significantly greater risk of VTEC/STEC: cattle livestock present in the meshblock of residence, contact with animal manure, contact with recreational water, travel to parts of New Zealand with interrupted or no main water supply, and (for young children) contact with animals (other than pets) by household members (9). Food sources were not found to be associated with an increased risk. From the data available for the current report, it is not possible to determine which factors were associated with an increased risk of VTEC/STEC between 2000 and 2014 due to the lack of a control group. However, some descriptive data related to exposure to some of the risk factors mentioned above are presented below.

## Dairy cattle density

Nationally, three of the four DHBs with VTEC/STEC notification rates in the highest two categories also had Territorial Local Authorities with dairy cattle density in the highest two categories (**Figures 9 and 10**). Although a limitation of this data is that it only includes dairy cattle (and not all cattle) the finding is consistent with overseas studies that have found a similar association (19, 20).

## Other exposures

In the C&PH region, more than half of rural cases reported contact with farm animals or animal manure in the week prior to becoming ill and less than one third reported exposure to water associated risk factors (**Table 8**).

**Table 8. Exposure to selected risk factors in the week prior to becoming ill among notified cases of VTEC/STEC, by urban/rural location of residence, in Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| Risk factor | Urban<br>% exposed (n) | Rural<br>% exposed (n) | Total<br>% exposed (n) |
|---|---|---|---|
| Contact with farm animals | 42.6 (46) | 78.7 (70) | 60.6 (129) |
| Contact with animal manure | 42.2 (43) | 75.0 (57) | 55.2 (107) |
| Used non-habitual water supply | 30.8 (45) | 25.9 (22) | 29.2 (73) |
| Contact with recreational water | 24.8 (40) | 27.7 (26) | 26.2 (73) |

Missing data were common among these variables.
The number of urban and rural cases exposed to each risk factor may not add up to the total number of cases exposed, as the Urban/Rural profile of 27 cases was unknown.

**Figure 9. Dairy cattle density, by Territorial Authority (2013/2014)**

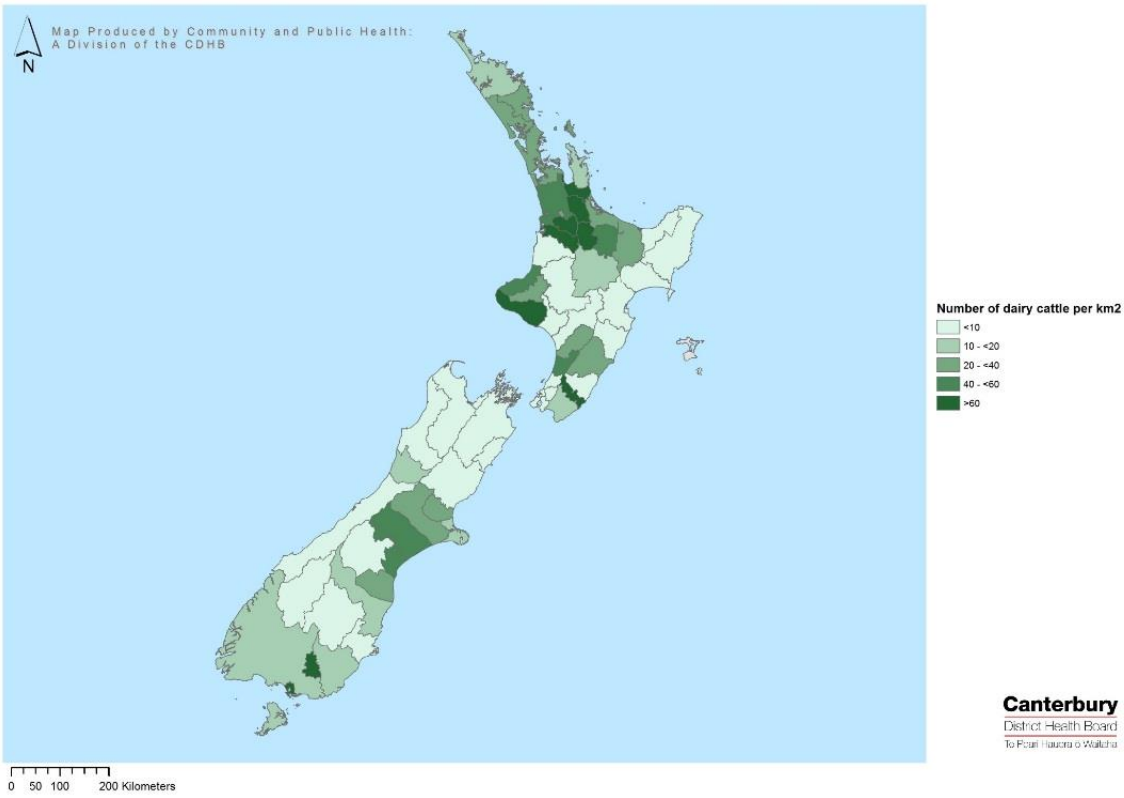
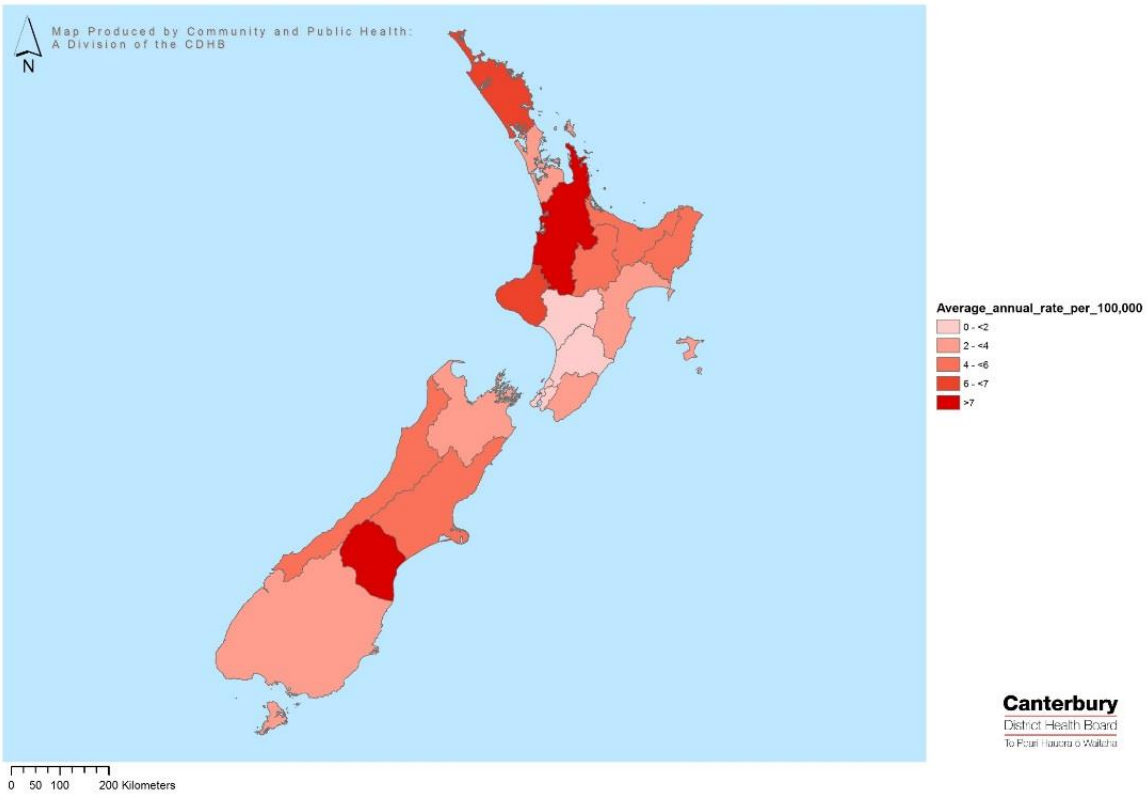



**Figure 10. Average annual rate of VTEC/STEC notifications, by DHB (per 100,000 population, 2010-2014)**



## Seasonality

VTEC/STEC notifications between 2000 and 2014 in the South Island and New Zealand show a biannual seasonality with peaks in autumn and late winter/spring and low rates in July (**Figure 11**). Analysis by Public Health Unit was limited by the small population numbers and small numbers of notifications resulting in greater variation in the average monthly notification rates for each of the Public Health Unit areas, but they each followed a similar bimodal pattern (**Figure 12**). A study in Australia (21), as well as a systematic review of overseas literature investigating the seasonality of human zoonotic enteric diseases (22), found that the incidence of VTEC/STEC was high in summer and low in winter.

**Figure 11. New Zealand and South Island mean rate of VTEC/STEC notifications, by month (2000-2014)**

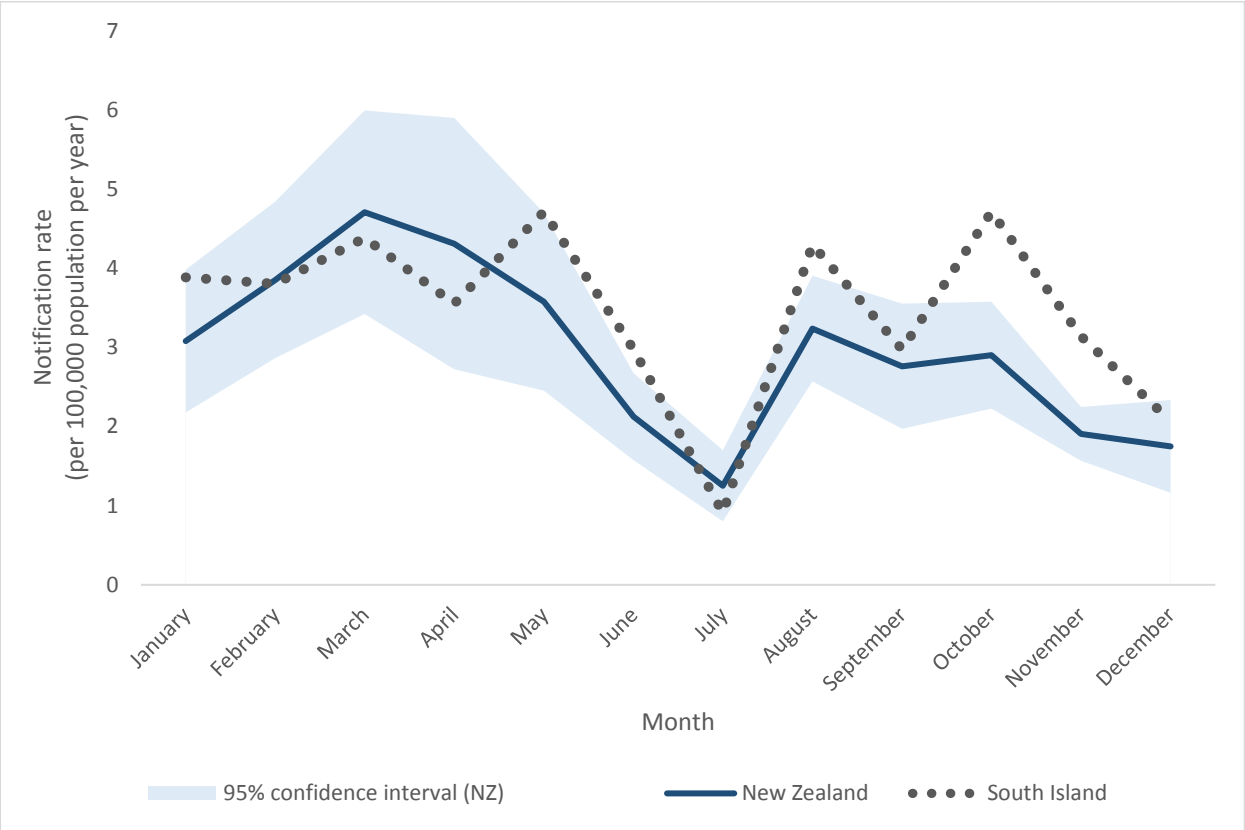
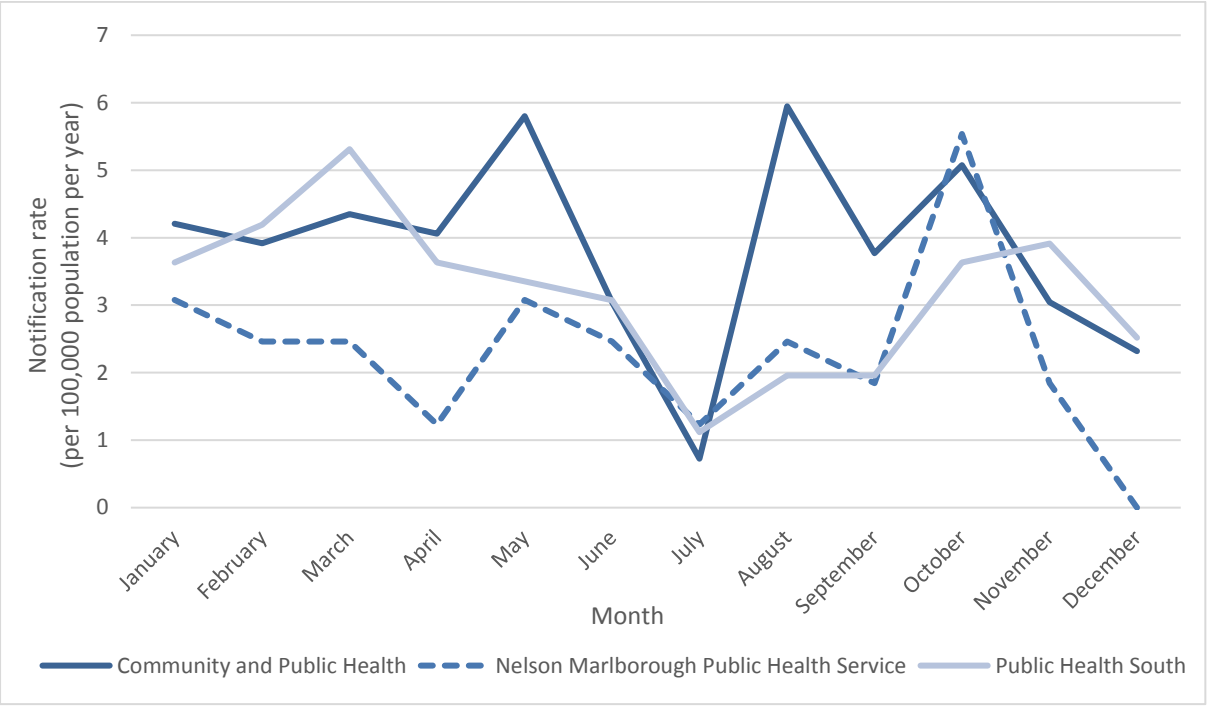


**Figure 12. Mean rate of VTEC/STEC notifications for the three South Island Public Health Units, by month (2000-2014).**



## Outbreaks and clusters

In the C&PH region between 2000 and 2014 six outbreaks were reported comprising between two and six cases (**Table 9**). However, prior to 2010, reporting of household outbreaks likely to have resulted from secondary transmission was discouraged (23). A new definition was introduced by ESR in 2010 that stated, "Any household outbreaks that are investigated should be reported regardless of mode of transmission." An investigation into the number of household clusters that had been unreported as such was therefore undertaken using surname and address. This identified an additional 45 clusters within 21 days* of the index case. There was one cluster of five cases, two of four cases, eight of three cases and 34 of two cases. Nationally between 2010 -2014, there was an average of 6.8 outbreaks per year (range 1-16) with an average of 3.4 cases per outbreak (11, 16-18).

**Table 9. Outbreaks of VTEC/STEC reported in EpiSurv for Canterbury, South Canterbury and West Coast DHBs (2000-2014)**

| Year of outbreak | Number of cases in outbreak |
|---|---|
| **2002** | 3 |
| **2002** | 3 |
| **2006** | 6 |
| **2007** | 2 |
| **2013** | 6 |
| **2014** | 2 |

* duration of communicability from a child

# Discussion

All 319 of the VTEC/STEC notifications in the C&PH region and 179 of the 182 notifications in the other South Island DHBs were laboratory confirmed. A notification bias however, was apparent with the highest rates occurring in the higher socioeconomic groups even though hospitalisation rates were similar across the deprivation deciles. High notification rates in low decile areas were also seen for pertussis in the South Island (24) and the explanation, along with cost being a barrier to services for patients most deprived, may be similar, as people from lower socioeconomic groups tend to use services less often in relation to need due to such factors as perception of illness severity, restrictions on available time limiting access to services, difficulties with transportation, and once services are accessed, problems with communication (25).

Notification rates for Māori and non-Māori were similar. Rates were higher among females aged 30-39 years and 60-69 years. A possible explanation is that these women were more likely to be exposed to infection as a result of caring for preschoolers with VTEC/STEC. The reason for the high percentage of cases aged 50 years and over who were hospitalised is unknown but it may be that admissions were precipitated by the finding of blood in the stools warranting further investigation.

The increasing incidence of VTEC/STEC both nationally and in the South Island may be in part due to improved laboratory methods (11), although in the South Island the increased exposure to cattle as a consequence of the expansion of dairying may also be a significant factor. Rates in rural areas were three times those of urban areas, a finding consistent with a greater exposure to environments contaminated by farm animal faecal material. Studies overseas (20, 26, 27) and in New Zealand (9) have shown an association between exposure to cattle and VTEC/STEC, and the evidence presented in this report suggesting higher notification rates in areas with higher dairy cattle density is consistent with those findings. The risk from cattle (faeces) may be either directly, or indirectly by contamination of food or water.

Approximately 30 percent of notified cases consumed water from a source other than their usual supply and 26 percent were exposed to recreational water during the incubation time. Of interest, the New Zealand case-control study by Jaros and colleagues (9) did not identify food as a risk factor although it has been the cause of numerous outbreaks overseas (28). Consuming unpasteurised milk or milk products is also a known risk factor and between 2010-2014, 12 percent of New Zealand cases had this risk exposure (11), compared with 4 percent (11 cases, data not shown) for the C&PH region.

The relatively high rate of HUS in young children is of concern, with 18 (13% of notified cases) aged 1-4 years developing HUS in the C&PH region between 2000 and 2014. This equated to 9 percent of children aged 0-16 years, consistent with the national range of 8-10 percent (4) (no other age group was reported as having cases). Death or end stage renal disease occurs in about 12 percent of patients aged 1-18 years with diarrhoea-associated HUS, and 25 percent of survivors demonstrate long-term renal sequelae (29).

A feature of the seasonality of notifications evident in all South Island DHBs and nationally was the consistency of a sharp decline in July, also a finding in other studies (21, 22). It has been suggested that this pattern, with increases in the warmer months, may be related to increased environmental exposure (e.g. contact with contaminated water during recreational activities, farm visits, and agricultural activities), and/or seasonal variation in faecal shedding of VTEC/STEC in cattle (9, 22).

Documented outbreaks were uncommon in the South Island and those that did occur were small, with the largest involving only six people. However, due to a reporting aberration from 2000 to 2010 that did not recognise multiple household cases as outbreaks (23), 45 clusters involving two or more cases were not officially reported. A study in Wales also noted most secondary cases occurred in households, with an attack rate of between 4-15 percent (30). Large outbreaks are not common overseas but when they do occur due to contaminated food or water, have the potential to be devastating (31, 32).

In order to minimise the incidence of VTEC/STEC, notified cases should be thoroughly investigated by public health staff to identify and mitigate risks where possible. Water supplies, particularly public supplies, should be monitored to ensure compliance, and food at risk of being contaminated by VTEC/STEC bacteria should be monitored closely to ensure safety and quality assurance programmes are complied with. The rates of disease among young children pose an ongoing challenge for public health because reduction in incidence would require reducing the risks associated with animal contact and the rural environment in this age group. Hygiene messages, particularly to do with hand washing, should target caregivers to prevent not only illness in young children but also subsequent transmission to others.

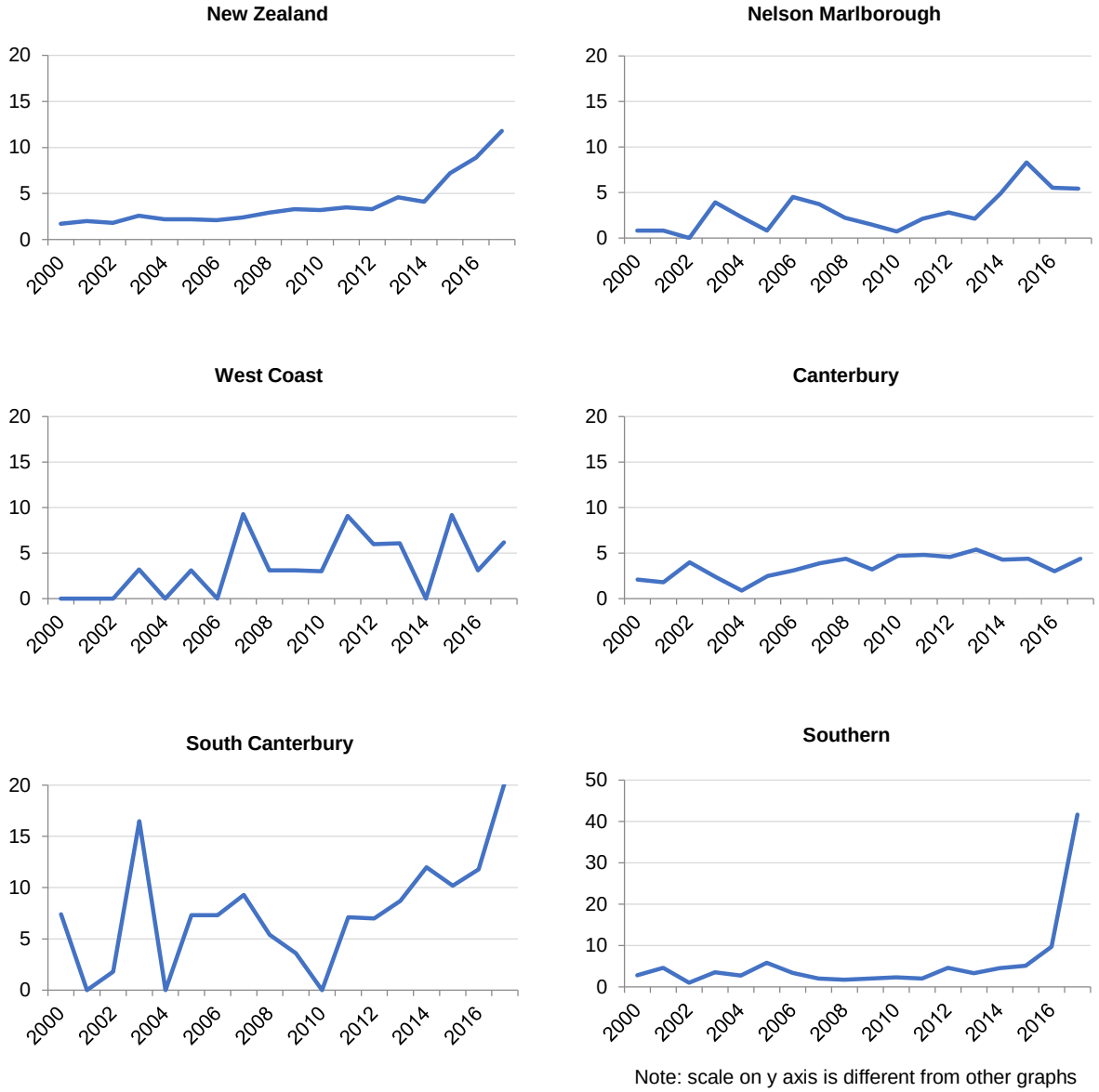
# Appendix

Updated May 2018

## Incidence 2015-2017

In the years 2015-2017 since the report was written there has been a significant increase in notifications in Southern and some North Island DHBs with the introduction of PCR testing. However, there has also been an increase in South Canterbury where PCR testing has not been introduced (**Figure 13**).

**Figure 13. Annual VTEC/STEC notification rates per 100,000 population for New Zealand and the South Island DHBs (2000-2017)**




Note: scale on y axis is different from other graphs

# References


1. Donnenberg MS. Enterobacteriaceae. In: Mandell GL, Dolin JE, Dolin R, editors. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases. Volume 51. 7th ed. Philadelphia, PA: Churchill Livingstone; 2009. p. 636-7.

2. ESR. Typed VTEC/STEC isolate data for 2012-2014. Porirua, New Zealand: Institute of Environmental Science and Research Ltd, 2015.

3. American Public Health Association. Control of Communicable Diseases Manual. 20th ed. Washington DC: APHA Press; 2015.

4. Ministry of Health. Communicable Disease Control Manual. Wellington, New Zealand: 2012.

5. Oliveira MG, Feitosa Brito JR, Carvalho RR, Guth BEC, Gomes TAT, Vieira MAM, et al. Water buffaloes (*Bubalus bubalis*) identified as an important reservoir of Shiga toxin-producing *Escherichia coli* in Brazil. Applied and Environmental Microbiology. 2007;73(18):5945-8.

6. Miko A, Pries K, Haby S, Steege K, Albrecht N, Krause G, et al. Assessment of Shiga toxin-producing *Escherichia coli* isolates from wildlife meat as potential pathogens for humans. Applied and Environmental Microbiology. 2009;75(20):6462-70.

7. Woodward DL, Clark CG, Caldeira RA, Ahmed R, Rodgers FG. Verotoxigenic *Escherichia coli* (VTEC): a major public health threat in Canada. The Canadian Journal of Infectious Diseases. 2002;13(5):321.

8. US Centers for Disease Control and Prevention. Outbreak of *Escherichia coli* O104:H4 infections associated with sprout consumption - Europe and North America, May-July 2011. Morbidity and Mortality Weekly Report. 2013;62(50):1029.

9. Jaros P, Cookson AL, Campbell DM, Besser TE, Shringi S, Mackereth GF, et al. A prospective case–control and molecular epidemiological study of human cases of Shiga toxin-producing *Escherichia coli* in New Zealand. BMC Infectious Disease. 2013;13(1):450.

10. Infectious and Notifiable Disease Order, S. 3 Schedule 1 of Health Act 1956, amended (2012).

11. ESR. Notifiable diseases in New Zealand: Annual report 2014. Porirua, New Zealand: Institute of Environmental Science and Research Ltd, 2015.

12. Statistics New Zealand. New Zealand: An urban/rural profile update. 2008.

13. Salmond C, Crampton P, Atkinson J. NZDep2006 Index of Deprivation: User's manual. Wellington, New Zealand: Department of Public Health, University of Otago, 2007.

14. Livestock Improvement Corporation Limited, DairyNZ Limited. New Zealand Dairy Statistics 2013-14. Hamilton, New Zealand: DairyNZ, 2014.

15. Statistics New Zealand. Geographic boundary files. 2015.

16. ESR. Notifiable diseases in New Zealand: Annual report 2013. Porirua, New Zealand: Institute of Environmental Science and Research Ltd, 2014.

17. ESR. Notifiable diseases in New Zealand: Annual report 2012. Porirua, New Zealand: Institute of Environmental Science and Research Ltd, 2013.

18. ESR. Notifiable diseases in New Zealand: Annual report 2011. Porirua, New Zealand: Institute of Environmental Science and Research Ltd, 2012.

19. Jalava K, Ollgren J, Eklund M, Siitonen A, Kuusi M. Agricultural, socioeconomic and environmental variables as risks for human verotoxigenic *Escherichia coli* (VTEC) infection in Finland. BMC Infectious Disease. 2011;11(1):275.

20. Kistemann T, Zimmer S, Vgsholm I, Andersson Y. GIS-supported investigation of human EHEC and cattle VTEC O157 infections in Sweden: Geographical distribution, spatial variation and possible risk factors. Epidemiology & Infection. 2004;132(3):495-505.

21. Vally H, Hall G, Dyda A, Raupach J, Knope K, Combs B, et al. Epidemiology of Shiga toxin producing *Escherichia coli* in Australia, 2000-2010. BMC Public Health. 2012;12:63.

22. Lal A, Hales S, French N, Baker MG. Seasonality in human zoonotic enteric diseases: a systematic review. PloS One. 2012;7(4):e31883.

23. ESR. Manual for Public Health Surveillance in New Zealand, Section C, Outbreak report form Porirua, New Zealand: Institute of Environmental Science and Research Ltd; 2010 [28 September 2015]. Available from: https://episurvsupport.esr.cri.nz/.

24. Community and Public Health Information Team. South Island pertussis: An analysis of notifications (2009-2013) and a review of incidence (1997-2013). Christchurch, New Zealand: Canterbury District Health Board, 2014.

25. Dixon A, Le Grand J, Henderson J, Murray R, Poteliakhoff E. Is the NHS equitable? A review of the evidence: LSE Health and Social Care, London School of Economics and Political Science; 2011.

26. Karama M, Johnson RP, Holtslander R, McEwen SA, Gyles CL. Prevalence and characterization of verotoxin-producing *Escherichia coli* (VTEC) in cattle from an Ontario abattoir. Canadian Journal of Veterinary Research. 2008;72(4):297.

27. European Centre for Disease Prevention and Control and European Food Safety Authority. Shiga toxin/verotoxin-producing *Escherichia coli* in humans, food and animals in the EU/EEA, with special reference to the German outbreak strain STEC O104. Stockholm: European Centre for Disease Prevention and Control 2011.

28. US Centers for Disease Control and Prevention. List of selected multistate foodborne outbreak investigations 2015 [cited 2015 2 October]. Available from: http://www.cdc.gov/foodsafety/outbreaks/multistate-outbreaks/outbreaks-list.html.

29. Garg AX, Suri RS, Barrowman N, Rehman F, Matsell D, Rosas-Arellano MP, et al. Long-term renal prognosis of diarrhea-associated hemolytic uremic syndrome. JAMA. 2003;290(10):1360.

30. Parry S. Sporadic STEC O157 infection: Secondary household transmission in Wales. Emerging Infectious Diseases. 1998;4(4):657-61.

31. Kriven S. Business risks from food poisoning in food processing: the Garibaldi case. Australasian Agribusiness Review. 1995;3:37-44.

32. Salvadori MI, Sontrop JM, Garg AX, Moist LM, Suri RS, Clark WF. Factors that led to the Walkerton tragedy. Kidney International. 2009;75:S33-S4.