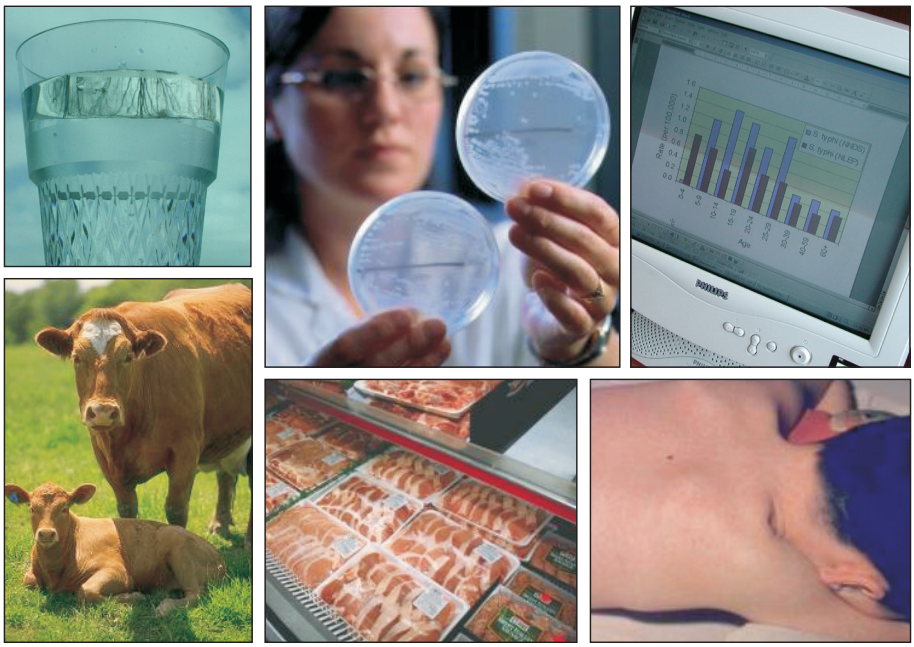
CCDR
Canada Communicable Disease Report
ISSN 1188-4169
Volume : 29S1 March 2003

Canadian Integrated Surveillance Report

Salmonella, *Campylobacter*, pathogenic *E. coli* and *Shigella*, from 1996 to 1999



Health Canada Santé Canada
Canada

Our mission is to help the people of Canada maintain and improve their health.

Health Canada

Suggested citation: Health Canada. *Canadian Integrated Surveillance Report:* ***Salmonella***, ***Campylobacter***, *pathogenic* ***E. coli*** *and* ***Shigella***, *from 1996 to 1999.* CCDR 2003;29S1

This publication was produced by the Scientific Publication and Multimedia Services Section of the Business Integration and Information Services Directorate, Health Canada.

To obtain additional copies or subscribe to the Canada Communicable Disease Report, please contact the Member Service Centre, Canadian Medical Association, 1867 Alta Vista Drive, Ottawa, ON, Canada K1G 3Y6.

Tel.: (613) 731-8610 ext. 2307 or 888-855-2555
Fax: (613) 236-8864.

This publication can also be accessed electronically via Internet using a web browser at <http://www.hc-sc.gc.ca/pphb-dgspsp>.

Canadian Integrated Surveillance Report: *Salmonella*, *Campylobacter*, pathogenic *E. coli* and *Shigella*, from 1996 to 1999

Prepared by Cara Bowman, James Flint and Frank Pollari
Division of Enteric, Foodborne and Waterborne Diseases
Centre for Infectious Disease Prevention and Control
Population and Public Health Branch
Health Canada

Canadian Integrated Surveillance Report: *Salmonella*, *Campylobacter*, pathogenic *E. coli* and *Shigella*, from 1996 to 1999

Background

Participants at the National Consensus Conference on Foodborne, Waterborne and Enteric Disease Surveillance, held in Ottawa, November 1995, recommended the development of a report showing trends in enteric disease in Canada. Another of their recommendations – a survey of local, provincial/territorial, federal, industry and academic stakeholders – was conducted in 1997 to identify the information needs and format preferences of these stakeholders for such a report. The results of that survey were used to develop the first integrated report, which covered *Salmonella*, *Campylobacter* and pathogenic *E. coli*, for 1995. Except for outbreak events, the changes in enteric disease incidence are gradual and become more evident when data are compared across multiple years. Therefore, the current report covers data for the subsequent 4 years, 1996 to1999.

The databases used to prepare this report were developed for different reasons and contain different data elements (see the Appendix for details). In general, notification of a case of enteric disease is initiated with the laboratory confirmation of a notifiable agent. The local public health unit is informed of the case by the laboratory or physician and through subsequent follow-up acquires detailed information about the patient and the potential risk factors. These data form the basis of reports in the National Notifiable Diseases Summary (NNDS) dataset and the National Notifiable Diseases Individual Case (NNDI) dataset. Local and regional laboratories forward some enteric pathogens to provincial/territorial laboratories for confirmation and identification. Provincial/territorial laboratories send summary information from cases associated with these isolates to the National Enteric Surveillance Program (NESP). As well, they send some isolates to the National Laboratory for Enteric Pathogens (NLEP) for identification and additional subtyping. Isolates from non-human sources (food, animals and the environment) are sent to the Laboratory for Foodborne Zoonoses (LFZ) for subtyping and confirmation. An additional source of data is the Discharge Abstract Database (DAD) from the Canadian Institute for Health Informatics (CIHI), which contains data about hospital admissions from across the nation. Thus, each database provides a unique perspective on enteric diseases in Canada.

This report uses all of these databases to describe agents, cases and outbreaks related to the top four enteric bacterial groups reported in Canada – *Salmonella*, *Campylobacter*, pathogenic *Escherichia coli* and *Shigella*. These data, from passive surveillance systems and a medical records abstract system, represent the best national data held in Canada for enteric disease. However, as each system has inherent limitations, the data should be interpreted with these limitations in mind (see Appendix for more information).

Although the main focus of this document is to describe disease trends over time and geographic area, comparisons among the main surveillance systems collecting similar data have been highlighted. For instance, the rates of infection with *Salmonella* are quite similar whether reported as National Notifiable Diseases data or as laboratory based data (NLEP/NESP). For *Campylobacter* infections, however, the rates can be quite different depending on the data source and the province/territory. No single data source is adequate to describe all the

various aspects of enteric disease in Canada. By combining the interpretation of these data sets, this document provides a comprehensive overview of enteric disease as well as an indication of which data source would be the most useful for answering particular questions about the occurrence of enteric diseases in Canada.

Any comments concerning this report should be directed to the authors at the address listed on the title page.

Acknowledgements

This document would not have been possible without the dedication and hard work of many medical, public health and scientific personnel from across Canada. Local inspectors, public and private health care workers, and public and private laboratory personnel collected the initial samples and data. Provincial, territorial and federal personnel ensured that the samples and data were managed appropriately for inclusion in the national databases. For their valuable input the authors would especially like to thank the personnel from the National Laboratory for Enteric Pathogens, National Science Centre, Winnipeg; the Laboratory for Foodborne Zoonoses – Guelph; and the Centre for Infectious Disease Prevention and Control.

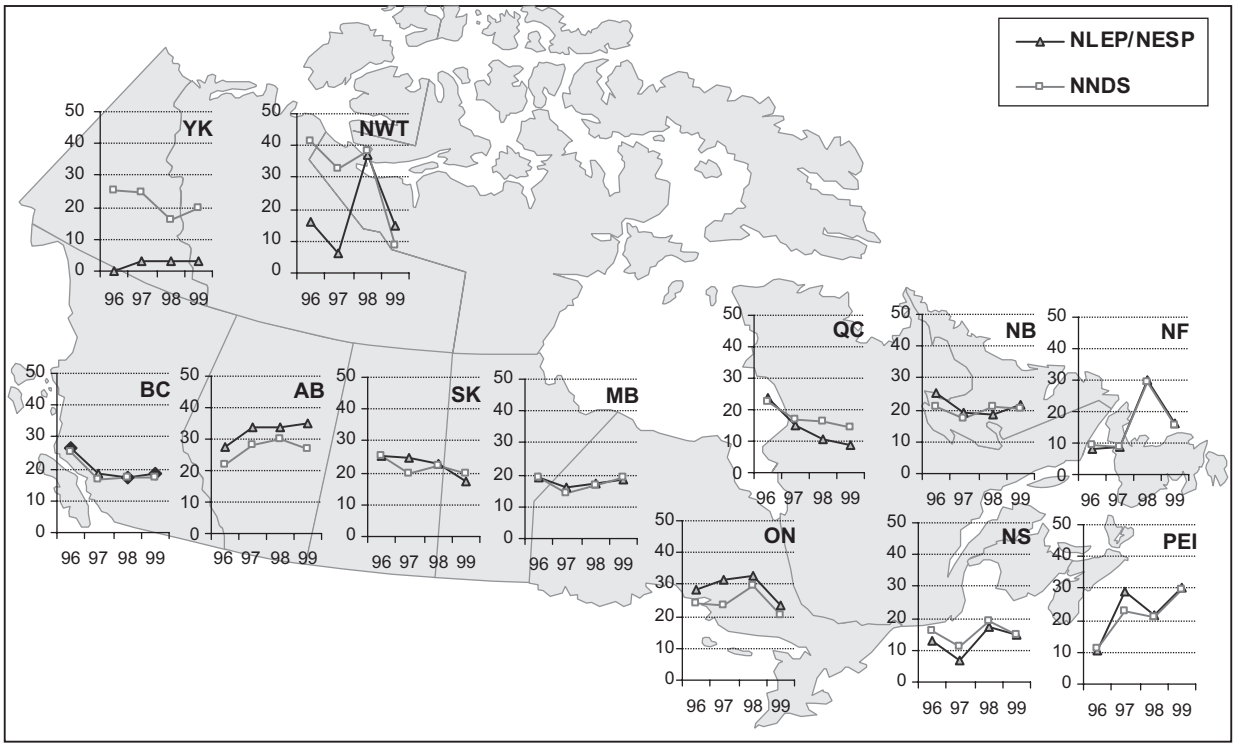
Table of Contents

Human Salmonellosis Cases

The number of human salmonellosis cases reported through the National Notifiable Diseases database decreased overall from 1996 to 1999 (6,650, 6,076, 7,149 and 5,724 cases respectively). A similar trend was seen in data reported by the National Laboratory for Enteric Pathogens and the National Enteric Surveillance Program (NLEP/NESP), although the total number of cases was higher in all 4 years (7,513, 7,063, 7,186 and 5,952 respectively). The NLEP/NESP database reflects information from two sources: the NLEP database (for 1996-1997 data) and the NESP database (for 1998-1999 data).

A comparison of salmonellosis rates between the National Notifiable Diseases Summary (NNDS) and NLEP/NESP by province/territory is shown in Figure 1. For *Salmonella*, there was relatively little variation between the two databases, with the exception of the Northwest Territories and the Yukon. This level of agreement was expected, given the high frequency with which local laboratories forward *Salmonella*

Figure 1: Rates of human salmonellosis (per 100,000 people) as reported through the National Notifiable Diseases Summary (NNDS) program and the National Laboratory for Enteric Pathogens and National Enteric Surveillance Program (NLEP/NESP) by province/territory, 1996 to 1999



Note: The NNDS database is considered the gold standard, as provincial/territorial legislation requires local laboratories or physicians to report specific diseases to a local health unit, which in turn reports via the province/territory to the NNDS database. However, the NNDS data do not contain the results of characterization beyond species. For cases included in the NLEP/NESP database, isolates are voluntarily forwarded from local laboratories to the provincial/territorial laboratory, and then the isolates (or data) are sent to the NLEP or NESP (see Appendix).

isolates to their provincial/territorial laboratory for serotyping. There was, however, no consistency in trends across provinces/territories or regions.

Top 10 Serovars

The top 10 serovars from human cases reported to the NLEP/NESP database from 1995 to 1999 are listed in Table 1. With one exception in 1998, the order of the four most common serovars remained unchanged over this period. *S.* Meleagridis, *S.* Brandenburg, *S.* 4,5,12:i:- ssp. I and *S.* Paratyphi B var. Java all placed among the top 10 serovars once during this period. *S.* Infantis was the only serovar that increased in rank consistently over the 5 years. The fluctuation of *S.* Newport over this period was related to an outbreak in 1996.

Emerging Serovars

Serovars that increased in number in all 4 years or in 3 out of 4 years are listed in Table 2. *S.* Oranienburg increased consistently over the whole period, from 31 cases in 1996 to 75 in 1999.

Long-term Trends

From 1990 to 1999 there was a slight overall decline in the number of *Salmonella* cases (Figure 2). Long-term trends of the most common *Salmonella* serovars are shown in Figures 3 to 6 (note the different scales used). One of the more prominent trends is seen in the continued decline of *S.* Hadar (Figure 4). The prominent 1996 peak in *S.* Newport was due to a large outbreak associated with alfalfa sprouts (Figure 5).

Table 1: Top 10 *Salmonella* serovars (number) from human cases reported from 1995 to 1999

	1995†	1996†	1997†	1998‡	1999‡
1	*S.* Typhimurium (1,366)	*S.* Typhimurium (1,755)	*S.* Typhimurium (1,568)	*S.* Enteritidis[3] (1,593)	*S.* Typhimurium (1,393)
2	*S.* Enteritidis (964)	*S.* Enteritidis (1,275)	*S.* Enteritidis (1,233)	*S.* Typhimurium (1,578)	*S.* Enteritidis (814)
3	*S.* Heidelberg (670)	*S.* Heidelberg (676)	*S.* Heidelberg (868)	*S.* Heidelberg (1,038)	*S.* Heidelberg (811)
4	*S.* Hadar (597)	*S.* Hadar (347)	*S.* Hadar (382)	*S.* Hadar (434)	*S.* Hadar (239)
5	*S.* Thompson (286)	*S.* Newport[1] (291)	*S.* Thompson (371)	*S.* Thompson (197)	*S.* Infantis (191)
6	*S.* Agona (166)	*S.* Thompson (232)	*S.* Agona (158)	*S.* Agona (149)	*S.* Thompson (191)
7	*S.* Newport (127)	*S.* Agona (174)	*S.* Infantis (129)	*S.* Infantis (127)	*S.* Newport (162)
8	*S.* Typhi (120)	*S.* Typhi (90)	*S.* Typhi (128)	*S.* Typhi (92)	*S.* Agona (149)
9	*S.* Infantis (114)	*S.* Infantis (81)	*S.* Newport (109)	*S.* Brandenburg (86)	*S.* 4,5,12:i:- ssp. I[4] (123)
10	*S.* Saintpaul (104)	*S.* Saintpaul (78)	*S.* Meleagridis[2] (108)	*S.* Newport (84)	*S.*Paratyphi B var. Java (101)

† NLEP data; ‡ NESP data

1 An *S.* Newport outbreak associated with alfalfa sprouts was noted in 1996.

2 An *S.* Meleagridis outbreak associated with alfalfa sprouts and seeds was noted in 1997.

3 An *S.* Enteritidis outbreak associated with a children's lunch product was noted in 1998.

4 An *S.* 4,5,12:i:-ssp.I outbreak associated with a community centre dinner was noted in 1999.

Table 2: *Salmonella* serovars showing an increase in reporting frequency, 1996 to1999

Serovar	1996 count†	1997 count†	1998 count‡	1999 count‡
S. 4,5,12:b:-	0	1	17	32
S. 4,5,12:i:-[1]	0	0	40	123
S. 6,7:-:1,5[2]	0	0	2	13
S. Brandenburg	56	67	86	45
S. Derby	24	30	41	29
S. Hartford	6	19	83	9
S. Kentucky	7	7	10	12
S. Manhattan	8	9	10	4
S. Muenster	6	12	16	8
S. Oranienburg	31	33	66	75
S. Virchow	27	33	34	19

†Data from NLEP; ‡Data from NESP

1 The increase in *S.* 4,5,12:i:- parallels a worldwide increase in this monophasic variant.

2 As of the end of 1997, *S.* 6,7:-:1,5 had no records in the NLEP database, thus the increase observed may in part be the result of differences in reporting patterns between the NLEP and NESP systems.

Figure 2: *Salmonella* cases from 1990 to 1999

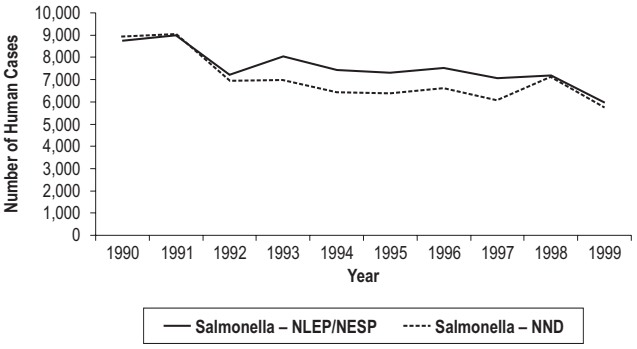
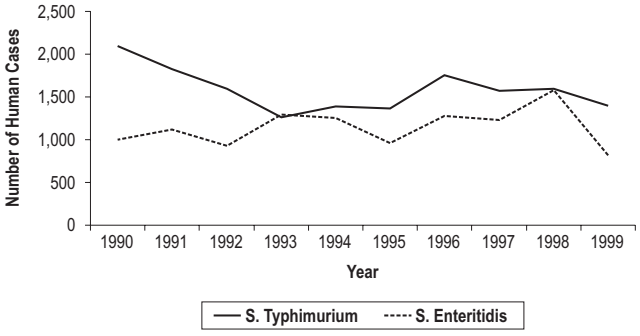
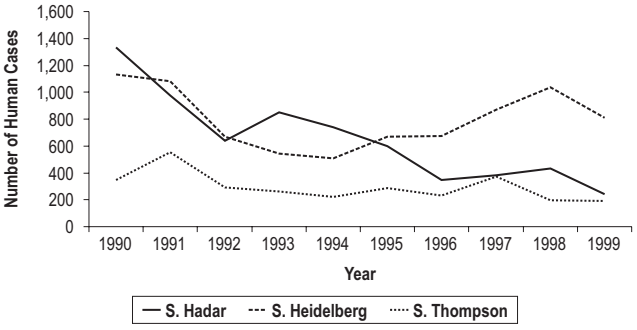


Figure 3: *S.* Typhimurium and *S.* Enteritidis cases from 1990 to 1999



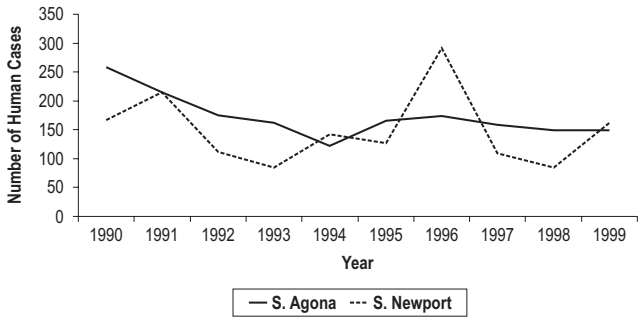
Data from NLEP and NESP

Figure 4: *S.* Hadar, *S.* Heidelburg and *S.* Thompson cases from 1990 to 1999



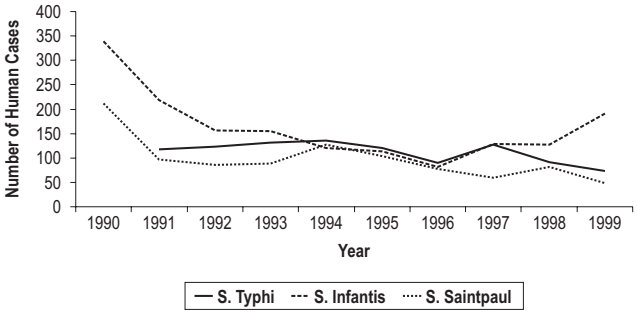
Data from NLEP and NESP

Figure 5: *S.* Agona and *S.* Newport cases from 1990 to 1999



Data from NLEP and NESP

Figure 6: *S.* Typhi, *S.* Infantis and *S.* Saintpaul cases from 1990 to 1999

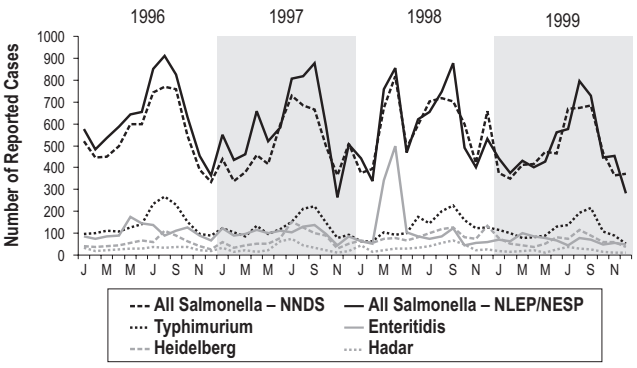


Data from NLEP and NESP

Monthly and Provincial/Territorial Trends

Distinct seasonal trends can be seen when the overall number of *Salmonella* cases are plotted by month, and the patterns are very similar in both NNDS and NLEP/NESP data (Figure 7). Consistent peaks were noted in the months of July through October and smaller peaks in the months of January and February. These winter peaks may be associated with travel-acquired infections. An especially noticeable peak in January 1997 coincided with increases in several serovars.

Figure 7: *Salmonella* reports by month, 1996 to 1999

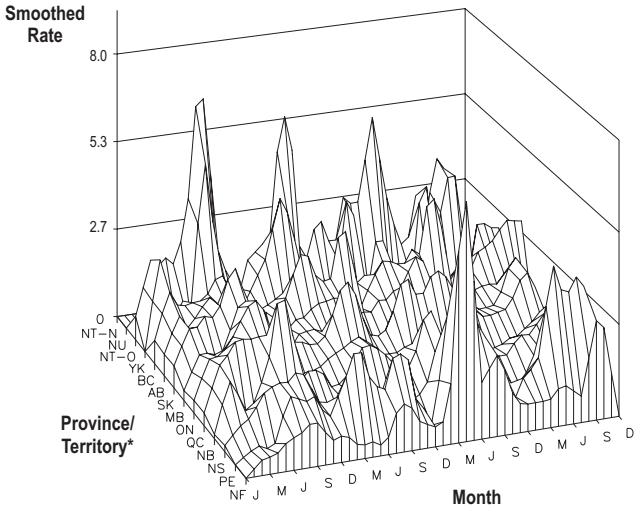


Data from NNDS, NLEP and NESP

Other prominent peaks represent some of the larger outbreaks that occurred during this time frame. An outbreak of *S.* Newport infections associated with alfalfa sprouts occurred in January 1996[1,2]. An outbreak associated with *S.* Thompson from roast beef occurred in April 1997[3]. A second outbreak associated with alfalfa sprouts, this time involving *S.* Meleagridis, peaked in December 1997[4]. The largest outbreak that occurred over the reporting period was national in scope and associated with *S.* Enteritidis in a pre-packaged lunch product[5-7]. In December 1998, *S.* Heidelberg in turkey and ham was associated with an outbreak[3]. Of the top four serovars, only *S.* Typhimurium and *S.* Heidelberg show strong seasonal trends.

The rate of *Salmonella* infections by month and province/territory shows that the seasonality of infection is still present, although less discernable (Figure 8). Additionally, no prominent regional variation is evident. The large summer peaks noted in the territories are, at least partially, an artifact of the small population bases.

Figure 8: *Salmonella* cases by province/territory, 1996 to 1999, rate per 100,000 population



Data from NNDS

* NT-N = Northwest Territories after creation of Nunavut;
NT-O = Northwest Territories before creation of Nunavut.

Figures 9 to 12 show the annual rate in each province/territory from 1996 to 1999 for the main human serovars. Considerable variation within and among provinces/territories can be noted for all serovars.

Figure 9: *S.* Typhimurium cases 1996 to 1999, rate per 100,000 population

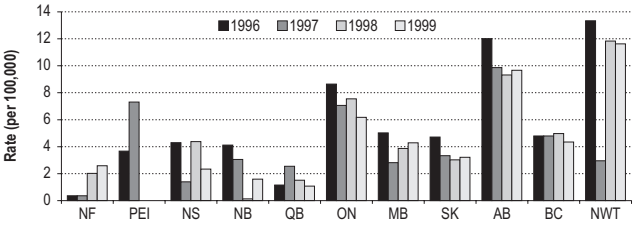
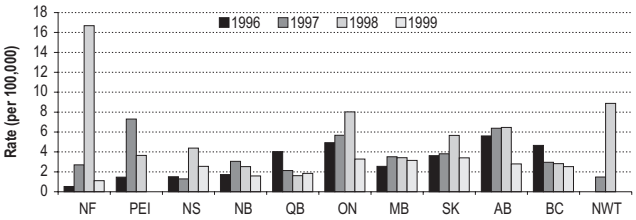


Figure 10: *S.* Enteritidis cases 1996 to 1999, rate per 100,000 population



Note: A *Salmonella* Enteritidis outbreak associated with a children's lunch product was noted in 1998.

Figure 11: *S.* Heidelberg cases 1996 to 1999, rate per 100,000 population

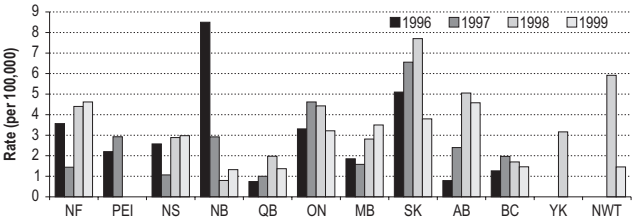
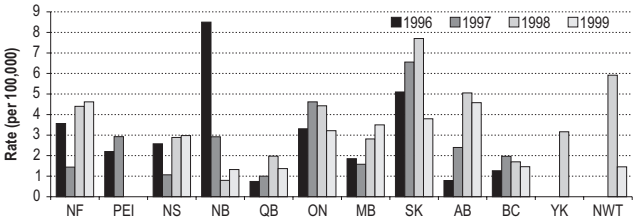


Figure 12: *S.* Hadar cases 1996 to 1999, rate per 100,000 population



S. Typhi and *S.* Paratyphi

The numbers of *S.* Paratyphi (includes *S.* Paratyphi A, B and C) and *S.* Typhi infections from 1996 to 1999 are shown in Table 3. The number of cases recorded in the NLEP/NESP database was consistently higher than in the NNDS database.

The increase in the number of *S.* Typhi noted in 1997 (NLEP/NESP) was primarily due to increases in the number of cases reported from Quebec (10 cases in 1996 to 18 cases in 1997) and Ontario (31 cases in 1996 to 60 cases in 1997). The increase in the average number of *S.* Typhi cases reported in the NNDS database from 1996/1997 to 1998/1999 was primarily due to increases in the number of cases reported by Ontario and British Columbia.

All of these cases are likely travel related, but travel histories were recorded for only 13 and 6 cases infected with *S.* Typhi in the NESP and National Notifiable Diseases Individual Case (NNDI) databases respectively. All but one of these cases travelled to Asia (India, Bangladesh, Pakistan, Indonesia or Thailand); the country implicated in the other was Mexico. For *S.* Paratyphi, three of the four cases with travel information in the NESP database went to Asia and one to South America. Only two *S.* Paratyphi cases in the NNDI database had travel information recorded; India and Pakistan were the countries identified.

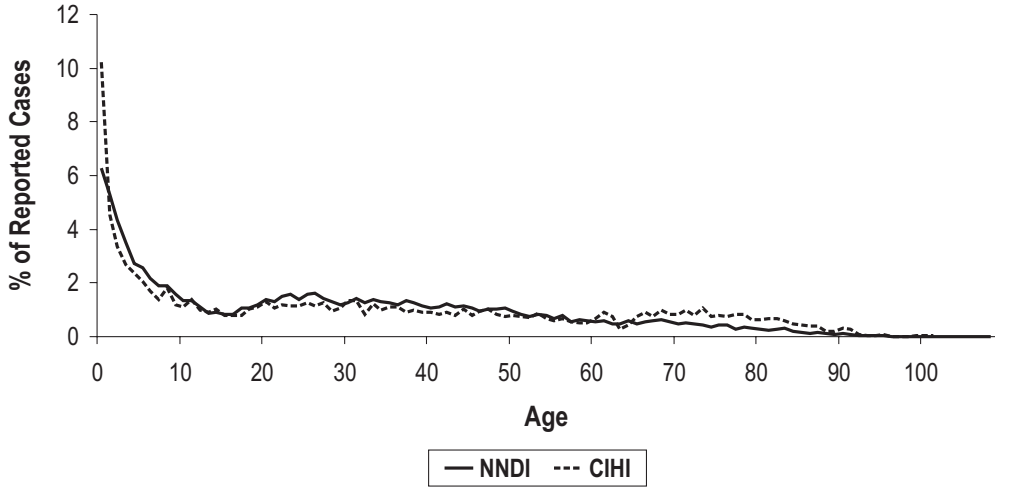
Table 3: Cases of *S.* Paratyphi and *S.* Typhi reported in the NLEP/NESP and NNDS databases from 1996 to 1999

		1996	1997	1998	1999
***S.* Paratyphi**	*NLEP/NESP*	48	38	44	52
	NNDS	22	14	27	37
***S.* Typhi**	*NLEP/NESP*	90	128	92	73
	NNDS	41	47	82	71

Age Distribution

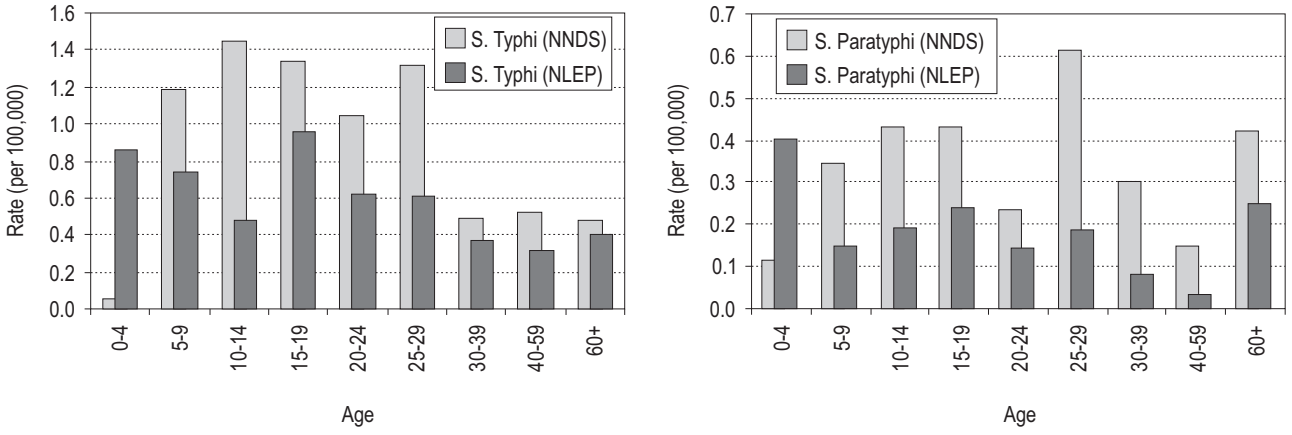
The percentage of *Salmonella* cases by age group is shown in Figure 13. Infants and young children have the highest percentage of reported cases. The age distribution for hospitalized cases (according to the Canadian Institute for Health Information [CIHI]) was markedly higher in the very young when compared with cases overall (as indicated by the NNDI database).

Figure 13: Human *Salmonella* isolates – frequency of reporting by age and data source, 1996 to 1999



For *S.* Typhi and *S.* Paratyphi, the age distribution is skewed towards the older age categories, reflecting the fact that the vast majority of these cases are acquired during travel in developing countries (Figure 14).

Figure 14: Rate (per 100,00 population) of *S.* Typhi and *S.* Paratyphi cases by age[†], 1996 to 1999



[†] Note: NLEP data are for 1996 and 1997 only.

Selected Phage Types

The proportion and number of the top four serovars that were phage typed, from human and non-human sources, are presented in Table 4. Consideration should be given to the proportion of individual serovars typed when comparing the human and non-human phage types depicted in Figures 15 to 18. Few similarities were noted between human and non-human phage types. For *S.* Heidelberg, differences in typing schemes among the laboratories testing human and non-human isolates prevent direct comparisons being made between sources.

Table 4: Proportion (number) of the top four *Salmonella* serovars that were typed, 1996 to 1999

Serovars from human sources: proportion (number) with phage type reported (NLEP data)				
	1996	**1997**	**1998**	**1999**
S. Typhimurium	20% (354)	82% (1,291)	91% (1,436)	98% (1,365)
S. Enteritidis	81% (1,028)	61% (751)	45% (722)	64% (524)
S. Heidelberg	14% (98)	25% (214)	46% (481)	33% (267)
S. Hadar	9% (32)	13% (51)	8% (35)	20% (47)
Serovars from non-human sources: proportion (number) with phage type reported (LFZ* data)				
	1996	**1997**	**1998**	**1999**
S. Typhimurium	62% (183)	97% (606)	100% (262)	100% (241)
S. Enteritidis	94% (127)	99% (171)	100% (133)	100% (30)
S. Heidelberg	82% (405)	98% (637)	100% (734)	100% (1,075)
S. Hadar	85% (105)	97% (149)	100% (79)	100% (57)

Note: there is good national representation for isolates from human sources; however, certain regions and industries are over-represented in the non-human database and thus may not be as representative as the human database (see Appendix for more information).

* Laboratory for Foodborne Zoonoses

Figure 15: Proportion of *S.* Typhimurium phage types from human and non-human sources, 1996 to 1999

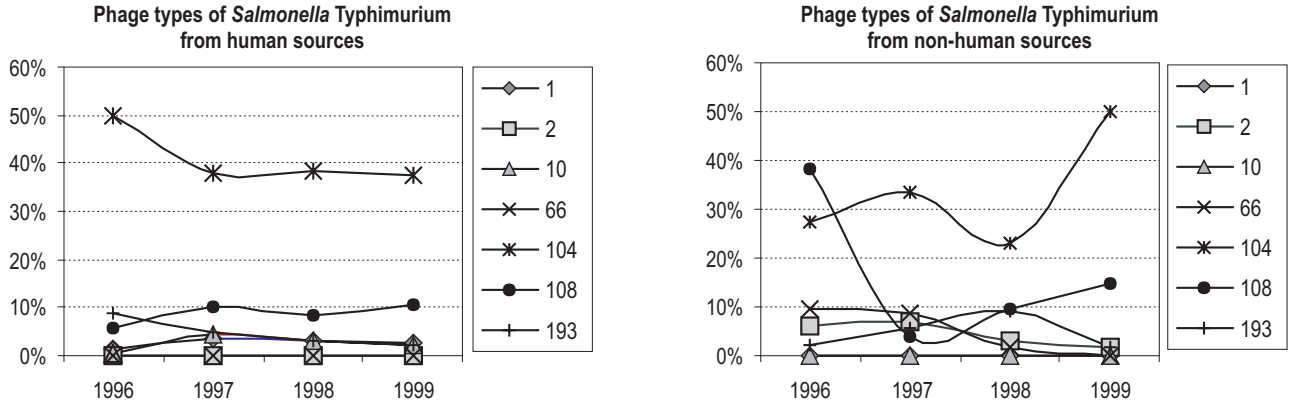


Figure 16: Proportion of *S.* Enteritidis phage types from human and non-human sources, 1996 to 1999

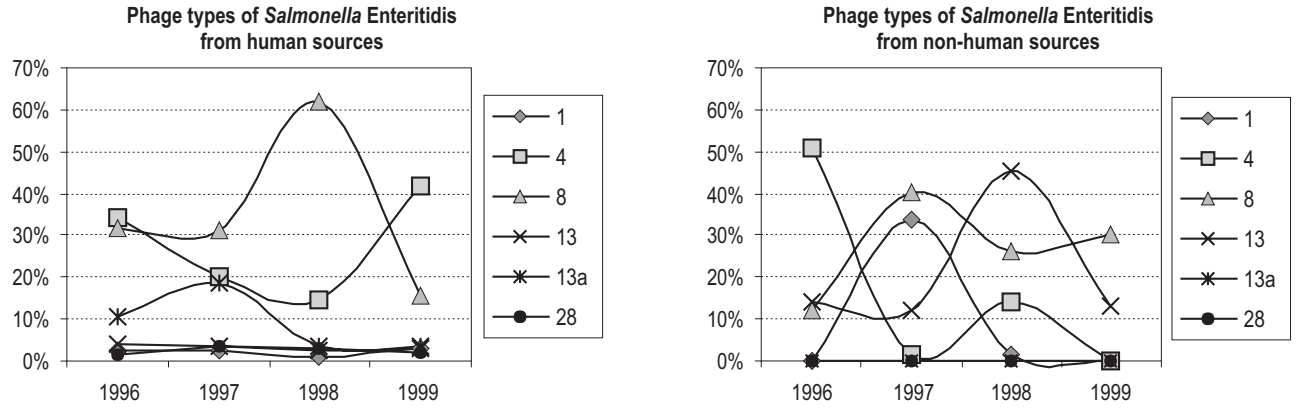
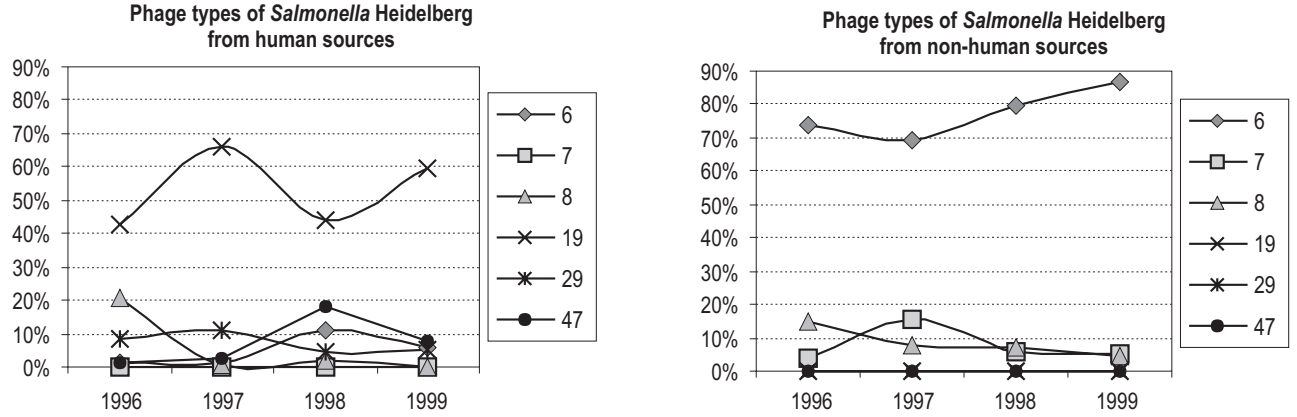
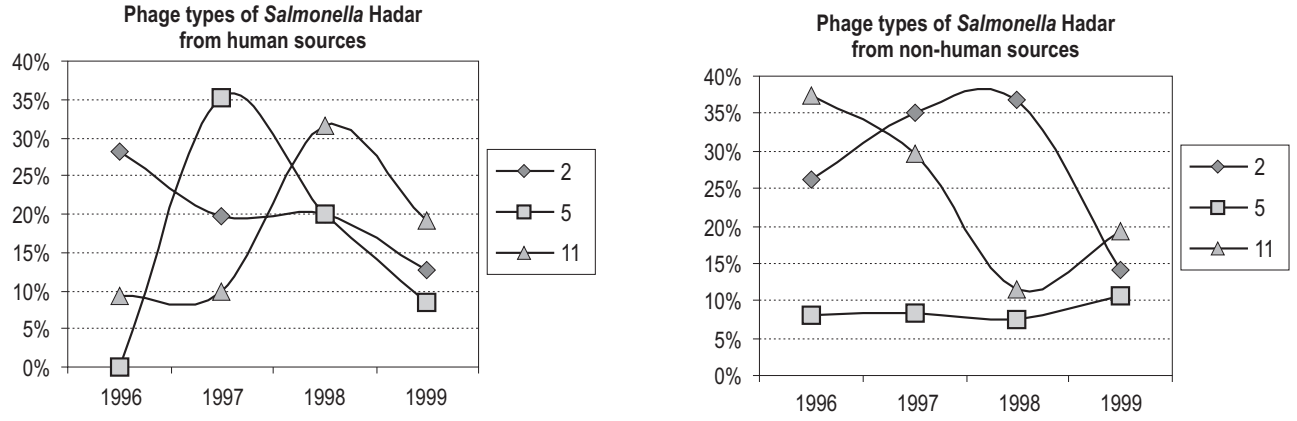


Figure 17: Proportion of *S.* Heidelberg phage types from human and non-human sources, 1996 to 1999



Note: different phage typing schemes were used for *S.* Heidelberg isolates from human and non-human sources

Figure 18: Proportion of *S.* Hadar phage types from human and non-human sources, 1996 to 1999



Salmonella Isolates from Non-human Sources

There were 1,727, 2,591, 2,690 and 3,351 *Salmonella* isolates from non-human sources sent to the LFZ from 1996 to 1999 respectively (these numbers exclude quality assurance and research isolates). The number of *Salmonella* isolates by province and year is shown in Table 5.

Table 5: Number of non-human *Salmonella* isolates per province from 1996 to 1999 (LFZ data)

	1996	1997	1998	1999
NF	15	20	101	109
PE	2	7	20	23
NS	15	26	49	84
NB	19	42	55	97
QC	431	562	453	505
ON	1,119	1,366	1,946	2,367
MB	18	57	24	62
SK	6	180	13	38
AB	59	218	17	42
BC	24	102	12	24
Foreign	19	11	0	0

Top 10 Serovars

The top 10 *Salmonella* serovars from non-human sources reported between 1995 and 1999 are listed in Table 6. With the exception of *S.* Heidelberg and *S.* Typhimurium, the order of the individual serovars fluctuated considerably from year to year. *S.* Hadar consistently declined over this period. At least four of the top 10 serovars from human cases were represented in the top 10 serovars from non-human sources for each year.

Emerging Serovars

Table 7 shows emerging *Salmonella* serovars from non-human sources from 1996 to 1999. *S.* Berta and *S.* Rough-O:r:1,2 ssp. I (probably a variant of *S.* Heidelberg) increased consecutively over all 4 years while the remaining serovars increased for 3 of the 4 years.

Table 6: Top 10 *Salmonella* serovars (number) from non-human sources reported from 1995 to 1999*

	1995†	1996†	1997†	1998‡	1999‡
1	***S.* Heidelberg** (522)	***S.* Heidelberg** (492)	***S.* Typhimurium**[a] (756)	***S.* Heidelberg** (734)	***S.* Heidelberg** (1,075)
2	***S.* Typhimurium** (273)	***S.* Typhimurium** (316)	***S.* Heidelberg** (643)	***S.* Typhimurium**[b] (341)	***S.* Typhimurium**[c] (357)
3	***S.* Hadar** (254)	***S.* Enteritidis** (135)	*S.* Mbandaka (268)	*S.* Tennessee (136)	***S.* Infantis** (165)
4	*S.* Anatum (171)	***S.* Hadar** (123)	***S.* Enteritidis** (172)	***S.* Enteritidis** (133)	*S.* Kentucky (151)
5	*S.* Kentucky (139)	*S.* Brandenburg (118)	***S.* Hadar** (153)	*S.* Kentucky (127)	*S.* Mbandaka (119)
6	*S.* Muenster (90)	*S.* Mbandaka (99)	***S.* Agona** (122)	*S.* Muenster (110)	***S.* Agona** (109)
7	*S.* Schwarzengrund (83)	***S.* Infantis** (92)	*S.* Kentucky (87)	*S.* Senftenberg (93)	*S.* Braenderup (96)
8	*S.* Senftenberg (71)	*S.* Kentucky (88)	*S.* Brandenburg (67)	*S.* Mbandaka (87)	*S.* Brandenburg (94)
9	***S.* Thompson** (67)	*S.* Braenderup (67)	***S.* Thompson** (63)	***S.* Hadar** (79)	*S.* Muenster (83)
10	***S.* Agona** (61)	*S.* Derby (62)	*S.* Senftenberg (59)	***S.* Agona** (72)	*S.* Schwarzengrund (83)

*Bold indicates that the serovar was also in the top 10 from human cases that year.
† LFZ/NLEP data; ‡ LFZ data (excluding quality assurance and research isolates)
[a] In 1997, 134 of the 756 *S.* Typhimurium were var. Copenhagen.
[b] In 1998, 79 of the 341 *S.* Typhimurium were var. Copenhagen.
[c] In 1999, 116 of the 357 *S.* Typhimurium were var. Copenhagen.

Table 7: Number of *Salmonella* serovars from non-human sources showing an increase in reporting frequency, 1996 to 1999

Serovar	1996 Count†	1997 Count†	1998 Count‡	1999 Count‡
S. Anatum var. 15+	23	15	36	56
S. Berta	5	9	15	19
S. Rough-O:r:1,2 ssp. I	34	39	48	63
S. Livingstone	6	11	29	11
S. Muenster	20	30	110	83
S. Schwarzengrund	28	25	41	83
S. Tennessee	15	26	136	58
S. Worthington	10	9	17	60

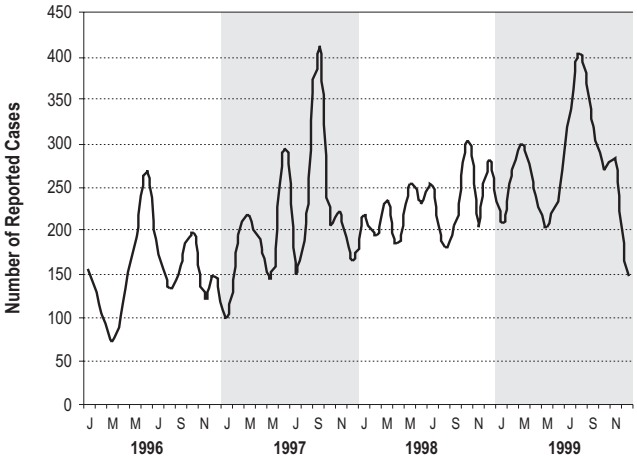
† LFZ/NLEP data; ‡ LFZ data (excluding quality assurance and research isolates)

Monthly and Provincial/Territorial Trends

The seasonal distribution of *Salmonella* isolates from non-human sources is shown in Figure 19. Multiple peaks were seen in all years.

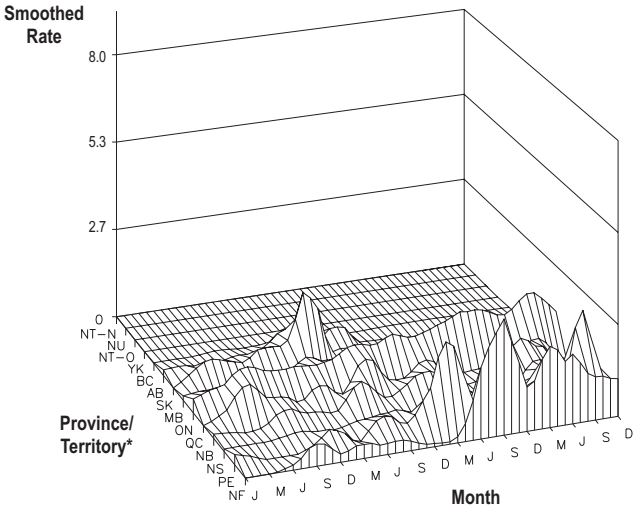
The distribution of non-human *Salmonella* isolates by month and province/territory is shown in Figure 20. As no true denominator for non-human isolates was available, the human population of each province/territory was used as a proxy. The rates presented are thus only valuable for identifying patterns over time within provinces/territories and for occurrence (but not rate) across provinces/territories.

Figure 19: *Salmonella* isolates from non-human sources by month, 1996 to 1999, LFZ



Note: Upward trend may be due to increased sampling by LFZ rather than a rise in incidence.

Figure 20: All *Salmonella* isolates from non-human sources by province/territory, 1996 to 1999, rate per 100,000 population



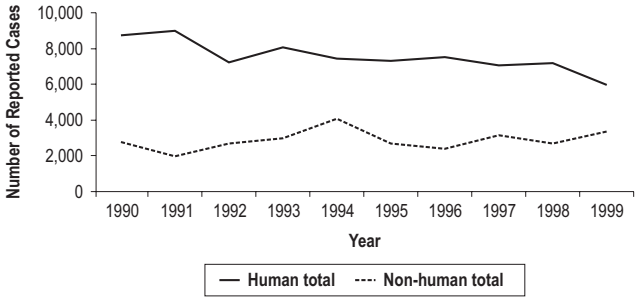
Data from LFZ

* NT-N = Northwest Territories after creation of Nunavut;
NT-O = Northwest Territories before creation of Nunavut.

Trends in the Number of *Salmonella* Isolates from Human and Non-human Sources

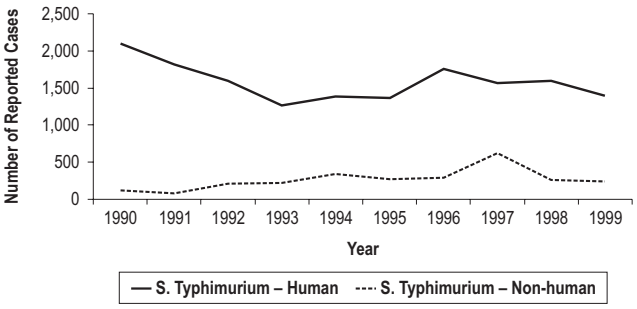
Comparisons between human and non-human *Salmonella* isolates from 1990 to 1999 are shown in Figure 21. Although there is a slight overall decline in the number of human *Salmonella* cases, the number of non-human isolates held relatively steady over the same period. Comparisons by serovar are shown in Figures 22 to 25.

Figure 21: Human and non-human counts of *Salmonella*, 1990 to 1999



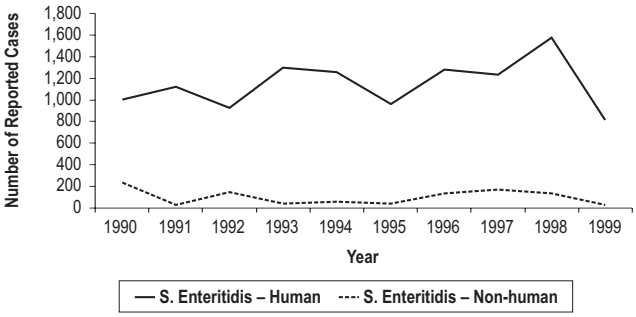
Data from NLEP, NESP and LFZ

Figure 22: *S.* Typhimurium isolates from human and non-human sources, 1990 to 1999



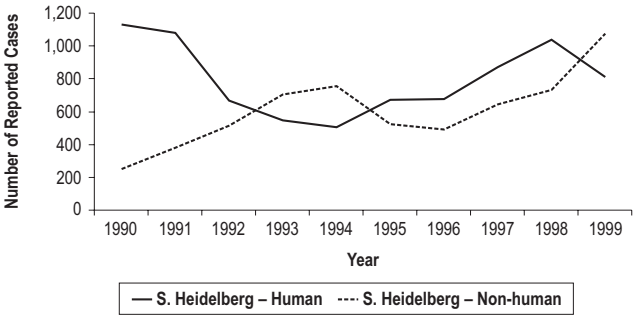
Data from NLEP, NESP and LFZ

Figure 23: *S.* Enteritidis isolates from human and non-human sources, 1990 to 1999



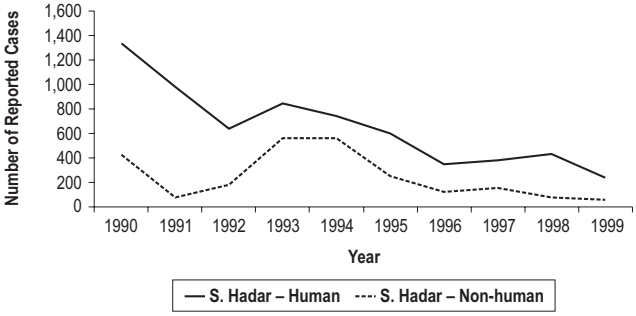
Data from NLEP, NESP and LFZ

Figure 24: *S.* Heidelberg isolates from human and non-human sources, 1990 to 1999



Data from NLEP, NESP and LFZ

Figure 25: *S.* Hadar isolates from human and non-human sources, 1990 to 1999

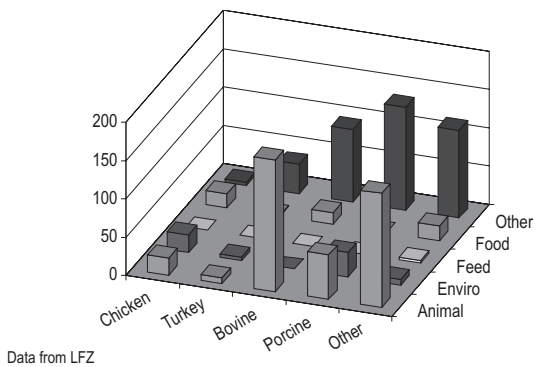


Data from NLEP, NESP and LFZ

Non-human Isolate Sources

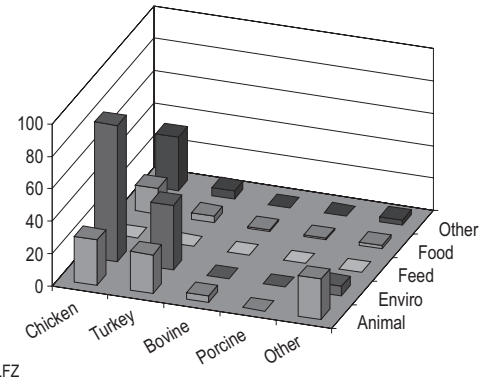
The source of non-human *S.* Typhimurium, *S.* Enteritidis, *S.* Heidelberg and *S.* Hadar isolates is summarized in Figures 26 to 29. If the "species of origin" or "source" was not indicated or did not fit into one of the listed categories, it was classified as "other". *S.* Enteritidis, *S.* Heidelberg and *S.* Hadar were almost exclusively isolated from poultry (chickens and turkeys), the majority of isolates coming from animal, environmental or food sources.

Figure 26: Source of *S.* Typhimurium isolates from non-human sources, 1996 to 1999



Data from LFZ

Figure 27: Source of *S.* Hadar isolates from non-human sources, 1996 to 1999



Data from LFZ

Figure 28: Source of *S.* Heidelberg isolates from non-human sources, 1996 to 1999

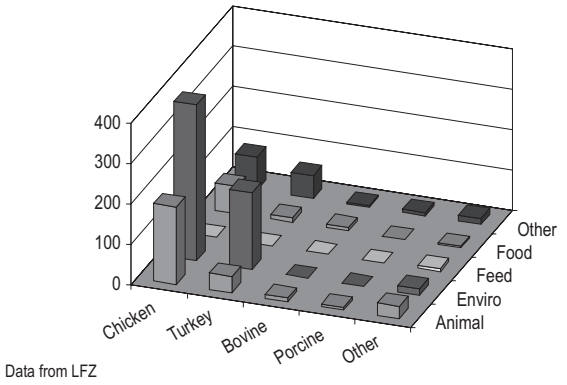
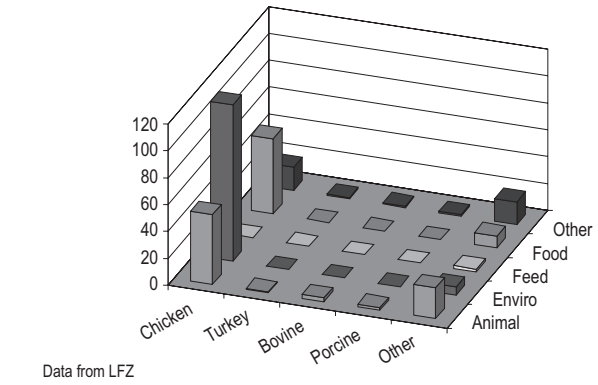


Figure 29: Source of *S.* Enteritidis isolates from non-human sources, 1996 to 1999



Pets as a Reservoir for *Salmonella*

S. Typhimurium was the most common serovar isolated from pets (Table 8), and the majority of these were isolated from birds.

Horses were the second most common source of *Salmonella* isolates from pets. *S.* Typhimurium made up 60% of all *Salmonella* isolates from pets.

Table 8. *Salmonella* serovars isolated from pets: LFZ data, 1996 to 1999

Serovar	Birds	Cats	Dogs	Horses	Other Warm Blooded	Cold Blooded†	Total
S. Anatum var. 15+	0	0	2	4	0	0	**6**
S. 4,5,12:i:- spp. I	0	0	0	22	0	0	**22**
S. 4,5:i:- spp. I	1	0	1	4	0	0	**6**
S. Typhimurium	136	3	5	22	4	0	**170**
Other serovars‡	8	0	17	28	0	29	**82**
Total	**145**	**3**	**25**	**80**	**4**	**29**	**286**

† Includes lizards and snakes

‡ Includes five serogroup I, three serogroup II, one serogroup IIIa, five serogroup IIIb and seven serogroup IV.

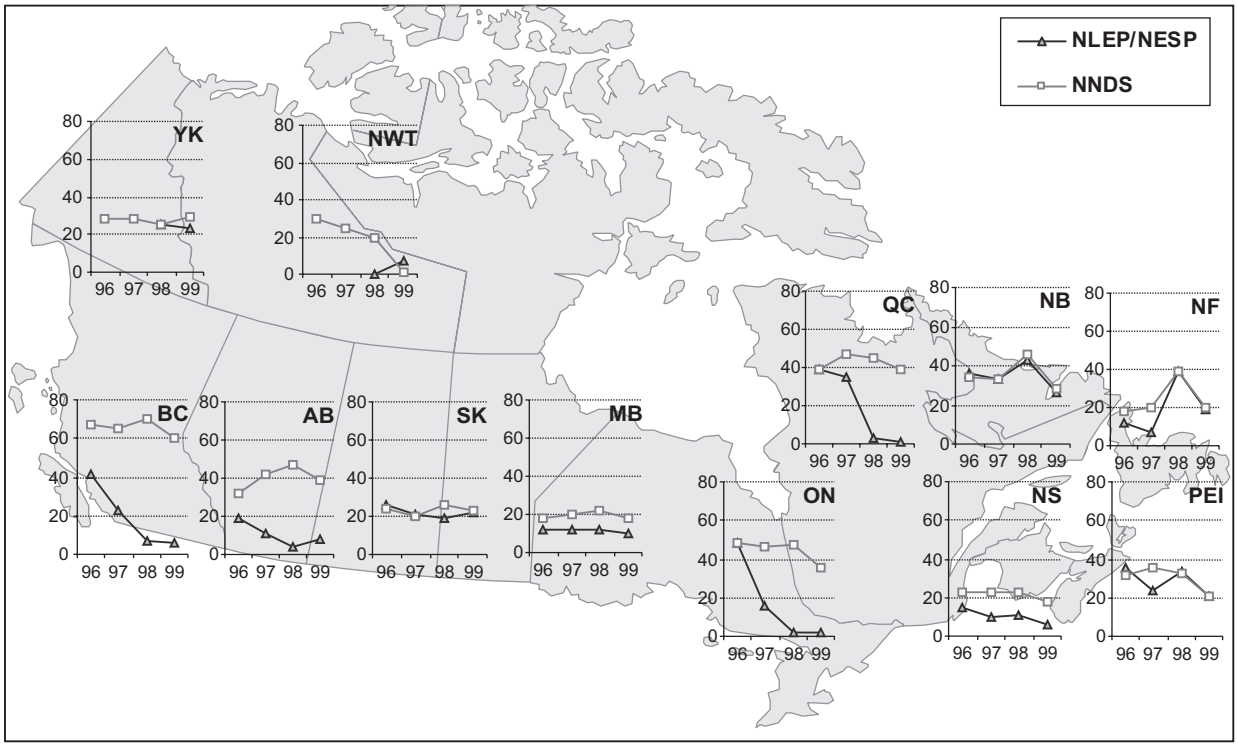
Human *Campylobacter* Cases

From 1996 to 1999 there were 12,803, 13,544, 14,236 and 11,503 *Campylobacter* infections respectively (NNDS). In contrast to the relatively steady rate observed in the NNDS database, there was a dramatic decline in the NLEP/NESP database (11,285, 6,370, 1,832 and 1,522 cases from 1996 to 1999 respectively). It should be noted that the 1996 and 1997 NLEP data used supplemental information from the NNDS database to make up for data loss. The 1998-1999 NESP data are based only on laboratory reports. Differences between rates derived from the NNDS database and the NLEP/NESP database are shown in Figure 30.

The most notable differences between the two databases were in 1998 when there were 31, 14, 11 and 10 fold differences in Ontario, Quebec, British Columbia and Alberta respectively. The differences in the rates between the NNDS and the NESP data reflect the low frequency with which *Campylobacter* isolates are sent or reported from local laboratories to the provincial/territorial laboratories.

For all provinces/territories, a decline in the rate of campylobacteriosis, according to the NNDS data, was seen in 1999. The four largest provinces had the highest rates, with British Columbia being the only province that had rates above 60 per 100,000 people (NNDS data).

Figure 30: Rates of campylobacteriosis (per 100,000 people) as reported through the National Notifiable Diseases Summary (NNDS) program and the National Laboratory for Enteric Pathogens and National Enteric Surveillance Program (NLEP/NESP) by province/territory, 1996 to 1999



Campylobacter Species

The majority (99.4%) of human *Campylobacter* isolates from 1995 through 1999 were *C. coli* or *C. jejuni*. When the species was specified, the ratio of *C. jejuni* to *C. coli* was approximately 12:1. The counts for each of the years are shown in Table 9.

Long-term Trends

According to the NNDS database, the number of *Campylobacter* cases from human sources remained relatively steady throughout the 1990s (Figure 31). The number of *Campylobacter* isolates reported to the NLEP/NESP database dropped sharply from 1996 through 1998 (most probably a reflection of changing reporting practices in the larger provinces).

Figure 31: *Campylocacter* isolates from human sources, 1990 to 1999

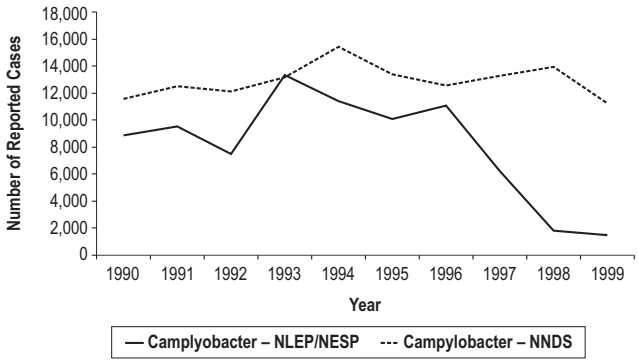


Table 9: *Campylobacter* species (number) from human cases reported from 1995 to 1999

	1995†	1996†	1997†	1998‡	1999‡
1	*C. jejuni/coli* (8,189)	*C. jejuni/coli* (10,147)	*C. jejuni/coli* (4,860)	*C. jejuni/coli* (1,364)	*C. jejuni/coli* (1,056)
2	*C. jejuni* (1,911)	*C. jejuni* (914)	*C. jejuni* (647)	*C. jejuni* (190)	*C. jejuni* (275)
3	*C. coli* (106)	*C. coli* (106)	*C. coli* (68)	*C. coli* (14)	*C. coli* (21)
4	*C. upsaliensis* (28)	*C. upsaliensis* (15)	*C. upsaliensis* (20)	*C. upsaliensis* (11)	*C. fetus* (20)
5	*C. fetus* (14)	C. fetus (10)	*C. lari* (10)	C. fetus (4)	*C. upsaliensis* (10)
6	*C. lari* (5)	*C. lari* (10)	*C. fetus* (4)	*C. lari* (2)	*C. lari* (6)
7	-	Other (3)	Other (2)	-	Other (2)
	Not specified (67)	Not specified (80)	Not specified (757)	Not specified (247)	Not specified (132)

† NLEP data; ‡ NESP data

Monthly and Provincial/Territorial Trends

The frequency of *Campylobacter* infections by month is shown in Figure 32. Clear summer peaks can be observed with a relatively stable low of approximately 600 cases in February to March. The variation in *Campylobacter* rates across provinces/territories from 1996 to 1999 is shown in Figure 33.

Figure 32: Frequency of reported *Campylobacter* cases by month, 1996 to 1999, NNDS

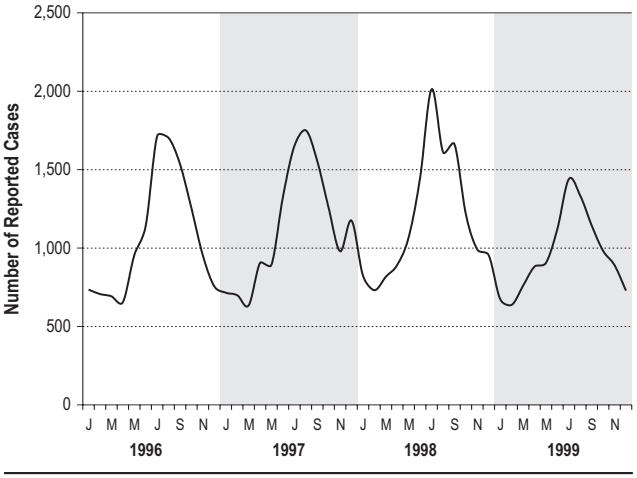
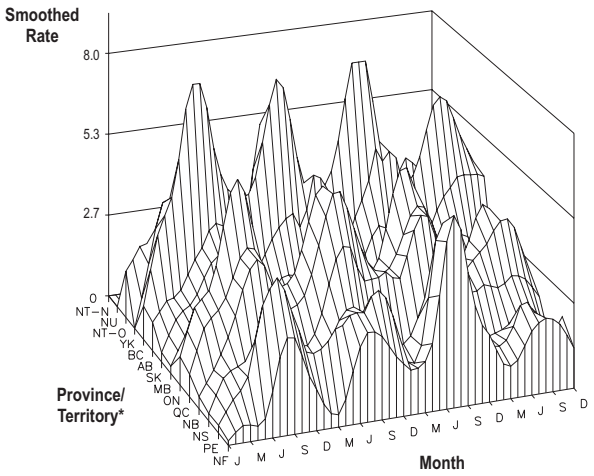


Figure 33: Human *Campylobacter* isolates by province/territory, 1996 to 1999, rate per 100,000 population



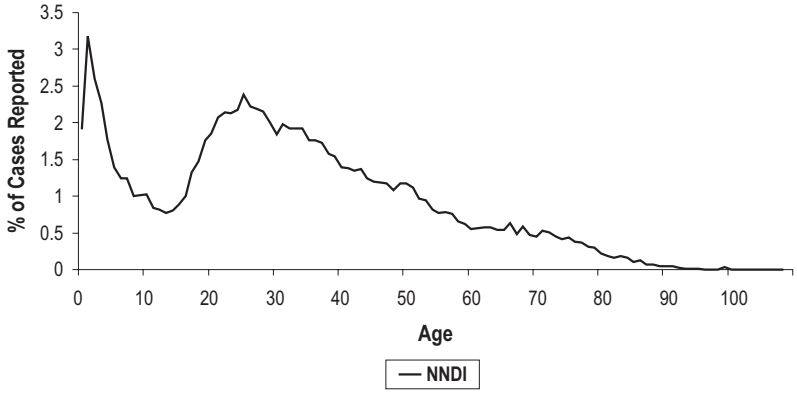
Data from NNDS

* NT-N = Northwest Territories after creation of Nunavut; NT-O = Northwest Territories before creation of Nunavut.

Age Distribution

The percentage of reported *Campylobacter* infections by age is shown in Figure 34. Two peaks can be noticed, one in young children (1 to 2 years old) and the second in adults in their late 20s. On the basis of limited data from the Canadian Institute for Health Information (CIHI) that were specific to *Campylobacter*, the trend in hospitalizations was similar to that of the NNDI data (not shown).

Figure 34: Age distribution of human *Campylobacter* isolates, 1996 to 1999, NNDI data

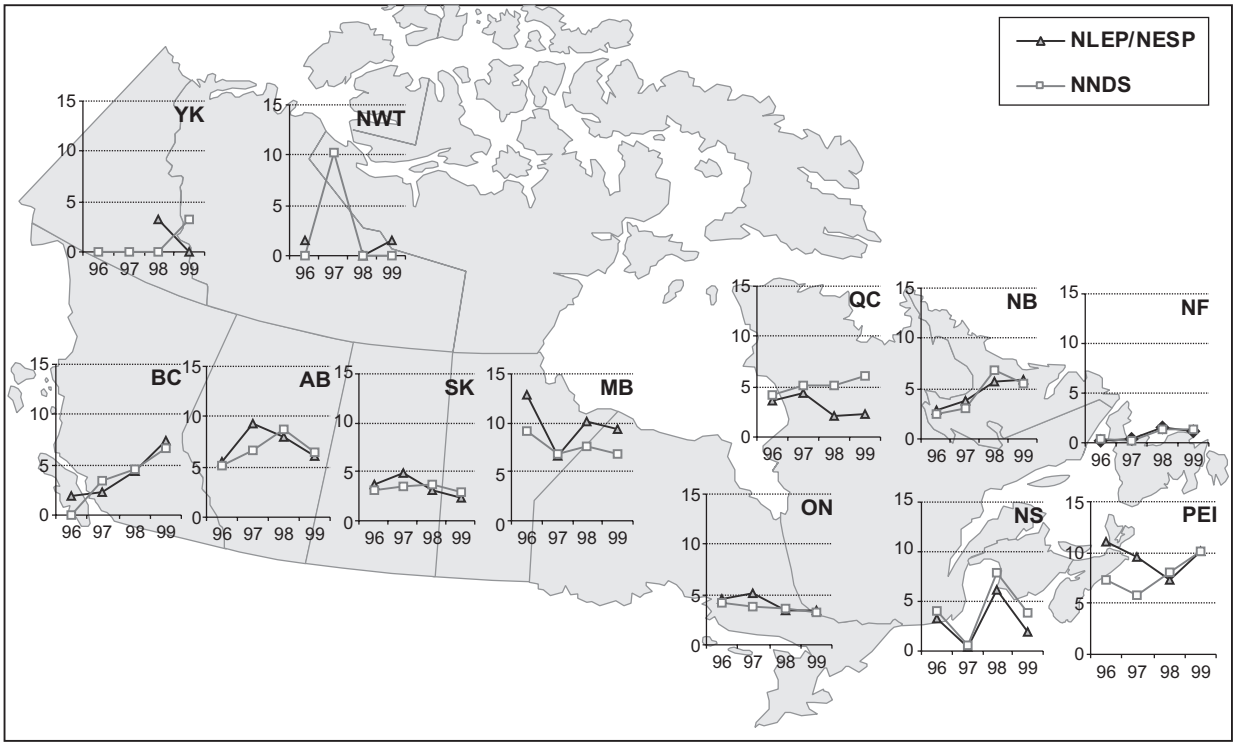


Human Pathogenic *E. coli* Cases

From 1996 to 1999, public health authorities reported 1,109, 1,273, 1,484 and 1,490 cases of pathogenic *E. coli* to the NNDS database. The numbers reported through provincial/territorial laboratories to the NLEP/NESP database were higher in 1996 and 1997 (1,248 and 1,413 respectively) and lower in 1998 and 1999 (1,212 and 1,259 respectively). In the NNDS, pathogenic *E. coli* are toxin producing *E. coli* (including verotoxigenic strains); in the NLEP/NESP, isolates are enteropathogenic and toxin producing *E. coli* (including verotoxigenic) strains.

Differences in *E. coli* rates between the national databases are shown in Figure 35.

Figure 35: Rates of pathogenic *E. coli* infection (per 100,000 people) as reported through the National Notifiable Diseases Summary (NNDS) program and the National Laboratory for Enteric Pathogens and National Enteric Surveillance Program (NLEP/NESP) by province/territory for 1996 to 1999



Pathogenic *E. coli* Serovars

The majority (95%) of pathogenic *E. coli* isolates from human cases were serovar O157. The number of isolates reported by year is listed in Table 10.

Table 10. Number of pathogenic *E. coli* serovars from human cases, by serovar, from 1995 to 1999

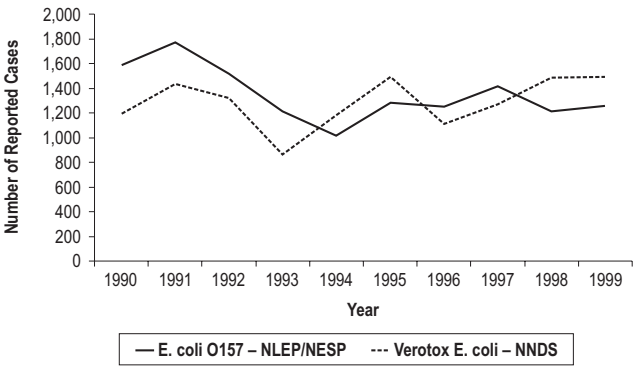
	1995†	1996†	1997†	1998‡	1999‡
O157	1,305	1,106	1,184	1,110	1,172
Non O157 or not specified	71	142	229	102	87

† NLEP data; ‡ NESP data

Long-term Trends

The total number of *E. coli* O157 cases reported in the NLEP/NESP databases dropped between 1991 and 1994, and then a slight overall increase was observed (Figure 36). A similar trend was observed for verotoxigenic *E. coli* cases reported to the NNDS database. Overall, the rates were relatively constant.

Figure 36: Pathogenic *E. coli* isolates from human sources, 1990 to 1999



Monthly and Provincial/Territorial Trends

The seasonal trend of pathogenic *E. coli* cases is similar to that of *Campylobacter*, with clear summer peaks (Figure 37). Seasonal trends were similar for O157 and non-O157 cases (data not shown). The peak indicated in October to November 1999 represents an outbreak associated with *E. coli* contaminated salami in two western provinces that affected over 140 people. The monthly variation in pathogenic *E. coli* rates across provinces/territories is shown in Figure 38.

Figure 37: All pathogenic *E. coli* cases by month, 1996 to 1999, NNDS

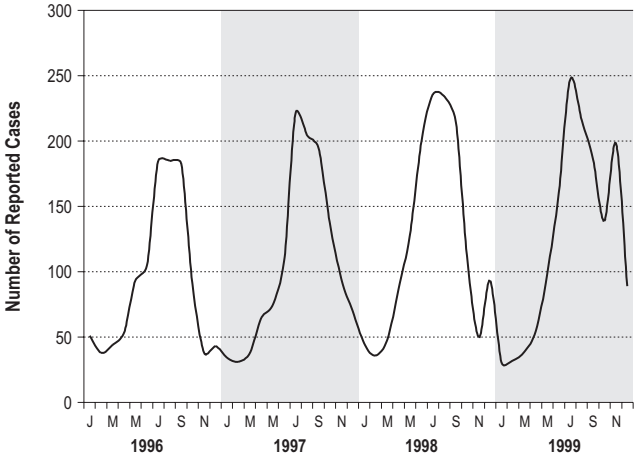
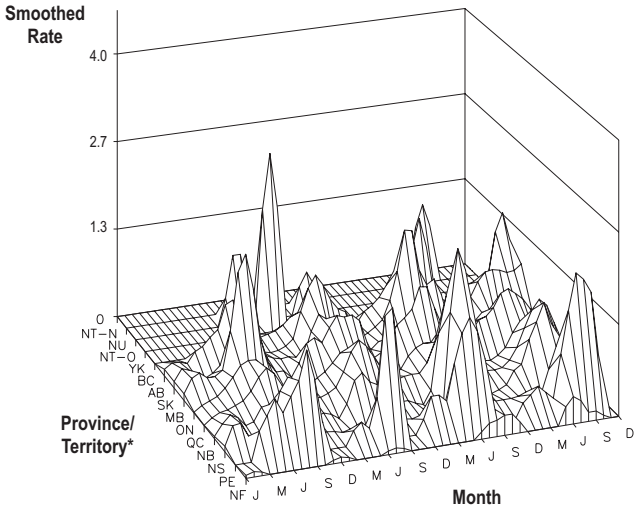


Figure 38: *E. coli* cases by province/territory, 1996 to 1999, rate per 100,000 population



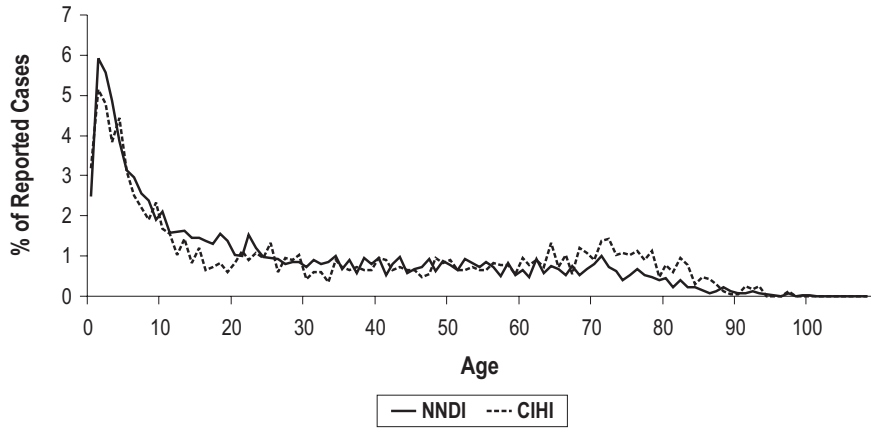
Data from NNDS

* NT-N = Northwest Territories after creation of Nunavut;
NT-O = Northwest Territories before creation of Nunavut.

Age Distribution

The percentage of reported *E. coli* infections by age is shown in Figure 39. The distribution of *E. coli* is similar to that of *Campylobacter* in that the highest percentage of reported cases was among young children (1 to 2 years old). The hospitalization data (CIHI) show a slightly higher proportion of cases among 60 to 90 year old people than in community cases (hospitalized and non-hospitalized).

Figure 39: Age distribution of human *E. coli* isolates, 1996 to 1999, NNDI and CIHI

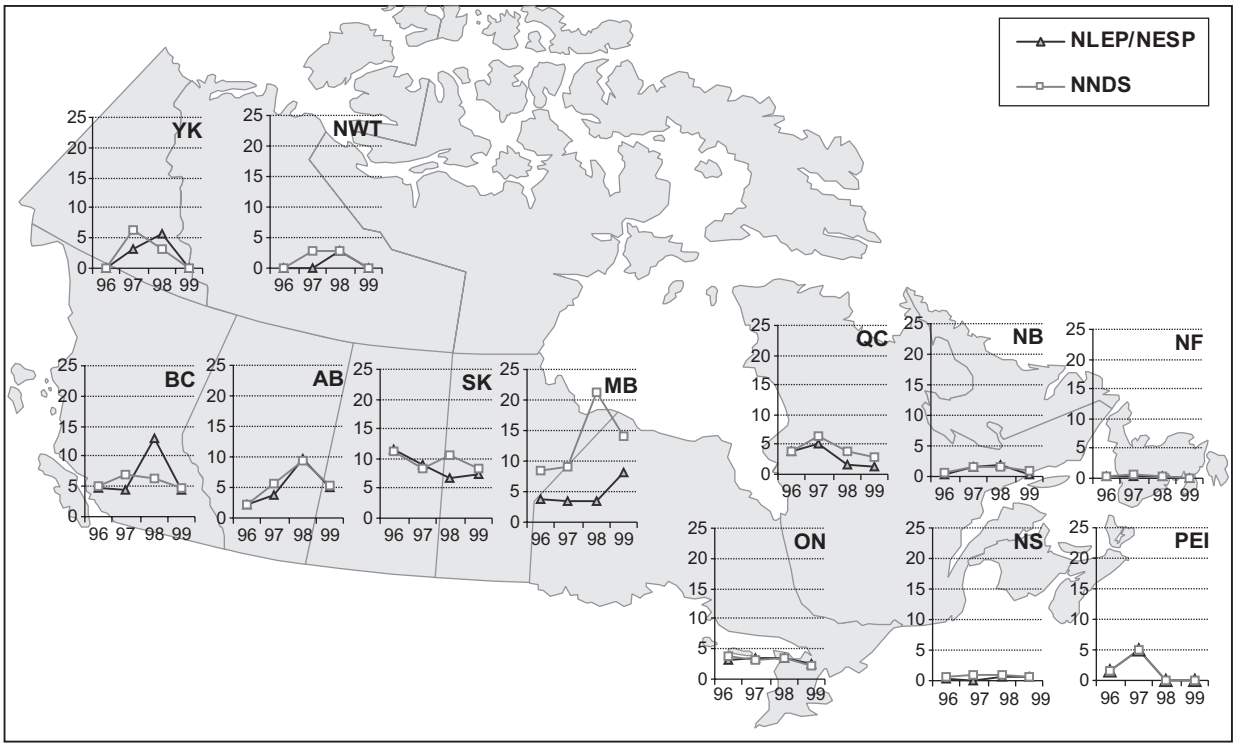


Human *Shigella* Cases

There were 1,086, 1,509, 1,593 and 1,086 cases of *Shigella* identified and reported to the NNDS database from 1996 to 1999 respectively. These figures were greater than those reported to the NLEP/NESP database (1,026, 1,189, 1,332 and 869 cases from 1996 to 1999 respectively). The increase in the total number of *Shigella* cases/isolates reported in 1997 and 1998 is more pronounced in the NNDS database than the NLEP/NESP database.

Differences in rates between the NLEP/NESP database and the NNDS database are shown in Figure 40.

Figure 40: Rates of *Shigella* infections (per 100,000 people) as reported through the National Notifiable Diseases Summary (NNDS) program and the National Laboratory for Enteric Pathogens and National Enteric Surveillance Program (NLEP/NESP) by province/territory for 1996 to 1999



Shigella Species/Serovars

The frequency of *Shigella* species from 1996 through 1999 is shown in Table 11. There is very little movement in the order of *Shigella* species. The frequency and rank of *Shigella flexneri* serovars are shown in Table 12.

Long-term Trends

The long-term reporting trends of *Shigella* cases in the NNDS and NLEP databases show strong similarities. NLEP data from before 1993 were not available (Figure 41).

Figure 41: *Shigella* isolates from human sources, 1990 to 1999

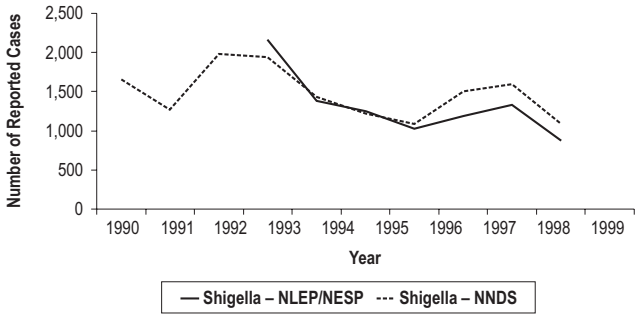


Table 11: *Shigella* species (number) reported from 1996 to 1999

	1996		1997		1998		1999	
1	*S. sonnei*	(491)	*S. sonnei*	(746)	*S. sonnei*	(925)	*S. sonnei*	(522)
2	*S. flexneri*	(390)	*S. flexneri*	(308)	*S. flexneri*	(303)	*S. flexneri*	(248)
3	*S. boydii*	(51)	*S. boydii*	(52)	*S. boydii*	(46)	*S. boydii*	(50)
4	*S. dysenteriae*	(48)	*S. dysenteriae*	(31)	*S. dysenteriae*	(34)	*S. dysenteriae*	(25)
5	*S.* unspecified	(46)	*S.* unspecified	(52)	*S.* unspecified	(24)	*S.* unspecified	(24)

Table 12: *Shigella* flexneri serovars (number) reported from 1996 to 1999

	1996		1997		1998		1999	
1	*S. flexneri* 2	(102)	*S. flexneri* 2	(86)	*S. flexneri* 2	(84)	*S. flexneri* 2	(52)
2	S. *flexneri* 6	(39)	*S. flexneri* 6	(34)	*S. flexneri* 6	(23)	*S. flexneri* 3	(20)
3	*S. flexneri* 1	(29)	*S. flexneri* 1	(22)	*S. flexneri* 1	(21)	*S. flexneri* 6	(20)
4	*S. flexneri* 3	(27)	*S. flexneri* 4	(16)	*S. flexneri* 3	(18)	*S. flexneri* 1	(15)
5	*S. flexneri* 4	(24)	*S. flexneri* 3	(15)	*S. flexneri* 4	(12)		
	S. flexneri†	(97)	*S. flexneri*†	(84)	*S. flexneri*†	(138)	*S. flexneri*†	(116)

†serotype unspecified

Monthly and Provincial/Territorial Trends

The seasonal distribution of *Shigella* cases is less discernable than for *Salmonella, E. coli* or *Campylobacter* (Figure 42). Multiple peaks can be seen in all years, with five peaks observed in 1997. The variation in *Shigella* rates across provinces/territories from 1996 to 1999 is shown in Figure 43. The western provinces show higher *Shigella* activity than Ontario, Quebec and the Atlantic provinces.

Figure 42: All *Shigella* cases by month, 1996 to 1999, NNDS

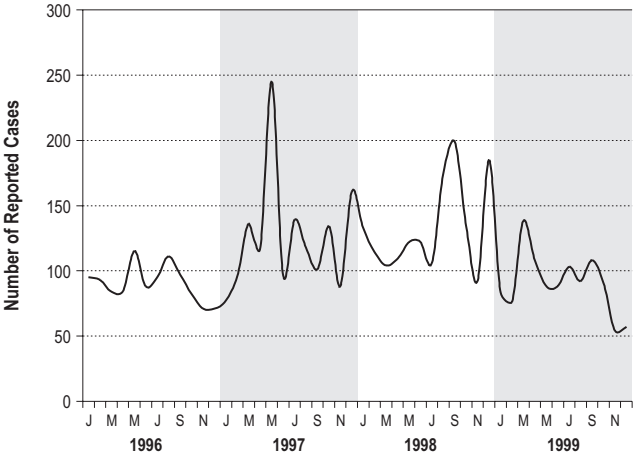
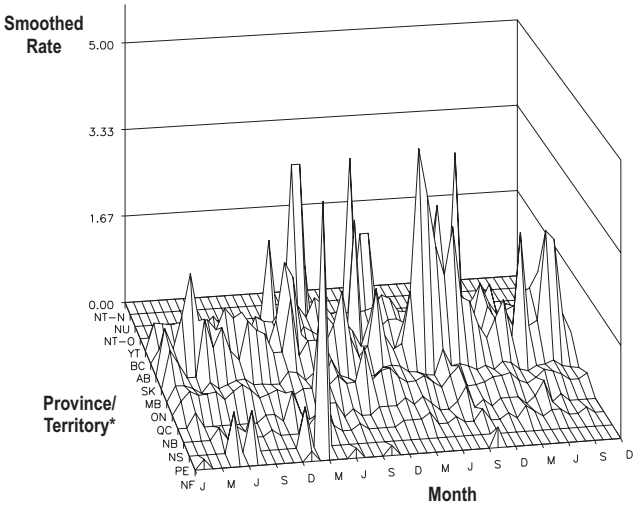


Figure 43: *Shigella* isolates by province/territory, 1996 to 1999, rate per 100,000 population



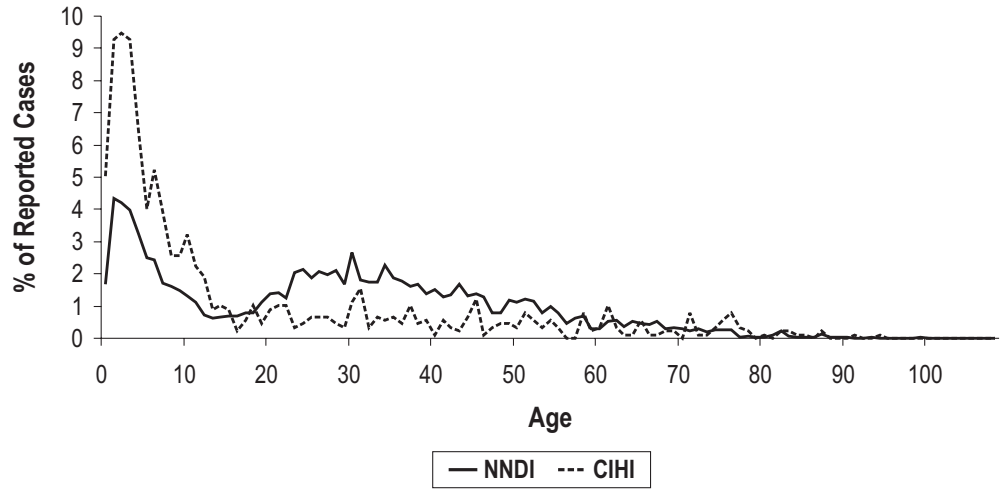
Data from NNDS

* NT-N = Northwest Territories after creation of Nunavut;
NT-O = Northwest Territories before creation of Nunavut.

Age Distribution

The percentage of reported *Shigella* infections by age is shown in Figure 44. Hospitalization data (CIHI) show a much higher proportion of cases among those < 15 years old and a lower proportion among people aged 20 to 50 than in all cases (hospitalized and non-hospitalized).

Figure 44: Age distribution of human *Shigella* isolates, 1996 to 1999, NNDI and CIHI



Outbreaks, Hospitalizations and Deaths

The number of reported outbreaks and the total number of laboratory confirmed outbreak-related cases for each of the four enteric pathogens covered in this report are summarized in Table 13. The numbers reported are highly dependent on the source of the data. The lack of uniformity between the two databases highlights the extent of under-reporting within each reporting system.

Table 13: Number of outbreaks (total number of laboratory confirmed cases linked to outbreak) from 1996 to 1999, all pathogens

		1996 outbreaks	1997 outbreaks	1998 outbreaks	1999 outbreaks
Salmonella	NLEP	67 (367)	43 (198)	40 (643)	40 (307)
	NNDS†	35 (67)	27 (77)	44 (427)	32 (59)
Campylobacter	NLEP	16 (33)	4 (9)	9 (18)	6 (12)
	NNDS	9 (32)	19 (27)	30 (42)	16 (24)
E. coli	NLEP	21 (77)	23 (50)	13 (213)	12 (60)
	NNDS	2 (41)	1 (1)	8 (58)	13 (20)
Shigella	NLEP	13 (35)	13 (41)	10 (24)	12 (29)
	NNDS	3 (18)	13 (26)	10 (27)	3 (3)

† The NNDS database has no unique identifiers linking outbreak related isolates. However, cases were grouped into apparent outbreaks on the basis of onset date and postal code.

Outbreak Isolate Details (NLEP)

In 1996, food was specifically implicated in only four of the 107 outbreaks recorded in the NLEP database: *S.* Typhimurium from cooked chicken, two outbreaks of *S.* Newport from alfalfa sprouts and *S.* Enteritidis in eggs. Turtle tank water was the source of an outbreak of *S.* Paratyphi B var. Java. *C. jejuni* was responsible for 14 of the 16 *Campylobacter* outbreaks in 1996 and 85% of the outbreak-associated cases. In the same year, all but two *E. coli* outbreaks were associated with serovar O157 (the two non-O157 outbreaks were caused by O26 and O91). All *Shigella* outbreaks were caused by *S. sonnei.*

In 1997, food was implicated in five outbreaks: *S.* Hadar from sausage, *S.* Meleagridis from alfalfa sprouts, *S.* Thompson from roast beef and two outbreaks of *S.* Enteritidis from poultry. For all the *Campylobacter* outbreaks, *C. jejuni* was the species responsible. One of the *E. coli* outbreaks was due to O26, and all the others were O157. Of the 13 *Shigella* outbreaks, 11 were due to *S. sonnei* and two to *S. flexneri* serotype 2.

In 1997, the *S.* Typhimurium phage types responsible for outbreaks (and the number of outbreaks they caused) were as follows: PT11 (n = 1), PT 104 (n = 9), PT193 (n = 1), PT208 (n = 1) and atypical (n = 3). The following *S.* Enteritidis phage types were associated with outbreaks: PT1 (n = 1), PT4 (n = 1), PT5a (n = 1), PT6a (n = 1), PT8 (n = 3), PT13a (n = 1), PT23 (n = 1), PT28 (n = 4) and atypical (n = 1). Of the 19 *E. coli* O157 phage typed, 15 outbreaks were associated with PT14, and one outbreak was caused by each of the following: PT4, PT31, PT32 and PT34.

In 1998, a large multi-provincial outbreak of *S.* Enteritidis (361 confirmed cases) was traced to a contaminated pre-packaged lunch product. Also in 1998,

there were eight outbreaks involving *S.* Heidelberg and 21 outbreaks involving *S.* Typhimurium. Food was implicated in six outbreaks: *E. coli* O157 from potato salad, salami and apple cider; *S.* Heidelberg from sandwiches; and the large *S.* Enteritidis outbreak described above. *C. coli* was the species identified in seven of the eight *Campylobacter* outbreaks. The remaining *Campylobacter* isolate was not characterized to the species level. All *E. coli* outbreaks were caused by O157:H7. *S. sonnei* was responsible for all 10 *Shigella* outbreaks recorded by the NLEP in 1998.

In 1998 *S.* Typhimurium outbreaks involved the following phage types: PT 1 (n = 1), PT 4 (n = 1), PT10 (n = 1), PT22 (n = 1), PT51 (n = 1), PT68 (n = 1), PT104 (n = 9), PT 104b (n = 1), PT170 (n = 1) and PT 191 (n = 4). The four *S.* Enteritidis outbreaks were caused by phage types 2, 4, 8 and 11b. Eleven of the *E. coli* O157:H7 outbreaks were caused by PT14, one involved PT33, and a large national outbreak traced to salami involved multiple phage types (PT2, PT8, PT10 and PT14).

In 1999, a large multi-provincial *Salmonella* outbreak (53 cases) was caused by *S.* Infantis contaminated pig ear dog snacks. A second large outbreak involving 52 cases was traced to alfalfa sprouts; *S.* Paratyphi B. var. Java was the organism responsible. Other foods implicated in outbreaks included two *E. coli* O157:H7 outbreaks from ground beef and salami; *S.* Muenchen from orange juice; *S.* Newport from raw meat; and two *S.* 4,5,12:i:- ssp. I outbreaks from poultry. Five of the six *Campylobacter* outbreaks were caused by *C. jejuni*, but the species of the remaining outbreak isolate was not determined. One *E. coli* outbreak was caused by O113. The remaining 11 were due to O157:H7. *S. sonnei* was responsible for 10 outbreaks in 1999 and *S. boydii* and *S. flexneri* for one each.

In 1999, the *S.* Typhimurium phage types responsible for outbreaks were as follows: PT21 (n = 1), PT104 (n = 14), PT104b (n = 1), PT108 (n = 1), PT124 var. (n = 1), PT170 (n = 1), PT208 var. (n = 1). Of the three *S.* Enteritidis outbreaks, one was caused by PT4 and two by PT8. Seven *E. coli* O157:H7 outbreaks were caused by PT14, three by PT8 and the remaining one by PT27.

For *S.* Typhimurium, DT104 was the only phage type consistently associated with outbreaks across the years under review. In 1996, 12 of 16 outbreaks were caused by DT104. In 1997 and 1998, this figure dropped to 9 out of 16 and 10 out of 21 outbreaks respectively, and in 1999 it rose to 15 of 20.

The number of outbreaks caused by specific *Salmonella* serovars is shown in Table 14. No consistent trends were noted in either database.

Table 14: Number of salmonellosis outbreaks (and associated laboratory confirmed cases) by serovar reported to the NLEP (1996 to 1997) and NNDI (1996 to 1999) databases

	1996		1997		1998		1999	
***Salmonella* serovar**	**NNDI**	**NLEP**	**NNDI**	**NLEP**	**NNDI**	**NLEP**	**NNDI**	**NLEP**
S. Agona	1(1)	2 (5)	1 (2)	-	1 (2)	-	1 (2)	1 (14)
S. Brandenburg	-	1 (2)	2 (5)	-	1 (3)	1 (20)	-	-
S. Braenderup	-	-	1 (2)	-	-	-	-	-
S. Enteritidis	3 (9)	24 (126)	5 (21)	14 (41)	5 (278)	4 (370)	6 (10)	3 (19)
S. Hadar	2 (5)	2 (4)	1 (2)	2 (13)	7 (15)	-	1 (1)	-
S. Hartford	-	-	-	-	-	1 (69)		1 (2)
S. Heidelberg	3 (10)	3 (9)	5 (14)	4 (7)	4 (81)	8 (91)	1 (1)	3 (8)
S. Infantis	-	-	-	-	1 (10)	-	1 (1)	1 (53)
S. Javiana	-	-	-	-	-	-	-	1 (3)
S. Mbandaka	-	-	-	-	-	-	-	1 (4)
S. Meleagridis	-	-	-	1 (38)	-	-	-	-
S. Montevideo	1 (2)	-	-	1 (4)	-	-	-	-
S. Muenchen	-	-	-	-	-	-	-	1 (11)
S. Newport	1 (1)	3 (126)	-	-	2 (5)	1 (5)	-	1 (28)
S. Oranienburg	-	-	-	-	1 (22)	-	-	-
S. Paratyphi B	-	-	-	1 (1)	-	-	-	-
S. Paratyphi B var. Java	-	3 (5)	-	1 (1)	-	2 (5)	-	2 (54)
S. Sandiego	-	-	-	1 (5)	-	-	-	-
S. Schwarzengrund	-	-	-	-	-	-	1 (2)	-
S. Thompson	1 (4)	2 (23)	-	1 (53)	1 (2)	-	-	-
S. Tilene	-	-	-	1 (1)	-	-	-	-
S. Typhi	-	4 (7)	-	-	-	2 (4)	-	1 (4)
S. Typhimurium	8 (15)	21 (57)	2 (18)	16 (34)	7 (13)	21 (57)	12 (25)	20 (45)
S. 4,5,12:i:- spp. I	-	-	-	-	-	-	-	4 (49)
S. sp (not specified)	15 (20)	2 (3)	10 (13)	-	15 (18)	-	9 (17)	-
Total *Salmonella*	**35 (67)**	67 (397)	27 (77)	43 (198)	45 (449)	40 (621)	32 (59)	40 (294)

Exposure Setting (NNDI)

The NNDI database (outbreak and non-outbreak cases) contained risk factor information for some cases. The frequency of identified exposure settings is shown in Table 15. Data for 1998 and 1999 were not available.

Home was identified as the most common exposure setting for cases infected with *Salmonella*, *Campylobacter* and pathogenic *E. coli*. Travel and restaurants were the most common settings identified for *Shigella* cases in 1996 and 1997 respectively. Day care was noted as a prominent exposure setting in 1996 for pathogenic *E. coli* infections.

Table 15: Exposure setting identified in the NNDI database (combined outbreak and non-outbreak cases) for 1996 and 1997

	Salmonella		***Campylobacter***		**Pathogenic *E. coli***		***Shigella***	
	1996	**1997**	**1996**	**1997**	**1996**	**1997**	**1996**	**1997**
Exposure setting	**Percentage of records with exposure setting data**							
	8%	**6%**	**5%**	**5%**	**6%**	**10%**	**7%**	**15%**
Home	39% (181)	48% (178)	41% (247)	42% (242)	44% (31)	54% (59)	9% (6)	5% (12)
Restaurant	23% (107)	12% (43)	21% (128)	13% (73)	30% (21)	24% (26)	3% (2)	50% (114)
Travel	36% (169)	36% (135)	35% (209)	42% (245)	14% (10)	20% (22)	87% (61)	44% (101)
Day care	< 1% (1)	< 2% (6)	< 1% (2)	< 1% (1)	10% (7)	2% (2)	1% (1)	0%
School or workplace	< 1% (2)	< 1% (3)	< 1% (4)	1% (6)	0%	0%	0%	0%
Other			1.2%† (7)	< 1%‡ (2)				

† Recreational water; ‡ Hospital

Hospitalizations and Deaths

The number of enteric infections resulting in hospitalization varied considerably between the NNDI and CIHI databases (Table 16). When the records without hospitalization information in the NNDI database were excluded, pathogenic *E. coli* was associated with the highest hospitalization rates per 1,000 records. It was also responsible for the highest hospitalization rate per 1,000 cases based on the CIHI data for hospitalizations and NNDS for reported cases.

Table 16: Hospitalization data from 1996 to 1999 (NNDI and CIHI databases)

		NNDI Database			CIHI Database		
	Year	Number of cases hospitalized	% of records with no hospitalization data	Rate per 1,000 records with information	Number of cases hospitalized	Rate per 1,000 enteric hospitalizations†	Hospitalization rate (per 1,000 cases)‡
Salmonella	1996	303	78	234	975	64	147
	1997	310	74	206	791	55	130
	1998	163	87	191	891	59	125
	1999	112	89	206	739	45	129
Campylobacter	1996	314	80	130	na*	na	na
	1997	235	82	103	na	na	na
	1998	99	91	84	na	na	na
	1999	87	93	111	na	na	na
Path. *E. coli*	1996	143	70	441	317	21	286
	1997	130	69	365	267	19	210
	1998	59	87	367	328	22	221
	1999	63	89	426	364	22	258
Shigella	1996	25	87	192	118	8	109
	1997	24	78	76	95	7	63
	1998	10	93	115	218	15	137
	1999	7	93	115	107	7	99

† Hospitalizations for which the diagnostic code indicated that the pathogen was detected.
‡ Calculated as the number of hospitalizations in CIHI/number of reports in NNDS.
* The four digit code required to specify *Campylobacter* is not consistently used.

The number of deaths associated with *Salmonella*, *Campylobacter*, pathogenic *E. coli* and *Shigella* infections is shown in Table 17. *Salmonella* infections resulted in the most deaths according to both databases (the only exception being pathogenic *E. coli* in 1999).

Salmonella and pathogenic *E. coli* were both prominent in the rates per 1,000 records with information and the rates per 1,000 hospitalized patients. No deaths were attributed to *Shigella* from 1996 to 1999.

Table 17: Deaths associated with enteric infections from 1996 to 1999 (NNDI and CIHI databases)

		NNDI Database		CIHI Database	
	Year	Number of deaths (NNDI)	Rate per 1,000 records with information†	Number of deaths (CIHI)	Rate per 1,000 hospitalized with illness‡
Salmonella	1996	11	49	10	10
	1997	11	54	8	10
	1998	15	133	10	11
	1999	8	140	5	7
Campylobacter	1996	8	16	na*	na
	1997	3	7	na	na
	1998	2	6	na	na
	1999	5	31	na	na
Path. *E. coli*	1996	1	22	3	10
	1997	3	48	4	15
	1998	3	158	1	3
	1999	4	133	7	19
Shigella	1996	0	0	0	0
	1997	0	0	0	0
	1998	0	0	0	0
	1999	0	0	0	0

† This rate takes into account the percentage of records in the NNDI database that did not contain hospitalization data.
‡ Cases hospitalized with an infection that was indicated in the CIHI database to be a contributing factor in their death.
* The four digit code required to specify *Campylobacter* is not consistently used.

References

1. B.C. Centre for Disease Control. *International outbreak of **Salmonella newport** associated with alfalfa sprouts.* BC Health and Disease Surveillance 1996;5(5):40-46.
2. Van Bendeden CA, Keene WE, Strang RA et al. *Multinational outbreak of **Salmonella enterica** serotype Newport infections due to contaminated alfalfa sprouts.* JAMA 1999;281(2):158-62.
3. Laboratory Centre for Disease Control, Health Canada. *National foodborne, waterborne, and enteric outbreak summary report 1997-1998.* Can J Infect Dis 1999;10(3):201-206.
4. Buck P, Grimsrud K, Waters J et al. *Would you like a little Salmonella with your sandwich?* In: Program and abstracts of the 47th Annual Epidemic Intelligence Service Conference, International Night. Atlanta, GA, 1998.
5. Ratnam S, Stratton F, O'Keefe C et al. ***Salmonella enteritidis** outbreak due to contaminated cheese – Newfoundland.* CCDR 1999;25:17-21.
6. Le Ber C. *Ontario outbreak of **S. enteritidis** associated with cheese in a commercially manufactured lunch product.* Public Health Epidemiol Rep Ontario 1998;9:172-77.
7. Ahmed R, Soule G, Demczuk WH et al. *Epidemiologic typing of **Salmonella enterica** serotype enteritidis in a Canada-wide outbreak of gastroenteritis due to contaminated cheese.* J Clin Microbiol 2000;38(6):2403-06.

Appendix: Data Sources

This section describes the data sources used to generate the integrated report.

Data on human cases for this report were derived from the

- National Notifiable Diseases databases (Individual Case [NNDI] and Summary [NNDS])
- National Laboratory for Enteric Pathogens (NLEP) database
- National Enteric Surveillance Program (NESP) database
- Discharge Abstract Database (DAD) from the Canadian Institute for Health Information (CIHI).

Data on isolates from non-human sources were obtained from the

- Laboratory for Foodborne Zoonoses (LFZ)
- NLEP.

Data in the **NNDI** dataset included case-level "confirmed" (laboratory identification of pathogen) and "closed" (investigation completed) reports that originated from public health units/authorities. These data were reported through the offices of provincial/territorial epidemiologists to the Centre for Infectious Disease Prevention and Control for inclusion in NNDI. Not all provinces and territories were represented in this database. The data fields and values varied among regions. However, disease, province/territory and a date were available for all. Date information varied from the date of diagnosis to the date the report was received. Other optional data included age, sex and risk factor information such as travel and mode of transmission.

The data sources for the **NNDS** dataset were the same as for the NNDI database. However, this database contained aggregate level data from all provinces and territories in Canada. Information was aggregated by disease (e.g. salmonellosis), age group, sex, year and month, and no case level information was included. Provincial/territorial counts reflected the introduction of Nunavut in April of 1999. All data were verified at the provincial/territorial level. This involved summarizing monthly reports into an annual report that was sent back to the originating jurisdiction for verification. Once updated and approved, the data were returned to Health Canada. These data are included in annual reports (*Notifiable Diseases Annual Summary*, *Canada Communicable Disease Report*, Supplement) and are available on the Web (http://cythera.ic.gc.ca/dsol/ndis/index_e.html).

Data in the **NLEP** (formerly called the National Laboratory for Bacteriology and Enteric Pathogens) database are primarily from provincial/territorial laboratories and work performed at the NLEP. Local and regional laboratories forward some enteric pathogen isolates to provincial/territorial laboratories for confirmation and identification. Some isolates from the provincial/territorial laboratories are sent to the NLEP for confirmation and additional subtyping. Provincial/territorial laboratories also send aggregate information on all notifiable enteric agents observed each month to the NLEP. For 1996 and 1997, approximately 57% of the enteric cases were submitted in aggregate form. However, the proportion of aggregate data varied across the provinces/territories, from 0% to 90%.

For this report, both case level and aggregate level data were used for 1996 and 1997, and the case level only was used for 1998 and 1999 (see NESP below). Both the aggregate and case level datasets included organism, province, species, serovar, source (human or non-human) and isolate source (e.g. human: stool, urine; non-human: meat, water). Additionally, both contained date information, but in the aggregate dataset this was the reporting date, and in the non-aggregate it was the date of isolation. Data supplied for some case level records included (but were not limited to) age, sex, country of travel and outbreak related information. Further details from these data

are available from annual summaries (*Enteric Pathogens Identified in Canada, Annual Summary*).

The **NESP** is a surveillance system that is co-managed by the Division of Enteric, Foodborne and Waterborne Diseases and the NLEP. This system receives totals of the enteric cases from each provincial/territorial laboratory to provide weekly national analyses and reports. A broad range of bacterial, viral and parasitic diseases is tracked in this program. National coverage was established in 1997, and 1998 was the first year covering the entire calendar year. Therefore, only 1998 and 1999 data were used for this report. These data included counts by week and species or serovar for each province/territory. Additional information on antimicrobial resistance, outbreaks and travel were also occasionally reported.

The **DAD** from **CIHI** contains information collected on a monthly basis from all regions in Canada except Nunavut. All provinces/territories except Quebec (one long-term hospital) and Manitoba (six hospitals) participated fully, covering approximately 85% of hospital inpatient discharges in Canada. For this report, records were selected in which the following enteric pathogens were indicated in the first three diagnostic codes: Cholera (001.0-001.9), Typhoid/Paratyphoid (002.0-002.9), *Salmonella* (003.0-003.9), *Shigella* (004.0-004.9), Other Food Poisoning (005.0-005.9), Amebiasis (006.0-006.9), Other Protozoal Intestinal Diseases (007.0-007.9), Other Organisms (008.0-008.8), Gastrointestinal Anthrax (022.2), Listeriosis (027.0), and Viral Hepatitis A (007.0 and 007.1). Because coding in DAD requires only the first four numbers of the ICD-9 code (International Statistical Classification of Diseases and Related Health Problems, 9th Revision), data specific to some organisms such as *Campylobacter* (008.43) were available for only a small subset of their category (e.g. Other specified bacteria, 008.4) when the additional digit was provided.

Records were classified according to the calendar year of hospital admission, not by the fiscal year coding used by CIHI. Key variables included diagnostic code, age, sex, province/territory and exit code (e.g. discharged or died). Additional information is available in annual (fiscal year) Hospital Morbidity Database – Tabular Reports from CIHI.

The **LFZ** (formerly the Health of Animals Laboratory) data were from *Salmonella* isolates from non-human sources that were sent to the laboratory, which serves as a national centre for serotyping *Salmonella* from non-human sources. For this report, isolates from research projects were excluded. Most of the samples were from environmental assessment or food quality programs (e.g. supply flocks, exportation, quality monitoring), and about a third were from diseased animals. Isolates were received from provincial veterinary laboratories, federal, university and private laboratories as well as agencies investigating outbreaks. There was inconsistency in the submission of isolates during the time covered by this report, in that the types of samples and regional distribution varied from year to year. Routine data for each record included isolate source, type of sample, species or product, submitting laboratory, specimen number, date of collection, province/territory, county or municipality, establishment, program, priority, serovar, phage type and biochemical characteristics. Monthly and annual summaries *(Salmonella Serovars and Salmonella Phagetypes Identified by the O.I.E. Reference Laboratory for Salmonellosis at the Health Canada Laboratory for Foodborne Zoonoses)* provide further detail regarding these isolates.

For 1996 and 1997, in addition to the LFZ data, the data from isolates of non-human origin identified at NLEP were also included in this report. Most of these isolates were outbreak related and the associated data were similar to those recorded in the LFZ database. Further details from these data (including research related isolates) are available from annual summaries (*Enteric Pathogens Identified in Canada, Annual Summary*).