A descriptive study of human *Salmonella* serotype typhimurium infections reported in Ontario from 1990 to 1998

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BACKGROUND: *Salmonella* infections cause gastrointestinal and systemic diseases worldwide and are the leading causes of food-borne illnesses in North America (1-4). *Salmonella* serotype typhimurium (ST), in particular, is increasingly becoming a major public health concern because of its ability to acquire multiple resistant genes (5,6).
OBJECTIVE: To describe demographic, temporal and geographical distributions, and reported risk factors of nonoutbreak cases of ST reported to a surveillance system in Ontario.
METHODOLOGY: Descriptive analyses were performed on data on salmonellosis cases reported in Ontario between 1990 and 1998. Direct age- and sex-standardized rates were computed, and temporal trend analyses were performed using simple linear regression and a general additive model with a locally weighted regression (LOESS) smoother.
RESULTS: The mean annual rates of infections with all *Salmonella* serotypes and with ST were 27 cases per 100,000 persons and 3.7 cases per 100,000 persons, respectively. Males and children under five years of age had significantly higher rates of both ST and ST definitive type 104 (DT104) infections. There was also evidence of temporal clustering of all strains of *Salmonella*, with significantly more cases being reported during the summer. Significantly higher rates of ST DT104 were observed in urban areas compared with rural areas, suggesting potential differences in the geographical distribution of risk factors.
CONCLUSIONS: Information on demographic, temporal and geographical distributions, and risk factors is critical in planning disease control strategies. Further prospective analytical observation studies are needed to gain a better understanding of the epidemiology of ST and ST DT104 in Ontario, which will better guide disease control decisions.

Key words: *Ontario; Spatial distribution; Surveillance; Salmonella typhimurium; Salmonella typhimurium DT104; Salmonella serotype typhimurium*

Étude descriptive sur des infections à Salmonella typhimurium sérotypes humaines signalées en Ontario de 1990 à 1997

CONTEXTE : Les infections à Salmonella causent des maladies systémiques et gastro-intestinales partout dans le monde et constituent les principales causes des intoxications alimentaires en Amérique du Nord (1-4). L'infection à Salmonella typhimurium sérotype (ST), en particulier, est en train de devenir une préoccupation majeure en santé publique étant donné sa capacité à acquérir de multiples gènes résistants (5,6).
OBJECTIF : Décrire les distributions démographiques, temporelles et géographiques, et les facteurs de risque qui ne constituent pas une flambée d'infection ST signalée à un système de surveillance en Ontario.
MÉTHODOLOGIE : On a effectué des analyses de données sur des cas d'infection à Salmonella (salmonellose?) signalés en Ontario entre 1990 et 1998. On a calculé des taux directs normalisés en fonction de l'âge et du sexe, et effectué des analyses de tendances temporelles à l'aide d'une régression linéaire simple et d'un modèle additif général avec un LOESS (épeler) plus souple.
RÉSULTATS : Les taux annuels moyens de toutes les infections à Salmonella sérotypes et ST s'établissaient respectivement à 27 et 3,7 cas par 100 000 personnes. Les hommes et les enfants de moins de cinq ans présentaient des taux de beaucoup supérieurs des infections ST et ST de type 104 (DT104). On a découvert également des preuves de concentration temporelle de toutes les souches d'infections à Salmonella, notamment on a signalé beaucoup plus de cas en été. On a observé des taux de beaucoup supérieurs de ST DT104 dans les régions urbaines comparativement aux régions rurales, laissant suggérer des écarts potentiels dans la distribution géographique des facteurs de risques.
CONCLUSIONS : Les renseignements sur les distributions démographiques, temporelles et géographiques, et les facteurs de risque sont de première importance dans la planification des stratégies de contrôle des maladies. On devra effectuer des études d'observation analytique prospective supplémentaires afin de mieux comprendre l'épidémiologie des infections ST et ST D104 en Ontario. Ces initiatives permettront de prendre de meilleures décisions en matière de contrôle des maladies en Ontario.

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Salmonella infections in general, and those of *Salmonella* serotype Typhimurium (ST) in particular, continue to cause gastrointestinal and systemic diseases worldwide. The infections are major public health concerns due to the ability of the organisms to acquire multiple resistant genes (5) and because the infections may sometimes be fatal (3). ST definitive type 104 (DT104), for example, is virulent to humans and animals and is known to be resistant to ampicillin, chloramphenicol, streptomycin, tetracycline hydrochloride and the sulfonamides (6,7). Since 1990 there have been dramatic increases in the occurrence of multiple drug-resistant strains of ST DT104 in many developed countries (8,9). Whereas the overall incidence of human *Salmonella* infections has decreased in some countries, such as Denmark, the number of infections with multiple resistant ST DT104 has risen (10), and the organism remains the leading cause of foodborne illnesses in Europe and North America (1,6).

In Canada, approximately 7000 to 12,000 *Salmonella* infections are reported annually, 2500 to 6500 of which occur in Ontario (11). *Salmonella* outbreaks such as the 1998 Canada-wide outbreak related to packaged lunch snacks (12) and the 1999 outbreak linked to frozen orange juice drinks (13) have contributed to an increased awareness of food safety issues among the general public. The costs associated with *Salmonella* infections can be quite substantial and include those related to case investigation, diagnosis, treatment, food recall, lost earnings and compensation for pain and suffering (14,15). In Canada, the average cost for each case of *Salmonella* infection is estimated at $1350 (1985 Canadian dollars) (16), which is comparable to the estimated costs from other countries (17,18).

Despite an estimated under-reporting rate of between 95% and 99% (19), approximately 600 ST infections are reported in Ontario each year through routine surveillance (20). Approximately 35% to 45% of these infections are thought to be ST DT104 (2,21). Prevention and control of ST and ST DT104 infections depend, in part, on an understanding of the risk factors of infection, as well as the temporal and geographical distribution of the disease. This information would be critical in identifying the highest risk groups and, therefore, aid in designing control strategies. The objective of the present study was to investigate temporal and geographical distributions, as well as the reported risk factors of endemic ST and ST DT104 infections in Ontario using passive surveillance data.

METHODS

Data sources and data manipulation

Data included cases of salmonellosis reported between 1990 and 1997 to the Reportable Disease Information System (RDIS) surveillance system. Phage-typing data were obtained from the National Laboratory for Enteric Pathogens (NLEP) in Winnipeg, Manitoba. Therefore, cases of ST were defined as those reported to the RDIS between 1990 and 1997, whereas cases of ST DT104 were those that were confirmed by NLEP. Because provincial surveillance of ST DT104 started in July 1997, data on these cases were limited to the period between August 1997 and July 1998. Antimicrobial resistance data were obtained from Ontario's Central Public Health Laboratory (CPHL). The ST DT104 data were obtained by linking records of ST infections identified in the RDIS to the antimicrobial resistance data provided by the CPHL and to phage-typing results on ST isolates from the NLEP. Since the objective of the present study was to investigate endemic *Salmonella* infections, outbreak-associated cases were excluded from the database before analyses began.

Using the residential postal code information of each of the cases reported in the RDIS between 1995 and 1997, a geographical conversion database (22) was used to assign cases to their respective census division (CD) or county of residence, as well as to assign them a status of rural or urban. This was important to enable geographical analyses of case distribution.

The 1991 Canadian census population was used as the reference population for calculations of age- and sex-standardized rates. The census data for 1991 and 1996 were used to interpolate and extrapolate population sizes for each census division and year. These were used as denominators in the rate calculations.

Data quality evaluation and statistical analyses

Fifteen data fields were examined in the RDIS database. The completion of nine of these fields was mandatory for transmission to the surveillance system under the Ontario Ministry of Health and Long-Term Care. Fields with text entries were examined manually for implausible values. The number and percentage of missing or unspecified values were calculated for each field. Where possible, within-record comparisons were performed to assess internal consistency.

Overall provincial age- and sex-standardized rates were computed for each year of the study period using the direct standardization method and expressed as the number of cases per 100,000 persons (23). CD-specific age- and sex-standardized rates were also computed and reported as number of cases per 100,000 persons. Poisson probabilities were used to assess if the number of cases of ST and ST DT104 reported per CD was significantly higher or lower than would be expected by chance alone. The binomial test, with exact P-values, was used to test for differences between observed and expected proportions. Differences between medians were tested using the Mann-Whitney U test (24). Temporal trend analysis was then performed using simple linear regression and a general additive model approach using S-Plus (Mathsoft Inc, USA) with a locally weighted regression (LOESS) smoother and the month entered as a class variable. All cartographic manipulations and displays were done in ArcView GIS (Environmental Systems Research Institute, USA).

RESULTS

Infections of all *Salmonella* serotypes

A total of 24,225 cases of *Salmonella* infections were reported during the study period. Of these cases, 1277 were outbreak related and were therefore excluded from the study. The mean annual provincial age- and sex-standardized rate of the remaining 22,948 endemic cases was 27 cases per 100,000 persons. Fifty-eight per cent of these cases had serotype data. The most commonly reported serotypes were ST (14%), *Salmonella* serotype enteritidis (12%), *Salmonella* serotype heidelberg (8%) and *Salmonella* serotype hadar (7%).

A significantly higher proportion of cases of endemic *Salmonella* infections (46%) was reported from June to September than would be expected (33%) ($P<0.01$). August had the highest monthly proportion of cases (13%), while February had the lowest (6%). The mean annual rate at the CD geographical/spatial scale was 20.8 cases per 100,000 persons. The highest CD level mean annual rates were observed in Toronto (37.2 cases per 100,000 persons), York Region (35.0 cases per 100,000 persons), Manitoulin Island (31.0 cases per 100,000 persons), and Grey County (28.4 cases per 100,000 persons).

TABLE 1
Frequency distribution of missing or unspecified values of fields of cases of *Salmonella* serotype typhimurium infections reported in Ontario from 1990 to 1997 (n=3129)

RDIS field*	Number missing	Number unspecified	% missing or unspecified
Responsible health unit	0	0	0.0
Episode date	0	0	0.0
Disease	0	0	0.0
Organism/Agent	0	0	0.0
Sex	1	2	0.1
Date of birth	9	0	0.3
Census division†	134	0	4.3
Outbreak related	169	142	9.9
Risk setting	434	1118	49.6
Symptoms	1604	204	57.8
Probable source	282	1677	62.6
Hospitalization	2217	21	71.5
Specify/Second source	2283	89	75.8
Complications	2580	161	87.6
Risk factor	2876	248	99.8

**Completion of Reportable Disease Information System (RDIS) field names in bold type was mandatory for reporting to the Ontario Ministry of Health; †Postal codes were converted to census divisions by the Ontario Ministry of Health, then removed from the database of cases reported before 1995. Permission was obtained to include postal codes in the database of cases reported between 1995 and 1997. These postal codes were converted to census divisions using a geographic conversion file.*

ST Infections

Of the 3226 cases of ST infections reported during the study period, 3129 (97%) were nonoutbreak related and were included in the study. Table 1 shows the proportions of missing and unspecified fields of the reported cases of ST infections. Generally, most mandatory/required fields had more complete data than the nonrequired fields. The field with the highest proportion of missing or unspecified data was 'risk factor' (Table 1).

The highest rates were observed in the zero- to four-year-old age group for both males (16.7 cases per 100,000 persons) and females (15.7 cases per 100,000 persons) (Figure 1). Moreover, the median age of male cases (13 years) was significantly lower than that of females (20 years) ($P<0.01$). The most commonly reported symptom of the cases of ST infections was loose stools (29%), followed by fever (14%) (Table 2). Table 3 shows the frequency distribution (by age, sex, hospitalization status, probable sources of infection and risk setting) of reported ST cases. The most frequent risk setting was the home (30.5%), followed by travel (7.8%). On the other hand, the most common source of infection was food (32%), while the least common was sexual contact (0.2%).

There were seasonal patterns in the occurrence of ST cases, with 53% being reported between June and September. For all *Salmonella* serotypes, August had the highest monthly proportion of cases (16%), while December had the lowest (4%) (Figure 2). There was also a significant linear trend, with a 0.5% monthly increase in the number of cases ($P<0.01$).

The spatial distribution of the CDs included in the study is shown in Figure 3. The geographical distribution of rates of ST infections is presented in Figure 4. The mean annual rate of ST infection at the CD spatial scale was 3.7 cases per 100,000 persons. The highest rates were observed in Manitoulin Island

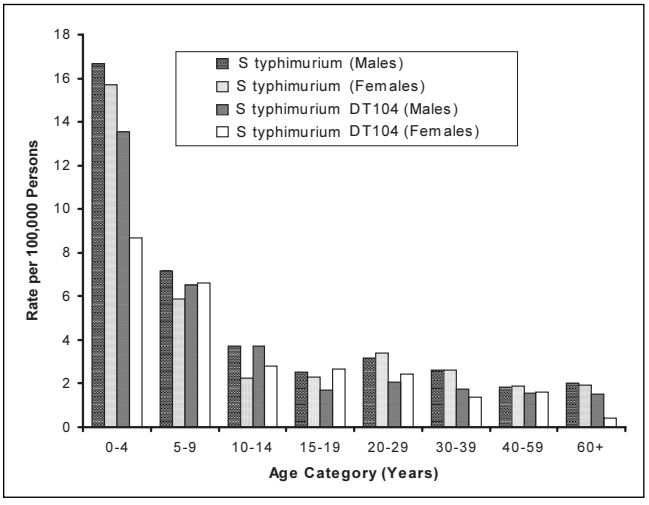

Figure 1) *Distribution, by age and gender, of* Salmonella *serotype typhimurium* (S typhimurium) *and* S typhimurium *definitive type 104 (DT104) rates reported in Ontario*

TABLE 2
Frequency distribution of symptoms reported for cases of *Salmonella* serotype typhimurium infections in Ontario from 1990 to 1997 (n=2567)

Symptom*	Number	%
Loose stools	745	29.02
Fever	359	14.00
Watery diarrhea	323	12.58
Cramps	306	11.92
Nausea/vomiting	272	10.60
Abdominal pain	205	7.99
Bloody diarrhea	185	7.21
Malaise	50	1.95
Headache	34	1.32
Chills	30	1.17
Dehydration	13	0.51
Weight loss	9	0.35
Anorexia	7	0.27
Fatigue	6	0.23
Weakness	5	0.19
Dizziness	4	0.16
Lethargy	3	0.12
Discharge	2	0.08
Convulsions	2	0.08
Loss of consciousness	2	0.08
Dysuria	1	0.04
Chest pain	1	0.04
Skin change	1	0.04
Stiff neck	1	0.04
Myopericarditis	1	0.04

**As many as three symptoms were reported per case*

(11.3 cases per 100,000 persons), Grey County (8.7 cases per 100,000 persons), Renfrew County (6.9 cases per 100,000 persons) and Bruce County (6.4 cases per 100,000 persons) (Figure 4). A number of CDs had no reported cases of ST. These included: Dufferin County, Haldimand-Norfolk Regional Municipality, Kent County, Lennox and Addington County, Northumberland County, Perth County, Rainy River

TABLE 3
Comparison of demographic characteristics, reported risk factors and hospitalization rates for cases of Salmonella serotype typhimurium (1990 to 1997) infections and ST definitive type 104 (DT104) infections (August 1997 to July 1998) in Ontario

Field name	Field summary	ST n (%)	ST DT104 n (%)
Number	Number of cases	3129	299
Age	Mean age	22.9	21.2
	Median age	16.0	13.8
Sex	Male	1609 (51.4%)	162 (54.2%)
	Female	1517 (48.5%)	134 (44.8%)
	Unspecified	3 (0.1%)	3 (1.0%)
Outbreak-associated	Yes	97 (3.0%)	2 (0.7%)
	No	2820 (87.4%)	227 (75.9%)
	Missing/Unspecified	309 (9.6%)	70 (23.4%)
Hospitalization	Inpatient	215 (6.9%)	15 (5.0%)
	Outpatient	64 (2.0%)	11 (3.7%)
	No/Unspecified	2850 (91.1%)	273 (91.3%)
Probable source	Food	995 (31.8%)	89 (29.8%)
	Person-to-person	106 (3.4%)	8 (2.7%)
	Water	40 (1.3%)	2 (0.7%)
	Animal	23 (0.7%)	0 (0.0%)
	Sexual contact	6 (0.2%)	0 (0.0%)
	Missing/Unspecified	1959 (62.6%)	200 (66.9%)
Risk setting	Home	955 (30.5%)	84 (28.1%)
	Travel	245 (7.8%)	17 (5.7%)
	Restaurants	193 (6.2%)	20 (6.7%)
	All others*	184 (5.9%)	8 (2.7%)
	Missing/Unspecified	1552 (49.6%)	170 (56.9%)

**'All others' includes workplace, schools, daycare, hospitals, facilities for the disabled, correctional facilities and/or natural bodies of water*

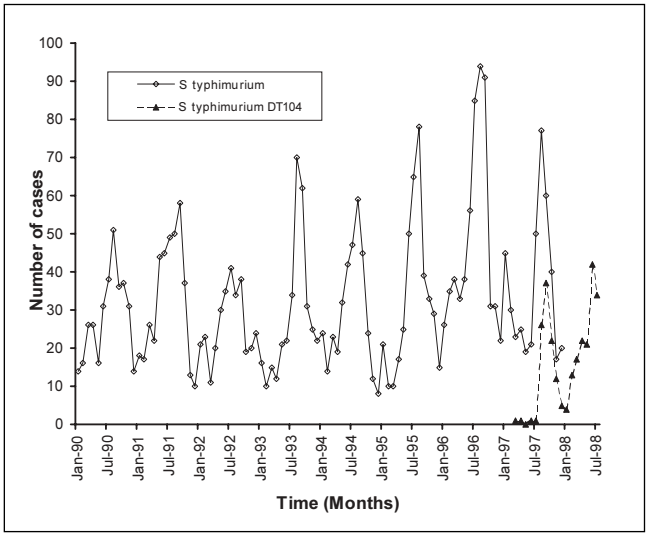

Figure 2) *Temporal Distribution of* Salmonella *serotype typhimurium (S typhimurium) and S typhimurium definitive type 104 (DT104) cases reported in Ontario*

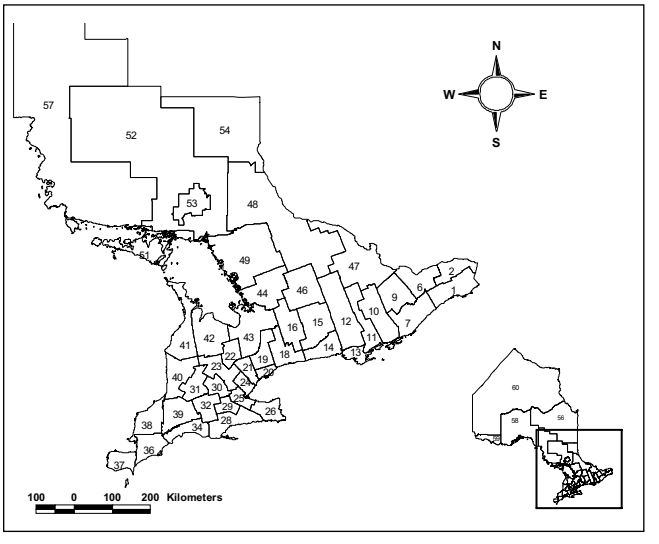

Figure 3) *Spatial distribution of counties (census divisions) of Ontario. Please see Appendix I for a legend of this map*

District, Toronto Metropolitan Municipality and York Regional Municipality. Although only 15% of the ST cases reported were from rural areas, most of the CDs with the highest rates were relatively rural.

ST DT104 infections

A total of 299 cases of ST DT104 infections were reported, two of which were identified as outbreak related. The age distribution of cases of ST DT104 infections was similar to that of ST cases, except for an absence of a significant peak in the 20- to 29-year-old age group. The annual provincial age- and sex-standardized rate was 2.7 cases per 100,000 persons, with the highest rate being reported among the zero- to four-year-old age group for both males (13.5 cases per 100,000 persons) and females (9.7 cases per 100,000 persons). As with the ST infections, higher rates were generally observed in males than in females. The most frequent risk setting was the home (28.1%), followed by restaurants (6.7%); the most common source of infection was food (29.8%) (Table 3). As was the case with ST infections, a significantly higher than expected (33%) proportion of ST DT104 cases (54%) was reported between June and September (P<0.01); however, September had the highest proportion of the cases (17%) (Figure 2).

Thirty-five of the 49 CDs across Ontario reported at least one case of ST DT104 infection, of which 14 reported single cases. The highest rates of ST DT104 infection were observed in Grey County (7.9 cases per 100,000 persons), Niagara Regional Municipality (4.4 cases per 100,000 persons), Toronto Metropolitan Municipality (3.9 cases per 100,000 persons) and Hamilton-Wentworth Regional Municipality (3.8 cases per 100,000 persons). The Toronto and Niagara regions had significantly higher numbers of ST DT104 infections than expected (P<0.01), while Hamilton-Wentworth and Grey County had only marginally significant numbers (P=0.06). Ninety-one per cent of the cases of ST DT104 infections were from urban areas; the rest were from rural areas.

Isolates of ST DT104 resistant to four or more antimicrobial agents were identified in 90.4% of the cases. The typical multiresistant pattern was observed in 87.6% of the isolates and it included resistance to ampicillin, chloramphenicol, piperacillin, tetracycline hydrochloride and ticarcillin disodium (Table 4). Only 6.8% of the isolates were susceptible to all 13 antimicrobials tested.

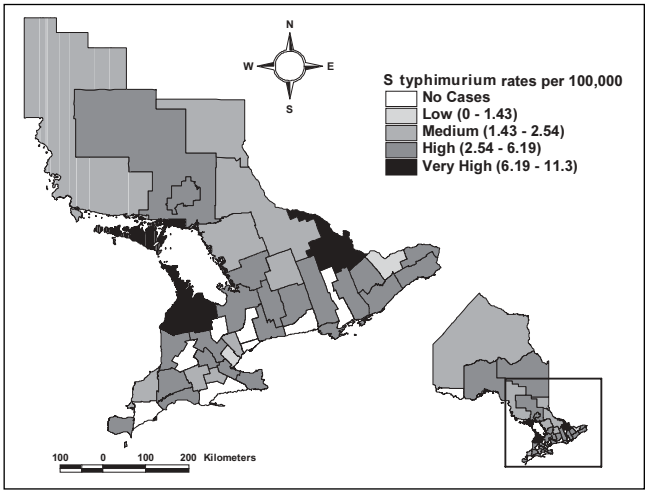

Figure 4) *Geographical distribution of rates of* Salmonella *serotype typhimurium (S typhimurium) reported in Ontario from 1990 to 1997*

TABLE 4
Frequency distribution of multiresistant patterns* of *Salmonella* serotype typhimurium definitive type 104 (DT104) isolates reported in Ontario from August 1997 to July 1998 (n=251)

Resistance pattern	Number of isolates	%
1. Ampicillin, chloramphenicol piperacillin, tetracycline HCl and ticarcillin disodium	220	87.6%
2. Same resistance pattern in #1 plus tobramycin sulfate	6	2.4%
3. Same resistance pattern in #1 plus sulphamethoxazole/ trimethoprim	1	0.4%
4. Resistance to one to three antibiotics	7	2.8%
5. Sensitive to all antibiotics	17	6.8%

**Isolates were screened for susceptibility to amikacin sulfate, ampicillin, cefoxitin sodium, cefotaxime sodium, cephalothin, chloramphenicol, ciprofloxacin, gentamicin sulfate, piperacillin sodium, tetracycline hydrochloride, ticarcillin disodium, tobramycin sulfate, and sulfamethoxazole/trimethoprim*

DISCUSSION

The results of this study suggest that salmonellosis remains a significant problem in Ontario, with rates as high as 37 cases per 100,000 in certain regions. In agreement with reports from other studies in Canada (25), ST was the most commonly reported serotype. ST DT104 comprised over one-third of all ST infections reported, suggesting it is a potentially important pathogen in the province.

The zero- to four-year-old age group had the highest rates of both ST and ST DT104 infections, a finding that is consistent with other reports (11,26,27) and may be due to the less developed immune system in this age group. However, there is no clear explanation for the higher rates among males compared with females. Consistent with the literature (2), the most commonly reported symptoms of ST infection included loose stools, fever, watery diarrhea, cramps, and nausea and vomiting. The home was identified as the most frequently reported risk setting for both ST and ST DT104 infections, suggesting that control programs need to focus on personal hygiene in the home, probably through education on best personal hygienic and food handling practices. Although food was the most commonly reported suspect-source of both ST and ST DT104 infections in the current study, the lack of specific information on the foods consumed creates difficulty in hypothesizing high-risk food items. However, other studies have reported that human infections most often occur through the consumption of contaminated poultry, eggs, red meat, unpasteurized milk and other dairy products (28-30), although foods such as alfalfa sprouts, unpasteurized fruit juices and tomatoes have also been incriminated (30-32).

The temporal distribution of both ST and ST DT104 infections with seasonal peaks in the late summer months is consistent with results from other studies (26,33,34). This could be attributed to the fact that in Canada this is the time with the highest proportion of outdoor activities, such as camping, vacation and family gatherings, which involve many 'barbecue activities' that could potentially increase the risk of food-borne infections. The increasing temporal trend in the number of reported cases of ST over the study period could be attributed to increasing incidence of infection, increasing reporting rates, and/or improved case ascertainment resulting from improved diagnostic and surveillance activities over time.

Contrary to the results of a Scottish study (35) that reported that higher rates of ST DT104 infection occur in rural areas, higher rates of ST infection were observed in urban areas in the present study, probably due to higher reporting rates in these areas resulting from greater availability of health care facilities. A number of studies (36,37) have demonstrated that the likelihood of ascertainment of disease cases in a population is a function of the amount and type of available health services, and may sometimes be independent of the extent of the disease in the population. However, the possibility of a true higher incidence of the disease in the more urban areas cannot be ruled out. It should, however, be noted that some of the infections reported in the urban areas probably occurred in rural areas during vacation and camping activities but were reported in the urban areas where the patients have their permanent residences. The significantly higher than expected number of cases of ST DT104 infections in Toronto and Niagara regions could therefore be due to either higher incidence or differential reporting of cases. Morever, the apparent differences in the geographical distribution of infections may also reflect differences in the geographical distribution of important risk factors/behaviours across the province. As has been noted by other authors (34), knowledge of the geographical patterns of infection should improve our knowledge of the transmission patterns and, therefore, aid in designing control strategies of *Salmonella* infections in the field.

Over 90% of ST DT104 isolates tested for antimicrobial susceptibility were resistant to four or more antimicrobials. Other authors (37) have reported multiresistance of ST DT104 to ampicillin, chloramphenicol, streptomycin, sulfonamides and tetracycline hydrochloride. A study in the United States reported that isolates of ST DT104 resistant to five or more antimicrobial drugs were on the increase in human populations, and that the proportion of resistant isolates in animals was 73% (38). That study also reported that 99% of the multiresistant phages in humans in the northwestern United States were ST DT104 (38). The authors also reported that human patients with the multiresistant isolates resided in areas with above-average cattle farm densities and were more likely to report direct contact with cattle than those patients infected with other, less resistant isolates. The pattern of infection with resistant isolates of

ST DT104 was different in the present study, in which most of the cases resided in the more urban areas, where they were less likely to have had contact with livestock. It is likely that these patients may have acquired infections from contaminated foods of animal origin (2) rather than through direct contact with livestock.

The present study reflects the potential usefulness of existing health databases in disease monitoring and surveillance. However, it should be pointed out that for the data to be useful for this purpose, it is imperative that the quality be improved. It was observed in the present study that the non-mandatory fields were not as complete as those that were mandatory. For example, there were high proportions of missing and unspecified values for most of the nonmandatory fields, the impact of which may bias the results (39). It therefore appears that inclusion of more important data fields under the required (mandatory) list of fields would greatly improve data completeness and, hence, quality. In addition, due to under-reporting, the rates of *Salmonella* infections reported in the present study likely considerably underestimate the true incidence of the disease in Ontario and should, therefore, be interpreted more as reporting rates than as incidence rates. Previous studies have shown that reporting rates for *Salmonella* infections may represent only 1% to 5% of the cases that actually occur (19). With this in mind, we estimate that between 5900 and 29900 cases of ST DT104 infection may occur annually in the province. Reduction of under-reporting and differential reporting would require increased awareness of Public Health professionals, especially those involved in the collection of the surveillance data, of the potential usefulness of these data and, therefore, of the need to improve their quality. Collaboration between these health professionals and research institutions would therefore be beneficial.

The results of this study suggest that ST and ST DT104 infections are important enteric diseases in Ontario, with increased risks of infection in the late summer months and higher rates of infection among males and children under five years of age. The geographical distribution of cases of ST DT104 infection was different from that for all ST infections, suggesting that the risk factors for ST DT104 infection may differ from those for ST infection as a whole. However, both ST and ST DT104 were characterized by significantly higher proportions of reported cases in urban areas. Since an understanding of risk factors is an important element in the control of these infections, prospective analytical observational studies of risk factors for ST and ST DT104 infection in Ontario are warranted.

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APPENDIX I
The Codes and Names of the counties (census divisions) in Ontario

CD (County Code)	CD Name	CD (County Code)	CD Name
1	Stormont, Dundas and Glengarry United Counties	32	Oxford County
2	Prescott and Russell United Counties	34	Elgin County
6	Ottawa-Carleton Regional Municipality	36	Kent County
7	Leeds and Grenville United Counties	37	Essex County
9	Lanark County	38	Lambton County
10	Frontenac County	39	Middlesex County
11	Lennox and Addington County	40	Huron County
12	Hastings County	41	Bruce County
13	Prince Edward County	42	Grey County
14	Northumberland County	43	Simcoe County
15	Peterborough County	44	Muskoka District Municipality
16	Victoria County	46	Haliburton County
18	Durham Regional Municipality	47	Renfrew County
19	York Regional Municipality	48	Nipissing District
20	Toronto Metropolitan Municipality	49	Parry Sound District
21	Peel Regional Municipality	51	Manitoulin District
22	Dufferin County	52	Sudbury District
23	Wellington County	53	Sudbury Regional Municipality
24	Halton Regional Municipality	54	Timiskaming District
25	Hamilton-Wentworth Regional Municipality	56	Cochrane District
26	Niagara Regional Municipality	57	Algoma District
28	Haldimand-Norfolk Regional Municipality	58	Thunder Bay District
29	Brant County	59	Rainy River District
30	Waterloo Regional Municipality	60	Kenora District
31	Perth County		

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