Animal and environmental risk factors for sporadic Shiga toxin-producing Escherichia coli (STEC) infection in England: A Case Control Study for O157, O26 and other STEC Serotypes

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Abstract Most Shiga toxin-producing E. coli (STEC) infections are sporadic. Routine enhanced surveillance questionnaires of confirmed STEC cases in England contained promising data to conduct a case-control study to identify non-food exposures linked to the risk of becoming infected with different STEC serotypes, including O157, O26 and all others; this study pulled eligible cases from the recorded enhanced surveillance data. Controls were recruited from the general population and answered a comparable postal questionnaire. Logistic regression was performed to identify risk factors associated with STEC infection for O157, O26 and other serotype cases. In adjusted models, travel outside of the UK and childcare occupations raised the risk of infection for all serotypes. Day trips within the UK, exposure to dogs and contact with soil were linked to lower infection risk. Resident region within England was often linked to decreased risk. Summer season was linked to O157 and O26, but not other STEC. Swimming in the sea was linked to increased risk of infection by O157 but not other types of STEC. Correlations between exposures and infection were similar when the analysis was repeated excluding participants with a history of foreign travel. As the first case-control study in England to include sporadic non-O157 STEC, the varying risk factors between O157 and non-O157 cases suggest there are potentially unique reservoirs for the different serotypes.

Methods

A prospective case-control study was run between February 2019 and March 2020. Participants had to be resident in England and between 0-70 years of age.

Cases Case data was extracted from PHE's National Enhanced Surveillance for STEC database. Cases completed a questionnaire over a telephone interview. Cases were excluded if they were part of a recognised outbreak, co-infected with another GI pathogen, or part of the prison system.

Controls NHS Digital provided a database of potential participants, randomly selected from English residents registered with a GP practice. Invitations to participate were mailed to participants and they completed the questionnaire on their own. Controls were asked not to participate if they'd experienced and an upset stomach or diarrhoea in the month prior to participation.

Invitations Sent	Completed Returns	Ineligible	Do Not Contact Again
11,000	600	274	351

Questionnaire The control questionnaire was based on PHE's Enhanced Surveillance Questionnaire. Both groups answered about exposures in the week prior to either illness (cases) or completing the questionnaire (controls).

Data Analysis Deprivation scores and rurality designations were assigned to each participant through their post code and lower super output areas (LSOA). After univariate analysis, all exposures with a $p < 0.2$ were included in a multivariate logistic regression model. All models were adjusted by age quintile (0-5, 6-18, 19-38, 39-56 and 57-71 years).

Results

Table 1: Characteristics of Study Cohort

Trait	Controls n=600	STEC O157 cases n=384	STEC O26 cases n=50	Other STEC cases n=127	All n=1161
Female*e	56.0%	54.4%	52.0%	59.8%	55.7%
Median age (years)	33	26 **	15.5 **	26 **	27
Age IQR	8-59	10-46	2-31	7-50	8-52
age 60-71	30.7%	8.1% **	10.0% **	14.2% **	20.2%
Resident in most deprived quintile	11.9%	15.2%	8.0%	18.1% **	13.8%
Resident in a large urban area	32.9%	35.7%	38.0%	40.9%	34.9%
History of recent foreign travel	7.5%	43.9% **	26% **	32.3% **	22.9%

* = p < 0.05; ** = p < 0.01

Figure 1: Age distributions of cases and controls

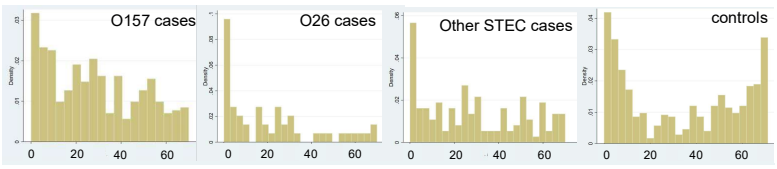

Table 2. Multivariate models for exposures associated with STEC infections in England

	STEC O157 n=935	STEC O26 n = 601	Other STEC n = 679
Factor	OR (95% CI)	OR (95% CI)	OR (95% CI)
Childcare Occupation	5.47 (3.21-9.33)**	11.16 (3.84-32.39)**	7.66 (3.61-16.26)**
Travel out of UK	8.81 (5.61-13.82)**	7.50 (2.90-19.40)**	8.78 (4.52-17.08)**
Travel in UK			0.56 (0.30-1.06)
Swam in Sea	2.18 (1.22-3.90)**		
Dogs	0.74 (0.53-1.03)	0.51 (0.24-1.08)	0.57 (0.34-0.95)*
Non domestic animals			3.88 (1.70-8.89)**
Day Trips	0.48 (0.33-0.70)**	0.38 (0.17-0.87)*	0.18 (0.09-0.37)**
Petting Zoo		4.01 (1.49-10.76)	
Food At Zoo			0.29 (0.09-1.00)
Soil/Muck	0.40 (0.27-0.60)**	0.56 (0.26-1.21)	0.28 (0.14-0.53)**

* = p < 0.05; ** = p < 0.01

Table 3. Multivariate models for exposures for STEC cases (excluding respondents without history of foreign travel)

	STEC O157 n = 727	STEC O26 n=547	Other STEC n = 596
Factor	OR (95% CI)	OR (95% CI)	OR (95% CI)
Childcare Occupation	5.67 (3.26-9.84)**	14.72 (4.97-43.7)**	8.68 (3.74-20.15)**
Swam in Sea	2.97 (1.38-6.40)**		
Swallowed water	0.63 (0.35-1.12)		
Dogs		0.49 (0.22-1.10)	0.53 (0.30-0.96)*
Non domestic animals			2.44 (0.99-6.02)
Petting Zoo		5.61 (2.14-14.74)**	
Day Trips	0.48 (0.31-0.75)**	0.43 (0.18-1.04)	0.09 (0.32-0.23)**
Paddock/Field			2.06 (1.04-5.43)*
Soil/Muck	0.47 (0.31-0.72)**		0.30 (0.14-0.62)**

* = p < 0.05; ** = p < 0.01

Table 4. Population attributable risk percentages for exposures that increase the risk of being an STEC case in England

	With foreign travel			No foreign travel		
Factor	O157	O26	Other	O157	O26	Other
Travel out of UK	38.3%	22.5%	28.6%			
Childcare occupation	14.7%	21.8%	17.%	18.9%	25.2%	19.5%
Swam in Sea	11.7%			5.8%		
Petting Zoo visit		18.0%			24.4%	
NonDom Animals			11.7%			8.9%
Paddock/Field						10.2%

Conclusions

- Childcare occupations and foreign travel are associated with an increased risk in STEC infections
- Day trips in the UK, contact with dogs and contact with soil decreased the risk of infection
- This case-control study provides evidence risk factors for different STEC serotypes may not be the same.

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