Epidemiology and Infection

www.cambridge.org/hyg

From the Field

Cite this article: Quinn O, Yanshi , King G, Hoban A, Sawyer C, Douglas A, Painset A, Charlett A, Nelson A, Rees C, Byers C, Williams C, Brown C, Mohan K, Brown C, Jenkins C, Neill C, Leckenby G, Larkin L, Allison L, Olufon O, Nickbakhsh S, Mannes T, Inns T and Balasegaram S (2024). National outbreak of Shiga toxin-producing *Escherichia coli* O145:H28 associated with pre-packed sandwiches, United Kingdom, May–June 2024. *Epidemiology and Infection*, **152**, e179, 1–5
https://doi.org/10.1017/S0950268824001729

Received: 14 August 2024
Accepted: 21 November 2024

Keywords:
Shiga toxin-producing *Escherichia coli*; outbreaks; United Kingdom; pre-packaged sandwiches; epidemiology; surveillance

Corresponding author:
Yanshi;
Email: yanshi.yanshi@ukhsa.gov.uk

National outbreak of Shiga toxin-producing *Escherichia coli* O145:H28 associated with pre-packed sandwiches, United Kingdom, May–June 2024

Orlagh Quinn[1], Yanshi[1], Grace King[1], Ann Hoban[1], Clare Sawyer[1], Amy Douglas[1], Anaïs Painset[1], Andre Charlett[1], Andrew Nelson[2], Carys Rees[1], Chloe Byers[1], Christopher Williams[2], Colin Brown[1], Kitty Mohan[1], Claire Brown[1], Claire Jenkins[1], Claire Neill[3], Genna Leckenby[4], Lesley Larkin[1], Lesley Allison[5], Oluwakemi Olufon[1], Sema Nickbakhsh[4], Trish Mannes[1], Thomas Inns[1] and Sooria Balasegaram[1]

[1]UK Health Security Agency, London, UK; [2]Public Health Wales, Cardiff, UK; [3]Public Health Agency, Belfast, Northern Ireland; [4]Public Health Scotland, Glasgow, UK and [5]Scottish Escherichia coli O157/STEC Reference Laboratory, Edinburgh, UK

Abstract

Shiga toxin-producing *Escherichia coli* (STEC) is a group of bacteria that causes gastrointestinal illness and occasionally causes large foodborne outbreaks. It represents a major public health concern due to its ability to cause severe illness which can sometimes be fatal. This study was undertaken as part of a rapid investigation into a national foodborne outbreak of STEC O145. On 22 May 2024, United Kingdom (UK) public health agencies and laboratories identified an increase in stool specimens submissions and patients testing positive for Shiga toxin-producing *E. coli* (STEC). Whole genome sequencing (WGS) identified serotype O145:H28 *stx2a/eae* belonging to the same five single nucleotide polymorphism (SNP) single linkage cluster as the causative agent. By 3 July 2024, 288 cases had been linked to the cluster. Most cases were adults (87%) and females (57%), 49% were hospitalized with a further 10% attending emergency care. Descriptive epidemiology and analytical studies were conducted which identified consumption of nationally distributed pre-packed sandwiches as a common food exposure. The implicated food business operators voluntarily recalled ready-to-eat sandwiches and wraps containing lettuce on 14 June 2024.

Background

Enhanced surveillance systems for STEC across the UK combine detailed clinical and epidemiological data (including symptoms, travel, food, and animal exposure) collected on enhanced surveillance questionnaires (ESQ) with the microbiological characterization of strains using whole genome sequencing (WGS) [1]. Diagnostic laboratories report presumptive cases of STEC based on PCR or culture, directly to health protection teams (and to local authorities in Wales), who undertake public health management including collection of information via the STEC ESQ within 48 h.

Faecal specimens from suspected cases of STEC and/or isolates of STEC are referred to the UKHSA Gastrointestinal Bacteria Reference Unit (GBRU) in London or the Scottish *E. coli* Reference Laboratory (SERL) in Edinburgh. Faecal specimens testing positive for STEC by PCR are cultured and all isolates of STEC are sequenced. Characterization includes clonal complex and sequence typing, serotyping, *stx* typing, and SNP typing [2].

Descriptive epidemiology

Of the 288 reported cases, confirmed to be linked by WGS within a five SNP cluster, 286 were symptomatic primary cases; four (two in England and two in Scotland) were symptomatic secondary cases. Symptom onset dates of the primary cases ranged from 29 April 2024 to 17 June 2024 (Figure 1). Primary cases had a median age of 29 years (range: 1–89) and were predominantly female (57%) (Figure 2). Cases were geographically dispersed across the UK. For cases where information was available (n = 263), 49% of cases were hospitalized, and 80% of symptomatic cases reported bloody diarrhoea. There were nine cases of haemolytic uraemic syndrome (HUS), and two deaths among these confirmed cases (Table 1).

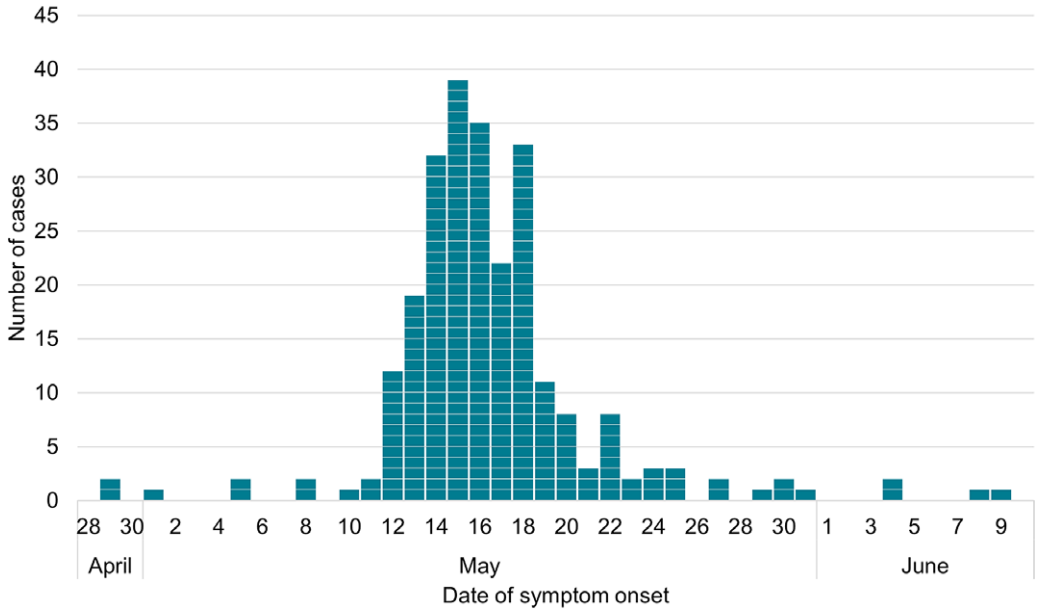

Figure 1. Confirmed primary cases by date of symptom onset (n = 248).
Note: Onset date is unavailable for 38 cases.

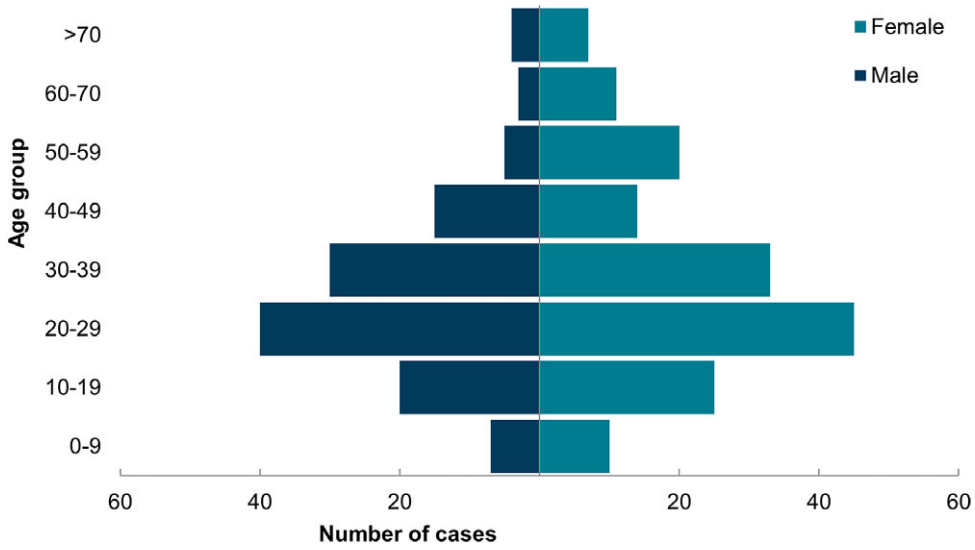

Figure 2. Age/sex pyramid of cases (n = 288).

Hypothesis generation

Data collected through UKHSA's National Enhanced STEC Surveillance System (NESSS), and complementary enhanced surveillance in Scotland, Wales, and Northern Ireland, were reviewed. A case–case study was conducted using English cases in the outbreak cluster as cases, and other English STEC cases as controls. Cases and controls with the same age profile and with sample dates from April 2024 to May 2024 were included. The analysis indicated pre-packaged sandwiches as a possible hypothesis, OR 4.91 (95%CI 1.51–15.1, P 0.004). A similar study in Wales identified the same hypothesis. In logistic regression with subsequent cases (outbreak cases n = 59, control cases n = 64) the final model included pre-packaged sandwiches (OR 3.88, 95%CI 1.65–9.57, P 0.002), iceberg lettuce (OR 2.99, 95%CI 1.24–7.48, P 0.016), and eating out (OR 2.17, 95%CI 0.91–5.37, P 0.08) as significant exposures for the outbreak cases.

In total, 11 of 15 cases interviewed with a trawling questionnaire reported consuming pre-packaged sandwiches from different national retailers. Additionally, given the incubation period of STEC, the epi curve indicated that the exposure period for the cases must have been very brief and therefore suggestive of a short shelf-life product. Based on the generated hypothesis, we undertook an analytical study using targeted questionnaires with more detail on pre-packaged sandwiches, eating out, and salad consumption. Case data were correct as of 09 June 2024 (n = 43).

Analytical studies

Following the initial case–case studies, outbreak cases were compared to two sources of control. All controls were frequency matched to cases in age bands and reported no travel outside of the UK in the week before data collection. Controls in study 1 were

https://doi.org/10.1017/S0950268824001729 Published online by Cambridge University Press

Table 1. Clinical information including reported symptoms (n = 263)

Clinical information	No. cases	%
Diarrhoea	253	96%
Blood in stool	210	80%
Nausea	147	56%
Vomiting	100	38%
Abdominal pain	238	90%
Fever	79	30%
Other symptoms	44	17%
Attended A&E	103	39%
Admitted to hospital	129	49%
Haemolytic uraemic syndrome	9	3%
Death	2	1%

Note: Data is unavailable for 25 cases.

cases of *Salmonella* residents in the UK with a notification date from 01 April 2024 to 09 June 2024, (n = 63) and were asked about their food histories for the week prior to their onset with *Salmonella*. Controls in study 2 were recruited by a Market Panel [3] and reported no diarrhoea in the previous week (06 June 2024).

In both analytical studies, variables significantly associated with outbreak case status (odds ratio (OR) > 1 and P < 0.1) in single variable analysis and age and sex as *a priori* potential confounding variables were included in a multivariable Firth logistic regression model using a forward step approach for model construction with all models including the potential confounders.

In the multivariable models, cases were significantly more likely to have consumed pre-packaged sandwiches containing lettuce (for Study 1 Model 1 OR 7.1, 95%CI 2.3–21.5, P 0.001; and for Study 2 Model 1 OR 4.8, 95%CI 1.9–12.0, P < 0.001) (Table 2).

In Study 2 Model 2 (Table 2), cases were significantly more likely to have consumed a prepackaged sandwich with lettuce compared to any other type of sandwich or no sandwiches (OR 7.1, 95%CI 3.0–17.5, P < 0.001).

Table 2. Multivariable analysis of estimated odds ratios of infection with STEC O145 t5.206

Study 1 Model 1: STEC O145 t5.206 cases with Salmonella cases as case-controls.	Cases (n = 43)		Controls (n = 63)				
Exposure	n	%	n	%	aOR*	95% CI**	P value
Age (ref: 11–18 year olds)							
Age: 19–29 year olds	25	58	18	29	4.4	0.9–21.3	0.06
Age: 30–70 year olds	12	28	33	52	2.3	0.5–10.8	0.3
Sex (ref: female)							
Male	15	35	22	35	1.2	0.4–3.1	0.3
Consumed a pre-packaged sandwich containing any lettuce leaf	25	58	6	10	7.1	2.3–21.5	0.001
Consumed a pre-packaged sandwich containing BLT/bacon	14	33	1	2	6.7	1.0–43.4	0.05
Study 2 Model 1: STEC O145 t5.206 cases with market panel controls							
Exposure	Cases (n = 43)		Controls (n = 93)				
	n	%	n	%	aOR*	95% CI**	P value
Age (ref: 11–18 year olds)							
Age: 19–34 year olds	25	58	43	46	2.1	0.5–8.4	0.3
Age: 35–70 year olds	12	28	37	40	1.1	0.3–4.5	0.9
Sex (ref: female)							
Male	15	35	35	38	1.0	0.4–2.6	>0.9
Consumed a pre-packaged sandwich containing BLT/bacon	14	33	3	3	6.4	1.7–24.7	0.007
Consumed a pre-packaged sandwich containing any lettuce leaf	25	58	15	16	4.8	1.9–12.0	0.001
Mince beef	15	35	18	19	2.7	1.0–6.9	0.04
Study 2 Model 2: Assessing lettuce in sandwich variable using market panel controls							
Exposure	Cases (n = 43)		Controls (n = 93)				
	n	%	n	%	aOR*	95% CI**	P value
Age (ref: 11–18 year olds)							
Age: 19–34 year olds	25	58	43	46	1.8	0.5–6.2	0.7
Age: 35–70 year olds	12	28	37	40	1.0	0.3–3.5	>0.9
Sex (ref: female)							
Male	15	35	35	38	1.2	0.5–2.9	0.7

(*Continued*)

https://doi.org/10.1017/S0950268824001729 Published online by Cambridge University Press

Table 2. (*Continued*)

Study 2 Model 2: Assessing lettuce in sandwich variable using market panel controls Exposure	Cases (n = 43)		Controls (n = 93)				
	n	%	*n*	%	aOR*	95% CI**	*P* value
Sandwich containing lettuce (ref: no sandwich eaten)							
Consumed sandwich containing lettuce	25	58	15	16	7.1	3.0–17.5	<0.001
Consumed sandwich without lettuce	3	7	13	14	1.0	0.3–3.9	>0.9
Consumed sandwich possibly containing lettuce	3	7	10	11	1.5	0.4–6.0	0.5
Study 2 Model 3: Assessing lettuce whilst dining out using market panel controls Exposure	**Cases (n = 43)**		**Controls (n = 93)**				
	n	%	*n*	%	aOR*	95% CI**	*P* value
Age (ref: 11–18 year olds)							
Age: 19–34 year olds	25	58	43	46	1.8	0.5–6.1	0.3
Age: 35–70 year olds	12	28	37	40	1.0	0.3–3.5	>0.9
Sex (ref: female)							
Male	15	35	35	38	1.2	0.5–2.8	0.7
Lettuce when dining out (ref: no sandwich eaten with lettuce or no dining out meal including lettuce)							
Consumed sandwich containing lettuce	25	58	15	16	7.2	3.1–16.8	<0.001
Consumed lettuce as part of a meal out (but not in a sandwich)	3	7	10	11	1.4	0.4–5.4	0.6

*aOR: Adjusted odds ratio.
**CI: confidence interval.

A separate model to compare lettuce consumed in sandwiches to lettuce consumed when eating out showed the latter was not significant either (Study 2 Model 3) (Table 2).

Food chain and environmental investigation

Food chain investigations identified the sandwich producer that supplied the retailers during May 2024. The sandwich producer had sourced lettuce from farms in England. Further food chain investigations are ongoing.

Control measures

On 13 June 2024, supplier/producer A and B voluntarily recalled various sandwiches, wraps, and salads because of possible contamination with *E. coli*. Consumers who had bought the products listed were advised not to eat them, and to return them to the store where they were purchased for a full refund. A further recall occurred on 15 June 2024 by supplier/producer C.

Epipulse communications to ECDC indicated of the 13 European countries who replied, none were affected.

Discussion

Since 2015, across the UK notifications of STEC O157:H7 have declined and STEC O26:H11 and STEC O145:H28 have emerged as a significant cause of gastrointestinal infectious disease and HUS [1, 4, 5]. Since 2020, STEC O145:H28 has consistently been in the top five most common STEC serotypes reported in England and Scotland [5, 6].

Outbreaks of STEC infection have previously been associated with pre-packed sandwiches and salad vegetables, mainly lettuce, in the UK and elsewhere [7–10]. Ready-to-eat salad vegetables are vulnerable to contamination with pathogens at the pre-harvest level via flooding, rainwater run-off, or irrigation water containing animal faeces [11]. Current methods for washing and decontaminating fresh produce cannot guarantee that pathogens, if present, will be removed. STEC can adhere to leaves and become internalized within leafy vegetables [12]. The application of controls to minimize the risk of faecal contamination during growing, handling, and processing is therefore of fundamental importance in ensuring the safety of fresh produce.

Monitoring PCR results provided an early indication of the outbreak and surveillance data case–case analysis facilitated rapid hypothesis generation. Subsequent analytical studies established a precise definition and exploration of the composite product. Interdisciplinary collaboration and cooperation from the major food retailers led to voluntarily removal of the implicated product from sale thus reducing the risk of an on-going transmission.

Number of confirmed cases decreased since 31 May 2024, but the outbreak has not yet been declared over. Food chain investigations are ongoing, and the location of the animal reservoir and/or mechanisms of crop contamination are currently unclear. Possible routes of contamination include a failure in control measures protecting the crop from agricultural run-off, contamination of water or growing materials used in lettuce production, or contaminated seeds. The implicated lettuce is a UK product, and no cases are known to have occurred outside the UK. Nevertheless, the international community should be aware of this vehicle of infection and monitor for possible ongoing cases linked to this outbreak

https://doi.org/10.1017/S0950268824001729 Published online by Cambridge University Press

of STEC O145:H28, as similar routes of contamination may occur in other countries.

Acknowledgements. The article has been written on behalf of the Incident Management Team. The authors thank the following for their contributions to the outbreak investigations: cases who provided detailed information; Health Protection Teams, the Rapid Investigation Team, the Syndromic Surveillance team, other Field Services Teams, the Gastrointestinal Infections, Food Safety and One Health Division and Local Authorities for their assistance in the investigation of cases and conducting interviews; frontline and reference laboratory colleagues, as well as members of the Diagnostics and Genomic Cell for their laboratory investigations including the generation, analysis and interpretation of WGS data; colleagues at the Food Standards Agency (including Wales and Northern Ireland) who led the Food Chain and Sampling Cell, as well as Food Standard Scotland; colleagues at the Animal and Plant Health Agency who supported environmental investigations into the root cause of the outbreak; to the staff in the Clinical Cell for clinical follow up of cases, assessing severity and liaising with National Health Service England colleagues; the Communications Cell for managing all internal and external communications including proactive public health messaging and to the members of the Data, Epidemiology and Analysis Cell and all the other staff from UK Health Security Agency, Public Health Scotland, Public Health Wales and Public Health Agency of Northern Ireland who assisted with this outbreak investigation and supported the completion of the analytical studies.

Author contribution. All authors were directly involved in the gathering of epidemiological and microbiological data to inform the management and investigation of the outbreak. Outbreak management was led by Amy Douglas, Lesley Larkin, Trish Mannes, Kitty Mohan, and Colin Brown. Interpretation of typing and whole genome sequencing data was led by Anaïs Painset, Claire Jenkins, and Lesley Allison. Coordination of Welsh cases, data, and response was managed by Andrew Nelson, and Christopher Williams. Coordination of Scottish cases, data, and response was managed by Genna Leckenby and Sema Nickbakhsh. Coordination of Northern Irish cases, data, and response was managed by Claire Neill. Follow up of English cases with trawling questionnaires was led by Oluwakemi Olufon and Cary Rees, with data collated and summarised by Orlagh Quinn, Chloe Byers, Claire Brown, and Ann Hoban. Additional analysis of the epidemiological data for hypothesis generation was led by Orlagh Quinn, Yanshi, Sooria Balasegaram, and Ann Hoban. Analytical studies were conducted by Clare Sawyer, Grace King, Ann Hoban, Andre Charlett, Sooria Balasegaram, and Tom Inns. Writing of the manuscript was led by Lesley Larkin, Sooria Balasegaram, Claire Jenkins, Orlagh Quinn, Yanshi, Grace King, and Amy Douglas. All authors reviewed the draft manuscript, submitted contributions, and approved the final version.

Competing interest. None declared.

Ethical standard. UKHSA has legal permission, provided by Regulation 3 of the Health Service (Control of Patient Information) Regulations 2002, to process patient confidential information for national surveillance of communicable diseases.

Funding statement. This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

[1] **Butt S**, et al (2022) The epidemiology of Shiga toxin-producing *Escherichia coli* serogroup O157 in England, 2009–2019. *Epidemiology & Infection* **150**, e52.

[2] **Chattaway MA**, et al (2016) Whole genome sequencing for public health surveillance of Shiga toxin-producing *Escherichia coli* other than serogroup O157. *Frontiers in Microbiology* **7**, 258.

[3] **Mook P**, et al (2018) Online market research panel members as controls in case–control studies to investigate gastrointestinal disease outbreaks: early experiences and lessons learnt from the UK. *Epidemiology & Infection* **146** (4), 458–464.

[4] **Vishram B**, et al (2021) The emerging importance of Shiga toxin-producing *Escherichia coli* other than serogroup O157 in England. *Journal of Medical Microbiology* **70**(7), 001375.

[5] **Rodwell EV**, et al (2022) Shiga toxin-producing *Escherichia coli* clonal complex 32, including serotype O145: H28, in the UK and Ireland. *Journal of Medical Microbiology* **71**(8), 001579.

[6] **UK Health Security Agency** (2024) *Shiga toxin-producing Escherichia coli (STEC) Data: 2021.* Available from: https://www.gov.uk/government/publications/escherichia-coli-e-coli-o157-annual-totals/shiga-toxin-producing-escherichia-coli-stec-data-2021

[7] **Mikhail AFW**, et al (2018) An outbreak of Shiga toxin-producing *Escherichia coli* O157: H7 associated with contaminated salad leaves: epidemiological, genomic and food trace back investigations. *Epidemiology & Infection* **146**(2), 187–196.

[8] **Gobin M**, et al (2018) National outbreak of Shiga toxin-producing *Escherichia coli* O157: H7 linked to mixed salad leaves, United Kingdom, 2016. *Eurosurveillance* **23**(18), 17–00197.

[9] **Butt S**, et al (2021) Epidemiological investigations identified an outbreak of Shiga toxin-producing Escherichia coli serotype O26: H11 associated with pre-packed sandwiches. *Epidemiology & Infection* **149**, e178.

[10] **Kintz E**, et al (2019) Outbreaks of Shiga toxin–producing *Escherichia coli* linked to sprouted seeds, salad, and leafy greens: a systematic review. *Journal of Food Protection* **82**(11), 1950–1958.

[11] **Dogan OB**, et al (2023) Understanding potential cattle contribution to leafy green outbreaks: A scoping review of the literature and public health reports. *Comprehensive Reviews in Food Science and Food Safety* **22**(5), 3506–3530.

[12] **Zhao X**, et al (2024) Research advances on the contamination of vegetables by enterohemorrhagic *Escherichia coli*: pathways, processes and interaction. *Critical Reviews in Food Science and Nutrition*, **64**(14), 4833–4847.

https://doi.org/10.1017/S0950268824001729 Published online by Cambridge University Press