Socioeconomic and ethnic inequalities in incidence and severity of enteric fever in England

Matylda Buczkowska, Claire Jenkins, Lisa Byrne, Jeremy Hawker, Benjamin Barr, Parisha Katwa, Hilary Kirkbride
UKHSA GI Surveillance Team
HPRU GI People and Places Theme

UK Health Security Agency

Introduction

- Enteric fever is a bacterial infection caused by the Typhoidal salmonellae (*Salmonella* Typhi and *Salmonella* Paratyphi). Transmission usually occurs through ingestion of food or water contaminated with faeces (1).
- It can only be spread from human to human as they are the only host (2). The infection is characterised by fever, headache, nausea, loss of appetite and constipation (3).
- There are approximately 11 to 21 million cases and 128 000 to 161 000 typhoid-related deaths each year globally (1).
- Most cases in the UK are caused by travelling to typhoid-endemic countries (3) such as parts of Asia (especially India, Pakistan, and Bangladesh), Africa, the Caribbean, Central and South America. Many parts of endemic countries have poor sanitation and poor hygiene (4).
- Literature suggests (5) that there might be existing inequalities among individuals from different ethnicities and socioeconomic status among enteric fever cases.

Figure 1. Symptoms of enteric fever (Source: Internet Accessed 12/02/2022 TYPHOID FEVER | MetroHealth HMO https://www.metrohealthhmo.com/typhoid-fever)

Aims and objectives

- To investigate the association between incidence rate in patients from different ethnicities and deprivation ranks presenting with enteric fever in England.
- To assess how ethnicity and deprivation rank affect the severity of symptoms, admission to hospital and absence from school/work.

Methods

Dataset

Data from cases of enteric fever in England were extracted from the typhoid and paratyphoid surveillance database from years 2015-2019. The database is based on responses to Enhanced Surveillance of Enteric Fever Questionnaire. This e-questionnaire is used to report cases of enteric fever in England, Wales and Northern Ireland to the national surveillance system. Data from five years was merged to achieve the representative sample size. Access to the data was provided by Travel Health and IHR Team. Dataset contains approximately 1,800 cases and covers fields such as ethnicity, travel history, symptoms, antibiotic administration or vaccination history, absence from school and work as well as history of hospital admission.

Predictors

The main predictors were ethnicity and deprivation quintile. Deprivation quintile was based on the Index of Multiple Deprivation (IMD) 2019, a measure that aggregates data on deprivation by lower super output area (LSOA) in seven domains: income, employment, education, health, crime, housing, and living environment. IMD was derived using respondent's UK home postcode. 1st quintile was the most deprived quintile while 5th quintile was the least deprived one. Six ethnicity categories were created: Bangladeshi, Indian, Pakistani, White (British/Other), Other Asian/Other, Black (African/Caribbean).

Outcomes

The main outcomes were the incidence rate of enteric fever, severity of symptoms, admittance to the hospital and absence from school/work. The symptom severity score was estimated based on the information on the presence/absence of symptoms, which were self-reported by the cases, using previously published methods. Each case received an overall symptom severity score. The symptom severity variable contained three approximately equally sized groups according to the distribution of the severity score.

Confounders

Confounders in the analysis were sex, age, rurality/urbanicity, travel status, organism identified and antibiotic administration.

Statistical methods

Incidence of enteric fever cases by ethnicity and IMD was calculated and compared. Descriptive analysis of severity of symptoms, hospital admission and absence from school/work was conducted. Crude incidence of enteric fever cases was calculated and compared by ethnicity and IMD. The results were further stratified by sex and age group for both, ethnicity and IMD. 95% confidence intervals were calculated using Byar's method for each incidence rate. Ordinal logistic regression was used to calculate the correlation between ethnicity, deprivation quintile and severity of symptoms. Binary logistic regression was used to calculate the correlation between ethnicity, deprivation quintile and hospital admission/ absence from school/work. Stata 15.0 was used for data cleaning, manipulation and analyses.

Results

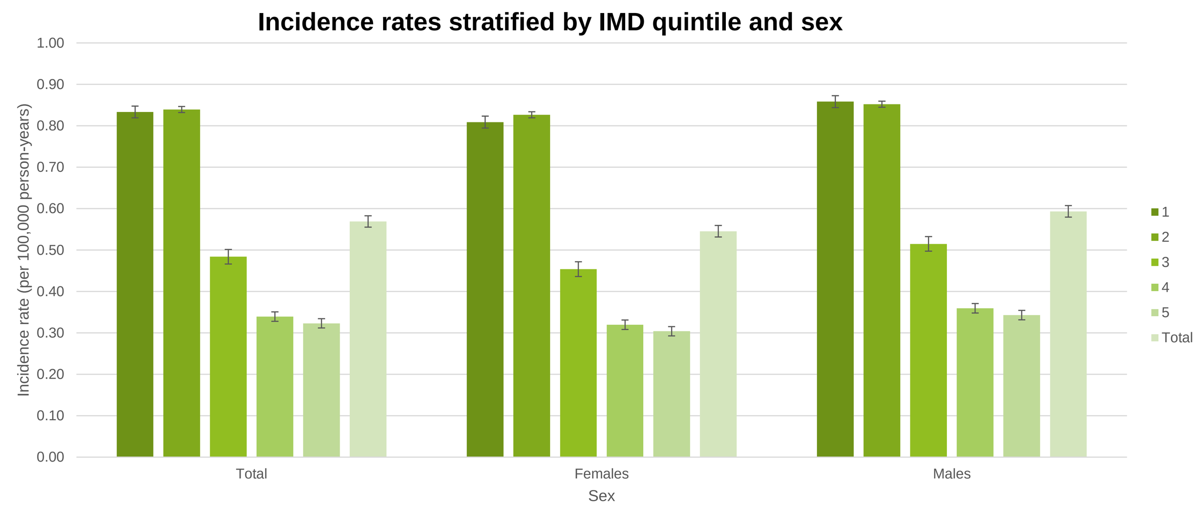

Figure 2. Enteric fever incidence rates per 100,000 person-years described by IMD quintile and sex

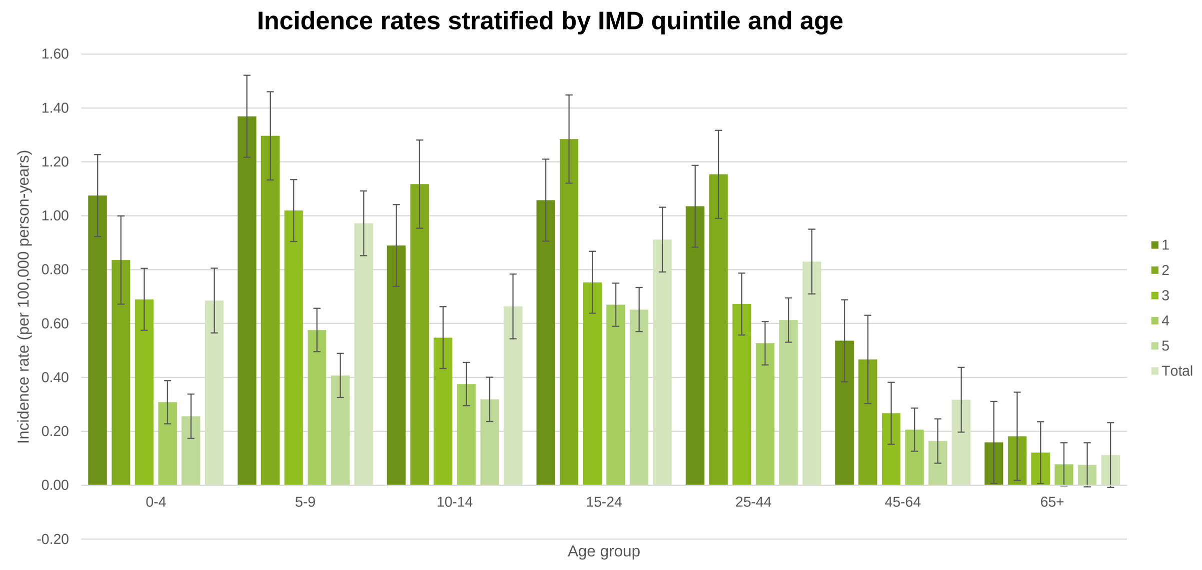

Figure 3. Enteric fever incidence rates per 100,000 person-years described by IMD quintile and age group

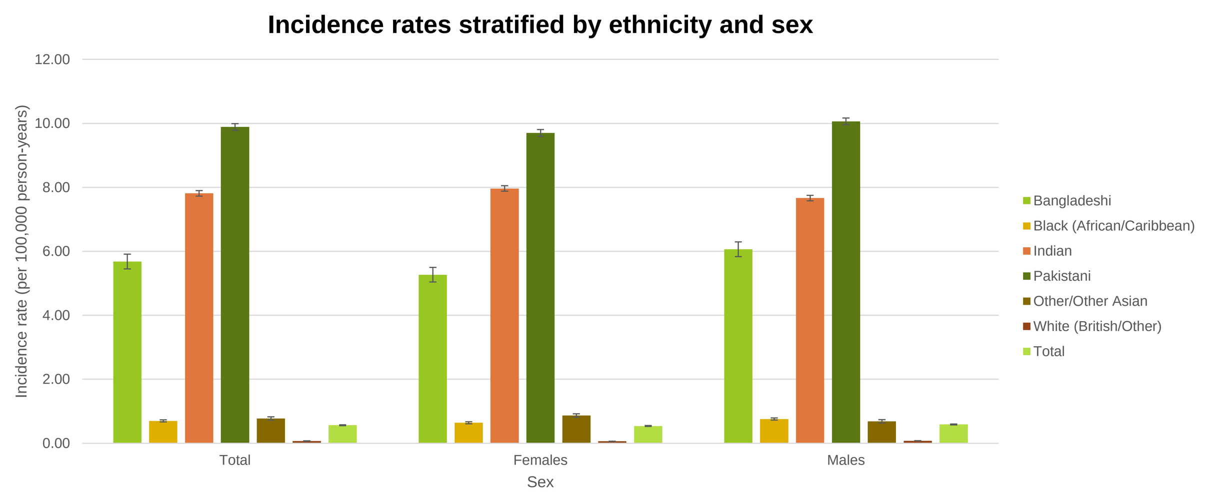

Figure 4. Enteric fever incidence rates per 100,000 person-years described by ethnicity and sex

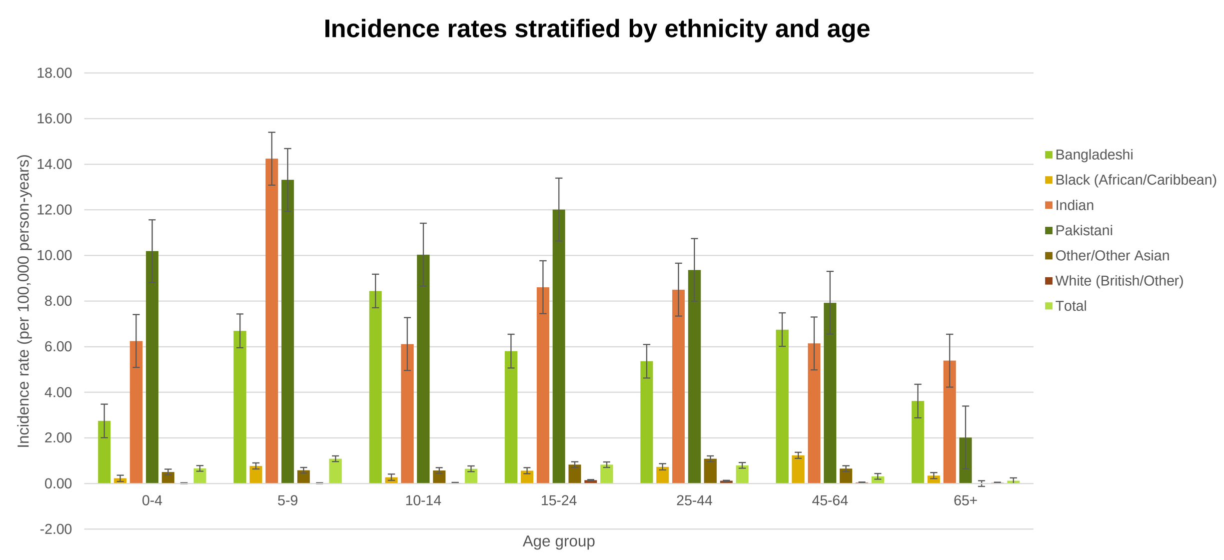

Figure 5. Enteric fever incidence rates per 100,000 person-years described by ethnicity and age group

Table 1. Binary and ordinal regression with IMD Quintile as the main predictor and hospital admission, absence from school/work and symptom severity as the main outcomes and age, sex, residence, travel abroad, antibiotic administration and organism as the confounders.

	Hospital Admission		Absence from School/Work		Symptom Severity	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
IMD Quintile						
1	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
2	0.56 (0.37, 0.85)	**0.006**	1.06 (0.70, 1.62)	0.771	0.87 (0.68, 1.12)	0.272
3	0.60 (0.37, 0.97)	**0.038**	1.04 (0.63, 1.72)	0.877	0.93 (0.69, 1.26)	0.649
4	0.95 (0.52, 1.73)	0.857	0.62 (0.37, 1.05)	0.074	1.04 (0.74, 1.47)	0.815
5	0.56 (0.32, 0.97)	**0.039**	0.78 (0.45, 1.36)	0.389	0.84 (0.59, 1.20)	0.336
Sex						
Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Female	0.97 (0.71, 1.32)	0.837	0.70 (0.51, 0.96)	**0.025**	1.27 (1.04, 1.54)	**0.017**
Age						
0-4	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
5-9	1.17 (0.55, 2.50)	0.679	10.49 (4.67, 23.60)	**<0.001**	2.49 (1.56, 3.96)	**<0.001**
10-14	1.26 (0.54, 2.97)	0.590	7.96 (3.23, 19.59)	**<0.001**	1.95 (1.17, 3.26)	**0.010**
15-24	1.98 (0.96, 4.11)	0.065	2.25 (1.22, 4.18)	**0.010**	2.94 (1.92, 4.50)	**<0.001**
25-44	1.17 (0.62, 2.24)	0.625	3.68 (2.04, 6.64)	**<0.001**	2.73 (1.83, 4.06)	**<0.001**
45-64	0.56 (0.28, 1.11)	0.097	2.30 (1.17, 4.52)	**0.016**	1.59 (1.02, 2.50)	**0.042**
65+	0.64 (0.24, 1.71)	0.374	0.18 (0.05, 0.73)	**0.016**	1.10 (0.54, 2.23)	0.789
Residence						
Urban	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Rural	1.08 (0.49, 2.37)	0.847	1.65 (0.70, 3.85)	0.250	2.39 (1.40, 4.09)	**0.001**
Travel Abroad						
No	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Yes	0.77 (0.35, 1.69)	0.513	1.04 (0.48, 2.25)	0.923	1.10 (0.68, 1.76)	0.706
Antibiotic Administration						
No	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Yes	16.19 (8.17, 32.11)	**<0.001**	1.82 (0.80, 4.14)	0.154	1.45 (0.82, 2.58)	0.205
Organism						
Salmonella Typhi	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Salmonella Paratyphi A	0.57 (0.41, 0.79)	**0.001**	0.84 (0.60, 1.17)	0.297	0.72 (0.59, 0.89)	**0.003**
Salmonella Paratyphi B	0.39 (0.19, 0.80)	**0.010**	0.57 (0.26, 1.25)	0.160	0.96 (0.57, 1.63)	0.884

Table 2. Binary and ordinal logistic regressions with ethnicity as the main predictor and hospital admission, absence from school/work and symptom severity as the main outcomes and age, sex, residence, travel abroad, antibiotic administration and organism as the confounders.

	Hospital Admission		Absence from School/Work		Symptom Severity	
	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value	Odds ratio (95% CI)	p-value
Ethnicity						
White (British/Other)	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Bangladeshi	1.61 (0.80, 3.25)	0.184	1.07 (0.48, 2.41)	0.870	0.69 (0.42, 1.13)	0.141
Pakistani	3.08 (1.73, 5.48)	**<0.001**	0.85 (0.47, 1.54)	0.593	0.56 (0.38, 0.84)	**0.005**
Indian	1.97 (1.15, 3.38)	**0.014**	1.13 (0.62, 2.05)	0.684	0.59 (0.40, 0.88)	**0.009**
Black (African/Caribbean)	1.42 (0.57, 3.53)	0.452	1.16 (0.40, 3.40)	0.784	0.48 (0.25, 0.92)	**0.027**
Other/Other Asian	3.62 (1.57, 8.33)	**0.003**	1.58 (0.70, 3.54)	0.268	0.58 (0.38, 0.84)	**0.033**
Sex						
Male	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Female	0.95 (0.70, 1.31)	0.772	0.68 (0.49, 0.93)	**0.017**	1.29 (1.06, 1.57)	**0.011**
Age						
0-4	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
5-9	1.19 (0.56, 2.54)	0.645	10.26 (4.57, 23.05)	**<0.001**	2.47 (1.55, 3.94)	**<0.001**
10-14	1.29 (0.55, 3.02)	0.564	7.62 (3.10, 18.76)	**<0.001**	1.89 (1.13, 3.16)	**0.015**
15-24	2.28 (1.09, 4.77)	0.028	2.12 (1.15, 3.93)	**0.016**	2.74 (1.79, 4.21)	**<0.001**
25-44	1.35 (0.70, 2.61)	0.363	3.37 (1.86, 6.08)	**<0.001**	2.55 (1.71, 3.81)	**<0.001**
45-64	0.68 (0.34, 1.37)	0.287	2.09 (1.06, 4.12)	**0.034**	1.52 (0.97, 2.40)	0.070
65+	0.83 (0.31, 2.26)	0.720	0.16 (0.04, 0.66)	**0.011**	1.00 (0.49, 2.04)	0.991
Residence						
Urban	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Rural	1.55 (0.69, 3.47)	0.287	1.34 (0.56, 3.21)	0.504	1.91 (1.11, 3.28)	**0.019**
Travel Abroad						
No	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Yes	0.66 (0.30, 1.45)	0.305	1.07 (0.49, 2.34)	0.870	1.11 (0.69, 1.78)	0.674
Antibiotic Administration						
No	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Yes	14.97 (7.44, 30.13)	**<0.001**	1.82 (0.79, 4.17)	0.157	1.54 (0.86, 2.76)	0.142
Organism						
Salmonella Typhi	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*	*Ref*
Salmonella Paratyphi A	0.60 (0.43, 0.83)	**0.002**	0.81 (0.58, 1.14)	0.234	0.70 (0.56, 0.86)	**0.001**
Salmonella Paratyphi B	0.48 (0.22, 1.06)	0.071	0.48 (0.21, 1.13)	0.092	0.75 (0.43, 1.33)	0.328

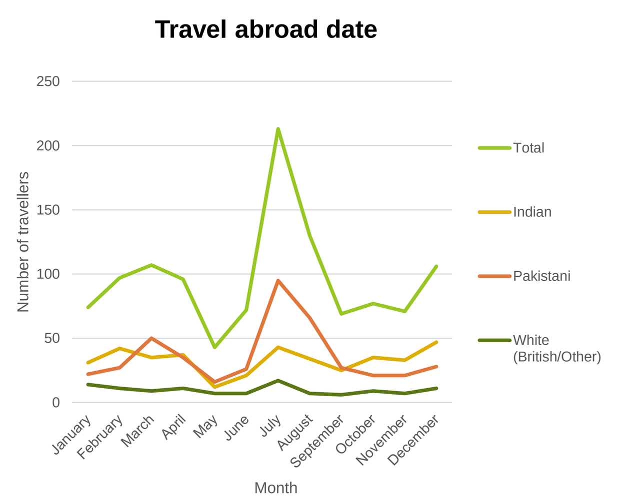

Figure 6. Date of travel abroad grouped by month

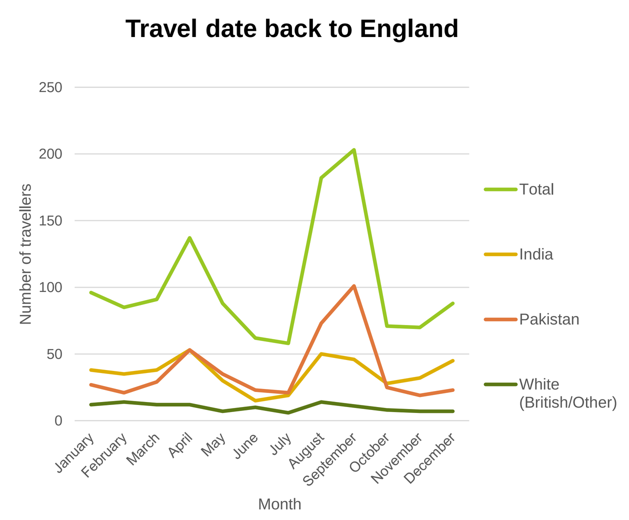

Figure 7. Date of return to England grouped by month

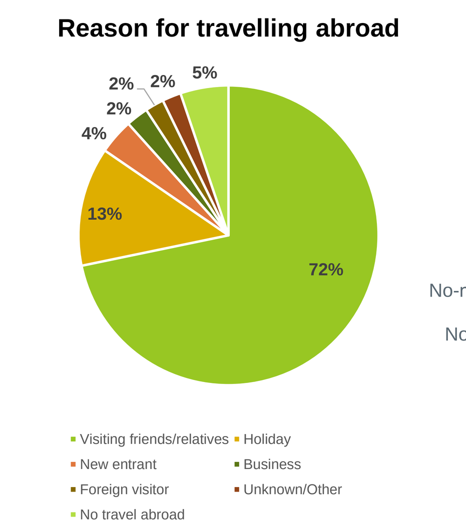

Figure 8. Descriptive chart of reasons for travelling abroad

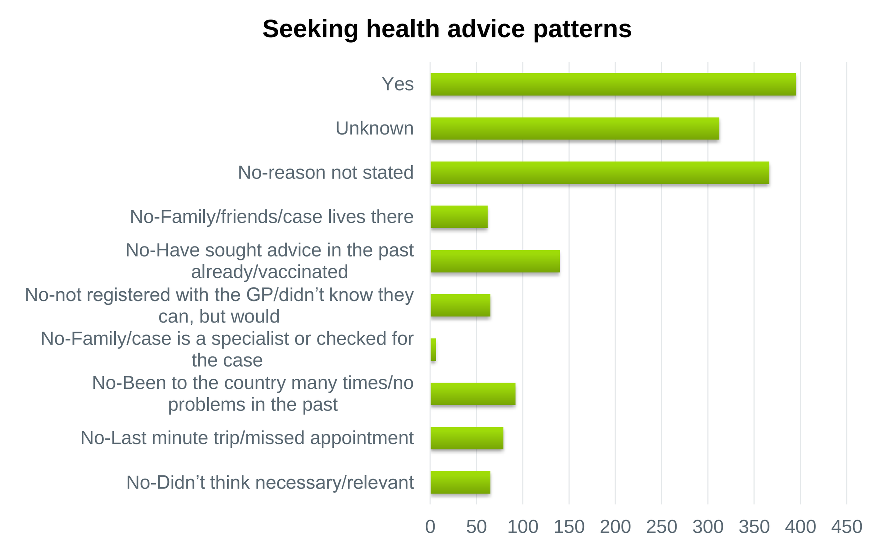

Figure 9. Descriptive chart of seeking health advice among travellers

Conclusions

- **Incidence rates of enteric fever were the highest among individuals from two least affluent quintiles and in individuals who were Pakistani or Indian.** Incidence rates were similar in men and women. **Young individuals had higher incidence rate of enteric fever** than the elderly.
- There were **seasonal travel patterns in total travellers and individuals who were Pakistani or Indian.** Travelling was less seasonal in individuals who were White (British/Other).
- Cases in the **least affluent quintile were more likely to be admitted to the hospital** than cases from the 2nd, 3rd and 5th (most affluent) quintile.
- **Indian, Pakistani and Other Asian/Other cases were more likely to be admitted to the hospital** than White (British/Other) cases.
- However, **Indian, Pakistani, Other Asian/Other and Black (African/Caribbean) cases were less likely to suffer from severe symptoms** than White (British/Other) cases.
- **Three quarters of enteric fever cases occurred in individuals travelling to visit family or friends.**
- **Less than a third of cases sought health advice before travelling.**
- Individuals visiting friends or relatives are more likely than other travellers to get ill: they often stay in the country for a prolonged period and are less cautious about food and drinks as they usually eat meals prepared in people's homes (2). They are also less likely to vaccinate before travelling and less likely to seek pre-travel advice. That would give them a similar risk profile to the locals (6). One of the potential reasons is low knowledge of safe food handling, which seem to be consistent among ethnic minorities (5).
- The results of the study provide similar conclusions to existing studies (7-11).
- Due to many variables having missing data and the study being observational, more research is necessary to address the aims further.

Recommendations

- It would be insightful to expand the fields covered by the Enhanced Surveillance of Enteric Fever Questionnaire to identify more factors related to increased risk of enteric fever in England. Additional questions regarding travel itinerary (such as travel accommodation, activities done while travelling) and diet history (such as consumption of improperly cooked meats, unpasteurized dairy products, seafood, or contaminated water and produce) would be particularly useful.
- Safe food and water practices (only drinking water that is disinfected or bottled and washing hands before eating) while travelling can provide the best protection against enteric fever.
- Enteric fever should be considered in young febrile adults returning from a visiting friends and relatives trip to South Asia and more education and health counselling should be given to individuals living in deprived regions and of Pakistani, Indian and Bangladeshi ethnicities.
- Further action is necessary regarding vaccination of travellers to South Asia. Due to high volume of individuals getting infected over the summer months, enhanced health advice should be promoted between July and September.

* *

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Acknowledgements and contact details

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Author's contact details:
Email address: Matylda.Buczkowska@phe.gov.uk
Telephone number:+442083277097