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Intestinal protozoa in returning travellers: a GeoSentinel analysis from 2007 to 2019

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Conflict of interest

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Abstract

Background: Prolonged diarrhoea is common amongst returning travellers and is often caused by intestinal protozoa. However, the epidemiology of travel-associated illness caused by protozoal pathogens is not well described.

Methods: We analysed records of returning international travellers with illness caused by *Giardia duodenalis*, *Cryptosporidium* spp., *Cyclospora cayetanensis* or *Cystoisospora belli*, reported to the GeoSentinel Network during January 2007–December 2019. We excluded records of travellers migrating, with an unascertainable exposure country, or from GeoSentinel sites that were not located in high-income countries.

Results: There were 2517 cases, 82.3% giardiasis (n = 2072), 11.4% cryptosporidiosis (n = 287), 6.0% cyclosporiasis (n = 150) and 0.3% cystoisosporiasis (n = 8). Overall, most travellers were tourists (64.4%) on long trips (median durations: 18–30 days). Cryptosporidiosis more frequently affected people < 18 years (13.9%) and cyclosporiasis affected people ≥ 40 years (59.4%). Giardiasis was most frequently acquired in South Central Asia (45.8%) and sub-Saharan Africa (22.6%), cryptosporidiosis in sub-Saharan Africa (24.7%) and South-Central Asia (19.5%), cyclosporiasis in South East Asia (31.3%) and Central America (27.3%), and cystoisosporiasis in sub-Saharan Africa (62.5%). Cyclosporiasis cases were reported from countries of uncertain endemicity (e.g. Cambodia) or in countries with no previous evidence of this parasite (e.g. French Guiana). The time from symptom onset to presentation at a GeoSentinel site was the longest amongst travellers with giardiasis (median: 30 days). Over 14% of travellers with cryptosporidiosis were hospitalized.

Conclusions: This analysis provides new insights into the epidemiology and clinical significance of four intestinal protozoa that can cause morbidity in international travellers. These data might help optimize pretravel advice and post-travel management of patients with travel-associated prolonged gastrointestinal illnesses. This analysis reinforces the importance of international travel-related surveillance to identify sentinel cases and areas where protozoal infections might be undetected or underreported.

Keywords

Travel; gastrointestinal diseases; Giardia; Cryptosporidium; Cyclospora; surveillance

Introduction

Gastrointestinal complaints are the most frequent travel-associated health problem, affecting ~40% of travellers from high-income countries visiting resource-poor regions.[1] Most cases present as travellers' diarrhoea, which are self-limited episodes of 3–5 days, typically caused by bacterial pathogens and commonly appearing during travel.[2] However, gastrointestinal complaints continuing beyond 14 days are often caused by intestinal protozoa, which have a longer incubation period and clinical course compared with bacterial and viral pathogens.[3] Such prolonged abdominal symptoms are a common cause of consultations in returning travellers[4,5]; however, the aetiology of this syndrome is poorly studied.[5]

Amongst imported intestinal protozoa, *Giardia duodenalis* (synonym *Giardia lamblia* or *Giardia intestinalis*) is the most frequently diagnosed pathogen,[4,6–8] whereas the prevalences of other protozoa such as *Cryptosporidium* spp., *Cyclospora cayetanensis* and *Cystoisospora belli* are not well described.[5] These apicomplexan protozoa are likely underreported because they are not reliably detected by routine parasitological examinations (e.g. microscopy for cysts, ova and parasites). However, studies that used adequate diagnostic methods detected *Cryptosporidium* in 1.3–2.9% of returning travellers with diarrhoea.[9–11]

Although intestinal protozoa commonly affect travellers, and international travel has been identified as a risk factor for giardiasis and cryptosporidiosis in industrialized countries,[12,13] there are few studies addressing the epidemiology of these and other travel-related protozoan diseases. Data have been derived from single site analyses, case series or surveillance studies

of intestinal illness or laboratory data. These studies have either small case numbers or limited data on travel-related variables, which hampers the development of evidence-based pretravel guidance (e.g. exposure prevention for immunocompromised travellers) and of post-travel disease management (e.g. empirical therapeutic interventions).

We analysed data from the GeoSentinel Surveillance Network from 2007 through 2019 on returning travellers diagnosed with *G. duodenalis*, *Cryptosporidium* spp., *C. cayetanensis* or *C. belli* infection to improve the understanding of the epidemiology of these pathogens.

Material and methods

Data source

GeoSentinel, a collaboration between the Centers for Disease Control and Prevention (CDC) and the International Society of Travel Medicine, is a global clinic-care-based surveillance system monitoring infectious diseases and other adverse health events that impact international travellers. It is composed of 71 sites in 29 countries, where clinicians diagnose patients and collect other relevant data, including demographic and travel-related information. GeoSentinel's surveillance data collection protocol has been reviewed by a human subjects advisor at CDC's National Center for Emerging and Zoonotic Infectious Diseases and is classified as public health surveillance and not human subjects research. Additional ethics clearance was obtained by sites as required by their respective institutions.

Inclusion/exclusion criteria

The report included cases of gastrointestinal illnesses confirmed to be caused by *G. duodenalis*, *Cryptosporidium* spp., *C. cayetanensis* or *C. belli* and reported to GeoSentinel during 1 January 2007 to 31 December 2019. Data from patients with coinfections of the above protozoa were analysed as separate cases. Other protozoa, such as *Balantidium coli*, *Dientamoeba fragilis* and *Sarcocystis* spp., were not included because of their very low frequencies, whereas *Entamoeba histolytica* and *Blastocystis hominis* were excluded because of diagnostic and pathogenic uncertainties, respectively. The plausibility of diagnoses was verified by an experienced clinician (K.M.A.), using the diagnostic methods recorded by the sites. Confirmed diagnoses of giardiasis and cryptosporidiosis were defined as positive microscopy, antigen detection or nucleic acid testing, whereas the diagnoses cyclosporiasis and cystoisosporiasis required positive microscopy or nucleic acid testing. Details on the applied diagnostic techniques were available from September 2015 onwards.

All included cases were travel-related, were seen after travel, were unrelated to migration and had ascertainable regions and countries of exposure. To ensure that the protozoal infection was most likely acquired during travel and not in the country of residence, data from GeoSentinel sites in low- and middle-income countries (per the World Bank), which have higher rates of protozoal infections, were excluded.

Data extraction

Data were extracted on traveller demographics (sex, age, resident country, birth country), clinical visit (date), travel details (travel duration, reason for travel, country/region of

acquisition, receipt of pretravel advice) and clinical information (date of illness onset, diagnosis, diagnosis status [confirmed or probable], diagnosis method(s), hospitalization). Regions of exposure were defined using modified UNICEF groupings.[7]

Statistical analysis

Proportions of cases (of cryptosporidiosis or cyclosporiasis) from a given exposure country relative to the proportion of giardiasis cases reported to GeoSentinel from the same exposure country were calculated to determine countries where cryptosporidiosis or cyclosporiasis might be more commonly acquired amongst travellers than giardiasis. This was calculated as the country-specific proportions of cases (number of cases of cryptosporidiosis or cyclosporiasis in a country divided by all cases of the given disease) divided by the country-specific proportion of giardiasis cases (number of cases of giardiasis in a country divided by all cases of giardiasis). This calculation was performed for exposure countries that accounted for ≥2% of cryptosporidiosis ($n = 6$) or cyclosporiasis ($n = 3$) cases.

Data were managed and extracted using Microsoft Access (Redmond, Washington, USA). All analyses were descriptive in nature, and frequencies were performed using SAS version 9.4 (Cary, North Carolina, USA). The heat map was created using the Conditional Formatting function of Microsoft Excel. Maps were created using ArcGIS Pro and Adobe Illustrator.

Results

In total, 2507 patients with 2517 diagnoses were included: 2072 (82.3%) giardiasis, 287 (11.4%) cryptosporidiosis, 150 (6.0%) cyclosporiasis and 8 (0.3%) cystoisosporiasis (Table 1). Protozoal coinfections were reported in 10 travellers (0.4%), 8 travellers had giardiasis and cryptosporidiosis and 2 travellers had giardiasis and cyclosporiasis. Most cases were reported from GeoSentinel sites in Europe (72.4%) and North America (21.5%). Reporting of cases to GeoSentinel varied over time, with increasing numbers of cryptosporidiosis reported in recent years (Figure 1).

Giardiasis

A median of 169 giardiasis cases (range: 95–204) were reported per year (Figure 1). The median age of the 2072 travellers with giardiasis was 31 years (range: 1–79); 53.2% were female. Travellers were most frequently 18–39 years of age (62.2%) (Table 1). Travellers were most frequently tourists (63.9%), missionaries/humanitarian aid workers (14.0%) or business travellers (10.4%). Most infections were acquired in South-Central Asia (45.8%) and sub-Saharan Africa (22.6%) (Figure 2). Giardiasis was acquired in 132 countries; the country where the greatest number of infections was acquired was India (810; 39.1%) (Figure 3, Table S1 available as Supplementary data at *JTM* online). The median trip duration was 30 days. Travellers presented to a GeoSentinel site a median of 30 days after illness onset. Amongst 696 travellers with information available, 30 (4.3%) were hospitalized. Of these, 21 (70.0%) did not have comorbidities. One immunocompromised patient required intensive care unit (ICU) care. Nearly two-thirds of travellers (66.5% of 1602 travellers with information available) received pretravel health advice (Table 1).

Cryptosporidiosis

A median of 20 cases of cryptosporidiosis (range: 5–40) were reported per year (Figure 1). The median age of the 287 travellers with cryptosporidiosis was 28 years (range: <1–80); 58.2% were female. Travellers were most frequently 18–39 years of age (51.3%) (Table 1). The most frequent travel reasons were tourism (65.5%), visiting friends or relatives (VFRs) (15.7%) and missionary or humanitarian aid work (10.5%). Most infections were acquired in sub-Saharan Africa (24.7%) and South-Central Asia (19.5%) (Figure 2). Cryptosporidiosis was acquired in 83 countries, most frequently in India (12.2%) and Mexico (7.3%) (Figure 3, Table S1 available as Supplementary data at *JTM* online). The median trip duration was 18 days. Travellers presented to a GeoSentinel site a median of 11 days after illness onset. Data on hospitalization were available for 127 travellers; 18 (14.2%) were hospitalized. Of these, 12 (66.7%) were without comorbidities and 2 (11.1%) were travellers, both immunocompromised and required ICU care. Less than half of travellers (48.3% of 236 travellers with information available) received pretravel health advice (Table 1).

Cyclosporiasis

A median of 10 cyclosporiasis cases (range: 2–24) were reported per year (Figure 1). The median age of the 150 travellers with cyclosporiasis was 43 years (range: 5–72); 50.7% were female. Travellers were most frequently 40–59 years of age (42.7%) (Table 1). Travellers were most frequently tourists (70.0%) or business travellers (13.3%). Most infections were acquired in South East Asia (31.3%) and Central America (27.3%) (Figure 2). Cyclosporiasis was acquired in 32 countries, most frequently Mexico (21.3%), Indonesia (14.7%), Peru (6.0%), India (5.3%) and Cambodia (5.3%) (Figure 3, Table S1 available as Supplementary data at *JTM* online). In 2014, over one-third ($n = 7$; 35.0%) of cyclosporiasis cases originated from Indonesia. The median trip duration was 19 days. Travellers presented to a GeoSentinel site a median of 19 days after illness onset. Amongst 47 travellers with information available, three (6.4%) were hospitalized, one (33.3%) of whom did not have comorbidities. Amongst 103 travellers with information available, 51.5% received pretravel health advice (Table 1).

Cystoisosporiasis

The median age of the eight cases with cystoisosporiasis was 35.5 years (range: 21–60); five were female. Travellers were most frequently VFRs ($n = 4$) or tourists ($n = 3$). Infections were acquired in sub-Saharan Africa [$n = 5$ (Cameroon, n = 2; Democratic Republic of the Congo, $n = 1$; Liberia, $n = 1$; Madagascar, $n = 1$)], the Caribbean ($n = 2$; Jamaica) and South-Central Asia ($n = 1$; India) (Figures 2 and 3, Table S1 available as Supplementary data at *JTM* online). The median trip duration was 28 days. Travellers presented to a GeoSentinel site a median of 9 days after illness onset. Amongst seven travellers with information available, three received pretravel health advice (Table 1).

Country-specific proportions

For certain travel destinations (e.g. Dominican Republic, the Philippines), the proportion of cryptosporidiosis cases was higher than the proportion of giardiasis cases (Figure S1 available as Supplementary data at *JTM* online). The proportion of cyclosporiasis acquired

in Timor Este and Taiwan was > 10 times higher than that of giardiasis; Indonesia, Mexico, Viet Nam, the Dominican Republic, Guatemala, Cuba, the Philippines, Cambodia and Haiti all had proportions greater than five times higher than giardiasis.

Diagnostic methods

Detailed information on the applied diagnostic methods used was available for 1224 travellers. Microscopy was the reported diagnostic method in 53.4% of all cases; it was less frequently reported in travellers with cryptosporidiosis (40.4%) than giardiasis (55.2%), cyclosporiasis (60.9%) or cystoisosporiasis (100%). Coproantigen assays were used to diagnose 22.1% of travellers with giardiasis and 11.0% of travellers with cryptosporidiosis. Nucleic acid testing was used to diagnose 27.0% of travellers, most frequently for travellers with cryptosporidiosis (48.6%) and cyclosporiasis (39.1%); there was a shift towards a higher frequency of nucleic acid testing in 2018 and 2019 (Figure 4).

Discussion

This is the first analysis of global epidemiological trends of travel-related intestinal infections with intestinal protozoa using data from an international surveillance network. Giardiasis was the most frequently reported illness amongst travellers included in this analysis. This is consistent with surveillance studies in Europe and North America, where *G. duodenalis* was the most prevalent travel-associated intestinal protozoan, affecting 3–4% of ill returnees.[7,8,14] Compared with cryptosporidiosis, relatively few giardiasis cases occurred amongst VFRs, despite their increased risk of exposure to local food and water sources during travel.[15] Possible explanations include that VFRs might have had prior exposure to *Giardia*, leading to a higher clinical tolerance upon reinfection.[16] More than half of travellers with giardiasis travelled for >4 weeks, consistent with other studies.[17,18] The reasons behind this could be cumulative risk of repeated exposures, but also lower hygiene standards and increased exposure risk of young adults (e.g. backpackers) on prolonged journeys.[19] Travellers predominantly acquired giardiasis in South-Central Asian countries (especially India), which were also frequent destinations in previous studies of travel-related giardiasis.[15,17,18,20]

Cryptosporidiosis has been recognized as an important cause of diarrheal disease worldwide,[21] and our report includes the largest analysis of data on travel-related cryptosporidiosis to date. Reports and data on travel-associated cryptosporidiosis are scarce, especially in the older literature, likely because of underdiagnosis.[6] A systematic review on the aetiology of travellers' diarrhoea from 2009, for example, reported only 40 cryptosporidiosis cases in 57 studies with over 30 000 cases.[1] In our analysis, cryptosporidiosis proportionally affected more children and adolescents, more VFRs and less business travellers than giardiasis. Children and VFRs might be more likely to have contact with contaminated water sources (e.g. freshwater swimming) or infected human or zoonotic reservoirs.[22] Cryptosporidiosis was frequently acquired in sub-Saharan Africa, which contrasts with a previous series in which most cases were acquired in South-Central Asia.[10] Travellers with cryptosporidiosis were hospitalized more frequently than those with other protozoa, which is consistent with previous observations.[21] Two-thirds of such severe

cases affected travellers without reported comorbidities. This might be the result of severe dehydration, because the only therapeutic option for cryptosporidiosis (nitazoxanide) is underutilized.[23] The annual number of cryptosporidiosis cases reported to GeoSentinel has increased over time, likely because of a more frequent use of molecular diagnostics such as multiplex panels, which are more sensitive and less operator-dependent than conventional techniques.[11] Surveillance studies in Europe and the USA have recently reported similar trends.[13,24,25]

Cyclospora cayetanensis is a coccidian protozoan with an uncertain epidemiology, life cycle and zoonotic reservoir.[26] Genetic lineages of the species probably represent distinct species.[27] Our report represents the largest analysis on travel-associated cyclosporiasis to date. Prior understanding of travel-associated cyclosporiasis has been based on case reports, case series and laboratory surveillance data,[9,28–30] because it is often missed in routine microscopic stool exams and likely underreported. The median age of patients appears older than patients with diagnosed illness caused by other three protozoan, but similar to the age of patients with sporadic cyclosporiasis cases in the USA.[29,30] Giardiasis, cryptosporidiosis and cyclosporiasis were frequently reported in tourists; however, cyclosporiasis was also frequent in business travellers and might be less frequent in VFRs than other protozoa. These epidemiological differences are likely related to the predominant transmission of *Cyclospora* by contaminated food, often reported from upscale tourist facilities, rather than consumption of or contact with contaminated water,[31] which could also influence the age distribution. Most infections were acquired in South-East Asia (31.3%) and Central America (27.3%), especially Mexico (21.3%), which has been recognized as a high-risk country for travel-associated cyclosporiasis in recent years.[29–31] Other known *Cyclospora* hotspots, including Guatemala, Cuba and Haiti,[32–34] had a higher proportion of cases than giardiasis in these data. Travellers in this analysis also served as sentinels to identify cyclosporiasis in countries with no previous evidence of this parasite, such as French Guiana, Timor-Leste, Bhutan, Taiwan and Macao, or in countries of uncertain endemicity, such as Cambodia, Viet Nam, Laos, the Philippines and Sri Lanka,[26,28–30,35,36] indicating the pathogen might be more ubiquitous than currently documented. The number of cases of cyclosporiasis peaked in 2009, 2014 and 2019 (Figure 1). Yearly fluctuations of travel-associated cyclosporiasis cases, which could be related to regional outbreaks, have also been described in the USA.[30] Clusters identified in 2014 and 2019 likely corresponded to travel-associated outbreaks in Indonesia and Mexico, respectively.[31,37]

Cystoisosporiasis is rare amongst travellers. Most infections were acquired in sub-Saharan Africa, which is in accordance with previous reports in travellers[38,39] and a recent global meta-analysis of intestinal protozoa in persons living with HIV.[40] The number of cases, however, was too low to generalize this observation.

Routine diagnosis of intestinal protozoa, including specific techniques for *Cryptosporidium* and *Cyclospora* oocysts (e.g. Kinyoun stain), is challenging and often not requested by clinicians. Cystoisosporiasis is often missed in microscopic stool exams because of the low number of excreted oocycsts.[38] To improve the sensitivity and specificity of microscopic methods, alternative techniques have been developed, which are less operator dependent. The implementation of new molecular tests has led to increased detection rates

of intestinal protozoa, especially for those requiring specific staining techniques.[11,41] Our analysis confirmed that traditional methods are being replaced by nucleic acid detection (e.g. multiplex PCR). This could explain the increasing reports of cryptosporidiosis and cyclosporiasis cases since 2017 in our database. However, giardiasis rates remained stable during this period, probably since traditional diagnostics are more reliable. Although these molecular methods are unlikely to replace microscopy for less common parasites, they feature higher diagnostic sensitivity; drawbacks include technological complexity and costs.[42] A future challenge might be to maintain microscopic expertise, whilst gaining experience in the interpretation of complex multiplex assay results, which frequently reveal coinfections with multiple potential pathogens.[42] A preliminary report from Chile, however, demonstrated that intestinal protozoa, especially *Cyclospora* and *Cryptosporidium* are amongst pathogens with a low index of coinfections.[43]

Almost two-thirds of patients with data available reported receiving travel advice before their trip. Although the prevention of travel-associated gastrointestinal infections is an integral part of pretravel advice (‘boil it, cook it, peel it, or forget it’), the effectiveness of this mantra is controversial.[2] Current guidelines do not specifically address the prevention of protozoal infections and recommend that travellers with diarrhoea for more than 2 weeks should seek medical evaluation.[44] The prevention of *Giardia* and intestinal apicomplexans is challenging because of their very low infectious dose and their high environmental durability and tolerance to chemical disinfectants used for water purification.[2,44] Therefore, exposure in endemic countries might be unavoidable, with a cumulative risk that affects long-term travellers more than short-term travellers. The presented spatial data might help to tailor pretravel recommendations. To prevent cyclosporiasis, for example, travellers visiting Mexico and other hotspots should strictly avoid risky foodstuff such as berries, even in business or high-end tourist settings. The presented maps might also help to guide immunocompromised travellers, e.g. those with cellular immunodeficiencies to prevent infections with *Cryptosporidium* spp. and other coccidians or those with IgA deficiency to avoid giardiasis.

This analysis has several limitations. GeoSentinel surveillance data do not collect data on travellers who are not ill, so incidence cannot be calculated and risk cannot be assessed. Therefore, the heat map and the maps represent relative (and not absolute) frequencies; to partly overcome this deficit,we provided country-specific proportions (Figure S1 available as Supplementary data at *JTM* online). As discussed previously, GeoSentinel data is a convenience sample and is not generalizable to all travellers.[45] Because of GeoSentinel sites’ specialization in travel and tropical medicine, there might be a selection bias for travellers returning from tropical or subtropical destinations; intestinal protozoa acquired in temperate climates might be underrepresented. Also, GeoSentinel sites often serve as referral centres and might not be the initial site of care, resulting in longer durations of time reported between illness onset and presentation to a GeoSentinel site. Both tourists on all-inclusive trips and backpackers are classified as tourists in the GeoSentinel Network, which might be an important distinction for further understanding the epidemiology of illness caused by intestinal protozoa.[15] Despite only including sites in high-income countries, with low background prevalence of intestinal protozoa, some reported cases might represent autochthonous symptomatic or asymptomatic infections. Although comorbidities

are collected in GeoSentinel, they are not systematically reported by sites and might be underestimated. This analysis relied on diagnostic facilities and parasitological workup of the participating institutions, which differ from country to country.

Conclusions

This analysis provides new insights into the epidemiology and clinical significance of illness caused by four intestinal protozoa that can cause morbidity in international travellers. These data might serve to optimize pretravel advice and post-travel management of travel-associated prolonged gastrointestinal illnesses and reinforces the importance of international travel-related surveillance to identify sentinel cases and areas where protozoa might be undetected or underreported.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data availability

Most data underlying this article are available in the article and in its online supplementary material. Further data will be shared on request to the corresponding author with permission of the GeoSentinel Network.

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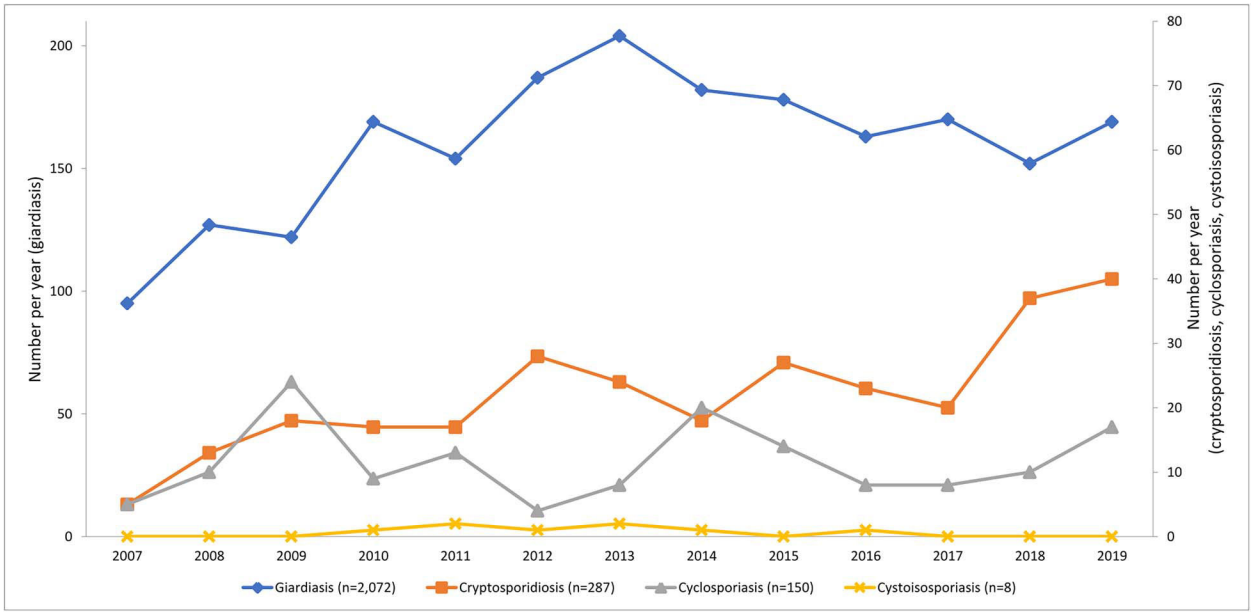

Figure 1.

Annual case numbers of travel-associated giardiasis, cryptosporidiosis, cyclosporiasis and cystoisosporiasis reported to GeoSentinel, 2007–19 (N = 2517).

	Giardiasis (n = 2,072)	Cryptosporidiosis (n = 287)	Cyclosporiasis (n = 150)	Cystoisosporiasis (n = 8)
South Central Asia	45,8	19,5	12,7	12,5
Sub-Saharan Africa	22,6	24,7	2,7	62,5
South America	8,7	6,3	8	0
South East Asia	7,7	13,6	31,3	0
Central America	5,3	12,2	27,3	0
Middle East	2,2	3,1	1,3	0
North Africa	2,2	3,8	0	0
Caribbean	2	7,3	10	25
Western Europe	1,5	5,2	0	0
North East Asia	0,8	0,7	4	0
Eastern Europe	0,5	1,4	0	0
North America	0,4	1,1	0,7	0
Oceania	0,2	1,1	1,3	0
Australia/New Zealand	0,1	0	0,7	0

Figure 2.

Heat map of regions where travellers acquired giardiasis, cryptosporidiosis, cyclosporiasis and cystoisosporiasis reported to GeoSentinel, 2007–19 (N = 2517). Numbers represent relative frequencies (%) of protozoal parasites in each region.

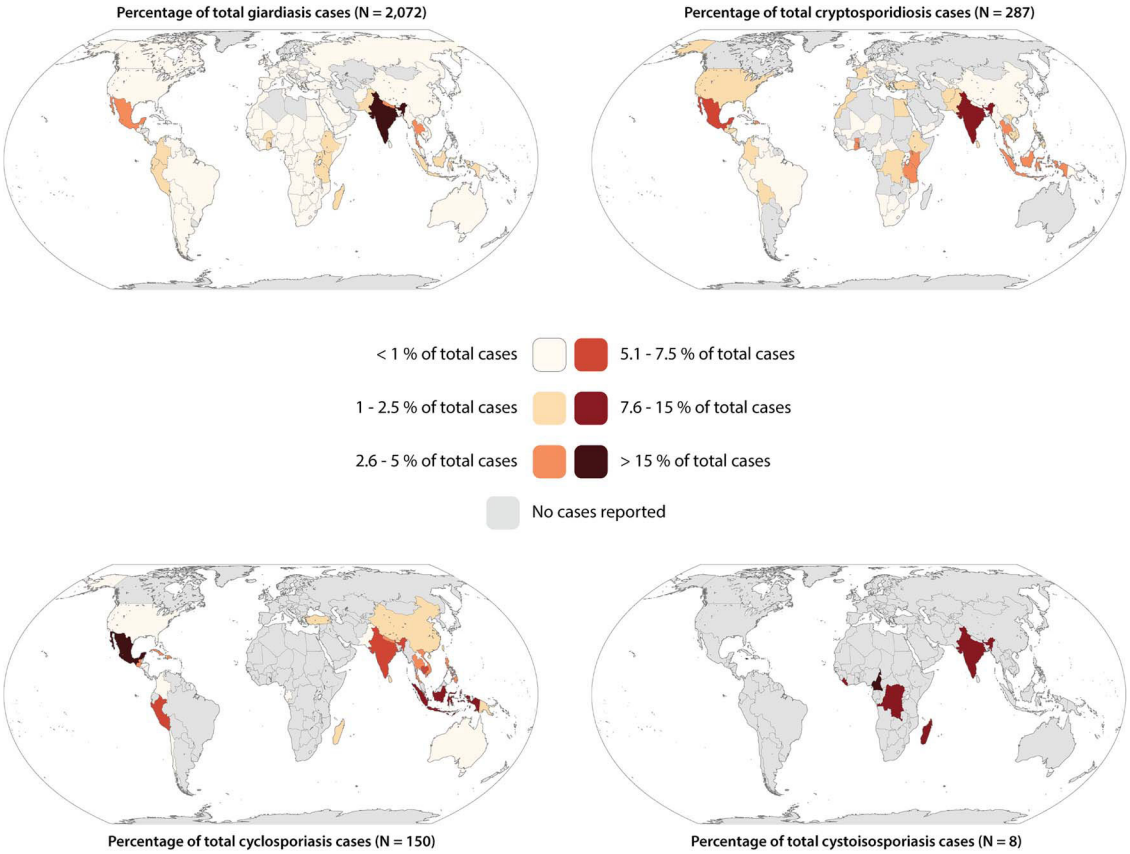

Figure 3.

Countries where travel-associated infections with intestinal protozoa were acquired (relative frequency) reported to GeoSentinel, 2007–19 (N = 2517).

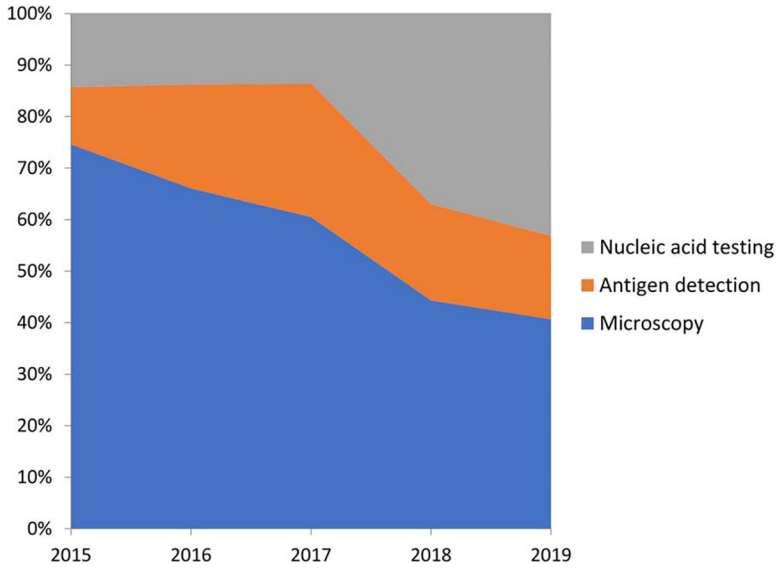

Figure 4.

Percentage of diagnostic methods applied to diagnose protozoal infections by year reported to GeoSentinel, 2007–19 (N = 1224).

Table 1

Characteristics of travellers diagnosed with giardiasis, cryptosporidiosis, cyclosporiasis and cystoisosporiasis reported to GeoSentinel, 2007–19 (n = 2507)

Characteristic	Giardiasis (n=2072)		Cryptosporidiosis (n=287)		Cyclosporiasis (n=150)		Cystoisosporiasis (n=8)	
Female, n (%)	**1100**	**(53.2)[a]**	**167**	**(58.2)**	**76**	**(50.7)**	**5**	**(62.5)**
Age, median years (range)	31	(1–79)[b]	28	(0–80)	43	(5–72)	35.5	(21–60)
Age group, n (%)								
<18 years	103	(5.0)[b]	40	(13.9)	3	(2.0)	0	
18–39 years	1287	(62.2)[b]	176	(51.3)	58	(38.7)	5	(62.5)
40–59 years	507	(24.5)[b]	47	(16.4)	64	(42.7)	2	(25.0)
≥60 years	171	(8.3)[b]	24	(8.4)	25	(16.7)	1	(12.5)
Immunocompromised	6	(0.3)	8	(2.8)	2	(1.3)	1	(12.5)
HIV infection	3	(50.0)	2	(25.0)	0		1	(100)
Immunosuppressing agents	2	(33.3)	4	(50.0)	1	(50.0)	0	
Transplant	0		1	(12.5)	2	(100)	0	
Other immunocompromising condition	1	(16.7)	2	(25.0)	0		0	
Travel reason, n (%)								
Tourism	1326	(63.9)	188	(65.5)	105	(70.0)	3	(37.5)
Missionary/humanitarian aid worker	290	(14.0)	30	(10.5)	13	(8.7)	1	(12.5)
Business	216	(10.4)	15	(5.2)	20	(13.3)	0	
VFR	147	(7.1)	45	(15.7)	9	(6.0)	4	(50.0)
Education/student	73	(3.5)	6	(2.1)	3	(2.0)	0	
Research	5	(0.2)	0		0		0	
Military	3	(0.1)	0		0		0	
Planned medical care	2	(0.1)	1	(0.3)	0		0	
Retirement	0		1	(0.3)	0		0	
Other	5	(0.2)	1	(0.3)	0		0	
Not ascertainable	3	(0.1)	0		0		0	
Trip duration, median days (IQR)	30	(17–77)	18	(11–31)	19	(11–31)	28	(21–66)
Illness onset to site visit, median days (IQR)	30	(14–63)	11	(6–21)	19	(11–29)	9	(7–11)

Characteristic	Giardiasis (*n*=2072)		Cryptosporidiosis (*n*=287)		Cyclosporiasis (*n*=150)		Cystoisosporiasis (*n*=8)	
Hospitalized (all), *n* (%)	30	(4.3)[c]	18	(14.2)[d]	3	(6.4)[d]	0	
Hospitalized (without comorbidities), *n* (%)	21	(70.0)	12	(66.7)	1	(33.3)	0[f]	
Pretravel consultation, *n* (%)	1064	(66.5)[g]	114	(48.3)[h]	53	(51.5)[i]	3	(42.9)[j]

IQR, interquartile range.

[a] Amongst 2069 records with information available.

[b] Amongst 2068 records with information available.

[c] Amongst 696 records with information available.

[d] Amongst 127 records with information available.

[e] Amongst 47 records with information available.

[f] Amongst one record with information available.

[g] Amongst 1600 records with information available.

[h] Amongst 236 records with information available.

[i] Amongst 103 records with information available.

[j] Amongst seven records with information available.