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Patterns of illness and injury on Antarctic research cruises, 2004–2019: a descriptive analysis

Jenny T Visser, MBChB, MTRavMed*

Department of Primary Health Care and General Practice, University of Otago, 23 Mein St., Wellington 6021, New Zealand

*To whom correspondence should be addressed. Email: jenny.visser@otago.ac.nz

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Abstract

Background: Before the impact of the coronavirus disease 2019 pandemic, cruise travel had experienced exponential growth in the preceding decade. Travel medicine practitioners were increasingly called upon to provide pre-cruise travel advice and medical clearance. Demand for these services will return at some time in the future.
Methods: The clinical conditions seen in those presenting for care on six small-vessel scientific cruises to Antarctica were analysed.
Results: Personnel presented on 196 occasions resulting in 257 consultations (when initial plus all follow-up consultations were included). Personnel presented with a clinical condition at a rate of 17.9 per 1000 person-days at sea. The total consultation rate was 23.5 per 1000 person-days at sea. Injury accounted for 24% of all presentations at a rate of 4.3 per 1000 person-days at sea. Dermatological, soft tissue and musculoskeletal, general malaise and motion sickness were the four most common presentations.
Conclusions: Pre-cruise advice for travellers planning small-vessel cruises to polar regions needs to include skin care, prevention and management of sea sickness and how to reduce the risk of injury. Those providing medical care on such cruises should be prepared to manage a wide range of clinical presentations.

Key words: Cruise medicine, research cruise, Antarctica, Antarctic cruise, injury, COVID-19, skin, pre-travel advice

Background

The recent impact of coronavirus disease 2019 (COVID-19) notwithstanding, cruise passenger numbers had seen substantial and sustained growth globally over the past decade, from 17.8 million in 2009 to a predicted 32 million in 2020.[1] Travel medicine practitioners were increasingly called upon to provide pre-cruise travel advice and medical clearance to both tourists and crew and will continue to do so when cruise travel resumes. Such advice needs to be informed by data on the risks associated with this particular form of travel.

Antarctica has long been a destination for voyages of exploration. Those wishing to exploit the natural resources of the area soon followed, including those on whaling, sealing and fishing vessels. Today, most vessels in Antarctic waters are there for tourism purposes. In the 2018–2019 season the International Association of Antarctica Tour Operators recorded 56 168 tourist visits, an increase of 8.6% in the 2017–2018 austral summer.[2] In addition to tourists, it is estimated that in any given season there might be 4000 scientists and support staff on land undertaking research and as many as 1000 scientists and crew aboard research vessels in Antarctic waters.[3]

There is considerable literature on passenger and crew health on cruises. The majority of these are studies of cruises originating in North America and Europe and cruising the Caribbean and Mediterranean.[1] These are usually large vessels plying relatively calm seas with easy evacuation to land-based medical facilities. There is less literature on medical presentations during cruises to polar regions and even less on those visiting polar regions on research vessels. Cruises to polar regions differ in that they usually consist of smaller vessels sailing through rough waters and have limited evacuation options. The characteristics of passengers on large leisure cruises will also differ. The elderly and those with significant health issues would be less likely to obtain medical clearance for a polar cruise, especially a work-related one.

The aim of this study is to describe the number and range of clinical conditions seen and the medical workload on six scientific research cruises to Antarctica. This descriptive analysis will

help medical personnel determine the mix of skills and medical stocks required for such cruises. It will help health practitioners target advice during the pre-cruise travel consultation.

The cruises analysed typically consisted of 40–45 people at sea for 6–7 weeks, leaving New Zealand (NZ) in January to sail south through the Southern Ocean to the Ross Sea area. Persons on board were a mix of permanent crew and research scientists including science technicians. Most scientific research was undertaken directly from the vessel. On occasion small vessels deployed for short journeys. In addition, in some years brief landings on off-shore islands and the Antarctic mainland were undertaken. Scientific research included recording animal (primarily bird and whale) sightings, sampling of pelagic and benthic flora and fauna, deep-sea imaging, water sampling, hydrographic surveying, acoustics and atmospherics. This involved a plethora of scientific sampling methods including deployment of trawls, deep-sea cameras, water sampling equipment and moorings. While some laboratory work and most data analysis usually involved indoor work, much sampling was undertaken on deck.

The vessel has a well-equipped hospital, medical stores exceeding the requirements set by Maritime NZ[4] for cruises of this nature; however, it has limited diagnostics and no imaging facilities. Medical staff for Antarctic cruises consists of one doctor, supported by ship's officers all of whom have first aid and advanced life support training. All remaining crew have basic first aid training. Once in Antarctic waters the opportunity for medical evacuation is limited. While ice strengthened, the vessel is not an icebreaker. In the event of a medical crisis, access to bases on Antarctica cannot be assumed. Bases will also be reducing staff and facilities in preparation for the over wintering period. Even if bases could be accessed, they would provide minimal medical support. There is a risk of the vessel becoming trapped in sea ice that would necessitate a wait to be freed by an icebreaker. For these reasons, it has to be assumed that medical evacuation would entail the ship returning to NZ, a sailing time of 5–8 days depending on departure point and sea conditions. Therefore, ill and injured persons might need care for extended periods of time on board.

All persons on board must undergo extensive medical checks and be medically cleared before sailing. Medical requirements are in keeping with those required by Antarctica NZ for summer placements.[5] Insurance cover for all personnel on board is provided by their employers.

Methods

The clinical presentations on six research cruises on a single vessel sailing from Wellington, NZ, to Antarctica were analysed. These cruises were undertaken between 2004 and 2019.

Clinical presentations were collated from medical records. They were grouped into dermatological, soft tissue and musculoskeletal, sea sickness, lacerations and abrasions, headache/general malaise, respiratory, gynaecological/genitourinary and sexual health, gastrointestinal, dental/oral, psychological, ophthalmological, head injury/concussion and other. They were divided into injury or non-injury related. The total number of days at sea for each voyage was multiplied by the number of personnel on the voyage to determine person days at sea for that voyage. The number of person days at sea for the study was the sum of the person days for all six voyages. This number was used to calculate rates per 1000 person-days at sea.

Results

The six voyages had 244 participants spending 40–51 days at sea, a total of 10 932 person days at sea (Table 1).

During this time personnel presented on 196 occasions resulting in 257 consultations (including initial presentation plus follow-up consultations for that presentation). Once the condition had fully resolved, if the same person presented again with the same condition, it was counted again. For example, someone seen twice over 2 days early in the voyage for sea sickness would count as one presentation and two consultations. If they remained symptom free but then presented again with sea sickness later in the voyage, it would be counted as a separate presentation. This equated to rates of 17.9 presentations and 23.5 consultations per 1000 person-days at sea (Table 2).

The range of clinical conditions was wide and varied. Dermatological (30.6% of all presentations), soft tissue and musculoskeletal (18.9%), general malaise (11.2%) and motion sickness (10.2%) were the top four groupings (Table 2). Injury accounted for 47 of 196 (24%) of presentations at a rate of 4.3 per 1000 person-days at sea.

Most presentations were managed with a single visit to the doctor. Patients with psychological, head injury/concussion, dermatological and sea sickness were more likely to require follow-up consultations. No medical evacuations were required. Only two patients, one with concussion and one having a miscarriage, had the potential to deteriorate and require evacuation. Both were closely monitored over a number of days.

Discussion

Direct comparison of the current data with published studies is difficult. The categories of illness and injury used, populations studied (crew versus passengers) and demographics of passengers vary greatly. In addition, the differing purposes of cruises are likely to influence illness and injury patterns. Most published data concern passengers on tourist cruises on large vessels plying popular tropical and subtropical itineraries. Findings are not necessarily comparable to crew and scientists working on a small vessel in Antarctic waters. Two studies of small vessels in Antarctic waters,[6,7] one to Iceland[8] and three others combining data from Antarctic and Artic cruises[9–11] were identified. However, where described, the Antarctic cruises differed in location from the current study. All cruises described in the published studies originated in South America to then cross the Drake Passage and explore the Antarctic Peninsula. This requires less time in open waters that the cruises in the current study. Crossing the Drake Passage typically takes 2 days, with cruises then staying close to the coast line of the Peninsula. In comparison, transiting from Wellington to the Ross Sea takes 7–9 days through the notoriously rough Southern Ocean. Then for much of the 6–7 weeks the vessel remains in the open sea.

The differing purposes of the cruises, tourism versus scientific research, will also limit comparison. One study[12] of consultations among members of Indian scientific expeditions to Antarctica combining land- and sea-based research has been published,

Table 1. Consultation rates per cruise

Year	Total personnel (crew plus scientific staff)	Total days at sea	Person days at sea	Presentations	Presentations per 1000 person-days at sea	All consultations	All consultations per 1000 person-days at sea
2004	44	46	2024	29	14.3	34	16.8
2006	37	48	1776	28	15.8	31	17.5
2008	43	51	2193	39	17.8	65	29.6
2015	40	43	1720	21	12.2	30	17.4
2018	40	41	1640	41	25.0	52	31.7
2019	40	40	1600	38	23.8	45	28.1
Total	244	269	10 932	196	17.9	257	23.5

Table 2. Consultations by category

Category	Clinical presentations (N/%)	Total consultations[a] (N/%)
Dermatological	60 (30.6)	63 (24.5)
Soft Tissue & Musculoskeletal	37 (18.9)	42 (16.3)
General Malaise	22 (11.2)	22 (8.6)
Other	21 (10.7)	24 (9.3)
Sea Sickness	20 (10.2)	27 (10.5)
Lacerations & Abrasions	9 (4.6)	16 (6.2)
Respiratory	7 (3.6)	9 (3.5)
Gynaecological, Genitourinary & Sexual Health	6 (3.1)	9 (3.5)
Gastrointestinal	4 (2.0)	8 (3.1)
Oral & Dental	3 (1.5)	3 (1.2)
Psychological/Counselling	2 (1.0)	21 (8.2)
Ophthalmological	2 (1.0)	4 (1.6)
Head Injury/Concussion	1 (0.5)	7 (2.7)
Insomnia	1 (0.5)	1 (0.4)
Cardiac[b]	1 (0.5)	1 (0.4)
TOTAL	196	257

[a]Includes both initial presentation and any follow-up consultations
[b]Atrial Fibrillation (known pre-existing medical condition)

but separate data were not given for sea-based researchers. Other studies have described general or specific illness and injury among scientists and personnel at Antarctic bases.[13–16] Considering the very different living conditions and activities, findings of these studies cannot necessarily be extrapolated to scientific cruises.

The rate of presentations and consultations in the current study (17.9 presentations and 23.5 consultations per 1000 person-days at sea) is similar to that reported on expedition tourist cruise ships to Antarctica. One study[6] reported 15.4 visits per 1000 person-days at sea (excluding visits for prevention of sea sickness), whereas another study[7] calculated an overall incidence of 21.7 medical complaints per 1000 person-days. It could be expected that rates of illness and injury might be lower in the current study; average age is likely lower than that on tourist cruises and all must be medically cleared by the company doctor. However, this could be offset by the fact that those on research cruises are working, often in rough sea conditions, which might make them more susceptible to injuries.

The considerable variation in the medical work load among the cruises is striking. The rates of all consultations almost doubled from 16.8 in 2004 to 28.1 and 31.7 per 1000 person-days in 2018 and 2019 respectively (Table 2). Some of the upward trend in the later years might be explained by enhanced safety messaging. Personnel were encouraged to have all injuries, even very minor ones recorded. However, the variation was also a reflection of sea conditions (in 2018 more storms were encountered) or could be explained by chance variation of presentations. For example, one person required frequent psychological support after the unexpected death of a family member. Others have also noted variation among cruises. One study of 16 cruises to polar regions[11] recorded rates of consultations as low as 10 per 1000 on one cruise and as high as 35.7 per 1000 passenger days at sea on another. They hypothesized that variation was largely explained by two things; the occurrence of 'big seas' causing sea sickness and the spread of infections, typically upper respiratory tract infections.

In many studies injuries account for significant morbidity among crew and passengers[6,7,9,10,17–19] especially in older passengers.[7] At 4.3 per 1000 person-days in the current study, the rate of presentations due to injury is much higher than those described in both crew[18] and passengers[17] over 3 years on a world cruise. This is not surprising as these studies describe the experience on large ships, where both the risk and impact of motion is likely to be less. Perhaps of greater interest and possible concern is that the rate of presentations due to injury is similar to that described in

older passengers (4.8 per 1000 person-days for those > 60 years) on an Antarctic tourist ship.[7] Some of this could be explained by enhanced reporting of injuries but it is possible that the work environment on board a small research vessel in Antarctic waters is one that lends itself to accidents and injuries.

Dermatological conditions have been recorded as one of the most common causes of presentation both in cruise ship passengers[8,10,11,20–22] and crew.[9,10,20–22] In studies directly comparing passengers and crew, dermatological presentations are more common in crew.[9,10,20,21] In keeping with these studies, the top presentation in the current study was dermatological. This category included infections (viral, bacterial and fungal), eczema, dry skin, skin fissures, burns and dry/cracked lips. A significant proportion resulted from the cold, low humidity and ultra violet radiation experienced in Antarctica, even on-board vessels. Much scientific sampling took place on deck and much of that required manual dexterity (difficult to obtain with gloves and mittens) resulting in hands being exposed to extreme cold for short periods of time.

Soft tissue and musculoskeletal problems are commonly reported in both passengers[20–22] and crew[20–22] including on smaller vessels.[6–8,10,11] Such problems may be the result of the constant motion of vessels, especially on smaller vessels in rough seas. In the current study, soft tissue and musculoskeletal problems were the second most common presentation. Problems included a wide range of conditions from ankle sprains, rotator cuff injuries, thoracic and lumbar pain, as well as contusions. These injuries might be expected given the physical nature of the work required including the deployment and retrieval of trawls and other scientific equipment in heavy seas in cold conditions on decks frequently covered in ice and snow. Injuries were often caused by falls. The motion of the ship was a factor in many injuries, as people lost balance, were thrown against objects or had to brace suddenly in an awkward position.

There was a category for general malaise. This has not been described in other studies. Typically personnel presented with headache, fatigue and 'just not feeling right'. It is possible some of this represents mild or a 'pre-motion sickness' syndrome as people adjusted to the motion of the ship. It also likely that this category captured those who were simply fatigued because of long hours of physically and mentally demanding work in almost constant motion. On these scientific cruises, personnel worked for the entire time at sea. There were no days off. Personnel rotated through 8 and sometimes 12-h shifts. Scientific sampling would cease if safety was compromised due to very heavy seas; however, work continued through days of moderate swells. As previously described, the physical demands of the cruises were significant. If not working on deck, many hours were spent sitting at workstations on computer screens or looking through microscopes, all on a constantly moving platform. Compared with shore-based persons, ships' crews experience low sleep efficacy scores and high sleep fragmentation.[23] This is exacerbated around changeover days when crew move between differing shifts. As in other settings, poor-quality sleep has been associated with fatigue, lowered alertness and lowered performance[23] and might explain some of the presentations for general malaise. Others have described a phenomenon in which exposure to ship vibration and wave slamming have been linked to poor sleep, headaches and nausea.[24]

In the current study sea sickness was the fifth most common presentation, whereas in other studies of small vessel cruises, it was often the most commonly reported presentation among passengers.[6,7,9] The difference could be explained by the fact that in the current study all persons are either permanent crew or marine scientists/technicians with many cruises over their careers. Those with a particular propensity for sea sickness will likely have not pursued such a career. Consultations for sea sickness are also possibly underrepresented because those with a history of sea sickness would usually bring a supply of their preferred anti-motion sickness medication and would not present to the doctor.

Although infections feature as one of the leading presentations in other studies, they did not feature significantly in the current study. Respiratory illness was one of the top presentations in many studies.[6,8–11,20–22,25] Influenza[26–29] and more recently COVID-19[30] outbreaks has brought into focus the potential for respiratory diseases to spread among passengers and crew on cruise ships. That respiratory illness was uncommon in the current study could be explained by the fact that personnel are NZ based and departing during the summer months, a time of lower risk for respiratory infections. Even if someone did come on board with an infection, it would soon 'burn out', as there is no contact with outside persons for the duration of the cruise. Infectious gastroenteritis also features in many studies.[10,20–22] Outbreaks on cruises have been well documented[31–35] but no presentations were recorded in the current study. This is likely explained by the fact that the cruises originate in a high-income country with no chance of introduction of infectious agents once underway.

There were no medical evacuations or deaths recorded in the current study. It is likely that the requirement for a thorough pre-cruise medical clearance will reduce risk by removing those with significant pre-existing health conditions. Although the bulk of clinical presentations are minor and can readily be managed on board, serious clinical conditions and deaths on cruises have been reported[6,19,20,22,25] and could occur on any cruise.

In a recent systematic review,[36] the lack of perceived risk was the major factor influencing travellers who failed to seek pre-travel advice. The current study outlines the rates of illness and injury in cruise participants, better informing both the public and those who advise them.

Limitations

All cruises were on the same vessel originating in NZ and may not be typical of research cruises.

There were limited diagnostics available on board, so diagnoses were based on history and examination.

Conclusion

Pre-cruise advice for travellers planning small vessel cruises to polar regions should include skin care, prevention and management of sea sickness and how to reduce the risk of injury. Those providing medical services on cruises to remote areas will encounter a wide range of clinical presentations. They should have an excellent generalist medical background as well as emergency skills. Physicians may need to take on roles beyond

their usual day-to-day practice including dentistry, nursing and counselling. In addition to their medical skills, they require the personal skills to facilitate their being part of a small community. Empathy, good communication and being able to fit in with the day-to-day running of the vessel will go a long way towards making a voyage safe and enjoyable.

Those advising and medically clearing cruise passengers need to understand the environmental conditions to which passengers will be exposed as well as the more common clinical conditions they might present with. Not all cruises are the same. Medical risks, thresholds for clearance and advice will differ between a 10-day Caribbean cruise and a multi-week cruise to Antarctica, for example. Even with the most stringent pre-cruise health screening and the best-equipped vessel, medical intervention will be limited and evacuation may be delayed or not possible. Travelling to remote parts of the planet carries inherent risk that cannot always be fully mitigated.

References

1. Cruise Lines International Association (CLIA). *Sate of the Cruise Industry Outlook 2020*. https://cruising.org/news-and-research/research/2019/december/state-of-the-cruise-industry-outlook-2020 (19 January 2020, date last accessed).
2. IAATO. *Report of the International Association of Antractica Tour Operators 2018-19*. 2019. https://iaato.org/documents/10157/2955630/IP139+-+Report+of+the+International+Association+of+Antarctica+Tour+Operators+2018-19.pdf/aa866188-e188-4c18-b7bb-8940eae4be71 (31 October 2019, date last accessed).
3. World Population Review. *Antarctica* http://worldpopulationreview.com/continents/antarctica-population/ (October 31 2019, date last accessed).
4. Maritime Rules: *Part 50: Medical Stores*. 2016. https://www.maritimenz.govt.nz/rules/part-50/Part50-maritime-rule.pdf (31 October 2019, date last accessed).
5. Antarctica New Zealand. *Travelling to Antarctica*. https://www.antarcticanz.govt.nz/education/travelling-to-antarctica (21 May 2020, date last accessed.
6. Schutz L, Zak D, Holmes JF. Pattern of passenger injury and illness on expedition cruise ships to Antarctica. *J Travel Med* 2014; **21**:228–34.
7. Bledsoe GH, Brill JD, Zak D, Li G. Injury and illness aboard an Antarctic cruise ship. *Wilderness Environ Med* 2007; **18**: 36–40.
8. Shaw MTM, Leggat PA. Illness and injury to travellers on a premium expedition to Iceland. *Travel Med Infect Dis* 2008; **6**: 148–51.
9. Hoyme HW, Meyer-Rochow VB. Reasons and frequency of visits to the ship's doctor by passengers and crew members of cruise ships in polar waters. *Polar Record* 2011; **47**:80–5.
10. Carron M, Emeyriat N, Levraut J, Blondeau N. Cruise ship pathologies in remote regions. *Int Marit Health* 2018; **69**:75–83.
11. Curry C, Johnston M. Emergency doctors by sea to Antarctica: small ship medicine in polar regions. *Emerg Med* 2001; **13**:233–6.
12. Bhatia A, Malhotra P, Agarwal A. Reasons for medical consultation among members of the Indian scientific expeditions to Antarctica. *Int J Circumpolar Health* 2013; **72**: 20175.
13. Otani S, Ohno G, Shimoeda N, Mikami H. Morbidity and health survey of wintering members in Japanese Antarctic research expedition. *Int J Circumpolar Health* 2004; **63**:165–8.
14. Bhatia A, Pal R. Morbidity pattern of the 27th Indian scientific expedition to Antarctica. *Wilderness Environ Med* 2012; **23**:231–8.e2.
15. Pattarini JM, Scarborough JR, Lee Sombito V, Parazynski SE. Primary Care in Extreme Environments: medical clinic utilization at Antarctic stations, 2013–2014. *Wilderness Environ Med* 2016; **27**:69–77.
16. Priddy RE. An "acute abdomen" in Antarctica: the problems of diagnosis and management. *Med J Aust* 1985; **143**:108–11.
17. Dahl E. Passenger accidents and injuries reported during 3 years on a cruise ship. *Int Marit Health* 2010; **61**:1–8.
18. Dahl E, Ulven A, Horneland AM. Crew accidents reported during 3 years on a cruise ship. *Int Marit Health* 2008; **59**:19–33.
19. Bansal V, Fortlage D, Lee JG, Hill LL, Potenza B, Coimbra R. Significant injury in cruise ship passengers: a case series. *Am J Prev Med* 2007; **33**:219–21.
20. Dahl E. Anatomy of a world cruise. *J Travel Med* 1999; **6**:168–71.
21. Dahl E. Medical practice during a world cruise: a descriptive epidemiologocal study of injury and illness among passengers and crew. *Int Marit Health* 2005; **56**:1–4.
22. DiGiovanna T, Rosen T, Forsett R, Sivertson K, Kelen GD. Shipboard medicine: a new niche for emergency medicine. *Ann Emerg Med* 1992; **21**:1476–9.
23. Arendt J, Middleton B, Williams P, Francis G, Luke C. Sleep and circadian phase in a Ship's crew. *J Biol Rhythms* 2006; **21**:214–21.
24. Omer H, Bekker A. Human responses to wave slamming vibration on a polar supply and research vessel. *Appl Ergon* 2018; **67**:71–82.
25. Peake DE, Gray CL, Ludwig MR, Hill CD. Descriptive epidemiology of injury and illness among cruise ship passengers. *Ann Emerg Med* 1999; **33**:67–72.
26. Young BE, Wilder-Smith A. Influenza on cruise ships. *J Travel Med* 2018; 1–2. doi: 10.1093/jtm/tay146.
27. Bell TR, Kornylo Duong K, Finelli L, Slaten DD. Influenza surveillance on cruise ships. *Am J Prev Med* 2014; **46**:327–9.
28. Brotherton J, Delpech C, Gilbert GL *et al*. A large outbreak of influenza A and B on a cruise ship causing widespread morbidity. *Epidemiol Infect* 2003; **130**:263–71.
29. Browne A, St-Onge Ahmad S, Beck CR, Nguyen-Van-Tam JS. The roles of transportation and transportation hubs in the propagation of influenza and coronaviruses: a systematic review. *J Travel Med* 2016; **23**:1–5.
30. Rocklöv J, Sjödin H, Wilder-Smith A. COVID-19 outbreak on the Diamond Princess cruise ship: estimating the epidemic potential and effectiveness of public health countermeasures. *J Travel Med* 2020; **27**:1–7.
31. Minooee A, Rickman LS. Infectious diseases on cruise ships. *Clin Infect Dis* 1999; **29**:737–43 quiz 44.
32. Daniels NA, Neimann J, Karpati A *et al*. Traveler's Diarrhea at sea: three outbreaks of waterborne Enterotoxigenic Escherichia coli on cruise ships. *J Infect Dis* 2000; **181**:1491–5.
33. Widdowson M-A, Cramer EH, Hadley L *et al*. Outbreaks of acute gastroenteritis on cruise ships and on land: identification of a predominant circulating strain of norovirus: United States, 2002. *J Infect Dis* 2004; **190**:27–36.
34. Lawrence D. Outbreaks of gastrointestinal diseases on cruise ships: lessons from three decades of progress. *Curr Infect Dis Rep* 2004; **6**:115–23.
35. Bert F, Scaioli G, Gualano MR *et al*. Norovirus outbreaks on commercial cruise ships: a systematic review and new targets for the public health agenda. *Food Environ Virol* 2014; **6**:67–74.
36. Kain D, Findlater A, Lightfoot D *et al*. Factors affecting pre-travel health seeking behaviour and adherence to pre-travel health advice: a systematic review. *J Travel Med* 2019; **26**:1–14.