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# What's the worst that could happen? The risk of illness, injury, and death related to international travel-the Australian experience

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ABSTRACT

*Introduction:* Medical advisors to travellers whose journeys begin and end in Australia will benefit from a review of the associated risks, to guide pre- and post-travel advice and care.
*Methods:* A literature search was conducted for original research on medical events in Australian residents related to international travel. Important findings were summarised, incidence and risk factor data extracted, and grouped thematically for narrative review.
*Results:* 31 studies published between 1995 and 2024 were identified. Reports of medical events during travel ranged between 28 % and 82 % of travellers, most commonly respiratory and gastrointestinal in nature (34 %–63 % of cases combined). Trauma accounted for 25 %–49 %. 23 studies (74 %) provided data only on events identified or treated after the traveller had returned. Respiratory, gastrointestinal and febrile illnesses were the most frequent reasons for these presentations. Respiratory infection was more common in older returned travellers. Younger adult travellers, more commonly experienced gastrointestinal infection and traumatic injury, including animal bites. Travellers Visiting Friends and Relatives (VFR) were at a higher risk of introducing notifiable diseases to Australia, and contracting tropical diseases.
*Conclusions:* Many travellers seek care after returning from international travel, with the majority due to diseases which commonly occur in Australia. Tropical diseases, however, which can be life-threatening, and require high levels of care, must be excluded. The changing demographic of the migrant population presents a public health risk when VFR travellers are exposed to diseases with limited presence in Australia. Travel advice should include a discussion about possible rabies exposure.

## 1. Introduction

UN Tourism reported that international tourism surpassed pre-pandemic levels in 2024 [1]. This aligns with the Australian experience. The monthly number of residents returning from short-term trips reached pre-COVID-19 volumes in January 2024 [2]. The Australian Bureau of Statistics (ABS) defines short-term travellers as Australian residents leaving the country and returning within one year [3]. The most popular reason for travel in this cohort is 'holiday' (57 %), followed by 'visiting friends/relatives' (VFR) (29 %) [3].

Unplanned medical events during travel can lead to significant disruption of travel plans and reduced well-being, care in foreign environments, expensive medical bills, and long-term consequences for the returned traveller's health. To minimise the impact of illness and injury in their clients, travel medical advisors need to counsel them on the risk associated with their planned itinerary, utilising evidence of factors associated with morbidity and mortality.

It is well-established that the chance of medical events occurring while travelling overseas depend on various characteristics of the planned journey, and the traveller undertaking it [4]. The travel destination has been shown to influence the risk of medical events; higher in lower income countries, due to the associated risk of infectious disease, inferior transportation safety standards, and the local standard of medical care [5,6]. The duration of travel positively relates to the risk of medical events, as does age [5–14]. Other risk factors identified for medical events during or after travel, include the presence of comorbidities or chronic disease, travel style (e.g. backpacking), journey purpose (e.g. aid work), activities (e.g. riding motorised vehicles) and

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precautionary behaviours (e.g. vaccination) [4,6,15,16]. In addition, health risks from international travel vary according to the traveller's normal place of residence [4,17]. Therefore, how these factors affect the likely illness or injuries associated with international travel for Australian residents, is best reflected by studying Australian travellers.

While pre-COVID-19 data suggested that only 30 % of Australians sought pre-travel advice, it is anticipated that the improved medical literacy e.g. risk and benefits of vaccinations, health promotion, risk perception and risk avoidance behaviour, introduced by the pandemic, will increase pre-travel consultations [18,19]. This review set out to explore the documented evidence of medical events in short-term Australian international travellers, to assist in the provision of realistic pre-travel risk assessment and health promotion strategies.

## 2. Materials and methods

A comprehensive search was undertaken on the 22nd of February 2024, of two electronic databases; Ovid Medline, and SCOPUS and one search engine, Google Scholar, to identify original research which provided data on medical events occurring in Australian international travellers both during their journey, or after their return to Australia. Pilot searches showed that recent data was scarce, so no restriction was made on publication date. The published language was restricted to English. Peer-reviewed articles were included, as were government reports with relevant data. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (http://www/prisma-statement.org/) were utilised to ensure a robust search process, although it was performed by a single reviewer, and was not a systematic review (Fig. 1).

For quality purposes, a specialist librarian was consulted to identify the search terms used; *Australia*, *international travel*, *returned travel*, *medical*, *health*, *travel medicine*, *injury*, *illness*, *travel-related illness,* and *death*. MeSH terms were considered when applicable and consideration given to spelling options, particularly '*traveller*' and '*traveler*'. The first 200 Google Scholar results were included, as they are sorted by relevance, and this ensured a manageable return of appropriate articles.

Articles were collected in an EndNote 21 library. The original list was screened for du-plicates; initially done using the comparison functionality of EndNote and followed by manual review by authors' names and document title. The reference lists of articles were reviewed for additional studies which might meet the search criteria, and they were added to the EndNote library. Only original research was included in the final review, review papers which were identified in the search were checked at this stage for appropriate studies, that may have been missed, but no further papers were identified.

In the title and abstract screening process, the main reasons for exclusion were document type (not original research), and unrelated topics. Because the intention was to capture studies of short-term international travellers from Australia, studies were excluded if the defined traveller cohort was specifically immigrant, refugee, expatriate populations or foreign visitors to Australia. Where there was a mixed cohort of those traveller types, papers were excluded if there was no explicit data on Australian resident travellers. Papers were excluded if all travel was domestic rather than international. Because the purpose was to review the Australian experience, the cohort must be clearly identified as Australian residents. Where Australian travellers were grouped only with New Zealand travellers, the papers were included, but larger groupings such as Oceania or Australasia were not.

An extraction spreadsheet was created for Excel (Version 16.63.1) to allow documentation of decisions during the full-text review. Studies were included if the paper included insight into the possible incidence of any medical event related to international travel. Papers which

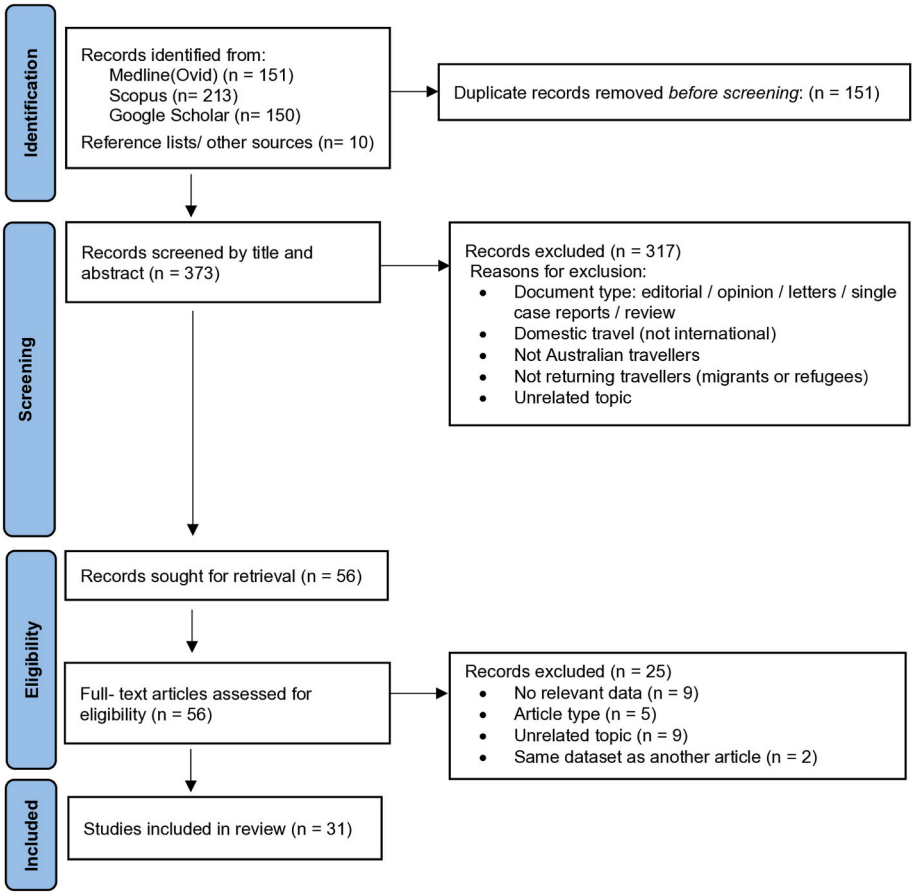


**Fig. 1.** Flow diagram of process for review of medical events in Australian international travellers.

identified risk factors for Australian international travellers were also included.

Once the final papers were identified, the important findings and themes of each paper were summarised in an Excel spreadsheet, to allow for grouping and comparison, in preparation for narrative review. Only data available in the published work was reviewed. The search was repeated on the 15th of April 2025, limited to the period from 1st January 2024 to 15th April 2025, to identify new publications.

## 3. Results

A total of 31 studies were identified which provided information on the occurrence of and risk factors for illness, injury, or death in international travellers from Australia (Table 1). 27 studies were identified in the initial search, and a further four in the later search. Publication dates were between 1995 and 2024. 30 of the studies were carried out in Australia and one in Thailand. Two papers recorded medical events during travel and immediately afterwards (72 h, and one week), five considered medical events during travel, one considered deaths during travel, and 23 provided data on events that became evident, or required treatment, only after the traveller had returned to Australia.

In the eight papers that measured events during travel, five detailed all-cause morbidity (62.5 %), two investigated infectious disease (25 %), and one all-cause mortality (12.5 %). Of the 25 that measured events after travel, 21 involved infectious diseases (84 %), two all-cause morbidity (8 %), and two the traumatic injury of animal bites/scratches and rabies exposure (8 %).

The key findings of the review were considered according to the measurement period with respect to travel and are outlined in Table 1. Reports of medical events during travel ranged between 28 % and 82 % of travellers. Respiratory and gastrointestinal diseases were the most common experienced by Australians during overseas travel (combined, they accounted for 34 %–63 % of medical cases). Traumatic injuries were most commonly classified as musculoskeletal events following accidents or falls. Between 25 % and 49 % of medical cases during travel were due to trauma.

Most commonly, medical events related to international travel, but diagnosed in Australia were respiratory, gastrointestinal infectious diseases, or systemic febrile illness. The most common non-infectious reason was traumatic injury.

The five papers with statistically significant risk factors identified for medical events related to international travel ($p < 0.05$) are summarised in Table 2.

## 4. Discussion

Based on international data, it is generally assumed that between 22 % and 64 % of travellers will experience a medical event during their journey [52,53]. Reports of medical events during travel ranged between 28 % and 82 % of Australian travellers in this review. The wide range reflects the non-uniform cohorts of the included studies, with various combinations of traveller age, travel duration, destination, and definition of medical event, among other contributing factors. Incidence values specific to events occurring after the Australian travellers had returned home were not identified. The consolidated research provides a number of overarching principles and notable findings relevant to Australian medical and public health practitioners.

### 4.1. Infectious diseases: Australian endemic infections

Currently, the most popular destinations for Australian travellers are Indonesia, New Zealand, the USA, the UK and Japan [3]. While Australians may consider these to be 'safe' destinations, the frequency of gastrointestinal, respiratory and febrile illnesses in Australian travellers returning from high-income countries has previously been highlighted by Drewett and Leder [54]. The results of this review reiterate that all international travellers should be made aware of the risk of gastrointestinal and respiratory illnesses during travel, and take appropriate precautionary measures, to minimise the disruption or discomfort in their journey [16,55].

Where a confirmed diagnosis was available, the review reinforced the adage that 'common things occur commonly.' The cause of illness in most Australian returned travellers was an infection endemic in Australia. Confirming the results in prior studies from global cohorts [4,6,56,57], respiratory and gastrointestinal infections were among the leading cause of complaints in Australian travellers [20,24,29].This pattern shows consistency across 25 years of research, despite changing traveller demographics in that period [3,58].

### 4.2. Infectious diseases: tropical diseases (Australian non-endemic infections)

While routine infections are frequent, it was repeatedly reported that returned travellers with tropical diseases required higher levels of care such as hospitalization [28,36]. This should further encourage the provision of pre-travel advice regarding prevention of such diseases through vaccines, prophylaxis, and personal hygiene instruction [59,60]. However, even with full adherence to recommended precautions, illness is still possible, so travellers should be aware of the warning signs of such diseases when travelling [56]. The increasing numbers of Australian travellers to Asian destinations, and Indonesia in particular, was seen to be reflected in increasing numbers of tropical diseases, like dengue [38]. This review further highlights the importance of clinical suspicion and history taking in post-travel medical care, to correctly diagnose life-threatening tropical diseases like malaria. The post-travel consultation should always consider the actual preventative behaviours undertaken, rather than what was planned, because there are risks associated with non-compliance [46]. The studies in this review showed that Australians overwhelmingly presented for medical care for tropical disease within six months of their return, reinforcing the message that details of travel in that period provide an important component of the medical history [61,62].

### 4.3. Traumatic injury

International evidence suggests that the risk of accidents and injuries in travellers requires more attention within the discipline of travel medicine [9,63]. A recent systematic review showed that travellers have a higher risk of injury than domestic populations but had no specific data from Australians travellers [64]. The predisposition for risk-taking behaviour while overseas, and resultant trauma highlighted in this review is consistent with other research outlining the increased risk taking in holidaymakers, particularly younger travellers [21,65]. Data from all cause morbidity and mortality in this review suggested that trauma is in important cause of medical events in Australian travellers, accounting for up to 49 % of medical cases during travel, and 27 % of deaths [23,24,27]. Significantly, 10 % of Sohail's cohort had experienced a traumatic injury during travel but sought care in the Australian medical system, representing a burden on Australian medical services, despite their occurrence overseas [29].

### 4.4. Traumatic injury: animal bites and rabies exposure

In terms of Australian tourist travellers, this review showed discussion of rabies exposure should always be included in pre-travel counselling. The absence of rabies in terrestrial Australian animals, leaves most residents unaware of the danger, despite its existence in some of the more frequent tourist destinations, including the most popular, Bali, Indonesia [2,66]. The reporting of presentations for rabies Post Exposure Prophylaxis provides an indication of the frequency of animal bites during travel, suggesting that potential rabies exposure is common and questions regarding animal exposure should actively be asked by the

**Table 1**
Summary of original research included in this review of medical events in Australians related to international travel.

| Category | Year of Publication | Reference | Cohort and medical events measured | Findings |
|---|---|---|---|---|
| *Events measured during travel* | | | | |
| All cause morbidity | 2019 | Oo et al. [20] | Medical events in travel clinic attendees | Of 24 Australian and New Zealand travellers presenting to a Bangkok hospital, the most common diagnostic groups were gastrointestinal disorders in nine (38 %) and respiratory disorders in six (25 %). |
| | 2017 | Furuya-Kanamori, Mills, Sheridan and Lau [21] | Medical and psychological events in gap-year travellers | 28 of the 34 (82 %) gap-year travellers reported medical problems. Sunburn was most common (19 cases, 56 %). 15 experienced respiratory infections (44 %), 14 reported weight change (41 %), and 13 diarrhoea or food poisoning (38 %). Psychological stressors were common, including 26 who felt homesick (76 %) and 18 (53 %) reporting culture shock. 19 (56 %) participants sought medical attention at least once during their placement. Three were admitted to hospital (9 %). At least 22 (65 %) engaged in risky behaviours, including excessive drinking or illicit drugs. |
| | 2015 | Bialy et al. [22] | Medical events in immunosuppressed travellers | 34 of the 105 (32 %) immunosuppressed (HIV-positive or renal transplant or rheumatology patients) participants reported being unwell while travelling, but only 18 (17 %) sought medical advice during the journey. 41 were VFR travellers (39 %) and 57 (54 %) were visiting a high-risk destination. |
| | 2005 | Leggat, Griffiths and Leggat [23] | Emergency medical events in travel insurance customers | Out of approximately 20,000 travel insurance policyholders, emergency medical assistance was accessed by 136. 46 were admitted to hospital, and 10 required medical evacuation. In total, there were 275 travel insurance claims for medical or dental treatment, and a further 59 for trip cancellation or curtailment for medical reasons. Claims causation was available in 308 of those 334 claims (92 %). The top disease categories were musculoskeletal 87 (28 %), gastrointestinal 45 (15 %), dental 42 (14 %), respiratory 36 (12 %), and ear, nose, and throat 26 (8 %). |
| | 2002 | Leggat and Leggat [24] | Medical/dental travel insurance claims | In 539 of 569 (95 %) insurance claims for medical and dental events, the nature of illness was available. The most common categories were respiratory 110 (20 %), musculoskeletal 90 (17 %), and gastrointestinal conditions 75 (14 %), ear, nose and throat 67 (12 %) and dental 39 (7 %). There were 2 deaths. Causation was only available in one, listed as acute myocardial infarction. Heart attack and stroke accounted for 6 (5 %) of the 122 claims for which causation was available. The most common causes were traumatic accidents and falls 60 (49 %) and infectious disease 29 (24 %). |
| Infectious disease | 2020 | Alqahtani et al. [25] | Respiratory, constitutional, and gastrointestinal symptoms in Hajj pilgrims | 288 of the 391 (74 %) participants reported one or more illness symptoms. Most common symptoms were cough 176 (45 %), sore throat 171 (44 %), runny nose 103 (26 %), diarrhoea 64 (16 %) and fever 59 (15 %). |
| | 2013 | Ratnam et al. [26] | Respiratory disease in travel clinic attendees | ARIs occurred in 109 of the 387 travellers (28 %) to Asia. 12 travellers experienced multiple episodes of illness (2 or more) during the travel period. By day 30, the cumulative risk of an episode of ARI was estimated to be 30 % and 44 % by day 100. The incidence was measured as 106.4 ARIs per 10,000 traveller days (95 % CI 88.6–126.7). The study identified four cases of influenza A during travel, providing an incidence density of 3.4 infections per 10,000 days of travel (95 % CI 1.4–8.6). |
| Mortality | 1995 | Prociv [27] | Overseas deaths of Australians as reported to the Department of Foreign Affairs and Trade. | Of 313 deaths of short-term Australian overseas travellers, 227 (73 %) were from illness, and 86 (27 %) due to trauma. Cardiovascular events were the single largest cause of death, with 117 (37 %) cases, while motor vehicle or road accident 28 (9 %) was the most common cause of traumatic deaths. The crude estimated mortality rate for Australian travellers was calculated as 10/100,000 per month. Death rates increased with age. Fatal trauma predominated in younger people. |
| *Events measured after travel* | | | | |
| All cause morbidity | 2024 | Mazzocato et al. [28] | Paediatric medical events in Emergency Department attendees and infectious disease referrals | Reason for travel was VFR in 193/282 (68 %) returning child travellers, and tourism in 83 (29 %). 91 VFR travellers were admitted to hospital (47 %) compared with 20 returned tourist travellers (24 %). VFR travellers contributed 44/51 (86 %) cases of 'uncommon' (non-endemic in Australia) infections and 149/244 (61 %) 'common' (endemic in Australia) diseases. 8/10 (80 %) children reporting return from a Pacific cruise had an RTI. |
| | 2019 | Sohail et al. [29] | Medical events in Emergency Department attendees | In the cohort of 464, the most common reasons for presentation were gastroenteritis 119 (26 %), systemic febrile illness 88 (19 %) and respiratory tract infection 51 (11 %). The most common non-infectious reasons were traumatic injury 47 (10 %) and post animal bite rabies Post Exposure Prophylaxis 29 (6 %). |
| Tropical and infectious disease | 2024 | Lee et al. [30] | Enteric fever in paediatric hospital presentations and *NNDSS* | 101 (89 %) of 114 paediatric cases of enteric fever were Australian resident travellers. Nine of the 11 cases where travel purpose was documented, (82 %) were VFR travellers. |

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**Table 1** (*continued*)

| Category | Year of Publication | Reference | Cohort and medical events measured | Findings |
|---|---|---|---|---|
| | 2023 | Jackson et al. [31] | COVID-19 cases from pathology laboratory data | 9 cases (9 %) of COVID-19 were detected from 99 symptomatic adult international travellers returning to Australia, before travel restrictions were enacted. |
| | 2023 | Peck et al. [32] | Influenza cases in hotel quarantine participants | 42 cases of influenza (0.3 %) among 15,026 returned travellers on COVID-19 repatriation flights. 41 cases (98 %) were from India and 1 case (2 %) was from Pakistan. Virus sequencing showed that there were independent infections prior to travel but also identified possible in-flight transmission. |
| | 2023 | Marsland et al. [33] | Measles from *NNDSS* | All 6 reported cases of measles resided in Australia and acquired the infection overseas. |
| | 2021 | Furuya-Kanamori, Mills, Trembizki et al. [34] | Antimicrobial-resistant *E. coli* colonisation after return from Asian countries | Of 59 participants, 34 (58 %) became colonised with antibiotic-resistant *E.coli* during travel. All were asymptomatic. A higher proportion of travellers to South Asia (India, Nepal, Sri Lanka) than other destinations. |
| | 2021 | Forster and Leder [35] | Typhoid fever from *NNDSS* | 96 % of Typhoid notifications (887/923) were acquired overseas. |
| | 2020 | Alqahtani et al. [25] | Respiratory, constitutional, and gastrointestinal symptoms in Hajj pilgrims | 157 (52 %) of 300 pilgrims reported symptoms, 7–10 days after their return to Australia; 111 (37 %) reported a cough, 47 (16 %) a runny nose, 45 (15 %) a sore throat, and 32 (11 %) fever. In some of these cases, the same symptoms had been experienced during the travel period, ranging from 16 % of those with fever (5 out of 32 cases) to 43 % of those with a sore throat (33 out of 76 cases). |
| | 2019 | Chong et al. [36] | Paediatric infectious diseases in Emergency Department attendees | All seven children who acquired tropical infections were Australian residents returning from South Asia and the Pacific Islands, with prolonged exposure periods of over 30 days. Six of the seven required hospitalization. |
| | 2018 | Quinn et al. [37] | Dengue fever from *NNDSS* | There were 49 unique patients with a positive result for dengue infection. All had a history of international travel. |
| | 2018 | Rowe et al. [38] | | Of 2187 notifications of dengue, three were acquired in Australia. 985 cases were acquired in Indonesia (45 %), 305 in Thailand (14 %) and 108 in Malaysia (5 %). |
| | 2017 | Tai et al. [39] | Dengue fever in hospitalised cases | Described 208 cases of dengue in returned travellers from four health care networks. Most frequent travel destinations were Indonesia 94 (45 %), Thailand 40 (19 %) and East Timor 23 (11 %). 138 (66 %) were travelling for tourism, 36 (17 %) VFR and 30 (14 %) for business. |
| | 2016 | Heywood et al. [40] | Infectious disease from *NNDSS* | Recent international travel was reported by 180/222 (81 %) of enhanced surveillance cases. 100 % of malaria, chikungunya and paratyphoid cases were associated with recent overseas travel. Of the 180 cases with a history of recent travel, 117 (65 %) were travelling for the purpose of VFR. |
| | 2014 | May et al. [41] | *Corynebacterium diphtheriae* infection data from pathology laboratory | In a review of *C. diphtheriae* isolates for whom a travel history was available, 44 out of 63 patients (70 %) had a recent history of overseas travel to a tropical destination. All were healthy individuals with a skin and soft tissue injury during travel, leading to a nonhealing wound. |
| | 2013 | Ratnam et al. [26] | Respiratory disease in travel clinic attendees | 29 of the 387 travellers (7.5 %) developed an ARI in the 72 h after their return to Australia from Asian destinations. |
| | 2012 | Freeman et al. [42] | Hepatitis A in *NNDSS* | 46 % of cases (411/886) of hepatitis A had travelled to a country where hepatitis A is endemic. Another 23 % (205/886) were household contacts of a case that travelled to an endemic country. |
| | 2012 | Gray et al. [43] | Malaria in *NNDSS* | 157/388 cases of malaria notifications were Australian travellers (40 %). |
| | 2012 | Warrilow et al. [44] | Dengue fever in symptomatic patients | Review of 135 returned travellers with acute dengue infection. Most frequent destinations were Asia 104 (77 %), Papua New Guinea 18 (13 %) and the Pacific Islands 11 (8 %). |
| | 2010 | Kennedy and Collignon [45] | Antimicrobial-resistant *E. coli* colonisation in hospital staff | Colonisation with antibiotic-resistant *E. coli* increased significantly from 8 (8 %) to 50 (49 %) in rectal swabs provided by 102 hospital employees before and after international travel. Colonisation was associated with travel to Asia. 19 (19 %) of travellers remained colonised at six months post-travel. |
| | 2007 | Massey et al. [46] | Malaria in PNG Kokoda Trek travel group | Six out of 38 (16 %) travellers were diagnosed with malaria on return from Papua New Guinea. Of the six cases, two had not used chemoprophylaxis, and four had terminated prophylaxis prematurely. |
| | 2006 | Einsiedel and Spelman [47] | Hospital presentations of strongyloidiasis | Of 29 diagnosed cases of strongyloidiasis where medical records were available, 11 (38 %) were returned travellers. Seven (24 %) had travelled to South-East Asia. |
| | 2002 | Kitchener et al. [48] | Dengue fever in Australian Defence Force members | From approximately 2500 soldiers returning from East Timor, nine cases of dengue were identified. |
| Traumatic injury | 2013 | Kardamanidis et al. [49] | Post Exposure Treatment cases following animal bites | Of the 780 presentations following possible rabies exposure overseas, 611 (78 %) were associated with travel to Southeast Asia. There were 277 cases (36 %) specific to the island of Bali. Most exposures were due to monkeys 385 (49 %) and dogs 279 (36 %). While the information was not provided in all cases, at least 152/385 (39 %) of |

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**Table 1** (*continued*)

| Category | Year of Publication | Reference | Cohort and medical events measured | Findings |
|---|---|---|---|---|
| | 2011 | Mills et al. [50] | | monkey exposures, and 68/279 (24 %) of dog exposures, resulted from contact initiated by the human.<br>Of 65 presentations of returned travellers following an animal bite or scratch, at travel medicine clinics, 30 of the incidents occurred in Bali (46 %) and 21 in Thailand (32 %). Monkeys were responsible in 29 cases (45 %) and dogs in 27 (42 %). It was noted that the incidents occurred most among travellers aged between 20 and 29 years. |

VFR, visiting friends/relatives; ARI, acute respiratory infection; CI, confidence interval; NNDSS, The Australian Government National Notifiable Diseases Surveillance System, Database of over 70 diseases that present a risk to public health in Australia. Also referred to as 'Notifiable disease data' [51]; RTI, respiratory tract infection; PNG, Papua New Guinea.

**Table 2**
Statistically significant risk factors and travel-related medical events identified in Australian international travellers.

| Publication | Risk Factor | Description |
|---|---|---|
| *During travel* | | |
| Ratnam et al. | Missionary/aid worker vs other travel purpose hazard ratio 2.3; 95 % CI 1.1–4.7, p = 0.027 | Travellers who acquired an ARI were more likely to be travelling for the purpose of missionary/ aid work than other travel purposes. |
| Oo et al. | Aust/NZ travellers vs Asians aOR 8.23; 95 % CI 1.64–41.25, p = 0.012<br>Aust/NZ travellers vs Asians aOR 0.09; 95 % CI 0.01–0.75, p = 0.035 | Travellers from Australian and New Zealand were more likely to present with diarrhoea and less likely to present with dengue in Thai clinics than Asian travellers. |
| *During and after travel* | | |
| Alqahtani et al. | Influenza vaccination vs unvaccinated aOR 0.2; 95 % CI 0.1–0.9, p = 0.02<br>Used alcoholic hand rubs vs not aOR 0.4; 95 % CI 0.2–0.9, p = 0.02<br>Used face mask during travel vs not aOR 2.1; 95 % CI 1.2–3.6, p < 0.01<br>Used disposable handkerchiefs vs not aOR 3.3 95 % CI 1–10.6, p < 0.05 | Travellers who experienced cough during or after travel were more likely to be unvaccinated or did not use alcoholic hand rubs during travel.<br>Those with runny nose during or after travel were more likely to have used face masks.<br>Travellers who experienced vomiting during or after travel were more likely to have used disposable handkerchiefs during travel. |
| *After travel* | | |
| Jackson et al. | Positive results (average age 58.8 years) vs negative results (average age 49.9 years) (p = 0.049).<br>Positive cases had higher CCI (p = 0.021) | Returned travellers with symptoms who tested positive to COVID-19 were more likely to be older or have known comorbidities than those who tested negative. |
| Sohail et al. | Patients aged 50 and over vs under 50<br>OR 2.86; 95 % CI, 1.43–5.59, p < 0.01<br>Patients aged 50 and over vs under 50<br>OR 0.4; 95 % CI, 0.20–0.83, p < 0.01 | Returned travellers over the age of 50 were more likely to present to the emergency department with respiratory infection, and less likely to present with gastrointestinal infection compared to other age groups. |

aOR, adjusted odds ratio; CI, confidence interval; ARI, acute respiratory infection; Aust/NZ, Australia and New Zealand; CCI, Charlson Comorbidity Index (numerical predictor of ten-year mortality for a patient with comorbid conditions).

health provider in all returned travellers [49]. While the risk of contracting rabies may be low, the catastrophic outcome of doing so means that pre-travel counselling regarding animals is vital for Australian travellers.

### 4.5. All-cause morbidity and mortality: pre-existing medical condition

Existing health status and possible drug-drug interaction remains an important topic for discussion in the pre-travel consultation, especially with the increasing age of the average Australian traveller, and increasing rate of Australians living with a chronic disease [58,67]. The significance of this dialogue was emphasised by the study of overseas deaths of Australians, where 50 % were associated with underlying chronic diseases [27]. In particular, the prominence of cardiovascular disease as a cause of emergency events and death underscore the importance of the exacerbation of existing disease as a cause of medical events during travel [23,27].

Aside from chronic disease aggravation, an important relationship between travellers with pre-existing morbidities, which can include hypertension, diabetes, and asthma, or advanced age, and the occurrence of new-onset disease was identified in this review [22,31]. In some cases, the potential consequences of illness may outweigh the perceived benefits of the journey.

### 4.6. Implications for public health in Australia

Internationally acquired infectious diseases can pose a life-threatening risk to the individual, and potential transmission to the Australian population, well-illustrated to travellers in recent years by the COVID-19 pandemic. This review illustrated that several of the 'notifiable diseases' monitored by Australian health authorities, including typhoid, and dengue, currently appear in Australia largely due to returned travellers [35,37,38,40]. It specifically highlighted the role of VFR travel in imported infectious disease.

Over the last two decades, the destination for Australian VFR travellers has significantly changed, from Western Europe to Asia and Africa, due to the increase in immigration from those regions [68]. The studies of paediatric populations included in this review noted that age-appropriate preparation, including travel vaccines specific to the destination, were underutilized prior to travel [28,30,36]. VFR travellers accounted for the majority of presentations with tropical diseases like malaria, and the introduction of transmissible diseases like measles [33,40]. Pre-travel communication and personalised advice needs to be promoted in VFR travellers, particularly when returning to their country of origin with Australian-born children who are immunologically naïve to the conditions endemic in parent's region of origin.

### 4.7. Limitations

This review was completed by a single reviewer, who was guided by the PRISMA procedures, to produce a summary of available published research, but there were limitations. The definition of 'traveller' can vary greatly. The Australian Bureau of Statistics has clear distinctions between 'short-term travellers (under 1 year)', 'returned long-term travellers', 'international visitors' and 'international students', however this was not followed in the reviewed studies [3]. Therefore, while included data was intended to only include returning Australian

residents, there is a possibility that other groups were included in the data, like foreign visitors to Australia, due to inconsistencies in data categorisation. Similarly, the Australian Government makes data on the consular assistance provided to Australian citizens abroad publicly available, including assaults, deaths and hospitalisations [69]. While it does not distinguish between short-term travellers and long-term expatriates and was therefore not used in this review, it could provide additional guidance for prospective travellers, similar to that recently published using Irish data [70].

There have been no published studies of all-cause morbidity in Australian travellers. While several studies have used general travel statistics trying to estimate incidence of specific diseases, none had true denominator data available. Without calculation of incidence, it is not possible to compare how risk factors affect that incidence. Most of the available data is retrospective, and prospective studies outside special groups like deployed military personal are largely lacking. The changes in travel destination, duration of journey, and age and medical status of travellers since the studies were undertaken in Australia are important considerations, as they will affect the number and type of medical events. In the years since data was collected for many of these studies, Australian international travel preferences have changed considerably, particularly with respect to duration of travel (shorter), and destination (favouring Asia) [71]. Additionally, the impact of global health considerations, such as the Covid-19 pandemic and growing antimicrobial resistance, together with political and economic challenges, continue to influence travel choices [3,72]. This represents a considerable limitation of this review-the age of some data limits its current applicability.

The lack of data identified regarding a number of travel medicine topics highlights possible priority research areas for the Australian travel medicine community. While there is some evidence that overseas-acquired STI cases are increasing, the number in short-term travellers, as distinct from new migrants, is unknown [73]. Considering the increasing popularity of sex tourism, this requires further investigation, as does medical tourism. Better evidence is also required regarding in-flight incidents, and deep vein thrombosis, resulting from long-haul flights to and from Australia, in order to appropriately counsel prospective and returned travellers.

### 4.8. Conclusion

Overall, limited incidence and prevalence data exists about the likelihood that Australian overseas travellers will experience travel-related illness or require medical care during or after their journey. The possibility of contact with notifiable diseases in VFR travellers, and the seriousness of rabies exposure through interaction with animals should be considered in both pre- and post-travel consultations with international travellers from Australia.

## CRediT authorship contribution statement

**Siobhan C. Carroll:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Maria Eugenia Castellanos:** Writing – review & editing. **Andreas Neumayr:** Writing – review & editing. **Lars Henning:** Writing – review & editing, Supervision, Methodology, Conceptualization.

## Data availability statement

No original data was generated for this article. Detailed search strategy and outcomes are available from the author.

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## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Siobhan Carroll reports a relationship with Allianz Partners that includes: employment. Lars Henning reports a relationship with James Cook University that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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