Japanese encephalitis (JE) is a leading cause of viral meningoencephalitis transmitted by *Aedes* mosquitoes in large parts of Asia. Travelers are at risk for JE, the main risk factors being outdoor evening and nighttime exposure in rural areas during the transmission period. Among travelers and expatriates visiting Asia since 1992, an increasing number, also after short-term visit, has contracted JE.\(^1\) – \(^4\) This increase has coincided with a huge expansion of tourism to endemic areas in Southeast Asia (SEA) during this period. Of the survivors, more than half experience neurological sequelae. The aim of this review was to describe and summarize published and anecdotal non indexed reports of cases of JE among travelers, with a special emphasis on travelers from Scandinavian countries.

**Traditional Assessment of Travelers’ Risk**

JE infections are most often asymptomatic\(^5\) but lead to overt encephalitis in 1 to 20 cases per 1,000 infected.\(^1\) – \(^6\) Although no seroprevalence study on travelers has been published, it is reasonable to assume that for each of the few clinical cases reported, several mild or inapparent cases have occurred. A higher probability of clinical disease has been seen in non-immune adults as exemplified by the ratio subclinical to clinical disease of 1 of 25 US servicemen stationed in SEA.\(^8\) Since the mean age of travelers in many Western countries is well over 50 years, an increased proportion of clinical cases as well as increased severity of illness by age have practical implications for prophylactic measures in travelers. Limited data indicate that JE acquired during the first or second trimesters of pregnancy causes intrauterine infection and miscarriage, but to our knowledge, no pregnancy-associated cases have been seen in travelers.\(^9\)

Risk figures for travelers at risk are a crude estimate, based on the number of outbound airline passengers to Asia (2–3 million US citizens annually during the past 5 years; US Department of Transportation, unpublished data), and suggest that the risk of acquiring JE among US travelers is less than 1 per million annually. This estimate may be low because short-term travelers to developed and urban areas probably constitute the majority of visitors to Asia, and not all travelers with JE will have been recognized. The vaccination recommendations and availability of JE vaccine may also vary both between countries and between periods that may influence attack rates.

As judged from published cases in travelers, the risk for acquiring JE for travelers visiting Asia is low. In previous reviews,\(^10\) – \(^11\) 131 cases of JE among US and allied military stationed in SEA occurred between 1945 and 1972. An additional 24 cases have been reported during the years 1978 to 1992 of which 6 were US soldiers and 2 their dependents. The outcomes were reported in 15 of these 24 cases: 6 fatalities, 5 disabled, and only 4 recovered.

The risk for an individual traveler is highly variable depending on type of activities, season, locations, and duration of travel. The extent and nature of outdoor activity, use of protective clothing, bed nets and repellents, and lodging in air-conditioned or well-screened rooms are additional factors that may influence exposure. Only one of the cases was reported up to 1992 classified as an occasional visitor, indicating that short-term tourism was not associated with a significant risk for contracting JE. Since residents of developed countries, with few exceptions, have no natural immunity to JE, all ages are susceptible to infection. No travel-associated JE in children was reported in this series.

For travelers to rural areas where JE is endemic, the risk may be extrapolated from incidence rates in the resident population. Assuming an annual incidence rate of 10 per 10,000 and recognizing that nearly all cases occur within a 5-month period, the estimated risk for JE during a 1-month period (the transmission season) is 1 per 5,000 or 1 per 20,000 per week.\(^10\) – \(^11\) Similar rates (less than 0.1–2.1 per 10,000 per week) have been observed in nonimmunized Western military personnel in Asia (data from 1945 to 1991).\(^10\) – \(^11\) This is the worst-case scenario, but the majority of travelers to SEA are tourists who preferentially visit the region during the dry season.

**Recent Cases of JE in Travelers**

Increased tourism to SEA during the past decades has markedly increased the potential exposure to JE among travelers. An additional 21 cases have been published or...
Countries from which JE has been imported are not surprisingly the countries harboring most tourists. Among these 21 cases, at least half were short-term visitors. Thirteen were fatal or resulted in permanent neurological sequelae, confirming the devastating consequences of JE in travelers from previous reports. It is particularly surprising that among the cases in Table 1, many were "usual tourists" contracting JE, exemplified by those with a brief visit to Bali with a single- or 2-day trip outside their beach hotel, respectively. The same is true for the Italian visiting Vietnam on a rather standard tour as well as the elderly Italian spending every winter in his bungalow at the touristic Kata Beach in Phuket. It is also worth mentioning that neither in this nor in the previous case series a single case was reported from India despite several major outbreaks in the 1980s, including the large outbreak in the Ganges Valley in 2005. The same is true for Nepal reporting an increase in indigenous cases during the past decades.

Figures concerning the number of cases must be viewed with great caution. The actual number of cases can be expected to be higher as there is no notification requirement. Furthermore, the incubation period for JE of 5 to 15 days may result in travelers falling ill during their travel, reducing the possibilities for both specific diagnosis and reporting. Among the 21 cases reviewed herein, 13 (60%) are reported from Scandinavian countries, strongly suggesting incomplete reports from many countries.

Several cases from regions with the major rains usually falling between May and September were contracted outside the rainy season. For the main tourist area in southern Thailand, this is especially striking (Figure 1), and the World Health Organization has also reconsidered the main tourist areas in southern Thailand as having all-year transmission.

Although not fully elucidated, it is tempting to suggest that the main reason for this observation is the fact that the low level of transmission also occurring outside the main transmission period becomes evident when millions of tourists avoid the rains and visit the area during the dry season. Additionally, rainy seasons have become less predictable subsequent to global climate changes. Basically, other countries in SEA may experience a similar situation if tourism increases to the proportions seen in southern Thailand. Therefore, transmission periods (except for the northern areas with cold winters) must be understood from a quantitative and not from a qualitative perspective.

During the 14-year period following 1994, approximately 2 million Swedish travelers have visited Thailand. Based on the seven reported cases during this period, the minimal attack rate per trip can be estimated to be 1 per 400,000 regardless of type or length of stay. At least half of these travelers were tourists staying for a shorter period (less than 4 wk). Similar incidence rates for the other Nordic countries seem to apply.

Conclusions

It seems that Culex tritaeniorhynchus hosting the JE virus are present at places and at times of the year contradicting expectation of no JE transmission. Mosquitoes do not acknowledge the rule not to bite travelers within their first 28 days of stay. The reported cases illustrate that current vaccination recommendations are incapable of protecting travelers, mainly short-term travelers, against JE. In half of the cases reported during the past 14 years, JE was transmitted to persons whom travel health professionals would have considered to be at virtually no risk. Our understanding of the travelers’ risks for JE thus is incomplete. The
risk for JE among Nordic travelers to Thailand, mainly during the dry season, is at least in the order of 1 in 400,000 travelers, probably higher.

Based on our experience with the so far used inactivated mouse brain–derived vaccine, the present restrictive JE vaccination recommendations were justified. However, since several new cell culture–derived JE vaccines are soon to be introduced, particularly considering that the vaccines are well tolerated, a revision of our JE vaccination recommendations seems logical to prevent tragic cases in travelers.

Declaration of Interests

The authors state that they have no conflicts of interest.

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