Descriptive Epidemiology of Travel-Associated Diarrhea Based on Surveillance Data at Narita International Airport

Masahiko Hachiya, PhD, MD, MPH,*† Hitoshi Kikuchi, PhD, MD,* and Tetsuya Mizoue, PhD, MD‡

*Quarantine Station, Narita International Airport, Ministry of Health, Labour and Welfare, Tokyo, Japan; †Bureau of International Cooperation, International Medical Center of Japan, Tokyo, Japan; ‡Department of Epidemiology and International Health, Research Institute, International Medical Center of Japan, Tokyo, Japan

Background. Although travelers' diarrhea is one of the most common health problems among international travelers, current findings depend largely on hospital and clinic-based information. To better understand the disease epidemiology and to identify specific subpopulations with increased risks, denominator data covering a large traveler population are needed.

Methods. We conducted a questionnaire survey of all travelers at the quarantine station, Narita International Airport, and retrospectively reviewed records from January 2001 to December 2005. The Immigration Bureau database was used as denominator data on travel patterns during the same period. To elucidate the risks of contracting diarrhea, we estimated incidence according to age, sex, month of travel, and travel destination.

Results. A total of 7,937,654 people voluntarily submitted questionnaires; 9,836 had travelers' diarrhea. Travelers of both sexes aged 20 to 29 years reported the disease most frequently. Men aged 20 to 24 had the highest estimated incidence compared with any other age and sex group. The incidence was higher in March, August, and September than other months, mainly due to the influx of young adult travelers. Travel to south-central Asia, Southeast Asia, and North Africa was associated with higher risks than that to other areas.

Conclusions. Risks of contracting travelers' diarrhea are dependent on age, sex, season, and destination of travel. Incidence of diarrhea in all four seasons varies with age. Some destinations are associated with increased risks regardless of age. To prevent travelers from contracting diarrhea, adequate measures should focus on specific subpopulations.

Travelers' diarrhea is one of the most predominant health threats among international travelers.[1–3] Some reports estimate that 20% to 50% of people traveling from industrialized countries to developing countries experience travelers' diarrhea.[4–6] Although most cases are mild and self-limiting, associated morbidity can affect the traveler's well-being.[1,3] Moreover, an exotic pathogen could spread from endemic regions to other communities.[7,8] Thus, preventing travelers' diarrhea is an important public health issue.

To reduce traveler's diarrhea, realistic preventive measures should be established based on accurate epidemiological findings.[8] Unfortunately, however, reliable information is scarce, as most relevant research has been conducted without denominator data and results might therefore be biased.[7,9–11] Ideally, specific subpopulations with increased risk of travelers' diarrhea should be identified based on data covering all relevant travelers.

The quarantine station at Narita International Airport is the largest quarantine office in Japan and is responsible for checking more than half of the international passengers from abroad. The aims of this study were to undertake a descriptive analysis of the epidemiology of travelers' diarrhea and to determine the factors associated with contracting this disorder. We estimated diarrhea incidence using Immigration Bureau data as the denominator and quarantine data as the numerator. Specifically, we retrospectively investigated

M. H. and H. K. contributed equally.

Corresponding Author: Masahiko Hachiya, PhD, MD, MPH, Bureau of International Cooperation, International Medical Center of Japan, 1-21-1 Toyama, Shinjuku, Tokyo 162-8655, Japan. E-mail: m-hachiya@it.imcj.go.jp

the characteristics of passengers arriving with diarrhea in terms of age, sex, seasonality, and travel destination.

Methods

Definition of Travelers' Diarrhea and Travel Destination

Travelers' diarrhea was defined as "the passage of three or more unformed stools per 24 hour period, with at least one passage accompanied by symptoms of nausea, vomiting, abdominal cramps or pain, fever or blood in the stool"[12,13] during or shortly after travel.

Travel destination was arbitrarily defined as "the location of the departing airport of the aircraft arriving at Narita International Airport," because we had no information on each traveler's travel route.

Quarantine Station, Narita International Airport

The study was conducted at quarantine station, Narita International Airport, approximately 60 km east of central Tokyo. In 2003, this was the 26th busiest passenger airport and third busiest freight hub worldwide. The airport has two separate terminal buildings, and each building has two different quarantine stations with health consultation rooms. All arriving passengers are requested to report any health problems during the previous 4 weeks. The station distributes questionnaires mainly to passengers from cholera- and shigella-endemic countries/areas. Upon visiting the health consultation rooms, quarantine doctors ask for a detailed travel history and perform a physical examination. Based on this information, combined with blood test results if available, doctors provide medical advice and references to hospitals free of charge. On average, nine quarantine officers, four nurses, and two medical doctors are on duty daily. This work has been performed in compliance with the Quarantine Law in Japan and dates back to 1879.

Questionnaire

Age and sex of travelers with diarrhea, as well as season of travel and travel destination, were obtained by questionnaires. In addition, the questionnaire identified date of arrival, flight code, place of residence in Japan, and symptoms that appeared during the previous 4 weeks (including fever, diarrhea, abdominal pain, vomiting, abnormal bleeding, and cough). Travelers who had diarrhea at the time of arrival were questioned about the frequency of defecation, characteristics of the stool (bloody, consistency), other symptoms, and the food and beverages consumed while traveling. Quarantine officers and nurses entered selected information into a Microsoft Access database (Microsoft, Inc., Redmond, WA, USA).

A total of 76,608,025 travelers arrived at Narita International Airport between 2001 and 2005. Of these, 60,765,529 (54.7% of all inbound travelers) entered Japan while the other 15,842,496 people either landed for transit purposes only or used alternate ports of entry into Japan. Of the travelers entering Japan, 7,937,654 voluntarily submitted questionnaires (response rate = 13.1%) and 9,870 met the criteria for travelers' diarrhea. Thirty-four patients were excluded from the analysis for lack of data. Finally, 9,836 respondents (1 per 807 of all respondents = 0.12%) were included in the study.

Denominator Data

The quarantine station does not obtain information regarding age and sex distribution of all travelers. We therefore obtained the number of travelers according to age group, sex, month of arrival, and travel destination using the database of the Immigration Bureau, Ministry of Justice, Japan.[14–18] Specifically, we referred to tables including "The number of people entering Japan," "The number of people that entered via Narita," "The number of travelers to Japan by month," and "The number of arrivals to Japan by age and sex" in the database.

Statistical Analysis

We used chi-square analysis to compare the estimated incidence of travelers' diarrhea by age group, sex, month, and travel destination. A p value <0.01 was defined as being statistically significant. Data were analyzed using Stata 9.0 software (Stata Corporation, College Station, TX, USA).

Results

Chronological Trends

To determine whether or not diarrhea incidence varies over time, we compared the number of all arriving passengers to those who had travelers' diarrhea on a monthly basis and estimated the incidence of diarrhea. The number of inbound passengers decreased markedly after the September 11 terrorist attacks in 2001 and during the severe acute respiratory syndrome outbreak in 2003 (Figure 1, top). Both curves showed two peaks each year: one in March and another in August or September. The number of travelers also peaked in January and May, although the incidence of travelers' diarrhea did not peak during these periods. Thirty-nine percent of travelers' diarrhea cases occurred in March, and in August or September, when 27% of the inbound travelers entered Japan. Estimated incidence showed regular periodic changes, with increased incidence observed exclusively in March, August, and September of each year except for May 2004 (Figure 1, bottom). Travelers' diarrhea has continued to occur regularly, even during and after the tourism recession.

Forty-one percent of diarrhea cases occurred in March, August, and September in young adults aged between 15 and 39, while 28.1% of the cases reported in these months occurred in subjects aged 40 or older. Age and seasonal distribution were similar in men and
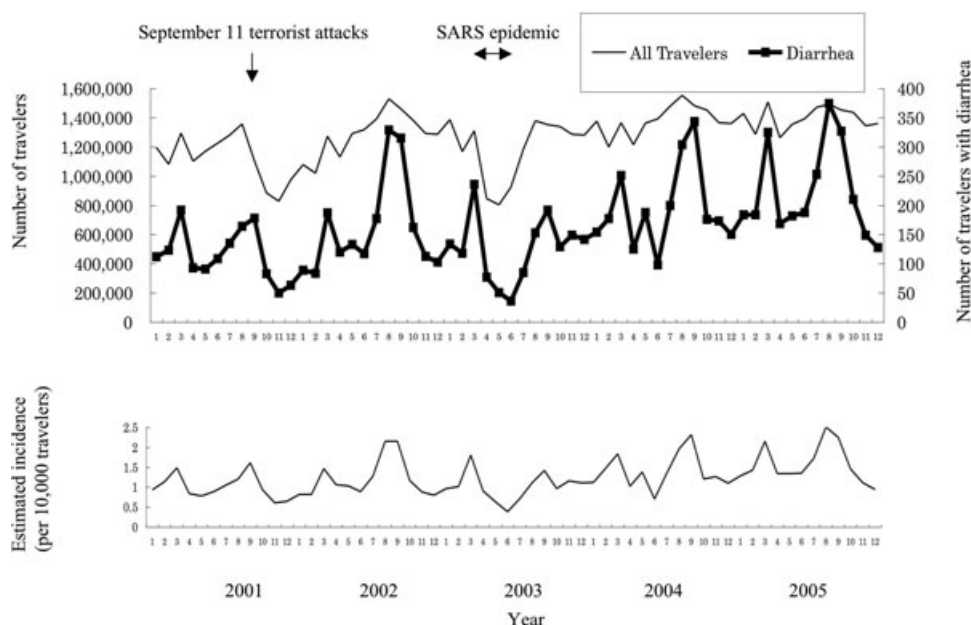
Figure 1 Inbound travelers and reported diarrhea. Chronological trend of all inbound travelers ($n = 76,608,025$), and those who reported diarrhea at the quarantine station ($n = 9,836$) at Narita International Airport for 2001 to 2005 (top). Estimated monthly incidence of diarrhea for a 5-year period (bottom).

women, whereas peaks were higher in men. Seasonal diarrhea distribution appears to be affected by subject age.

Age and Sex Distribution

To clarify how travelers' diarrhea incidence differs by age and sex, we compared the number of travelers and the number with reported diarrhea, and compared diarrhea incidence in men with that in women. The mean age of patients with travelers' diarrhea was 29.7 years (SD, ±10.8); 5,197 (52.8%) were males, and 4,639 (47.2%) were females. Age distribution of all travelers showed two peaks in both sexes: 30 to 39 and 50 to 54 years for men, and 25 to 29 and 50 to 54 years for women (Figure 2, top). Conversely, diarrhea cases presented as a single peak and were skewed to younger age cohorts in each sex. Young adults aged 20 to 29 comprised 57.6% of all diarrhea cases, but only 19.9% of all travelers (Figure 2, middle). The estimated incidence peaked at the age of 20 to 24 years in both sexes (Figure 2, bottom). Young men aged 20 to 24, however, reported having diarrhea more frequently than women in the same age cohort ($p < 0.001$), or any other age cohort in both sexes ($p < 0.001$). The estimated diarrhea incidence thus varies by age and sex.

Destination

To elucidate the impact of travel destination on contracting diarrhea, we compared region-specific incidence by sex, aggregated for the 5-year study period. Compared with other destinations, travel to south-central Asia, Southeast Asia, and North Africa

was associated with a higher incidence of diarrhea in both sexes; 79.8% of patients with diarrhea originated from these three destinations, despite only 17.5% of the international travelers surveyed coming from these areas. Males showed a higher incidence than females for most of these regions (Table 1). Travel destination seems to be an important factor in contracting diarrhea.

Discussion

We conducted this study to better understand the epidemiology of travelers' diarrhea and to test the hypothesis that specific subpopulations are at greater risk of contracting diarrhea during travel. Our study has three major findings. First, age and sex distribution in patients with diarrhea were significantly different from those of the general traveler population, with young men exhibiting the highest incidence among all age and sex groups. Second, travelers' diarrhea had a distinct seasonal pattern with spring and summer surges, but this seasonality may largely depend on age. Third, travel to some parts of Asia and Africa was significantly associated with contracting diarrhea.

Chronological Trends

We illustrated chronological trends of diarrhea (Figure 1), and found that the disease incidence exhibited a similar yearly pattern for 2001 to 2005, even during periods of marked negative impacts on international tourism. Travel activities and hygiene behaviors might not be affected by terrorism or disease outbreak. This phenomenon has not been reported
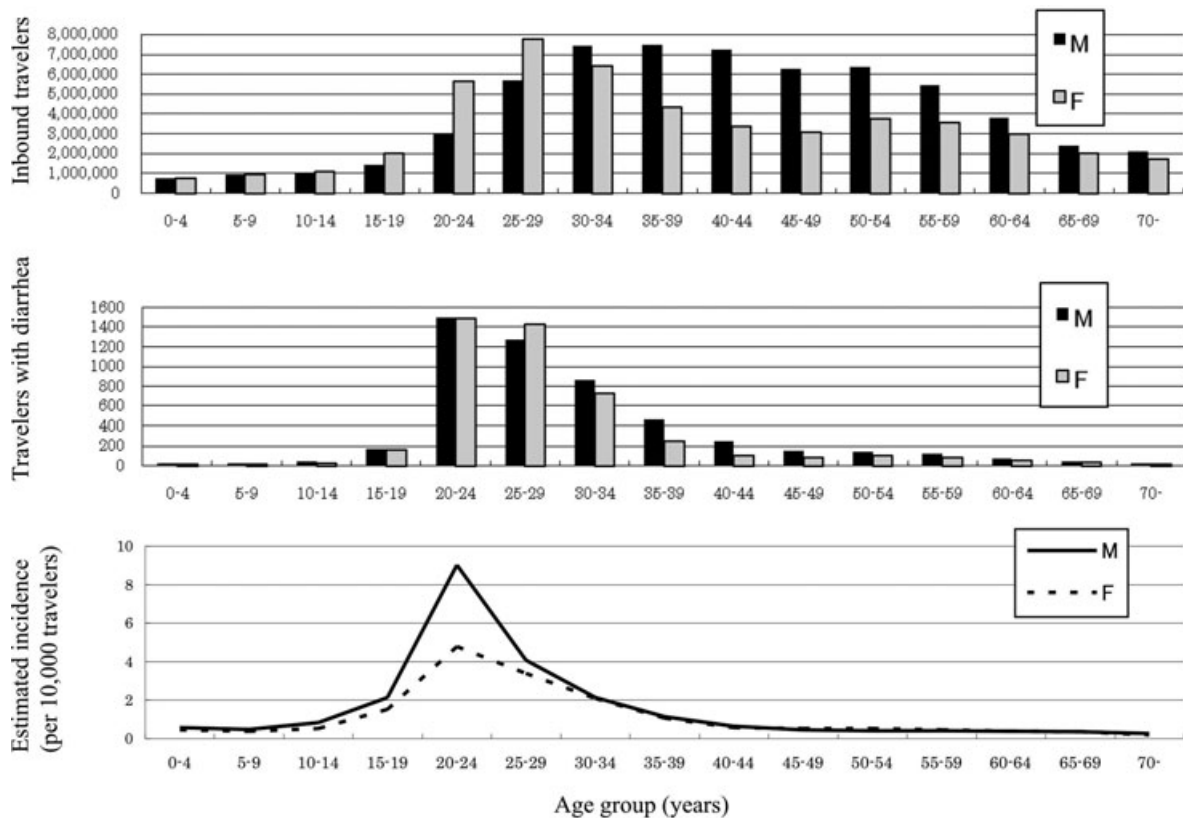
Figure 2 Age distribution for inbound travelers: reported diarrhea and estimated incidence by sex. All inbound travelers to Japan (top, $n = 111,098,944$) and self-reported diarrhea at the quarantine station (middle, $n = 9,836$) at Narita International Airport for 2001 to 2005. Estimated diarrhea incidence was calculated by quarantine and immigration data sources (bottom).

Table 1 Estimated diarrhea incidence by destination and sex

Destination	Male Mean ± SD	Female Mean ± SD
Australia and New Zealand	0.08 ± 0.11	0.05 ± 0.07
Polynesia and Micronesia	0.53 ± 0.98	0.41 ± 0.71
West South Asia	0.86 ± 1.10	1.28 ± 1.43
South-central Asia	27.92 ± 57.83	16.76 ± 20.50
Central America	0.11 ± 0.39	0.11 ± 0.38
East Asia	0.70 ± 1.19	0.42 ± 0.54
Southeast Asia	5.67 ± 7.02	4.69 ± 5.06
South Europe	0.28 ± 0.41	0.27 ± 0.33
Tropical South America	2.21 ± 4.22	0.64 ± 0.67
North Africa	16.06 ± 30.47	13.50 ± 13.93
North Europe	0.21 ± 0.29	0.24 ± 0.29

Estimated diarrhea incidence among travelers by travel destination in males and in females at Narita International Airport for 2001 to 2005 (per 10,000 travelers)

so far, and could only be confirmed by longitudinal observations, which are scarce for reports of travel-related illnesses.[8] Since diarrhea incidence is likely to continue showing this pattern, these findings must be used to develop plans directed at public health initiatives to prevent travelers' diarrhea.

Summer is generally considered to be the riskiest season for contracting diarrhea in the northern hemisphere,[1,21] because it is often difficult to maintain food hygiene in warmer weather.[10] The increased incidence of diarrhea observed in August and September in our study supports this assumption. However, the high incidence in March requires another explanation. In Japan, the fiscal year ends in March, and most colleges and universities have spring break during this month. Considering the age distribution among travelers with diarrhea, the high incidence in March may be due to increased travel among college/university students, although we do not have data to support this hypothesis.

Age and Sex Distribution

Traveler age and sex distribution are associated with the travel patterns adopted by each age category. For example, young women travelers outnumber males in the same age group because of their travel preferences,[19,20] whereas middle-aged men travel more than women in the same age category for their business activities.[19,20] Those aged 20 to 29 years showed a higher incidence of travelers' diarrhea than other age groups, a finding consistent with other reports.[3,5,6,9,21] This may reflect the relatively more adventurous and

careless behavior[6,22] or larger appetite in this age group.[1] Differences in disease incidence between sexes might be ascribed to hygiene behavior, destination, and purpose of travel. For instance, young men are more adventurous and thus show higher incidence of travelers' diarrhea than young women in general. However, many studies have not shown any significant differences in travelers' diarrhea by gender.[6,13,22] In contrast, our results indicate that the difference in incidence between sexes largely varies by age. Additional studies will be needed to determine the reasons behind our findings.

Destination

Our study revealed that travel to south-central Asia, Southeast Asia, and North Africa is positively associated with contracting diarrhea. Studies in other countries have also found that these regions are associated with travelers' diarrhea,[6,13,23] salmonellosis,[11] shigellosis,[10] and enteric fever.[22] In contrast to the age-month analysis, age distribution of travelers to specific destinations was not available (Table 1). However, information regarding the increased possibility of contracting various diseases in specific countries should be given to all travelers going to these regions.

Strengths and Weaknesses

The present study is based on the data covering more than half of the total traveler population entering Japan during the study period. Narita is not that different from other Japanese international airports in terms of proportion of travelers' age, sex, travel season, and destination.[19] Consequently, our results are likely to be representative of the present situation in Japan. Questionnaire distribution and collection and patient consultation are part of the quarantine facility's daily activities and offered to travelers for free. Therefore, patients with diarrhea presented here are less likely to be affected by any financial or insurance-related constraints of the subject.[9,10] Additionally, questionnaire forms, data entry management, and database system have not dramatically changed during the study period. These characteristics are unique for the Narita quarantine station,[8] and are the major strengths of this report.

However, our study has several limitations. First, our results demonstrated a low response rate and overall incidence of travelers' diarrhea compared with other studies, in which an incidence ranging from 20% to 50% was reported.[4-6,13] Thus, the incidence rates of diarrhea could be biased. There may be some explanations for our lower rate of travelers' diarrhea. For example, travelers may have already recovered from the disease on arrival at Narita, and thus did not report its occurrence. In addition, travelers may not have reported their physical problems to save time or to avoid incurring potentially frustrating consequences. Quarantine officers sometimes witness that package tourists have been advised by tour conductors not to submit questionnaire forms to avoid the possibility of

being examined. Self-report bias is difficult to avoid when using current quarantine system.[6] Second, some important risk factors, such as type and duration of travel or diet, were not analyzed, as the questionnaire was not structured to collect this information. Since these factors have a marked influence on the incidence of travelers' diarrhea,[1,5,6] this aspect needs to be carefully considered when interpreting results. Third, our data on the incidences of travelers' diarrhea were not controlled by factors other than the one in question, and therefore, we could not formally identify an independent risk factor for contracting travelers' diarrhea. Likewise, we need additional studies to clarify age- and/or sex-dependent differences in contracting diarrhea. Finally, Japanese and foreign travelers were not separated in this study, because the quarantine station's primary purpose is to prevent the spread of exotic pathogens in the country regardless of traveler's nationality. However, since approximately 75% of all inbound travelers were Japanese, our data could mainly represent the situation of travelers' diarrhea contracted by Japanese travelers.

Conclusions

Using a questionnaire survey data at the Narita quarantine station, we successfully demonstrated that the risk of contracting travelers' diarrhea is associated with age, sex, month, and destination of travel. The difference in incidence between sexes and seasonal pattern depended on the travelers' ages. Some destinations increased the risk of contracting disease. Special attention should focus on specific subpopulations, and the results presented here may offer potentially useful information for international travelers, clinicians, public health officials, travel agencies, and the international travel community at large.

Acknowledgments

Declaration of Interests

The authors state that they have no conflicts of interest to declare.

References

1. Steffen R, Collard F, Tornieporth N, et al. Epidemiology, etiology, and impact of traveler's diarrhea in Jamaica. JAMA 1999; 281:811–817.

2. Freedman DO, Weld LH, Kozarsky PE, et al. Spectrum of disease and relation to place of exposure among ill returned travelers. N Engl J Med 2006; 354:119–130.

3. Steffen R, Tornieporth N, Costa Clemens SA, et al. Epidemiology of travelers' diarrhea: details of a global survey. J Travel Med 2004; 11:231–238.

4. Steffen R, van der Linde F, Gyr K, Schar M. Epidemiology of diarrhea in travelers. JAMA 1983; 249:1176–1180.

5. Evans MR, Shickle D, Morgan MZ. Travel illness in British package holiday tourists: prospective cohort study. J Infect 2001; 43:140–147.

6. Redman CA, MacLennan A, Wilson E, Walker E. Diarrhea and respiratory symptoms among travelers to Asia, Africa, and South and Central America from Scotland. J Travel Med 2006; 13:203–211.

7. Duval B, De Serres G, Shadmani R, et al. A population-based comparison between travelers who consulted travel clinics and those who did not. J Travel Med 2003; 10:4–10.

8. Cartwright RY. Food and waterborne infections associated with package holidays. J Appl Microbiol. 2003; 94(Suppl):12S–24S.

9. Fleck S, Jager H, Zeeb H. Travel and health status: a survey follow-up study. Eur J Public Health 2006; 16:96–100.

10. Ekdahl K, Andersson Y. The epidemiology of travel-associated shigellosis—regional risks, seasonality and serogroups. J Infect 2005; 51:222–229.

11. Ekdahl K, de Jong B, Wollin R, Andersson Y. Travel-associated non-typhoidal salmonellosis: geographical and seasonal differences and serotype distribution. Clin Microbiol Infect 2004; 11:138–144.

12. DuPont HL, Ericsson CD. Prevention and treatment of traveler's diarrhea. N Engl J Med 1993; 328:1821–1827.

13. von Sonnenburg F, Tornieporth N, Waiyaki P, et al. Risk and aetiology of diarrhoea at various tourist destinations. Lancet 2000; 356:133–134.

14. Ministry of Justice, Japan. Annual report of statistics on legal migrants for 2001. Ministry of Justice, Tokyo, Japan. 2002.

15. Ministry of Justice, Japan. Annual report of statistics on legal migrants for 2002. Ministry of Justice, Tokyo, Japan. 2003.

16. Ministry of Justice, Japan. Annual report of statistics on legal migrants for 2003. Ministry of Justice, Tokyo, Japan. 2004.

17. Ministry of Justice, Japan. Annual report of statistics on legal migrants for 2004. Ministry of Justice, Tokyo, Japan. 2005.

18. Ministry of Justice, Japan. Annual report of statistics on legal migrants for 2005. Ministry of Justice, Tokyo, Japan. 2006.

19. JTB report 2006. All about Japanese overseas travelers, 2006. Japan Tourism Marketing Co., 2006.

20. Market insight 2006. Nihonjin Kaigai Ryoko Shijo no Doko. (in Japanese) Tokyo: Zaidan Hojin Nihon Kotsu Kosha. 2006.

21. Kollaritsch H. Traveller's diarrhea among Austrian tourists in warm climate countries: I. Epidemiology. Eur J Epidemiol 1989; 5:74–81.

22. Ekdahl K, de Jong B, Andersson Y. Risk of travel-associated typhoid and paratyphoid fevers in various regions. J Travel Med 2005; 12:197–204.

23. Steffen R, Kollaritsch H, Fleischer K. Travelers' diarrhea in the new millennium: consensus among experts from German-speaking countries. J Travel Med 2003; 10:38–45.