SUPPLEMENT ARTICLE

Epidemiology of Traveler's Diarrhea

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Among travelers from developed countries who visit developing countries, >60% may experience traveler's diarrhea, accounting for 40,000 travelers daily or >15 million travelers annually. Traveler's diarrhea is often accompanied by other symptoms, most often abdominal cramps. Although the spontaneous cure occurs after a mean of 4 days, a few patients have symptoms for weeks, and it is increasingly noted that some patients may later develop irritable bowel syndrome. Traveler's diarrhea is life threatening only exceptionally, but it frequently it leads to incapacitation. Both host factors (e.g., age, behavior, nationality, and genetic factors) and environmental factors (primarily the selected destination and hotel) play an important role in risk for traveler's diarrhea.

Diarrhea is a frequent health problem in developing countries. Most important, it still is a very relevant cause of death, mainly among infants and children; according to a World Health Organization fact sheet, 2.1 million people died of diarrheal diseases in 2000 [1]. Similar to these children, travelers visiting destinations in developing countries are nonimmune with respect to the many gastrointestinal pathogens that are endemic to those countries; because the travelers have never been exposed to the pathogens, they have been unable to gradually develop immunity.

If we estimate conservatively that 50 million travelers will visit developing countries every year (World Tourism Organization, unpublished data) and that 30%–40% of those travelers will experience traveler's diarrhea, then we can conclude that 15–20 million travelers will experience traveler's diarrhea annually (i.e., 40,000 travelers daily).

Classic traveler's diarrhea is usually defined as ⩾3 unformed bowel movements occurring within 24 h and accompanied by other symptoms, most often cramps, nausea, fever, blood admixed to the stools, and vomiting [2–5]. Fecal urgency is usually also associated with traveler's diarrhea. Moderate traveler's diarrhea is defined as 1 or 2 unformed bowel movements occurring every 24 h with additional symptoms or as ⩾3 unformed bowel movements without additional symptoms. Mild traveler's diarrhea is defined as 1 or 2 unformed bowel movements without any additional symptoms [2].

Dysentery in travelers is usually defined as invasive traveler's diarrhea resulting in fever and/or accompanied by blood admixed to the stools. In a recent study, the rates of dysentery were 7% in Goa, India, 5% in Mombasa, Kenya, and ⩽2% in Jamaica and Fortaleza, Brazil [3]. Rates >10% have previously been noted in North Africa and Turkey (figure 1).

RATES AND CHRONOLOGY

Data from different parts of the world are shown in table 1; data are lacking for many destinations. Business travelers and military populations, as well as tourists, are affected by traveler's diarrhea [8, 9]. In outbreaks in hotels or on cruise ships, a single pathogen can often be identified [10]. Frequently, data cannot be compared with precision, because some are defined in terms of attack rates per stay abroad, whereas others are defined in terms of incidence rates per 1 or 2 weeks of stay. Nevertheless, an order of magnitude of risk for regions emerges. As shown in figure 1, developing countries are high-risk regions, with rates of traveler's diarrhea of 20%–90% per each 2-week stay. In contrast, visitors to low-risk areas experience traveler's diarrhea at rates of <8% per each 2-week stay. Destinations with incidence rates >8% but <20% are considered to be intermediate-risk regions.

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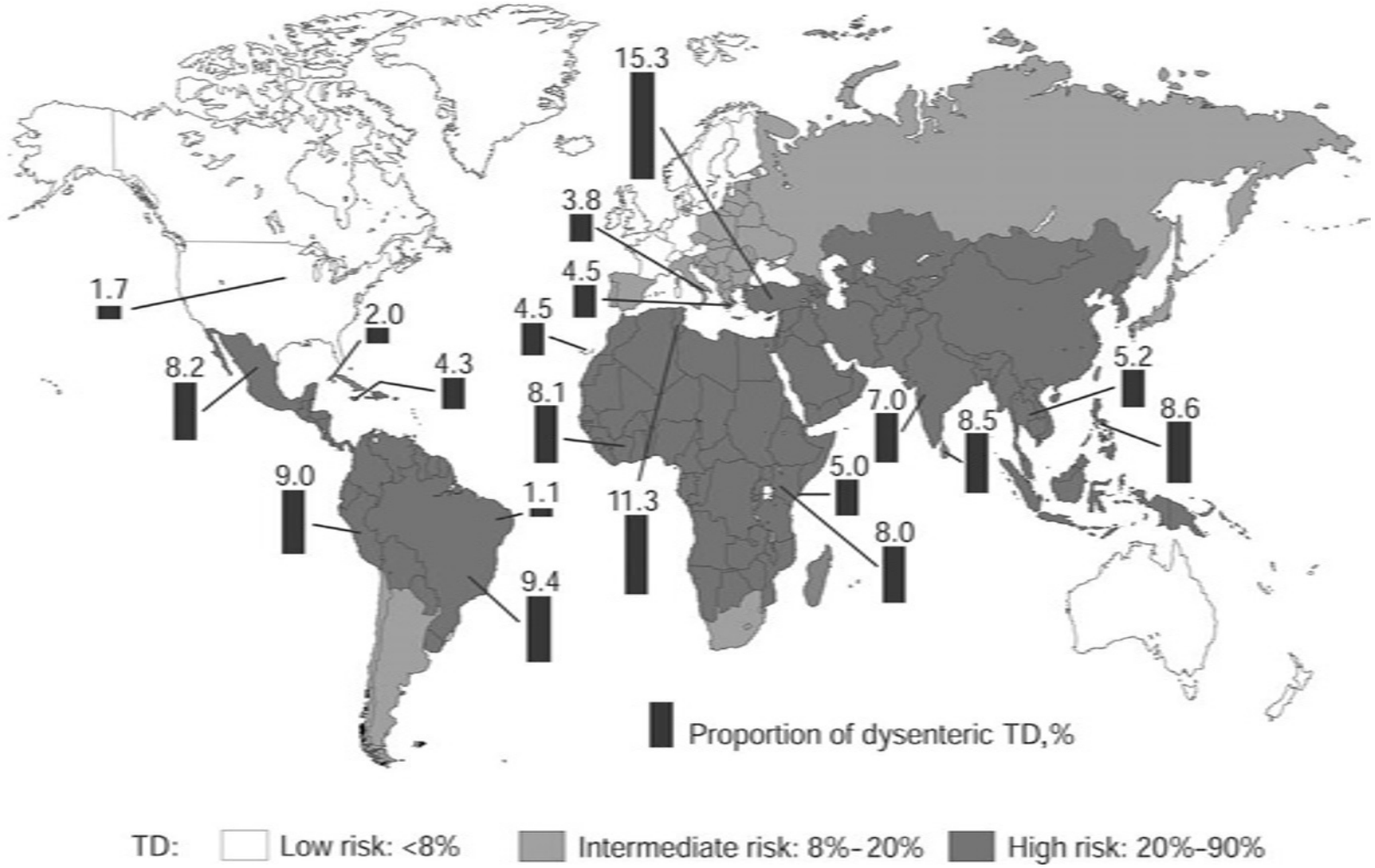

Figure 1. Worldwide risk zones for travelers' diarrhea (TD) and proportion of cases of dysenteric TD (i.e., TD resulting in fever and/or accompanied by blood admixed to the stools) associated with a stay of 2 weeks abroad [6].

Table 1. Observational studies of attack/incidence rates of travelers' diarrhea (TD) among civilian travelers originating from developed countries at various destinations.

Continent, region or country	Year	Rate of TD, %	No. of travelers at risk
Africa			
East Africa	1975–1981	30	2646
West Africa	1975–1977	39	505
Tunisia	1975–1977	48	988
Kenya	1977–1978	43	42
Morocco	1977	54	24
Tunisia	1979–1980	20	706
Egypt	1979–1980	20	706
Morocco	1979–1980	38	706
Egypt (Nile cruises)	1989–1991	10–90	>500
Egypt	1992	59	257
Tunisia	1992	40	2695
Morocco	1992	30	1639
Algeria	1992	13	728
West Africa	1995	27	141
East Africa	1995	26	383
West Africa	1991–1992	25	53
Kenya	1997–1998	55	15,181
Tunisia	1998	34	397
Morocco	1998	25	263
North and South America			
Mexico	1957	33	1000
Mexico	1975	40	55
Mexico	1975	29	133
Mexico	1976	49	121
Mexico (from Panama)	1979	36	64
Mexico	1975–1981	31	1104
Brazil	1975–1981	33	1305
South America (various)	1975–1981	36	420
United States/Canada	1975–1977	4[a]	1379
Mexico (Cuba)	1986–1987	34	227
Mexico	1992	45	84
South America	1995	33	282
Central America	1995	33	120
Honduras	1980	54	22
Honduras	1984	100	22
Jamaica	1996–1997	24	30,369
Brazil	1997	14	6050
Asia			
Sri Lanka/ Maldives	1975–1981	35	1371
Thailand	1975–1981	22	1838
Far East (various)	1975–1981	31	2470
Thailand	1984	24	33
Thailand	1981	57	35
Middle East	1991–1992	48	30
Southeast Asia	1995	19	487
South Asia	1995	39	250
India (Goa)	1997–1998	54	15,631
Turkey	1998	27	617
Europe			
Northern Europe	1953	35	26
Southern Europe	1953	67	127
Northern Europe	1970	4	1551
Western Europe	1970	6	1465
Southern Europe	1970	12	1498
Spain	1979–1980	<15	1685
Canary Islands	1981	20	572
Rhodes	1981	13	987
Southern Europe	1984	15	720
Portugal	1998	9	560
Spain	1998	7	906
Greece	1998	7	1398
Cyprus	1998	8	688
Italy	1998	4	113

NOTE. Incidence was calculated for a 1-week stay [7].

[a] Control.

Seasonality has only a limited relevance to rates of traveler's diarrhea: among British tourists in Monastir, Tunisia, the rates of traveler's diarrhea varied from 16%–18% in May–July to 20%–23% in August–October [11]. Similarly, rates of total and classic traveler's diarrhea were highest from June to October in Jamaica and elsewhere [2, 12].

When rates are compared over time, it becomes obvious that there has been a dramatic reduction in traveler's diarrhea rates in southern Europe [13]. It also appears that Tunisia and Jamaica have been able to reduce the risk of illness through the systematic efforts of their authorities, mainly the ministries of health and tourism [14, 15]. In contrast, over the past decades, hardly any risk reduction has been observed at most other destinations, when travelers were investigated with identical questionnaires by our group.

RISK GROUPS

Even at a single destination, there are highly significant differences in traveler's diarrhea incidence rates for different risk groups. The most important factor likely is the selection of a hotel. As demonstrated in Jamaica, the incidence rates of traveler's diarrhea for 18 hotels visited by at least 40 clients for 1 week varied from 0% to 33% ($P < .001$) [2]. Experts realize that the incidence rates of traveler's diarrhea mirror the hygienic conditions of the places visited [14]. As expected, the duration of exposure is also relevant [16]. It has already been demonstrated in previous studies that 5-star hotels tend to have a slightly higher traveler's diarrhea incidence rate, compared

with many 3- or 4-star hotels. This finding is plausible, considering that food items are more frequently prepared by hand in higher-end hotels. The type of travel also plays a role: beach vacations in a resort are associated with lower attack rates (28%), tours are associated with slightly higher rates (31% for group tours and 32% for individual tours), and adventure tours are associated with the highest rates (34%; $P = .04$) [4]. "All-inclusive" tours tend to be associated with higher attack rates, which can hypothetically be explained by greater consumption of alcoholic beverages by travelers on such tours [17].

Second, the origin of traveler is the most relevant host factor. It has long been known that persons from developing countries have a very low incidence rate of traveler's diarrhea (2%–8%) when visiting other developing countries; this phenomenon has been demonstrated in delegates to conventions and in students and military populations [7, 18]. Similarly, various studies have demonstrated that travelers who recently visited the tropics have a diminished incidence rate of traveler's diarrhea, probably as a result of some developed immunity [3].

Various studies have demonstrated that younger age is a risk factor for traveler's diarrhea. Infants, toddlers, and young adults 15–30 years old are particularly prone to developing traveler's diarrhea [19–21]. We could imagine that small children are at particularly high risk for traveler's diarrhea, because their fingers indiscriminately touch floors and other contaminated things before being licked, whereas, in young adults, a greater appetite may result in consumption of a larger inoculum of pathogens. In most studies, no significant, or at least no clinically relevant, difference in traveler's diarrhea incidence rates has been observed according to sex [3, 16]. The more adventurous travel style of young adults is not the only explanation for the higher risk, because the significant difference is demonstrated even when the population is stratified by hotel and when only travelers on all-inclusive tours, who do not consume any meals outside the hotel, are analyzed.

Recently, it has been demonstrated that there is also a genetic susceptibility to traveler's diarrhea. Diarrhea due to infection with enteroaggregative *Escherichia coli* occurs significantly more often in individuals with the AA genotype −251 (OR, 209; 95% CI, 28–1525) than in individuals with the T genotype (OR, 14; 95% CI, 2–105) or even the TT genotype (OR, 1) [22]. It is unknown whether a higher incidence rate of traveler's diarrhea among British travelers is associated with genetic differences or different dietary habits [23]. In addition, a lack of gastric acidity, either as a result of surgery or in association with the use of such medications as omeprazole or magnesium and aluminium hydroxide (e.g., Maalox; Novartis), has been identified as a risk factor for traveler's diarrhea [24].

Lack of avoidance of potentially contaminated food and beverages may play a role, as discussed elsewhere in this supplement [25]. Additional behavioral risk factors may be bathing in seawater [26] or eating meals purchased in cafeterias or from street vendors [21, 27, 28]. The consumption of unpasteurized milk also resulted in excessive risk (OR, 6.2); similarly, Mexican sauces have often been identified as being contaminated [29]. With regard to alcohol consumption, drinking beer resulted in a significant higher traveler's diarrhea rate [3], whereas there is indication that drinking wine may have some protective effect [30, 31].

IMPACT

Traveler's diarrhea usually is not a severe illness, but it may lead to extreme frustration at times of highest expectations. Slightly fewer than 1 in 4 patients voids ⩾6 unformed stools per day. The proportion of patients with classic traveler's diarrhea is <40% at intermediate-risk destinations, but clearly is >55% at typical high-risk destinations [3].

Traveler's diarrhea is hardly life threatening, although a few fatalities have been reported anecdotally [32]. More important is the incapacitation due to traveler's diarrhea. As demonstrated in table 2, approximately one-third of all patients are unable to pursue planned activities, which means that, at such typical high-risk destinations as India or Kenya, 30% and 20%, respectively, of all travelers are incapacitated. The duration of incapacitation is half to a full day, which is considerable, particularly if we assume that many trips last for 1 week only. Additional time is lost when health professionals need to be consulted.

CHRONOLOGY OF TRAVELER'S DIARRHEA

Traveler's diarrhea usually occurs during the first week of travel abroad. Although there is still a risk of illness occurring in subsequent weeks and for up to 2 years even after episodes of traveler's diarrhea [21, 33], it appears that some immunity is gradually developed [34]. The average duration of untreated traveler's diarrhea is ~4 days; 50% of patients who experience traveler's diarrhea are free of symptoms within 48 h [4, 5]. Patients with fever or other symptoms suggestive of severe traveler's diarrhea and patients in whom pathogens are identified tend to have a longer duration of illness [35].

Table 2. Incapacitation due to travelers' diarrhea (TD) in 3 countries.

	Country		
Variable	Jamaica	India	Kenya
Proportion of incapacitated subjects, %			
Patients only	31.0	45.7	29.4
All travelers	8.3	29.9	20.9
Duration of incapacitation due to any TD, h	11.6	21.2	15.6
Effect in all travelers, %[a]	8.1	34.6	32.7

NOTE. "Incapacitation" is defined as the inability to pursue planned activities [2, 3].

[a] Includes incapacitation, consultation of a health care professional, and use of (exotic) medication.

There is a growing interest in sequelae associated with traveler's diarrhea [36–38]. Early studies have already indicated that traveler's diarrhea persists in 1% of patients for ⩾4 months [39]. According to a recent study, 10% of patients who have had traveler's diarrhea thereafter experience irritable bowel syndrome [40]. In addition, it has been suggested that inflammatory bowel syndrome, which is uncommon in most populations indigenous to tropical countries, may present for the first time after a trip to the tropics [41].

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