Travel Medicine and Infectious Disease 23 (2018) 56–63

Contents lists available at ScienceDirect

Travel Medicine and Infectious Disease

journal homepage: www.elsevier.com/locate/tmaid

Diarrhea and related factors among passengers on world cruises departing from Japan

Michiyo Yamakawa[a,*], Megumi Sasai[b], Yosuke Kasai[c], Toshihide Tsuda[b], Etsuji Suzuki[c,d]

[a] Center for Regional Research, Okayama University, 3-1-1 Tsushima-naka, Kita-ku, Okayama, 700-8530, Japan
[b] Department of Human Ecology, Graduate School of Environmental and Life Science, Okayama University, 3-1-1 Tsushima-naka, Kita-ku, Okayama, 700-8530, Japan
[c] Department of Epidemiology, Graduate School of Medicine, Dentistry and Pharmaceutical Sciences, Okayama University, 2-5-1, Shikata-cho, Kita-ku, Okayama, 700-8558, Japan
[d] Department of Epidemiology, Harvard T. H. Chan School of Public Health, 677 Huntington Avenue, Boston, MA, 02115, USA

ARTICLE INFO

Keywords:
Disease
Epidemiology
Cruise ship travel

ABSTRACT

Background: Despite growth in the number of cruises worldwide, evidence about diarrhea experienced by cruise ship passengers remains sparse. We investigated rates of diarrhea and related factors among passengers on world cruises departing from Japan.

Methods: Targeting passengers on five world cruises (n = 4180) from 2012 to 2013 (85–103 travel days), we calculated rates of health seeking behavior for diarrhea by sex, age group, and number of roommates for each cruise. We estimated rate ratios and 95% confidence intervals, using the group aged 20–39 years, women, and 2–4 roommates as referent categories.

Results: We found 5.04–6.00 cases per 10,000 person-days in the five cruises, with an elevated number after calling at ports. Older passengers (> 60 years) and passengers with fewer roommates had an elevated risk of health seeking behavior for diarrhea, although passengers aged < 20 years had an elevated risk on one cruise. After controlling for covariates (including cruise), significant associations remained for passengers aged > 60 years and without roommates.

Conclusions: Older passengers and passengers with fewer roommates may be more likely to seek medical treatment for diarrhea during travel on a world cruise, and should take preventive measures.

1. Introduction

Globally, the number of cruise ship passengers has grown in recent years, and the Japanese government has put effort into promoting cruises [1,2]. Acute diarrhea is the most common travel-related health problem, particularly among travelers visiting tropical and developing parts of the world [3]. Cruise ship passengers are also reported to have an elevated risk for diarrhea if they have opportunity to disembark at ports of call and go on short trips during their cruise [4]. In addition, the crowded, semi-enclosed ship environment may spread infectious diarrhea via human-to-human transmission, leading to outbreaks among passengers (e.g., norovirus) [5–7].

Evidence about the health status of cruise ship passengers remains sparse, and few studies have investigated the incidence of diarrhea on short-term cruises (≤1 month) [8–13]. The estimated probability of contracting gastroenteritis aboard a 7-day cruise is < 1%, which is less than that for overland travel [8,9,11]. No longitudinal studies have been conducted to examine rates of diarrhea on long-term cruises (> 1 month) during which passengers have opportunities to disembark at ports of call to go on trips.

On land-based holidays, younger travelers tend to be at greater risk for diarrhea than older travelers [14]. Younger travelers may eat larger amounts and more types of food, resulting in ingestion of a larger amount of pathogen inoculums [15]. Conversely, older travelers may be more susceptible to diarrhea because decreased gastric acidity lowers the inoculum level required for illness to occur [16]. No epidemiologic studies have examined associations between age and diarrhea among travelers on cruise-based holidays; therefore, it is worth investigating these associations for long-term cruise ship travel. We aimed to examine potential factors (e.g., age) related to health seeking behavior for diarrhea among passengers on long-term world cruises departing from Japan.

Abbreviations: CI, confidence interval; RR, rate ratio

* Corresponding author.
E-mail addresses: michi.yamak@cc.okayama-u.ac.jp (M. Yamakawa), m.sasai@s.okayama-u.ac.jp (M. Sasai), yosuke.kasai@gmail.com (Y. Kasai), tsudatos@md.okayama-u.ac.jp (T. Tsuda), etsuji-s@cc.okayama-u.ac.jp (E. Suzuki).

https://doi.org/10.1016/j.tmaid.2018.01.004
Received 24 July 2017; Received in revised form 8 December 2017; Accepted 17 January 2018
Available online 31 January 2018

Table 1
Overview of the five world cruises departing from Japan.

Cruises	Travel period start to end (travel days)	Ports of call n	Shipping route (start from and return to Japan)
A	May 8 to Aug 17, 2012 (102)	24	Singapore–Strait of Malacca–Indian Ocean–Suez Canal–Mediterranean Sea–North Sea--Greenland–Atlantic Ocean–Caribbean Sea–Panama Canal–Pacific Ocean
B	Aug 24 to Nov 17, 2012 (86)	22	Singapore–Strait of Malacca–Indian Ocean–Suez Canal–Mediterranean Sea--Atlantic Ocean–Caribbean Sea–Panama Canal–Pacific Ocean
C	Dec 14, 2012 to Mar 25, 2013 (102)	17	Singapore–Sunda Strait–Indian Ocean–South Africa–Atlantic Ocean--South America–Argentina–Easter Island–Pacific Ocean
D	Apr 1 to Jul 12, 2013 (103)	22	Singapore–Strait of Malacca–Indian Ocean–Suez Canal–Mediterranean Sea–North Sea--Baltic Sea–Atlantic Ocean–Caribbean Sea–Panama Canal–Pacific Ocean
E	Jul 17 to Oct 10, 2013 (86)	21	Singapore–Strait of Malacca–Indian Ocean–Suez Canal–Mediterranean Sea--Atlantic Ocean–Caribbean Sea–Panama Canal–Pacific Ocean

Abbreviation: n, number.

2. Materials and methods

2.1. Study setting

Study participants were passengers on five world cruises from one major cruise ship line (n = 4180) (Table 1). All cruises used the same vessel, and all rooms had a bathroom. The cruises started at a port of Japan between May 2012 and October 2013, and returned to the port of origin after 85–103 travel days. Shipping routes and ports of call were not identical among the cruises, and only Cruise C traveled in the Southern Hemisphere. During the cruises, passengers could participate in arranged excursions or personal trips at any ports of call. As shown in Supplementary Table 1, all cruises stopped at ports of call in countries where travelers' risk for diarrhea was likely to be higher.

We obtained data from passenger list records and medical records. The passenger list records included data on passenger ID number, age (at application), nationality, cabin type (number of beds available in the cabin), and ports of embarkation and disembarkation. Medical records were maintained by one Japanese ship physician aboard each of the five cruises, and only reported on patients who visited the ship's clinic. The clinic opened daily from 9:30–11:30 a.m., and 2–4 p.m., except in cases of emergency. Ship physicians could schedule non-consultation days at ports of call and if cruises continued to travel for ≥7 days. Data from medical records included passenger ID number, sex, age (at clinic visit), cabin number, first or follow-up visit, date of consultation, and diagnosis.

In this study, we used the date and data for a passenger's first visit to the ship's clinic for diarrhea from the medical records, even if a passenger visited the clinic multiple times during their travel days. The study outcome was gastroenteritis or diarrhea, as diagnosed by ship physicians. We used sex, age (at passenger application), number of roommates, and cruise as covariates. Because cruise passengers experience a semi-closed environment in which infectious diseases can spread rapidly, environmental factors were also considered as an indicator of transmission by person-to-person contact [7,17]. We assumed the number of roommates as a surrogate for environmental factors, which was determined through cabin type, whether or not passenger ID numbers were consecutive, and recorded passengers' same ports of embarkation and disembarkation.

We merged passenger list records and medical records by passenger ID number. Eight cases in the medical records did not match passenger list records because of missing passenger ID numbers. This group included four cases of respiratory tract infections, one case of injury, and one case of acute pneumonia.

2.2. Statistical analysis

After describing passengers' characteristics for all five cruises, we investigated potential diarrhea outbreaks and associated factors. We drew epidemic curves of diarrhea cases by date of diagnosis. We also conducted supplementary analyses to examine the number of passengers who were diagnosed with diarrhea on the day after leaving each port of call. Age (years) was categorized into five groups: < 20, 20–39, 40–59, 60–74, and ≥75 years. The number of roommates was classified as none, 1, and 2–4. We calculated rates of health seeking behavior for diarrhea by sex, age group, and number of roommates. Throughout the analyses, we calculated person-days from the date of embarkation to the date of diarrhea consultation or the date of disembarkation, whichever occurred first. We calculated crude rate ratios (RR) and 95% confidence intervals (CIs) [18] using 20–39 years of age, women, and 2–4 roommates as reference categories. As supplemental analyses for the five cruises, we estimated hazard ratios and 95% CIs in Cox proportional hazards regression models, adjusted for sex, age group, number of roommates, and cruise.

We used Stata statistical software (Stata SE version 14.2, StataCorp, TX, USA) for all analyses. This study was approved by the Okayama University Graduate School of Medicine, Dentistry, and Pharmaceutical Sciences Institutional Review Board (No. R1611-003).

3. Results

Table 2 shows the distribution of passengers' characteristics among the five cruises. Most passengers (> 97%) were Japanese citizens and completed the total cruise schedule. More than half of the passengers were women, the median age ranged from 58 to 65 years, and > 70% had one or more roommates. Diarrhea cases were observed most frequently in Cruise A (n = 49, 5.7%) and least frequently in Cruise B (n = 35, 4.2%). Cruise C had a higher proportion of male passengers and a higher median age. Cruises B, D, and E had a higher proportion of passengers with one or more roommates (approximately 90%) than Cruises A and C.

Table 2
Overview of passengers' characteristics and diarrhea cases on the five world cruises from Japan, by cruise.

	Cruise				
	A	B	C	D	E
Passengers, n	863	843	905	774	795
Japanese citizens, n (%)	858 (99.4)	829 (98.3)	899 (99.3)	767 (99.1)	773 (97.2)
Boarding days, median (min, max)	102 (16, 102)	86 (17, 86)	102 (12, 102)	103 (6, 103)	85 (11, 85)
Men, n (%)	386 (44.7)	365 (43.3)	428 (47.3)	340 (43.9)	338 (42.5)
Median age (IQR1, IQR3)	63 (35, 70)	61 (26, 67)	65 (61, 71)	64 (33, 70)	58 (25, 66)
1 or more roommates, n (%)	661 (76.8)	745 (88.4)	700 (77.4)	683 (88.2)	709 (89.2)
Diarrhea cases, n (%)	49 (5.7)	35 (4.2)	45 (5.0)	37 (4.8)	36 (4.5)

Abbreviations: n, number; IQR, interquartile range.