

# Characteristics and Potential Quality Indicators for Evaluating Pre-travel Consultations in Japan Hospitals: the Japan Pretravel Consultation Registry (J-PRECOR)

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## Research

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# Abstract

## Background

Awareness of pre-travel consultation (PTC) and prevention methods of overseas travel-related diseases is low in Japan, and understanding of PTC among Japanese travelers and medical professionals remains low. A multicenter registry was established to examine PTC in Japan. This study assessed the PTC implementation rate and examined indicators to be used as criteria for data-quality evaluation.

## Methods

Clients who presented for PTC at 17 facilities registered between February 1, 2018, and May 31, 2020, were included. Medical information was retrospectively extracted via a web-based system. Correlations between vaccination risk categories and advice/intervention proportions by facility were evaluated by Spearman's ordered phase relations ( $\alpha=0.05$ ).

## Results

Of 9,700 eligible clients (median age, 32 years; 880 (9.1%) aged <16 years and 549 (5.7%) aged  $\geq 65$  years), the most common travel duration was  $\geq 181$  days (35.8%), higher among younger clients. The most common reason for travel was business (40.5%); the US (1,118 [11.5%]) and Asia (4,008 [41.3%]) were the most common destination and continent, respectively. Vaccine number (median 3 per person) increased after PTC except for tetanus toxoid. Only 60.8% of clients recommended for malaria prophylaxis received anti-malarial agents. The gross national income, incidence of human rabies, typhoid fever, and falciparum malaria, and dengue risk category were associated with the percentage of hepatitis-A vaccine, explaining rabies post-exposure prophylaxis, typhoid-fever vaccination, malaria-prophylaxis prescription, and mosquito repellants, respectively.

## Conclusions

Although the characteristics of travelers differ, the quality of PTC should improve to address, for example, the lower rate of acceptance of malaria prophylaxis in Japan.

## Background

The number of travel clinics registered with the Japanese Society of Travel and Health that provides pre-travel consultations (PTC) in Japan increased from 45 to 90 between 2011 and 2016 [1]. Awareness of PTC among Japanese travelers and medical professionals remains low. An airport survey conducted in Japan showed that awareness of prevention methods of overseas travel-related diseases was quite low in Japan, compared to other countries [3–6]. How PTC is implemented in Japan and the needs of travelers are not well known. Therefore, vaccines for use in overseas travel, such as typhoid vaccines, have not been approved in Japan. Hence, the Japan Pretravel Consultation Registry (J-PRECOR), a multicenter registry of general hospitals in Japan, which runs travel clinics was established.

An objective of this registry is to ensure similar quality of PTC care across Japan by considering criteria for evaluating PTC quality. Although the quality of PTCs has been evaluated by questionnaire surveys or prospective observational studies among health care providers in other countries [7–9], evaluation guidelines are not yet established. Therefore, this study evaluated variations in PTC implementation rates according to indicators (the risk of food-borne infectious diseases, mosquito-borne diseases, and rabies) among facilities, based on actual medical data, and examined indicators of PTCs that can be used as criteria for evaluating quality.

## Methods

In this multicenter retrospective study, hospitals registry and clients' data collected from February 1, 2018 to May 31, 2020 were extracted. Clients who only underwent a health check-up for travels abroad or who were not planning to travel abroad were excluded. Furthermore, clients with missing country, date, and purpose of travel, were excluded. PTCs were treated as separate if the purpose or countries of travel was different. The clients' data were extracted retrospectively from the clinical records when the schedule of immunizations and/or prescriptions for the clients was determined. Four cooperating hospitals were registered at the beginning of the study, and 17 hospitals overall, had registered clients during the study period. Of these 17, four were yellow fever vaccine (YFV)-capable hospitals and 11 handle unapproved vaccines in Japan (see Supplementary Table 1 in Additional file 1).

The demographic and medical information was extracted (see Supplementary Material in Additional file 1). Vaccines approved and unapproved in Japan as of March 2020 are shown in Supplementary Table 2 (see Additional file 1).

The duration of travel was categorized into 1–7, 8–14, 15–28, 29–80, and > 181 days. Country income was categorized into low, lower-middle, upper-middle, and high according to the gross national income (GNI) published by the World Bank [11]. The following were classified according to the number of deaths due to rabies (per 100,000 population) [12], typhoid fever (per 1,000 population) [13], confirmed *Plasmodium falciparum* malaria (per 1,000 population) [14], and dengue fever risk categories ("Frequent/continuous," "Sporadic/uncertain," "Risk variations based on region," and "No/unknown risk"), were defined as reducing risk levels, in that order [15]. For travel to multiple countries, GNI was calculated and classified by the country with the lowest income, while the risk of diseases was calculated and classified by the country with the highest risk. To evaluate the quality of PTCs, the percentages of interventions and advice implemented were calculated based on the categories (see Supplementary Material Methods in Additional file 1) and by facility. Data with no more than 5 applicable cases in each category were excluded from the figure without calculating the percentage. Study information was presented in a poster and/or on the Web for the possibility of opting out of consent. The protocol was approved by the institutional review board (IRB) of the National Center for Global Health and Medicine (NCGM) (NCGM-G-002347-01) or IRBs/ethical committees of the other cooperating facilities.

## Statistical analysis

Discrete data are expressed as numbers (percentages), while continuous data are expressed as medians (interquartile ranges [IQR]). Correlations between vaccination risk categories and advice/intervention proportions by facility were evaluated by Spearman's ordered phase relations ( $\alpha = 0.05$ ). All statistical analyses were performed using IBM SPSS Statistics for Windows, version 26.0 (IBM Corp., Armonk, N.Y., USA).

## Results

### Characteristics of the travelers

Of 9,746 registered clients, 46 with missing values were excluded, leaving 9,700 (see Supplemental Table 3 in Additional file 1). The overall median age was 32 [21–45] years; 880 (9.1%) and 549 (5.7%) clients were aged 0–15 and  $\geq 65$  years, respectively (Table 1). The duration of travel was known in 9,190 (94.7%) clients, and the most common was  $\geq 181$  days (35.8%), with a higher percentage of younger than elderly clients, who tended to travel for  $\leq 2$  weeks. The most common reason for travel overall was business (3,930, 40.5%), accompanying their family members (66.8%) in the less-than-16-year-old group, and sightseeing (65.6%) in the elderly (> 65 years) group (Table 1). By country, the US (1,118 [11.5%]) was the most common destination, followed by Brazil (1,001 [10.3%]), while Asia was the most common continent with 4,008 (41.3%) clients.

Table 1  
Characteristics of participants by age group

	All	Age 0 to 15 years	Age 16 to 64 years	Age 65 years or over
Number of clients	9700	880	8271	549
Male (%)	5806 (59.9)	436 (49.5)	5042 (61)	328 (59.7)
Female (%)	3894 (40.1)	444 (50.5)	3229 (39)	221 (40.3)
Age, median, years [IQR]	32 [21,45]	6 [3, 11]	32 [23,43]	69 [67,72]
Days from first consultation to travel, median, days [IQR]	33 [17,60]	50 [25,96]	32 [16,57]	35 [20,60]
Immunization record (%)	4876 (50.3)	666 (75.7)	4113 (49.7)	97 (17.7)
Request for vaccine (%)	7793 (80.3)	657 (74.7)	6726 (81.3)	410 (74.7)
Travel period (%)				
less than 7 days	675 (7.3)	14 (1.7)	622 (7.9)	39 (7.3)
7–13 days	2272 (24.7)	75 (9.1)	1936 (24.7)	261 (48.8)
14–27 days	1468 (16)	55 (6.6)	1270 (16.2)	143 (26.7)
28–55 days	811 (8.8)	35 (4.2)	732 (9.4)	44 (8.2)
56–181 days	674 (7.3)	29 (3.5)	616 (7.9)	29 (5.4)
more than 181 days	3290 (35.8)	620 (74.9)	2651 (33.9)	19 (3.6)
Travel purpose (%)				
Group tourism	640 (6.6)	26 (3.0)	413 (5.0)	201 (36.6)
Individual tourism	1910 (19.7)	70 (8.0)	1681 (20.3)	159 (29.0)
Business	3930 (40.5)	10 (1.1)	3790 (45.8)	130 (23.7)
Moving with family	1198 (12.4)	588 (66.8)	602 (7.3)	8 (1.5)
Migration	26 (0.3)	7 (0.8)	17 (0.2)	2 (0.4)
Study	1330 (13.7)	127 (14.4)	1201 (14.5)	2 (0.4)
Volunteer work	472 (4.9)	14 (1.6)	441 (5.3)	17 (3.1)
Visiting friends/relatives	132 (1.4)	42 (4.8)	76 (0.9)	14 (2.6)
Others	214 (2.2)	15 (1.7)	167 (2.0)	32 (5.8)
Most visited countries (%)				
First	USA 1118 (11.5)	USA 173 (19.7)	USA 916 (11.1)	Brazil 114 (20.8)
Second	Brazil 1001 (10.3)	China 101 (11.5)	Brazil 812 (9.8)	Kenya 85 (15.5)
Third	China 769 (7.9)	Brazil 75 (8.5)	China 662 (8.0)	Tanzania 53 (9.7)

IQR, interquartile range; USA, United States of America

	All	Age 0 to 15 years	Age 16 to 64 years	Age 65 years or over
Fourth	Kenya 750 (7.7)	Thailand 70 (8.0)	India 647 (7.8)	South Africa 49 (8.9)
Fifth	India 696 (7.2)	Indonesia 41 (4.7)	Kenya 647 (7.8)	Peru 39 (7.1)
Visit more than one country (%)	1666 (17.2)	20 (2.3)	1471 (17.8)	175 (31.9)
Visit low or lower-middle income countries included (%)	5067 (52.2)	252 (28.6)	4502 (54.4)	313 (57)
IQR, interquartile range; USA, United States of America				

Except for the YFV, the most common vaccines requested were against hepatitis A, rabies, tetanus, and hepatitis B (Table 2). Vaccines were required in 7,793 clients (80.3%). Those traveling outside Asia, Africa, and Latin America, had more requests for vaccines against measles, rubella, meningococcal, and Tdap than those planning to travel to these regions. YFV was requested and planned by 3,014 and 3,559 (36.7%) clients, respectively. The proportion of YFV requests in those aged  $\geq 65$  years was higher (52.3%) than in those aged  $< 16$  years (14.4%) and 16–64 years (31.4%). Altitude sickness and malaria prophylaxes were most requested by travelers into Latin America (77.2%) and Africa (72.4%) (Table 2).

Table 2

Differences between the interventions that the participants wanted to use and the interventions they actually used after the travel consultation

	Vaccines and prescriptions that the participants themselves wanted	Vaccines and prescriptions actually given after pre-travel consultation	*Percentage difference	**Change ratio	***p value
Hepatitis A vaccine	3946	5655	17.6	1.43	< 0.001
Hepatitis B vaccine	2562	2961	4.1	1.16	< 0.001
Rabies vaccine	2804	3209	4.2	1.14	< 0.001
Vaccines containing tetanus toxoid	3017	4625	16.6	1.53	< 0.001
Tdap	151	597	4.6	3.95	< 0.001
DTaP	471	2388	19.8	5.07	< 0.001
Typhoid fever vaccine	1513	2468	9.8	1.63	< 0.001
Japanese encephalitis vaccine	1231	1745	5.3	1.42	< 0.001
Meningococcal ACWY vaccine	463	772	3.2	1.67	< 0.001
Meningococcal B vaccine	8	32	0.2	4.00	< 0.001
Vaccines containing measles	772	2012	12.8	2.61	< 0.001
Vaccines containing rubella	682	2006	13.6	2.94	< 0.001
Yellow fever vaccine	3014	3559	5.6	1.18	< 0.001
Prophylaxis for acute altitude sickness	338	370	0.3	1.09	< 0.05
Prophylaxis for malaria	1146	1252	1.12	1.10	< 0.001
*Percentage difference: percentage after pretravel consultation minus that before pretravel consultation (after - before).					
**Change ratio: Ratio of the number of cases after pretravel consultation to that before pretravel consultation (after/ before).					
***Compared by McNemar test					

### Interventions

Following the PTC, the median number of and most common vaccines planned were 3 (IQR, 1–4) per person, and HAV, followed by tetanus-containing vaccine, respectively. Several travelers to Asia were vaccinated against hepatitis A, hepatitis B,

rabies, and typhoid (see Supplementary Table 4 in Additional file 1). Of 29,082 planned vaccines, 24.5% were unapproved in Japan. Of the unapproved vaccines, the most frequently vaccinated were adjuvant-containing hepatitis A, typhoid fever, and rabies vaccines.

Overall, the number of planned vaccines after PTC increased compared to the required vaccines before PTC, especially for vaccines containing measles and rubella, and diphtheria, Tetanus, Pertussis (Table 2 and Supplementary Table 4 in Additional file 1). The number of planned meningococcal vaccine recipients was small, but with a remarkable increase after consultation (Table 2). The numbers of rabies, hepatitis B, yellow fever, and Japanese encephalitis vaccines were generally similar between the planned and requested numbers. The YFV number of consultations was higher among  $\geq 65$ -year-olds than the  $< 65$ -year-olds (60.1% vs. 35.3%,  $p < 0.001$ ). The percentage of prescriptions for altitude sickness prophylaxis did not change significantly after the consultation. For malaria prophylaxis, there was a slight increase in those planning travels to Africa, and conversely, a decrease in those traveling to other regions.

Malaria prophylaxis or emergency standby treatment was recommended in 22.5% (2,180/9,700) of clients, and in 34.8% (1,821/5,226) of those traveling for  $< 56$  days; and especially in those who planned to travel to the African region (68.8%, 1,429/2,078). Among those traveling for  $< 56$  days, there were two clients each with unknown prescription status and planned emergency standby treatment; beside these, only 60.8% of those recommended for malaria prophylaxis actually received the prescriptions. The most common destination countries for which malaria prophylaxis was prescribed were Kenya, Tanzania, Uganda, and Ghana. However, even in countries with high malaria risk (over 10 confirmed cases per 1,000 populations), the prescription rate for those who received prophylaxis recommendations varied from 42.1–84.2% (see Supplementary Table 5 in Additional file 1).

The most common advice was for rabies post-exposure prophylaxis (PEP), mosquito repellent use, and dietary precautions; all of which were common among travelers to Asia and Africa (Table 3).

Table 3  
Advice given during consultations by region of travel

	All	Asia	Africa	South America	Others	Multi
N (%)	9700	4008	2593	1809	1660	1670
Explanation of post-exposure prophylaxis for rabies	6436 (66.4)	3115 (77.7)	1784 (68.8)	1207 (66.7)	597 (36)	1097 (65.7)
How to use mosquito repellents	6486 (66.9)	2841 (70.9)	2092 (80.7)	1394 (77.1)	457 (27.5)	1248 (74.7)
Explanation of the risk of leptospirosis and/or schistosomiasis due to freshwater exposure	2901 (29.9)	1514 (37.8)	740 (28.5)	454 (25.1)	314 (18.9)	476 (28.5)
Explanation of dietary habits to avoid foodborne diseases	5780 (59.6)	2842 (70.9)	1592 (61.4)	1071 (59.2)	507 (30.5)	998 (59.8)
Avoiding traffic accidents	3286 (33.9)	1817 (45.3)	626 (24.1)	440 (24.3)	501 (30.2)	482 (28.9)
Preventive actions for acute mountain sickness	768 (7.9)	304 (7.6)	121 (4.7)	256 (14.2)	134 (8.1)	185 (11.1)
Discussing the risks and prevention of sexually transmitted diseases	809 (8.3)	321 (8)	280 (10.8)	179 (9.9)	85 (5.1)	198 (11.9)
Taking overseas travel accident insurance	3359 (34.6)	1436 (35.8)	954 (36.8)	640 (35.4)	456 (27.5)	596 (35.7)
Others	116 (1.2)	64 (1.6)	18 (0.7)	13 (0.7)	26 (1.6)	11 (0.7)

## Quality indicators

*GNI category, the percentage of hepatitis A vaccination (HAV) planning and dietary advice to prevent foodborne diseases (Fig. 1)*

These vaccines and advice were weakly correlated with each of the GNI categories respectively ( $\rho = 0.37$ ,  $p < 0.01$ ;  $\rho = 0.41$ ,  $p < 0.01$ ). These vaccines and advice tended to be considered when people were traveling to lower or upper-middle income countries. Compared to the advice on HAV, there was a greater difference in advice about eating and drinking among facilities.

*Risk category of rabies, the percentage of pre-exposure prophylaxis (PrEP) planning, and explaining post-exposure prophylaxis (PEP) (Fig. 2)*

As rabies incidence rate increased, the percentage of explaining PEP increased for those that planned to travel to high-risk rabies countries ( $\rho = 0.30$ ,  $p < 0.01$ ). However, the percentage of explaining PEP was quite low in some facilities, as with the other advice. Furthermore, the rate of PrEP planning was not related to the incidence rate ( $p > 0.05$ ). There was a tendency for the implementation rate to decrease in most facilities in countries with a slightly high risk of human rabies (0.6–1.5 deaths per 100,000 population), including African countries (such as Kenya and Tanzania) with relatively large numbers of visitors from Japan.

*Risk category of typhoid fever and the percentage of typhoid fever vaccination planning (Fig. 3)*

The percentage of typhoid fever vaccine planning and advice both tended to increase in proportion to the incidence of typhoid fever ( $\rho = 0.41$ ,  $p < 0.01$ ). Since typhoid vaccine is an unapproved vaccine in Japan, the vaccine planning rate was lower in facilities that do not handle unapproved vaccines.

*Recommendations for prevention of mosquito-borne diseases and implementation of mosquito control advice (Fig. 4)*

For *P. falciparum* malaria, the higher the incidence in the destination country, the higher the rate of preventive medication prescription plans ( $\rho = 0.66$ ,  $p < 0.001$ ). The percentage of advice on mosquito repellent use was non-significantly higher for those traveling to high-risk countries according to the dengue fever risk category ( $p > 0.05$ ).

*Catch-up vaccination rate of measles-containing vaccines to the clients (with and without vaccination records) by age (Fig. 5)*

For those without an immunization record, many facilities tended to immunize more clients in their 30s and 40s, with less natural immunity and who are likely to have been immunized once (Fig. 2A and B). For those with a record, the catch-up immunization rate was relatively high among those in their teens to their 50s. However, regardless of vaccination history, there was a strong inter-institutional variation in measles-containing vaccine coverage (Fig. 2C).

## Discussion

The characteristics of clients who presented for PTC in Japan in this study included that 35.8% were long-term travelers with a travel period of > 6 months. In PTCs in other countries, clients who traveled for > 6 months were few, ranging from 3–6.5% [2, 19]. However, in Scottish region (the UK) and China reports, long-term travelers were more (22.7 to 78.2%) [20, 21]. Although business was the most common reason for travel in this report, the main purpose of travel was tourism, based on other countries' PTCs (49.4 to 74.8%) [2, 19, 21–24]. Unlike other countries, Japan showed a similar trend, although not as much as in the previously mentioned China report [20], in that there were several long-term travelers for business. Compared to previous Europe reports [19, 22, 23], the percentage of those who traveled to Africa was slightly lower, and most destination countries were in Asia. More than half of the clients traveled to low- to lower-middle-income countries, which is slightly lower than that reported in the US [2]. However, there was no difference in that many clients traveled to high-risk health problem

countries. In an airport survey of mainly tourism Japanese travelers [3], the travel clinic consultation rate was very low at only 2%. This rate is clearly lower than the rates of PTCs in airport surveys conducted in other countries [4–6]. This is considered a major problem faced by Japanese travelers abroad. The age groups of the subjects in this study were generally the same as those reported in PTCs in other countries [2, 19, 22]. Although Japan has the highest percentage of people aged > 65 years worldwide [25], the percentage of those aged > 65 years who received pre-departure counseling was about 6%, which is similar to the US and Europe percentages (4.6–9%) [2, 22]. These results are due to the small number of elderly people who travel abroad [26], rather than that they do not present for PTC. Most elderly clients who visit the clinic for consultation were traveling for tourism, most commonly to Brazil, Kenya, and Tanzania, and it is likely that their consultations were for YFV. This is because of the high percentage of those aged  $\geq 65$  years who received YFV in this study, unlike those in a Greek report [23], with a significantly lower rate of vaccination against yellow fever. This difference may be attributed to the vaccination system in Japan. YFV facilities in Japan are conducted at 19 quarantine stations and medical institutions nationwide [16]. Hospitals 1, 2, 9, and 12 were among these 19 facilities (see Supplementary Table 1 in Additional file 1). The elderly often avoid vaccination at quarantine stations, due to the increased frequency of adverse reactions, and are therefore often vaccinated at medical institutions. Therefore, the proportion of elderly people vaccinated with the YFV in this study was high.

The acceptance of malaria chemoprophylaxis in recommended cases among travelers who planned to travel for < 2 months (60%) was lower than the acceptance rate in other countries (70.7 to 80.5%) [19, 22]. The airport survey also showed that only 20% of travelers to malaria high-risk countries received malaria chemoprophylaxis [27], suggesting the need for disease education and prevention awareness. However, there were two possible reasons for the low acceptance rate in this study. First, the number of facilities in Japan that can conduct YFV upon entry into yellow fever risk countries, where malaria prophylaxis is often required, is limited. It is assumed that a considerable number of clients come to the hospital after completing PTCs at another hospital. This is also likely to be the reason for the low prescription rate of malaria prophylaxis in malaria high-risk countries' facilities that can provide yellow fever vaccination (Fig. 1G). In addition, since many Japanese travel clients travel for long-term business, it is thought that this rate includes instances where companies had already provided malaria prophylaxis. In the future, we believe that this information should be aggregated to obtain an accurate understanding.

The quality of PTC was previously assessed by confirming the level of knowledge on travel medicine and simulation of cases through questionnaires [7, 8]. However, in the field of travel medicine, there is a wide variation in individual cases, and it is controversial whether a small number of simulated problems can be used to make a valid quality assessment. Although the frequency of recommended vaccination according to the guidelines was evaluated by comparing the contents of medical care at multiple institutions in Boston, and in an observational study at a single institution [9, 10], the validity of conducting PTCs according to set guidelines also remains controversial. In this study, we assessed the implementation rate of each facility according to the risk of food-borne infectious diseases, mosquito-borne diseases, and rabies in the destination countries, and examined indicators that can be used as criteria for evaluating quality. In terms of the implementation of food-borne vaccines and interventions, the GNI, which is a strong predictor of hepatitis A seroprevalence rates [28], was generally below the upper-middle level ( $\leq \$12,535$  or less), with nearly 70% of diet-related advice and HAV being implemented, which could be considered as one criterion. Correlation occurred between the vaccination rate and the incidence of typhoid fever, suggesting that typhoid fever vaccination is a good quality indicator in facilities where it is available. For rabies, the rate of education about PEP increased as the risk increased, but the rate of education about PrEP did not correlate well with the risk; this might be because of the relatively high cost of PrEP vaccination and because PrEP is largely related to the lifestyle after travel. Price is also a major factor for the acceptance of vaccination in Japan, where vaccination is self-financed [17]. Regarding the catch-up immunization rate of measles-containing vaccine, there was a large difference in the vaccination rate between facilities regardless of vaccination records. As measles outbreaks often occur in young adults [18], it is a good quality indicator that the catch-up immunization rate among clients in their 30s and 40s (the main age reported in PTC) remained high. Although it was difficult to set cutoffs for the quality indicators, if each facility provides pre-travel counseling in a way that achieves certain target values for the quality indicators, it will be possible to provide more homogeneous and higher quality pre-departure counseling.

## Limitations

This study had two limitations. Although vaccination was planned, it was unclear whether it was being implemented. However, a survey conducted by the NCGM on the implementation status of vaccines among clients who first visited on April 2019 showed that over 95% of the planned vaccines were administered (data not shown). Therefore, we believe that the planned vaccines were implemented as planned. However, the implementation rate is unknown in this study; because whether multiple series could be implemented including vaccinations that are given after travel, is unclear.

Second, the number of enrolled facilities was skewed, with Hospital 2 accounting for more than half of the total. On comparison by age, sex, purpose of travel, region of travel, and number of regions of travel between Hospital 2 and those of the other facilities, there were no clinically meaningful differences (< 10%) in most of the items. However, Hospital 2, the yellow fever vaccination center, tended to have more travelers going to Africa and South America, more short-term travelers (7–13 days), and fewer people traveling for business overall (see Supplementary Table 6 in Additional file 1). There were limitations related to these.

## Conclusions

The real-world data of pre-travel consultation in Japan was ascertained through a registry-based data and compared to those of other countries; showing more long-term travelers who traveled for business purposes. The percentage of travelers leaving Japan for low-income countries did not change significantly, but those to Asian region were more.

Quality indicators for pre-travel counseling included: explanation of PEP in high rabies risk countries, HAV rates in low GNI countries, vaccination rates in typhoid risk areas, prescription rates in malaria risk areas, explanation of mosquito control measures in dengue risk countries, and measles vaccination rates in those in their 30s and 40s. Vaccination rates were considered a possible indicator of the quality of care.

## Abbreviations

PTC: pre-travel consultations, J-PRECOR: Japan Pretravel Consultation Registry, YFV: yellow fever vaccine, IRB: institutional review board, IQR: interquartile ranges HAV: hepatitis A vaccination, PrEP: pre-exposure prophylaxis, PEP: post-exposure prophylaxis, GNI: gross national income

## Declarations

### Ethics approval and consent to participate

Study information was presented in a poster and/or on the Web for the possibility of opting out of consent. The protocol was approved by the institutional review board (IRB) of the National Center for Global Health and Medicine (NCGM) (NCGM-G-002347-01) or IRBs/ethical committees of the other cooperating facilities.

### Consent for publication

Not applicable.

### Availability of data and materials

Not applicable.

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### Conflicts of interest

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### Authors' contributions

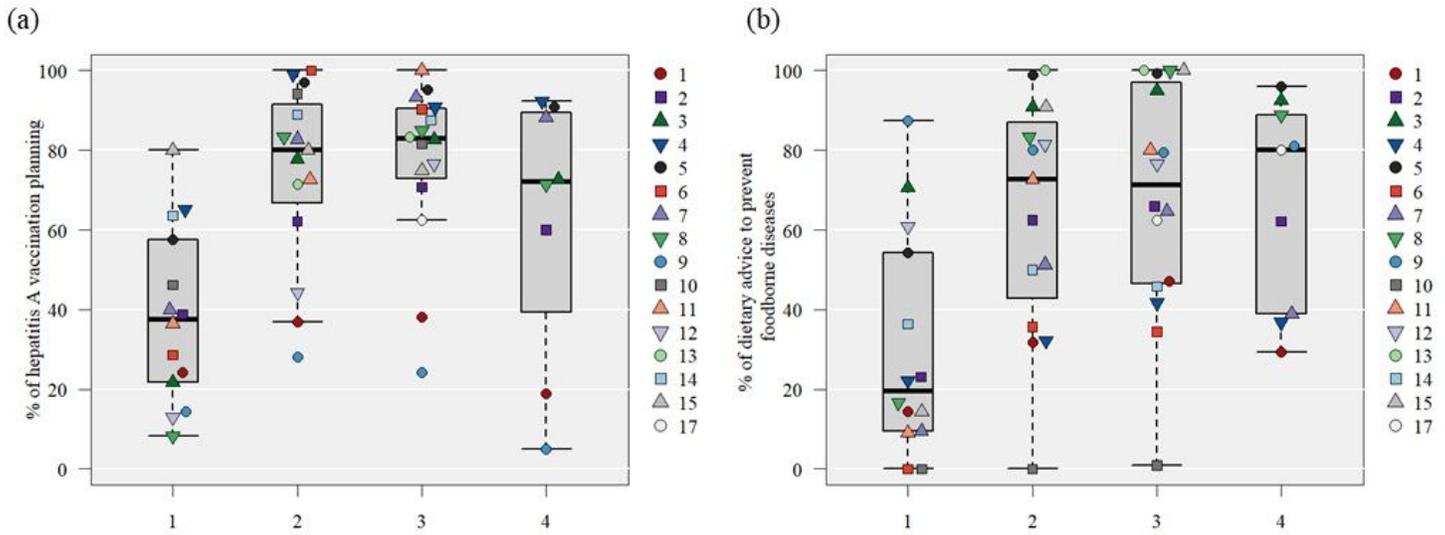
KY and SK came up with the conception and design of the study. KY, IN, KH, HN, KS, SK, MS, MY, NS, TK, NK, AN, TM, AM, TM, YY, and TO acquired data. YA analyzed and interpreted of data. KY and was a major contributor in writing the manuscript. NO revised it critically for important intellectual content. All authors read and approved the final manuscript.

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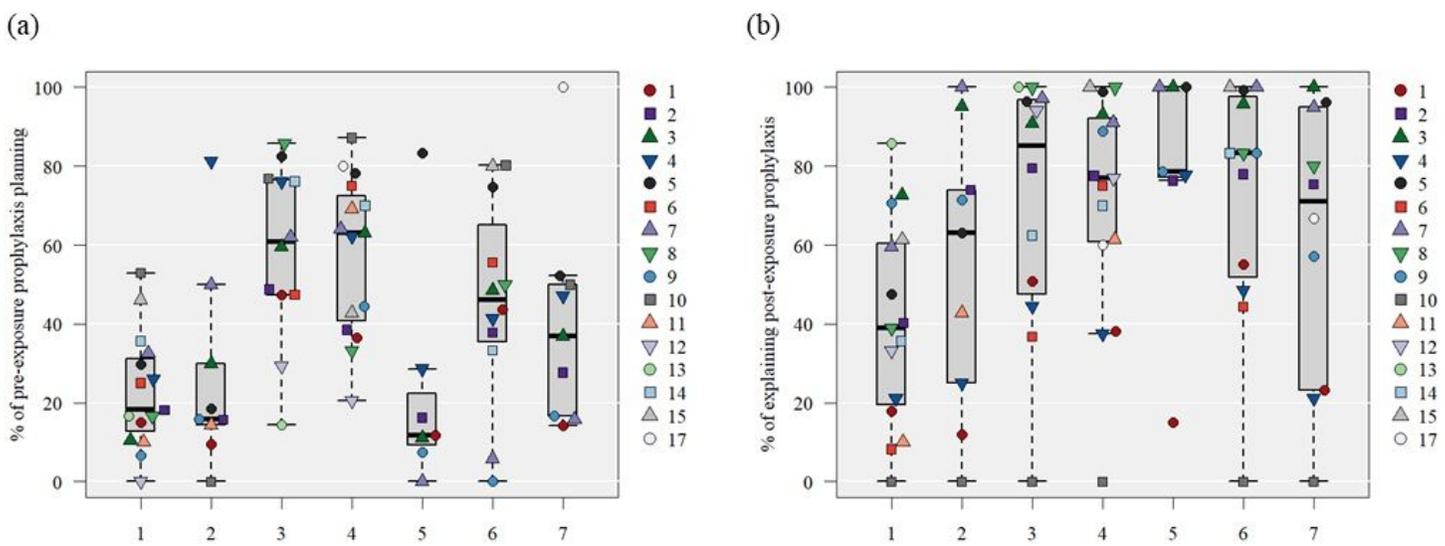
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## Figures



**Figure 1**

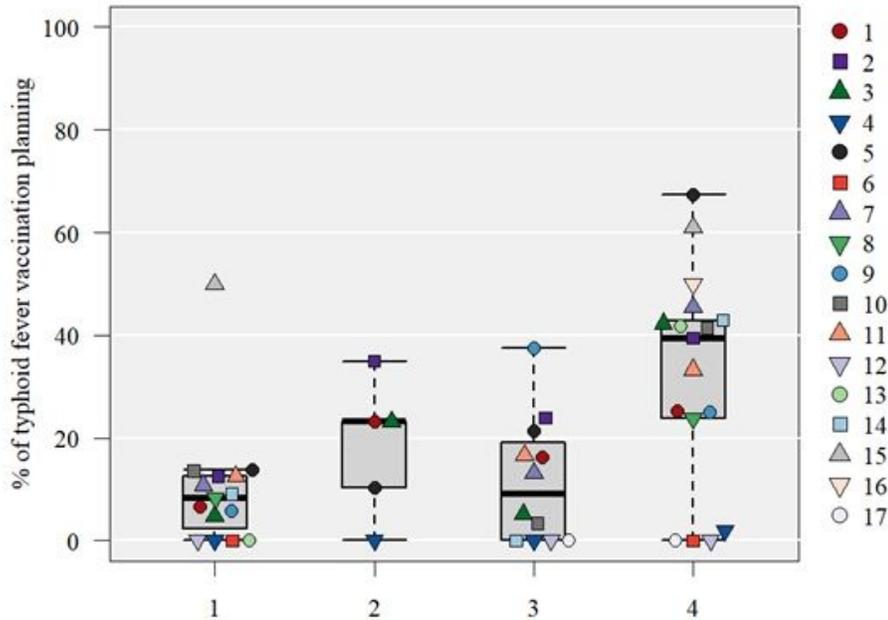
Country classification by income level and interventions implemented during pre-travel consultation by each collaborated hospital. The numbers in the legend correspond to the "Hospital number." (a): The percentage of hepatitis A vaccine planning in clients without immunization history of hepatitis A vaccine categorized by the gross national income (GNI). The risk categories, in order, from 1 to 4, are "high GNI: \$12,536 or more"; "upper-middle GNI: \$4,046 and \$12,535"; "lower-middle GNI: \$1,036 and \$4,045"; and "low GNI: \$1,035 or less." Cases in which hepatitis A vaccine had been implemented, with a vaccination history, were excluded. Of the 8,204 patients included in the validation, data from 10 patients (1 facility) were excluded because they could not be classified into a risk category. (b): The advisory rate of dietary habits to avoid foodborne diseases categorized by the GNI. The risk categories, in order, from 1 to 4, are "high GNI: \$12,536 or more"; "upper-middle GNI: \$4,046 and \$12,535"; "lower-middle GNI: \$1,036 and \$4,045"; and "low GNI: \$1,035 or less." Of the 9,658 patients included in the validation, data from 11 patients (1 facility) were excluded because they could not be classified into a risk category. \* See the supplementary materials for the country names (ISO 3166-1 codes, Alpha-3 code) included.



**Figure 2**

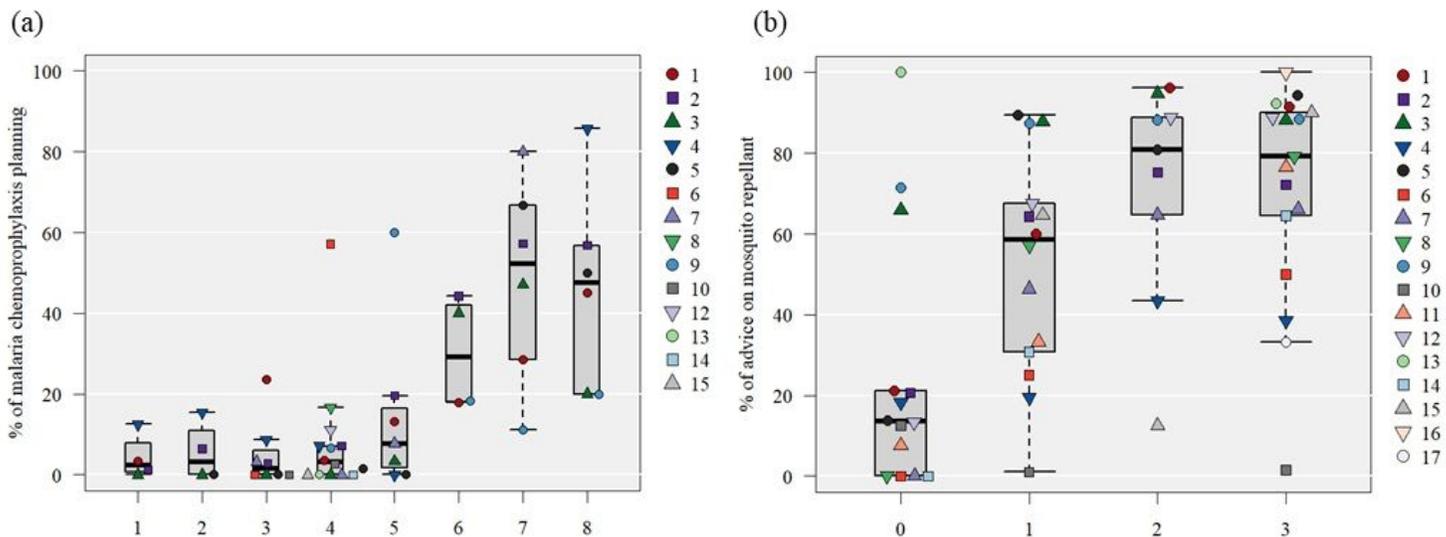
Risk classification of rabies and interventions implemented during pre-travel consultation by each collaborated hospital. The numbers in the legend correspond to the "Hospital number." (a): Percentage of rabies pre-exposure prophylaxis (PrEP) planning in clients without history of completed PrEP categorized by the risk of rabies. The risk categories, in order, from 1 to

7, are death rates due to human rabies per capita (per 100,000 persons): "less than 0.0024"; "0.0024 to less than 0.038"; "0.038 to less than 0.19"; "0.19 to less than 0.6"; "0.6 to less than 1.5"; "1.5 to less than 3.0"; and "3.0 or more." Cases in which rabies PrEP had been implemented, with a vaccination history, were excluded. Of the 8,803 patients included in the validation, data from 136 patients (5 facilities) were excluded because they could not be classified into a risk category. (b): The rate of explaining of post-exposure prophylaxis categorized by the risk of rabies. Risk categories were defined in the same way as in (c). Of the 9,618 patients included in the validation, data from 145 patients (5 facilities) were excluded because they could not be classified into a risk category. \* See the supplementary materials for the country names (ISO 3166-1 codes, Alpha-3 code) included.



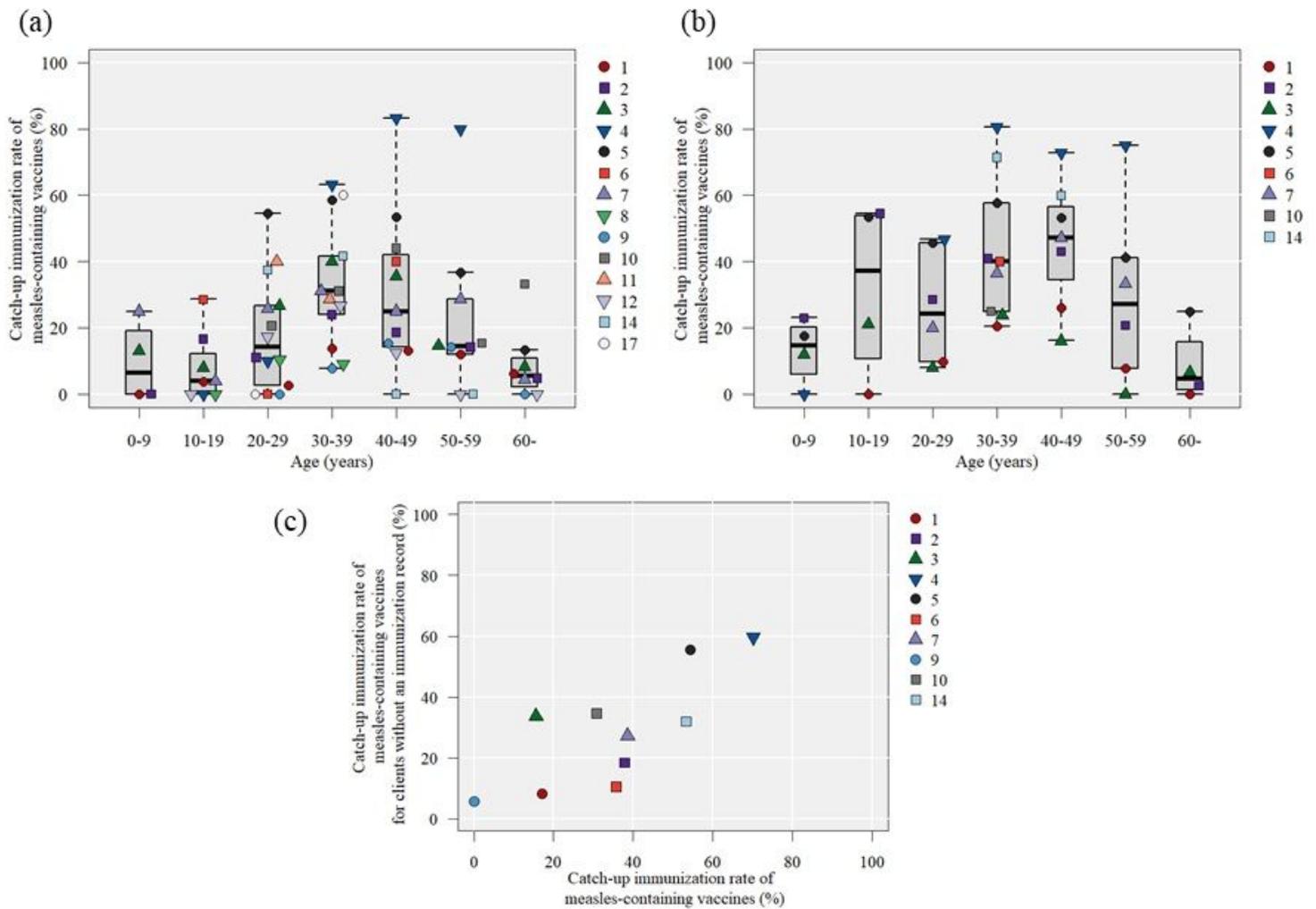
**Figure 3**

Risk classification of typhoid fever and vaccinations implemented during pre-travel consultation by each collaborated hospital. The numbers in the legend correspond to the "Hospital number." Percentage of typhoid fever vaccination planning in clients without immunization history of typhoid fever vaccine within 3 years, categorized by the risk of typhoid fever. The risk categories, in order, from 1 to 4, are the incidence of typhoid fever per 100,000 persons: "less than 20"; "20 to less than 50"; "50 to less than 100"; and "100 or more." Cases in which typhoid fever vaccine within 3 years had been implemented, with a vaccination history, were excluded. Of the 9,333 patients included in the validation, data from 26 patients (2 facilities) were excluded because they could not be classified into a risk category. \* See the supplementary materials for the country names (ISO 3166-1 codes, Alpha-3 code) included.



**Figure 4**

Risk classification of mosquito-borne diseases and interventions implemented during pre-travel consultation by each collaborated hospital. The numbers in the legend correspond to the "Hospital number." (a): The prescription rate of malaria prophylaxis in clients traveling for <56 days categorized by the risk of falciparum malaria. The risk categories, in order, from 1 to 8, are the incidence of falciparum malaria per 100,000 persons: "no risk"; "less than 0.1"; "0.1 to less than 1.0"; "1.0 to less than 10"; "10 to less than 50"; "50 to less than 100"; "100 to less than 250"; and "250 or more." Of the 5,124 patients included in the validation, data from 403 patients (8 facilities) were excluded because they could not be classified into a risk category. (b): Implementation of mosquito control advice about mosquito repellent, categorized by the risk of dengue fever: The risk categories, in order, from 0 to 3, are classified according to the reference 15 dengue risk categories: "no or unknown risk"; "risk varies based on region"; "sporadic/uncertain"; and "frequent/continuous." \* See the supplementary materials for the country names (ISO 3166-1 codes, Alpha-3 code) included.



**Figure 5**

Catch-up immunization rate of measles-containing vaccines by age group in each facility The numbers in the legend correspond to the "Hospital number." Data with no more than five applicable cases in each category were excluded from the figure without calculating the percentage. (a): Catch-up immunization rates of measles-containing vaccines by age group among participants without vaccination records (4,643 patients were included in the validation). (b): Catch-up immunization rates of measles-containing vaccines by age group among participants with vaccination records who have received none or one measles-containing vaccine (2,551 patients included in the validation). (c): Association between catch-up immunization rates among participants without vaccination records and subjects with vaccination records who require catch-up measles-containing vaccines.

## Supplementary Files

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