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Clinical Practices for Measles-Mumps-Rubella Vaccination Among US Pediatric International Travelers

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Key Points

Question

Are there missed opportunities for measles-mumps-rubella (MMR) vaccination at pretravel consultations for US pediatric international travelers?

Findings

In this cross-sectional study of 14 602 pediatric travelers, 91.7% of infants, 59.6% of preschool-aged travelers, and 3.2% of school-aged travelers were eligible for MMR vaccination; however, 44.1% of MMR vaccination–eligible infants, 56.5% of MMR vaccination–eligible preschool-aged travelers, and 88.5% of MMR vaccination–eligible school-aged travelers were not vaccinated at the consultation. Clinician decision and guardian refusal were the most common reasons for nonvaccination.

Meaning

The findings suggest that opportunities exist for clinicians to provide pretravel MMR vaccination to US pediatric travelers and that additional education of clinicians and guardians may be needed.

Abstract

Importance

The US population is experiencing a resurgence of measles, with more than 1000 cases during the first 6 months of 2019. Imported measles cases among returning international travelers are the source of most US measles outbreaks, and these importations can be reduced with pretravel measles-mumps-rubella (MMR) vaccination of pediatric travelers. Although it is estimated that children account for less than 10% of US international travelers, pediatric travelers account for 47% of all known measles importations.

Objective

To examine clinical practice regarding MMR vaccination of pediatric international travelers and to identify reasons for nonvaccination of pediatric travelers identified as MMR eligible.

Design, Setting, and Participants

This cross-sectional study of pediatric travelers (ages ≥6 months and <18 years) attending pretravel consultation at 29 sites associated with Global TravEpiNet (GTEN), a Centers for Disease Control and Prevention–supported consortium of clinical sites that provide pretravel consultations, was performed from January 1, 2009, through December 31, 2018.

Main Outcomes and Measures

Measles-mumps-rubella vaccination among MMR vaccination–eligible pediatric travelers.

Results

Of 14 602 pretravel consultations for pediatric international travelers, 2864 travelers (19.6%; 1475 [51.5%] males; 1389 [48.5%] females) were eligible to receive pretravel MMR vaccination at the time of the consultation: 365 of 398 infants aged 6 to 12 months (91.7%), 2161 of 3623 preschool-aged travelers aged 1 to 6 years (59.6%), and 338 of 10 581 school-aged travelers aged 6 to 18 years (3.2%). Of 2864 total MMR vaccination–eligible travelers, 1182 (41.3%) received the MMR vaccine and 1682 (58.7%) did not. The MMR vaccination–eligible travelers who did not receive vaccine included 161 of 365 infants (44.1%), 1222 of 2161 preschool-aged travelers (56.5%), and 299 of 338 school-aged travelers (88.5%). We observed a diversity of clinical practice at different GTEN sites. In multivariable analysis, MMR vaccination–eligible pediatric travelers were less likely to be vaccinated at the pretravel consultation if

they were school-aged (model 1: odds ratio [OR], 0.32 [95% CI, 0.24-0.42; $P < .001$]; model 2: OR, 0.26 [95% CI, 0.14-0.47; $P < .001$]) or evaluated at specific GTEN sites (South: OR, 0.06 [95% CI, 0.01-0.52; $P < .001$]; West: OR, 0.10 [95% CI, 0.02-0.47; $P < .001$]). The most common reasons for nonvaccination were clinician decision not to administer MMR vaccine (621 of 1682 travelers [36.9%]) and guardian refusal (612 [36.4%]).

Conclusions and Relevance

Although most infant and preschool-aged travelers evaluated at GTEN sites were eligible for pretravel MMR vaccination, only 41.3% were vaccinated during pretravel consultation, mostly because of clinician decision or guardian refusal. Strategies may be needed to improve MMR vaccination among pediatric travelers and to reduce measles importations and outbreaks in the United States.

Introduction

The United States has had a resurgence of measles. More than 1000 cases were reported from 28 states within the first 6 months of 2019, which is the greatest number of cases in the United States since 2000.[1] Measles is a viral illness associated with fever, cough, coryza, and conjunctivitis followed by rash that can result in hospitalization, severe neurologic disease, and death.[2,3] A safe and effective measles-mumps-rubella (MMR) vaccine is included in the routine childhood vaccination schedule in the United States,[4,5,6] and widespread vaccine coverage has ensured maintenance of measles elimination (ie, lack of sustained measles transmissions for >12 months) in the United States since 2000.[7] Although MMR vaccination rates are stable at the national level,[8] refused or delayed MMR vaccination among healthy children has increased, and communities with large numbers of incompletely vaccinated children are highly susceptible to outbreaks.[9] This major public health concern jeopardizes the elimination of measles in the United States.[1,10]

Since elimination in 2000, measles outbreaks in the United States have been associated with international importation, and more than half of all measles importations occur among US residents who are infected during international travel.[11,12] However, the risk of measles exposure during international travel is often underrecognized by clinicians and travelers. At pretravel consultations in the Global TravEpiNet (GTEN) Consortium from 2009 through 2014, clinicians identified 16% of US adult international travelers born after 1956 as eligible for pretravel MMR vaccination before travel, yet only 47% of these individuals were vaccinated.[13]

Pediatric travelers are a particularly important group for pretravel MMR vaccination. Although pediatric travelers comprise less than 10% of US international travelers annually,[14] they accounted for 47% of measles importations among returning US travelers from 2001 through 2016.[11,12] The Advisory Committee on Immunization Practices (ACIP) recommends that US children without other evidence of immunity receive 2 lifetime MMR doses as part of routine vaccination; the first dose is given between 12 and 15 months of age and a second dose between 4 and 6 years of age (Table 1).[6] Since 1989, ACIP has recommended a specific schedule of MMR vaccination among pediatric international travelers.[15,16] Infants (aged 6 to <12 months) should receive 1 MMR vaccine dose before international travel that does not count toward the 2 lifetime doses. Preschool-aged travelers (aged 1 to <6 years) should receive both lifetime MMR doses before departure, at least 28 days apart. The ACIP recommendations for international travelers do not differ from the routine immunization schedule for school-aged children and adolescents (aged 6 to <18 years), who should have already received 2 MMR doses during routine care.[15]

The objective of this multisite observational study was to characterize clinical practice regarding MMR vaccination of pediatric travelers seen for pretravel consultation. We characterized how frequently clinicians identified pediatric travelers eligible for MMR vaccination. We then examined whether MMR

vaccination was administered during the pretravel consultation and reasons for nonvaccination.

Methods

Study Setting

This cross-sectional study used data from the Global TravEpiNet (GTEN), a consortium of US clinical sites, supported by the Centers for Disease Control and Prevention, where clinicians evaluate travelers in anticipation of upcoming travel; data have been prospectively collected since 2009 regarding clinical practice patterns.[17] Twenty-nine sites contributed data to this analysis from 4 US census regions: Northeast (9 sites), Midwest (2 sites), West (8 sites), and South (10 sites).[18] Nineteen sites were academic centers, and 10 were other types of health facilities, including primary care practices, pharmacies, and public health clinics. Institutional review board approval was obtained at all participating GTEN sites (eTable 1 in the Supplement). The institutional review boards that reviewed the study at participating clinical sites waived the need for written or oral informed consent because the study collected only deidentified data that are routinely collected during a standard clinical encounter.

Study Population and Eligibility Criteria

Travelers were eligible for inclusion if they were younger than 18 years when they attended a GTEN site from January 1, 2009, through December 31, 2018. We excluded data on pediatric travelers whose itineraries were restricted to the United States or who were younger than 6 months at the pretravel consultation because they would not be eligible for ACIP-recommended pretravel MMR vaccination.[15,16] We characterized pediatric travelers into 3 age groups given age-stratified ACIP guidelines for MMR vaccination (Table 1): infants (aged 6 to <12 months), preschool-aged children (aged 1 to <6 years), and school-aged children and adolescents (aged 6 to <18 years).

Data Collection

Clinicians used a structured, online questionnaire during pretravel consultations to confirm details entered by the traveler or guardian regarding demographics, medical conditions, and travel itinerary (eg, region, purpose, and duration of travel).[17] Clinicians entered data about immunization history based on traveler or guardian report or written documentation, as well as health advice provided, vaccines administered, and medications prescribed. Incomplete answers were not allowed.

Assessment of MMR Vaccination Eligibility

We reviewed the data that clinicians entered in the GTEN structured questionnaire to classify travelers as eligible for MMR vaccination according to our age-stratified study definition: infants (aged 6 to <12 months), if clinicians noted no previous MMR vaccination and no alternative evidence of immunity; or children older than 1 year (ie, preschool-aged and school-aged travelers), if clinicians did not elicit a history of 2 MMR vaccine doses or other evidence of immunity.[15,16] We considered pediatric travelers to be ineligible for MMR vaccination if they had evidence of preexisting measles immunity, had contraindications to MMR vaccination (ie, immunosuppression), or had received a dose of MMR vaccine less than 28 days before the pretravel consultation.

Clinical Management

Clinicians assessed travelers' past MMR vaccination status and administered MMR vaccine doses according to their clinical practice. When clinicians identified travelers as eligible for MMR vaccination, the structured questionnaire prompted clinicians to consider MMR vaccination and to select 1 reason for nonvaccination from a list of possibilities available for any travel-related vaccination: not indicated for this

patient or itinerary, insufficient time before departure, guardian refusal, or referral to another clinician for vaccination.[13] If clinicians failed to identify travelers who were eligible for MMR vaccination, the structured questionnaire did not prompt clinicians to provide a reason for nonvaccination.

Reasons for nonvaccination were grouped into 3 categories: clinician decision, guardian refusal, or referral to another clinician. Because MMR vaccination is indicated for all MMR vaccination–eligible international travelers regardless of itinerary and at any time before departure, we categorized encounters as clinician decision if the clinician (1) failed to identify an MMR vaccination–eligible traveler (ie, traveler met the study definition of MMR vaccination eligibility, but the clinician misclassified as ineligible) or (2) selected the answers, "not indicated for this traveler or itinerary" or "insufficient time before departure." Before 2012, guardian refusal of MMR vaccination was recorded without a more specific reason. Beginning in 2012, clinicians recorded 1 of 3 reasons for guardian refusal: (1) lack of concern about illness, (2) concerns about vaccine safety, or (3) concerns about cost. Clinicians could also note that the MMR vaccine was not available at the pretravel consultation.

Statistical Analyses

Destinations were grouped into 6 geographic regions as defined by the World Health Organization.[19] The most common purposes of pediatric travel were (1) leisure, (2) visiting friends and relatives, or (3) nonmedical service work or education. We defined travelers as visiting friends and relatives if they reported traveling to a region of origin of self or family to visit friends or relatives or residing with relatives in a low- or middle-income country.[17,20] We grouped additional reasons for travel (eg, business) as other because they were infrequent. We calculated the time between pretravel consultation and departure.

We obtained distributions of traveler and site characteristics among all pediatric travelers and MMR vaccination–eligible travelers, stratified by age group. We examined whether the distribution of characteristics varied by whether the vaccine was administered to MMR vaccination–eligible travelers or by reasons for nonvaccination among the MMR vaccination–eligible travelers who were not vaccinated.

Odds ratios (ORs) with 95% CIs were obtained from 2 separate multivariable logistic regressions to assess the association of vaccination of MMR vaccination–eligible pediatric travelers with traveler sex, age group, region, purpose and duration of travel, and time to departure. Model 1 also included type of site, whereas model 2 included US census region. Although vaccination rates varied by the type of site and census region, we were unable to include both variables in a single model or study the interaction of these 2 variables because of the unequal distribution of academic and nonacademic sites across the US census regions and insufficient sample sizes. The multivariable models used Taylor linearization methods to adjust for the clustering of patients within sites. Analyses were conducted using SAS, version 9.2 (SAS Institute Inc) and SUDAAN, version 11.0.3 (RTI International). We considered a 2-sided $P < .05$ to be statistically significant.

Results

Of the 121 295 pretravel consultations at 29 GTEN sites from January 1, 2009, through December 31, 2018, pediatric travelers comprised 14 802 (12.2%) consultations (eFigure in the Supplement). We excluded 12 pediatric travelers reporting destinations only within the United States or associated territories and 188 travelers younger than 6 months. Demographics from these 14 602 pediatric travel consultations are presented in Table 2 and are stratified by age group in eTable 2 in the Supplement.

MMR Vaccination–Eligible Pediatric Travelers

Among 14 602 pretravel consultations for pediatric travelers, we identified 11 708 pediatric travelers (80.2%) who were not eligible for MMR vaccination and 2864 (19.6%; 1475 [51.5%] males; 1389 [48.5%] females) who were eligible. Of all travelers, 0.3% had medical contraindications or received the first dose of MMR vaccine within the previous 28 days (eFigure in the Supplement).

Eligibility for MMR vaccination varied substantially by age group (eFigure in the Supplement). Infants were most frequently eligible for MMR vaccination (365 of 398 travelers [91.7%]), whereas 2161 of 3623 preschool-aged travelers (59.6%) were eligible. School-aged travelers were rarely eligible (338 of 10 581 travelers [3.2%]).

Nonvaccination of MMR Vaccination–Eligible Pediatric Travelers

Pediatric travelers who were eligible for MMR vaccination were not vaccinated at 1682 of 2864 GTEN pretravel consultations (58.7%) (Figure 1). Among these MMR vaccination–eligible individuals, 161 of 365 infants (44.1%), 1222 of 2161 preschoolers (56.5%), and 299 of 338 school-aged travelers (88.5%) were not vaccinated.

Reasons for nonvaccination of 1682 MMR vaccination–eligible travelers included clinician decision (621 travelers [36.9%]), guardian refusal (612 [36.4%]), referral to another clinician (433 [25.7%]), and vaccine unavailable (16 [1.0%]) (Figure 1). Among the 621 consultations in which clinicians decided not to vaccinate MMR vaccination–eligible travelers, clinicians failed to identify MMR vaccination eligibility in 475 consultations (76.5%), incorrectly endorsed that MMR vaccination was not indicated in 104 consultations (16.7%), and incorrectly cited insufficient time for vaccination in 42 consultations (6.8%). Most guardians (75% for infants, 88% for preschool-aged, and 89% for school-aged) who refused MMR vaccination cited a lack of concern about measles illness and rarely expressed concerns about MMR vaccination safety or cost (Figure 1). Clinician decision occurred most often among infants (70 of 161 [43.5%]) and preschool-aged travelers (497 of 1222 [40.7%]), whereas guardians refused most frequently for school-aged travelers (187 of 299 [62.5%]). Referral to another clinician occurred for 63 of 161 infants (39.1%), 314 of 1222 preschoolers (25.7%), and 56 of 299 school-aged travelers (18.7%) who were eligible for MMR vaccination but were not vaccinated.

Characteristics of MMR Vaccination–Eligible Travelers

We examined the traveler and site characteristics of all pretravel consultations at which MMR vaccination–eligible pediatric travelers were vaccinated compared with consultations at which these individuals were not vaccinated (Table 2 and eTable 3 in the Supplement). Of 2864 total MMR vaccination–eligible travelers, 1182 (41.3%) were vaccinated and 1682 (58.7%) were not vaccinated. The MMR vaccination–eligible travelers were less likely to be vaccinated if they were school-aged, were traveling within North and South America, were traveling fewer than 14 days, or were evaluated at a nonacademic center or in the South or West region of the United States. The MMR vaccination–eligible travelers were more likely to be vaccinated if they were visiting friends or relatives or if they were traveling to Africa.

In both multivariable models (Table 3), MMR vaccination–eligible travelers were more likely to be vaccinated if they were traveling to Africa (model 1: OR, 1.86 [95% CI, 1.15-3.01], $P = .008$; model 2: OR, 1.74 [95% CI, 1.17-2.58], $P = .004$) and were less likely to be vaccinated if they were school-aged (model 1: OR, 0.32 [95% CI, 0.24-0.42], $P < .001$; model 2: OR, 0.26 [95% CI, 0.14-0.47], $P < .001$). They were also less likely to be vaccinated if they were traveling for leisure (Model 1: OR, 0.49; 95% CI, 0.26-0.94; model 2: OR, 0.64 [95% CI, 0.38-1.08]), service or education (model 1: OR, 0.18 [95% CI, 0.07-0.48]; model 2: OR, 0.47 [95% CI, 0.16-1.34]), or other purposes (model 1: OR, 0.60 [95% CI, 0.36-1.00]; model 2: OR, 0.77 [95% CI, 0.49-1.19]) compared with visiting friends and relative ($P = .002$). They were

less likely to be vaccinated if they were evaluated at nonacademic centers in model 1 (OR, 0.04; 95% CI, 0.01-0.20; $P < .001$) or at GTEN sites in the South (OR, 0.06; 95% CI, 0.01-0.52; $P < .001$) or West (OR, 0.10; 95% CI, 0.02-0.47; $P < .001$) in model 2.

Specific reasons for nonvaccination among MMR vaccination–eligible travelers were also associated with traveler and site characteristics (Table 2 and eTable 3 in the Supplement). Clinician decision to not vaccinate was more common in evaluation of travelers with 1 previous MMR vaccination or at academic centers or in the Northeast. Guardians were more likely to refuse MMR vaccination for school-aged travelers, travel to Africa, itineraries of at least 14 days, or at nonacademic centers or sites in the South. Guardians of preschool-aged and school-aged travelers with no previous MMR vaccinations were also more likely to refuse MMR vaccination. Referral to another clinician occurred more frequently when departure was at least 14 days after pretravel consultation among infants or preschool-aged travelers or at sites in the West.

A wide range of clinical practice was evident among the GTEN sites (Figure 2 and eTable 4 in the Supplement). Travelers eligible for MMR vaccination were more frequently not vaccinated at nonacademic centers in the Northeast (100%), nonacademic centers in the South (97.1%), and academic centers in the West (94.8%) compared with 36.0% to 59.1% at other sites. The most common reasons for nonvaccination varied by site: clinician decision (nonacademic centers in the Northeast and Midwest), guardian refusal (nonacademic centers in the South), and referral to another clinician (academic centers in the West).

Discussion

These data from the largest US consortium of clinicians offering pretravel consultations showed that 19.6% of pediatric international travelers were eligible for pretravel MMR vaccination, yet 58.7% were not vaccinated during the consultation despite evaluation by clinicians experienced in pretravel consultations. These missed opportunities were attributable in similar proportions to clinician decision not to vaccinate and guardian refusal. A better understanding of the benefits of MMR vaccination and the risks of measles illness is essential among clinicians and guardians to improve measles immunity among pediatric international travelers before travel and potentially reduce measles importations to the United States.

In more than 40% (43.5% of infant travelers; 40.7% of preschool-aged travelers) of pretravel consultations with MMR vaccination–eligible infant and preschool-aged travelers who were not vaccinated, clinicians had not recommended MMR vaccination, which underscores major knowledge gaps even among this group of clinicians with expertise in travel medicine and vaccinations. Infants and preschool-aged travelers are at high risk for serious disease with measles infection and are unlikely to have had appropriate previous MMR vaccinations.[2,3] Although MMR vaccination is safe for children aged 6 to 12 months, it is not routinely recommended because of the low likelihood of measles exposure in the United States. There is also lower effectiveness when given to children younger than 12 months (ie, 85% instead of 93% with 1 dose) because of potential interference by maternal antibodies and immaturity of the immune system.[15,21,22] However, infants at high risk for measles exposure, such as international travelers, should be offered early MMR vaccination followed by the standard 2 MMR vaccinations after 12 months of age.[15,16] An investigation of reasons why clinicians did not identify MMR vaccination–eligible travelers or did not administer MMR vaccination is needed to educate clinicians and to improve implementation of ACIP recommendations for MMR vaccination of pediatric travelers.

Only 3% of school-aged travelers were eligible for MMR vaccination in this study, reflecting the overall high uptake of routine vaccines in the United States.[23,24] However, those identified as eligible for MMR vaccination were usually not vaccinated at the pretravel consultation because of guardian refusal. Vaccine-hesitant guardians are commonly noted to minimize concerns about vaccine-preventable disease,[25,26] which is notable because the study period included major measles outbreaks with robust media

coverage.[27,28,29] Clinicians should preemptively discuss beliefs regarding the risks of becoming infected with measles and the realities of clinical illness with measles. School-aged travelers should already have received 2 MMR vaccinations routinely; however, 11.5% (39 of 338) MMR vaccination–eligible school-aged travelers in this study were successfully vaccinated at the pretravel consultation. Clinicians are trusted sources of information about vaccinations and should take advantage of every opportunity to address vaccine effectiveness, even in the context of previous vaccine refusal.

Referral to another clinician for MMR vaccination was common among pediatric travelers of all age groups in our study, particularly when there were 14 days or more between the pretravel consultation and departure. Previous GTEN analyses have shown that routine vaccinations are less likely to be administered at pretravel consultations than travel-related vaccinations,[30] which may reflect clinicians' concerns that routine vaccinations can prompt higher out-of-pocket costs for the traveler and family or might not be recorded in the travelers' permanent medical record if given at pretravel consultations. However, missed opportunities for MMR vaccination remain likely because families may not pursue another health care appointment before travel.

These data from GTEN sites likely underestimated the percentage of MMR vaccination–eligible pediatric travelers. Clinicians followed their typical clinical practice and were not required to accept only written documentation of previous MMR vaccinations or other evidence for immunity. If strict ACIP criteria had been required, an even greater proportion of pediatric travelers may have been considered to be eligible for MMR vaccination. In addition, primary care practices may be less likely to consider and recommend pretravel MMR vaccination for eligible pediatric travelers, in contrast to GTEN clinicians who are travel medicine specialists. This is of particular concern for travelers to Europe, who are rarely referred for pretravel consultation (ie, only 3% of the pediatric travelers evaluated at GTEN sites had itineraries restricted to Europe). Measles remains widespread in Europe, and travelers returning from Europe accounted for 30% of imported measles cases to the United States from 2001 through 2016.[12,31] Ensuring measles immunity among international travelers is essential and can only be improved if primary care pediatricians also discuss pretravel MMR vaccination recommendations with pediatric travelers and their guardians at routine visits.

Limitations

These data are from a large, prospective, multisite study, but our analysis has limitations. Although the observed patterns of reported vaccination were consistent with US coverage levels, our estimates of MMR vaccination eligibility may be underestimates or overestimates because we did not have access to written documentation of previous immunizations.[8,23,24] Health-seeking behavior may be more likely among travelers and families who pursue pretravel consultation; such travelers may be more likely to be up to date on routine vaccines and to follow recommendations about additional vaccinations. An even greater proportion of US travelers might lack measles immunity or refuse vaccination if recommended. These GTEN data showed diverse clinical practices at different types of sites in different regions of the United States that may not be representative of any specific region; the uneven distribution of the types of sites across the US census regions and relatively small sample sizes precluded accounting for both variables simultaneously in the multivariable models. Our data were not representative of travelers to international settings who did not attend specialized pretravel consultation.

Conclusions

We observed extensive missed opportunities for MMR vaccination among eligible pediatric travelers. Clinicians often did not administer pretravel MMR vaccination, even for vulnerable infants and preschool-aged travelers, and guardians did not recognize measles as a serious illness. Strategies may be needed to improve clinician and guardian knowledge of measles as a serious travel-related illness and the benefits of MMR vaccination, particularly in the setting of ongoing US measles outbreaks.

Notes

Supplement.

eTable 1. IRB Approvals for Participating Global TravEpiNet sites.

eTable 2. Baseline Demographics of All Eligible Pediatric Travelers and MMR-eligible Pediatric Travelers Attending GTEN Sites From 2009 Through 2018.

eTable 3. Baseline Demographics of MMR-eligible Travelers Attending GTEN Sites From 2009 Through 2018, Stratified by Age Group.

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Figures and Tables

Table 1.

Differences Between the Routine MMR Vaccination Schedule and the MMR Vaccination Recommendations for US Pediatric International Travelers

MMR Vaccination	Infants (6 to <12 mo)	Preschool Aged (1 to <6 y)	School Aged (6 to <18 y)
Routine[6]	None	1 Dose: 12-15 mo of age[a]	2 Doses: 12-15 mo of age and 4-6 y of age[a]
International travelers[15]	1 Dose[b]	2 Doses[c]	2 Doses[c]

Abbreviation: MMR, measles-mumps-rubella.

[a]For children aged 1 year to 4 and 6 years who have not received 1 dose of MMR vaccine after age 12 months, the catch-up immunization schedule recommends 1 dose of MMR vaccine. For children aged between 4 and 6 years to younger than 18 years who have not received MMR vaccine after age 12 months, the catch-up immunization schedule recommends 2 doses of MMR vaccine administered at least 28 days apart.
[b]A total of 3 lifetime doses of MMR vaccine is recommended for children who received a dose of MMR vaccine before 12 months of age.
[c]The second dose of MMR vaccine should be given at least 28 days after the first dose.

Table 2.

Traveler and Site Characteristics of Global TravEpiNet Pretravel Consultations for Pediatric Travelers Eligible for MMR Vaccination (2009-2018)

Characteristic	Total (N = 2864)	Vaccinated (n = 1182)	Not Vaccinated (n = 1682)	*P* Value[a]	Not Vaccinated				
					Total (n = 1682)	Clinician Decision (n = 621)	Guardian Refusal (n = 612)	Referred to Another Clinician (n = 449)[b]	*P* Value[a]
Sex, No. (%)									
Female	1389 (48.5)	576 (48.7)	813 (48.3)	.08	813 (48.3)	295 (47.5)	296 (48.4)	222 (49.4)	.91
Male	1475 (51.5)	606 (51.3)	869 (51.7)		869 (51.7)	326 (52.5)	316 (51.6)	227 (50.6)	
Age group, No. (%)									
Infants, 6 to <12 mo	365 (12.7)	204 (17.2)	161 (9.6)	.045	161 (9.6)	70 (11.3)	27 (4.4)	64 (14.2)	<.001
Preschool-aged, 1 to <6 y	2161 (75.5)	939 (79.4)	1222 (72.6)		1222 (72.6)	497 (80.0)	398 (65.0)	327 (72.8)	
School-aged, 6 to <18 y	338 (11.8)	39 (3.3)	299 (17.8)		299 (17.8)	54 (8.7)	187 (30.6)	58 (12.9)	
Previous MMR vaccinations, No. (%)									
0	891 (31.1)	334 (28.3)	557 (33.1)	.12	557 (33.1)	120 (19.3)	285 (46.6)	152 (33.8)	<.001
1	1973 68.9)	848 (71.7)	1125 (66.9)		1125 (66.9)	501 (80.7)	327 (53.4)	297 (66.1)	
Region of travel, No. (%)[c]									
Africa	1634 (57.1)	739 (62.5)	895 (53.2)	.007	895 (53.2)	324 (52.2)	392 (64.1)	179 (39.9)	.01

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Abbreviation: MMR, measles-mumps-rubella.

[a]Categorical variables: 2-sided *P* values were obtained from the Cochran-Mantel-Haenszel test and indicate whether the association of the characteristic and the outcome is statistically significant after adjusting for clinic site. Two-sided *P* values for testing the association of type of site or US census region were obtained from χ^2 test of

independence. Continuous variables: *P* values were obtained from the Wilcoxon/Kruskal-Wallis test and indicate whether the distribution of the variable is significantly different in the outcome groups.

[b]The 16 pediatric travelers not vaccinated because of vaccine unavailability were included with those referred to another clinician for demographic analysis.

[c]Column percentages may not sum to 100% because more than 1 selection was allowed.

[d]Midwest excluded from this comparison given its low sample size.

Figure 1.

Reasons for Nonvaccination Among Pediatric Travelers Eligible for Measles-Mumps-Rubella (MMR) Vaccination at 29 Global TravEpiNet Clinic Sites (2009-2018)

All travelers included all MMR vaccination–eligible pediatric travelers (infants, aged 6 to <12 months; preschool-aged, aged 1 to <6 years; and school-aged, aged 6 to <18 years).

[a]Clinicians did not collect reason for guardian refusal of MMR vaccination (January 1, 2009, to June 30, 2012).

[b]Clinicians were prompted to ask guardians to specify 1 of 3 reasons for refusal of MMR vaccination (July 1, 2012, to December 31, 2018).

Table 3.

Association of Traveler and Site Characteristics With MMR Vaccination at Global TravEpiNet Sites Among Pediatric Travelers Eligible for MMR Vaccination (2009-2018)[a]

Variable	Model 1		Model 2	
	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Sex				
Male	1 [Reference]	.74	1 [Reference]	.13
Female	1.04 (0.83-1.29)		1.14 (0.95-1.37)	
Age group				
Infants, 6 to <12 mo	1 [Reference]		1 [Reference]	
Preschool-aged, 1 to <6 y	0.77 (0.53-1.11)	<.001	0.83 (0.58-1.20)	<.001
School-aged, 6 to <18 y	0.32 (0.24-0.42)		0.26 (0.14-0.47)	
Region of travel				
Africa	1.86 (1.15-3.01)	.008	1.74 (1.17-2.58)	.004
Americas	1.07 (0.63-1.80)	.80	1.17 (0.66-2.07)	.56
Eastern Mediterranean	0.77 (0.45-1.33)	.33	0.70 (0.41-1.21)	.18
Europe	0.91 (0.61-1.36)	.62	1.05 (0.78-1.40)	.75
Southeast Asia	0.97 (0.48-1.95)	.93	1.26 (0.68-2.32)	.44
Western Pacific	0.76 (0.44-1.30)	.29	0.90 (0.56-1.45)	.66
Duration of travel				
<14 d	1 [Reference]	.36	1 [Reference]	.24
≥14 d	1.17 (0.82-1.67)		1.19 (0.88-1.62)	
Purpose of travel				
Visiting friends or relatives	1 [Reference]		1 [Reference]	
Leisure	0.49 (0.26-0.94)	.002	0.64 (0.38-1.08)	.22
Service or education	0.18 (0.07-0.48)		0.47 (0.16-1.34)	
Other	0.60 (0.36-1.00)		0.77 (0.49-1.19)	
Time until departure				
<14 d	1 [Reference]	.34	1 [Reference]	.24
≥14 d	1.13 (0.87-1.48)		1.18 (0.88-1.59)	
Type of site		<.001		
Academic center	1 [Reference]	<.001	NA	NA
Nonacademic center	0.04 (0.01-0.20)		NA	

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Abbreviations: MMR, measles-mumps-rubella; NA, not applicable; OR, odds ratio.

[a]Models used Taylor linearization methods, a form of generalized estimating evaluations, to adjust for the clustering of patients within sites.

Figure 2.

Measles-Mumps-Rubella (MMR) Vaccination and Reasons for Nonvaccination Among MMR Vaccination–Eligible Pediatric Travelers at Academic Sites and Nonacademic Sites, Stratified by US Census Region of Global TravEpiNet Site

Travelers not vaccinated because of unavailability of MMR vaccine were included with those who were referred to another clinician. No pediatric travelers evaluated at academic centers in the Midwest were eligible for MMR vaccination.