

Inadequate Measles, Mumps, Rubella, and Varicella Immunity Among Employees

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Abstract

Objectives: The purpose of this cohort study was to evaluate measles, mumps, rubella (MMR), and varicella immunity among a population of adult employees receiving primary care in an employer-sponsored health center.

Methods: Participants were eligible for MMR and varicella immunity screening if they were an employee receiving primary care in an employer-sponsored health center between January 1, 2019 and November 1, 2020 who could not provide proof of immunization and 1) had it recommended by their provider, 2) specifically requested immunity testing (often because they had heard of measles outbreaks in their country of origin), or 3) were seen for an immigration physical for their Green Card application.

Results: Overall, 3494 patients were screened for their MMR immunity. Of these, 3057 were also screened for varicella immunity. Among these patients, 13.9% lacked measles immunity, 0.83% lacked immunity to all 3 components of MMR, and 13.2% lacked varicella immunity. Among the 262 patients who presented specifically for immunity screening, the rates of lacking immunity were higher for all conditions: 22.7% lacked measles immunity and 9.2% lacked varicella immunity.

Conclusion: Given declines in immunizations during the COVID-19 pandemic, there is reason to be concerned that measles and varicella-associated morbidity and mortality may rise. Employers, especially those with large foreign-born populations or who require international travel may want to educate their populations about common contagious illnesses and offer immunity validation or vaccinations at no or low cost.

Keywords

community health, global health, prevention, primary care, occupational health

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Introduction

Measles and varicella are highly contagious viral infections with 90% transmission rates in susceptible contacts.¹ Despite global immunization efforts, the number of measles cases increased 132 490 in 2016 to 869 770 in 2019—the most reported cases since 1996.² In 2019, 9 countries (Central African Republic, Democratic Republic of the Congo, Georgia, Kazakhstan, Madagascar, North Macedonia, Samoa, Tonga, and Ukraine) experienced large outbreaks that accounted for 631 847 (73%) of all reported cases worldwide.² Although there were no measles deaths in the US in 2019, measles cases skyrocketed with 1282 cases in 31 states (the most since 1992)—89% of cases were unvaccinated or had an unknown vaccination status and most were due to international travel to or contact with

those from countries where measles is endemic.² The median total cost of a measles outbreak is \$152 308 (range: \$9862–\$1 063 936), the median cost per case is \$32 805 (range: \$7396–\$76 154), and the median cost per contact is \$223 (range, \$81–\$746).³ Recently, in the US, varicella incidence has declined significantly and although adults

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represent only 5% of cases (1030 in 2016), they account for 35% of the morbidity.⁴

Measles vaccinations are highly effective with protective antibodies found in 95% of children vaccinated at age 12 months and 99% of children who receive 2 doses.⁵ A 1999 report of population immunity to measles among in the US was 93% although young adults aged 24 to 33 years had the lowest immunity (81%).⁶ Similarly, varicella vaccinations are highly effective with protective antibodies found in 97% of children with after the first dose and 99% of children with their second dose.⁷ Notably, there has never been a published report of the rates of immunity to measles or varicella among employee populations.

Communicable diseases are of particular concern to US employers with populations of foreign-born employees, who require international travel, and have workplaces that encourage congregation. Because measles vaccinations in the US are administered with mumps and rubella (MMR), the purpose of this cohort study was to evaluate MMR and varicella immunity among a population of adult employees receiving primary care in an employer-sponsored health center.

Methods

Participants

Participants were eligible for MMR and varicella immunity screening if they were an employee receiving primary care in an onsite or near-site, outpatient employer-sponsored health center in northern California between January 1, 2019 and November 1, 2020 who 1) had it recommended by their provider, 2) specifically requested immunity testing (often because they had heard of measles outbreaks in their country of origin), or 3) were seen for an immigration physical for their Green Card application.

Data Collection

Immunization records were uploaded to the electronic health record (EHR). If a patient provided a record of 2 MMR and varicella vaccinations, they were not tested further. If they could not provide proof of immunization, they were offered immunity testing. Immunity status for MMR and varicella was extracted from the EHR, noting the laboratory cutoff for “adequate immunity.”

Since CDC recommends that people get a two-dose course of both MMR and varicella vaccinations with the first doses at age 12 to 15 months with the second doses at age 4 to 6 years of age,^{7,8} we collected place of birth from the EHR as a proxy for where the patient was likely to have received their primary immunizations.

Participants did not incur incremental costs or receive any incentives for study participation. Since all data were

collected as a routine part of clinical care, it was considered an IRB exempt protocol.

Statistical Methods

We conducted univariate analysis to assess the rates of inadequate immunity for each of the 4 diseases singly and in combination (Excel v16.43).

Results

Participant Characteristics and Immunity Status

Overall, 3494 patients were screened for their MMR immunity and 3057 of these were also screened for varicella immunity. Their average age was 33.3 years (SD 7.3 years) and they were mostly male (58%). Among these patients, 13.9% lacked measles immunity (notably, nearly 1% of these lacked immunity to all 3 components of MMR) and 13.2% lacked varicella immunity (Table 1).

Among the 262 patients who presented specifically for immunity screening, the rates of lacking immunity were higher for all conditions: 22.7% lacked measles immunity and 9.2% lacked varicella immunity.

A total of 88 patients who presented to the immigration clinic lacked a record of MMR vaccinations and 100 lacked a record of varicella vaccinations. Of these, 15.9% lacked measles immunity and 12% lacked immunity to varicella.

Notably, the vast preponderance of patients lacking measles immunity were born in the US, Canada, and Western Europe (Table 2). Kazakhstan is the only global measles hotspot from which we identified a patient lacking immunity.

Costs

The costs of immunity screenings and vaccinations among the population included in this study was fully covered as part of their employee benefits. The costs of vaccines and immunity checks incurred by employers is critical for determining a policy for employee populations who cannot provide proof of vaccination. The cost to employer for MMR vaccination ranges from \$49 to \$79, varicella vaccination ranges from \$82 to \$136, and immunity titers range from \$99 to \$139.⁹

Discussion

This, the first published report of immunity to measles and varicella among an employee population had 3 key results. First, more than a third of the employee population could not document their vaccination history. Approximately 10 000 patients were seen in the primary care clinics during this study period. While not all of these patients were asked about their immunity status, at least 35% of patients were

Table 1. Percent of Population Lacking Immunity Status by Population

Population/ clinical setting	Lacking any measles (% N)	Lacking any mumps (% N)	Lacking any rubella (% N)	Lacking measles & mumps (% N)	Lacking measles & rubella (% N)	Lacking mumps & rubella (% N)	Lacking measles, mumps & rubella (% N)	Lacking varicella (% N)
Overall population screened in the employer-sponsored clinics	13.9% (485/3494)	11.8% (412/3494)	5.9% (205/3494)	3.5% (123/3494)	1.2% (42/3494)	1.1% (38/3494)	0.83% (29/3494)	13.2% (402/3057)
Self-selected into an immunity check	22.7% (59/262)	13.0% (34/262)	7.6% (20/262)	3.4% (9/262)	1.9% (5/262)	0.4% (1/262)	1.9% (5/262)	9.2% (24/262)
Immigration clinic	15.9% (14/88)	12.5% (11/88)	8.0% (7/88)	3.4% (3/88)	1.1% (1/88)	0% (0/88)	2.3% (2/88)	12% (12/100)

Table 2. Percent of Population Lacking Immunity by Country of Birth.

Country of birth*	Measles	Mumps	Rubella	Measles & mumps only	Measles & rubella only	Mumps & rubella only	Measles Mumps & rubella	Varicella	Measles, mumps, rubella, varicella
Asia NOS	<u>1</u>	0	<u>1</u>	0	0	0	0	<u>2</u>	0
Australia	0	0	0	0	0	0	0	<u>1</u>	0
Bangladesh	0	0	0	0	0	0	0	<u>1</u>	0
Brazil	0	<u>1</u>	0	0	0	0	0	0	0
Canada	<u>2</u>	0	<u>3</u>	0	<u>1</u>	0	0	0	0
Central America NOS	<u>1</u>	0	0	0	0	0	0	<u>0</u>	0
China	0	<u>1</u>	<u>2</u>	0	0	0	0	<u>4, 1</u>	0
Columbia	<u>1</u>	<u>1</u>	0	<u>1</u>	0	0	0	<u>0</u>	0
Eastern Europe NOS	<u>1</u>	0	0	0	0	0	0	0	0
Ecuador	<u>1</u>	0	0	0	0	0	0	0	0
Egypt	<u>1</u>	0	0	0	0	0	0	0	0
France	<u>1</u>	<u>1</u>	0	0	0	0	0	0	0
Germany	0	<u>1</u>	0	0	0	0	0	<u>1</u>	0
Kazakhstan	<u>1</u>	0	0	0	0	0	0	<u>1</u>	0
Korea	<u>1</u>	0	0	0	0	0	0	0	0
India	<u>1, 2</u>	<u>2, 2</u>	<u>1, 1</u>	0	0	0	<u>1</u>	<u>1, 1</u>	<u>1</u>
Iran	0	<u>1</u>	0	0	0	0	0	<u>2</u>	0
Malaysia	<u>2</u>	<u>2</u>	<u>1</u>	<u>1</u>	0	0	<u>1</u>	0	0
Mexico	<u>1</u>	<u>1, 1</u>	0	0	0	0	0	0	0
Middle East NOS	<u>1</u>	0	0	0	0	0	0	0	0
Pakistan	<u>1</u>	0	0	0	0	0	0	0	0
Philippines	<u>1</u>	<u>1</u>	0	<u>1</u>	0	0	0	0	0
Puerto Rico	<u>1</u>	0	0	0	0	0	0	0	0
Russia	<u>1</u>	0	0	0	0	0	0	0	0
Singapore	<u>2, 1</u>	<u>1</u>	0	<u>1</u>	0	0	0	0	0
S. Korea	<u>1</u>	<u>1</u>	<u>1</u>	0	0	0	<u>1</u>	0	0
Thailand	<u>1</u>	<u>1</u>	0	<u>1</u>	0	0	0	0	0
Turkey	<u>1</u>	0	0	0	0	0	0	0	0
UK	0	<u>1</u>	0	0	0	0	0	0	0
US	<u>24</u>	<u>20</u>	<u>8</u>	<u>4</u>	<u>5</u>	<u>1</u>	<u>2</u>	<u>7</u>	0
Unknown	<u>21</u>	<u>6</u>	<u>9</u>	<u>3</u>	<u>1</u>	0	<u>2</u>	<u>1, 13</u>	0

The people included in this table were those who presented either to the immigration clinic or who self-selected into an immunity screen. Numbers that are underlined are for people presenting for an immunity screen and those that are not underlined are for people presenting for an immigration physical. Cells highlighted in black are for those lacking measles immunity and gray for those lacking immunity to another illness.

*Country of birth was recorded for 88 people in the immigration clinic and 158 people who presented for an immunity check. Country of birth for patients presenting to the immigration clinic was their own country of birth; however, for those patients presenting for an immunity screen, they could list either their own country of birth or their parents' country of origin. Some patients reported only the continent but did not specify the country of their birth. The cells highlighted in black are for people who lacked measles immunity either alone or in conjunction with other conditions.

unable to document their vaccination history. Given that vaccination status is not typically a requirement of employment (as it is for matriculation at most educational institutions), this finding might be of particular interest to employers who require their employees to work or socialize in close proximity to each other or who require their employees to travel internationally.

Second, 14% of employees in a general primary care setting lacked adequate immunity to measles and 13% lacked adequate immunity to varicella. Notably, among the self-selected population of employees who specifically presented requesting an immunity check, nearly 23% lacked measles immunity. Given the highly contagious nature of measles and varicella, this population is at enormous risk of infection should they be exposed.

Third, the vast majority of people lacking measles and varicella immunity in this study were born in the US. Given that all 50 states and the District of Columbia have state laws that require entering childcare or public schools have measles and varicella vaccines,^{5,7} finding so many US-born adults lacking immunity is quite surprising. Since appropriate vaccinations against these viruses have been shown to produce lifelong immunity^{5,7} and the average age of the population was 33 years old, it is unlikely that these populations were ever vaccinated. It may be that, although these individuals were born in the US, they moved as children outside the US. Alternatively, since birthplace was self-reported by patients, perhaps there was a reporting error. This finding warrants further investigation in a broader population of employees and suggests that workplace policies regarding vaccination requirements should include both US and foreign born populations.

In 2018, there 44.8 million people living in the US who were born in another country, of whom approximately half are US citizens.¹⁰ Of these, 29.8 million are employed adults (compared with 136.6 million US born employed adults).¹⁰ Among all foreign born people living in the US, 22.5 million people have private insurance (the vast majority of which is employer-sponsored).¹⁰ Therefore, these findings are highly relevant to employers with large populations of foreign born populations. Immigrants to the US tend to live in large urban areas and are concentrated in a few states: California (24%), Texas (11%), Florida (10%), New York (10%), and New Jersey (5%).¹⁰ Thus, the findings of this study are particularly relevant with large employee populations in these states.

This study had 3 important limitations: First, immunity screening was voluntary and we did not check the immunity status of patients who presented a vaccination record. Second, the population of employees evaluated here may not be representative of companies with fewer foreign-born employees. Third, the country of birth is not necessarily where the employee lived when they were due to have received their MMR and varicella immunizations.

Given declines in pediatric immunizations during the early months of the COVID-19 pandemic (18.0% in March and 22.6% April 2020 compared to the same months in 2019),¹¹ there is reason to be concerned that measles and varicella-associated morbidity and mortality may rise further in 2021. Employers, especially those with large foreign-born populations or who require international travel may want to educate their populations about common contagious illnesses and offer immunity validation or vaccinations at no or low cost. Given that vaccine costs may be lower than immunity checks, a cost-effective policy may be to vaccinate those populations who cannot provide proof of vaccination.

Declaration of Conflicting Interests

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