Supplement to:

Susceptibility to vaccine-preventable infections in unstably housed asylum-seekers

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1. Supplemental Methods

Study Design

We conducted a cross-sectional study of people seeking asylum and experiencing homelessness in New York City who sought primary care from January to November 2023 in RyanHealth, a federally qualified health center in New York City. We tested people for serologic evidence of immunity using immunoglobulin G (IgG) testing against varicella, measles, mumps, rubella, hepatitis A, and hepatitis B. We characterized an equivocal or indeterminate laboratory result as not having evidence of immunity, or being susceptible to the infection, and we excluded people who did not complete any testing.

Description of Assays

We used the DiaSorin LIAISON® chemiluminescent immunoassays to test for measles, mumps, rubella, and varicella. We used the Siemens Atellica® chemiluminescent immunoassays to test for hepatitis A total antibody and hepatitis B surface antibody. Sample collection, storage, and transport were completed according to manufacturer specifications. Our clinical laboratory used Quest Diagnostics for sample processing with cut-off values consistent with the manufacturer specifications and package inserts.

Inference of Protective Immunity

Enzyme-linked immunosorbent assay (EIA)-based methods of measuring IgG titer, such as the ones used in this study, are commonly used to determine protective immunity even though they are not functional assays. The predictive capacity of EIA-based tests

varies based on several factors, but generally performs well for the infections evaluated in this study. For example, the reference standard used to determine protective immunity in measles is the plaque reduction neutralization test, which is technically challenging and not feasible to employ in high volume clinical settings.[1] The assay we used to detect measles IgG has been shown to have a high sensitivity when compared to that reference standard, particularly for IgG-negative sera.[2,3] The US Centers for Disease Control and Prevention (CDC) recommend the use of EIA-based IgG measurements to estimate the presence of protective immunity against these vaccine-preventable infections.[4–7] None of the serologic tests used in this study could distinguish between vaccine-derived or infection-derived immunity.

Statistical Analysis

We used multivariable logistic regression to determine adjusted odds ratios (aOR) of demographic factors associated with serologic immunity to all tested conditions. We categorized ages into children (<13 years), adolescents/ young adults (13- 21y), and adults (>21y). As part of their clinical care, all patients had data collected regarding their country of origin and migration history. We grouped countries into regions based on their population in the sample. We defined secondary migration as residence >1 year in a different country after displacement prior to entering the US. We received ethical approval for this study from RyanHealth review board and non-human subjects research status from the MassGeneral Brigham ethical review board.

2. Supplemental Results

Supplement Table 1. Multivariable logistic regression of factors associated with susceptibility to measles

Characteristic	Adjusted Odds Ratio (95% CI)
Age Group	
Adult (>21y)	Reference
Child (<13y)	1.69 (1.24- 2.30)
Adolescent (13- 21y)	2.10 (1.37- 3.19)
Sex	
Female	Reference
Male	1.20 (0.92- 1.57)
Region of Origin	
Venezuela	Reference
Mexico/ Central America	1.50 (0.86- 2.60)
Caribbean	0.88 (0.43- 1.70)
Ecuador	1.25 (0.87- 1.79)
Other (South America)	0.94 (0.65- 1.34)
Other (Africa, Asia)	0.84 (0.41- 1.64)
Secondary Migration	
No/ Unknown	Reference
Yes	1.10 (0.68- 1.75)

Supplement Table 2. Multivariable logistic regression of factors associated with susceptibility to varicella

Characteristic	Adjusted Odds Ratio (95% CI)
Age Group	
Adult (>21y)	Reference
Child (<13y)	9.85 (6.81- 14.59)
Adolescent (13- 21y)	4.90 (3.02- 8.01)
Sex	
Female	Reference
Male	1.35 (1.02- 1.78)
Region of Origin	
Venezuela	Reference
Mexico/ Central America	1.14 (0.63- 2.06)
Caribbean	1.19 (0.59- 2.37)
Ecuador	0.91 (0.63- 1.32)
Other (South America)	0.62 (0.43- 0.89)
Other (Africa, Asia)	0.58 (0.27- 1.20)
Secondary Migration	
No/ Unknown	Reference
Yes	0.94 (0.55- 1.58)

Supplement Table 3. Multivariable logistic regression of factors associated with susceptibility to hepatitis A

Characteristic	Adjusted Odds Ratio (95% CI)
Age Group	
Adult (>21y)	Reference
Child (<13y)	5.69 (4.07- 8.09)
Adolescent (13- 21y)	5.52 (3.54- 8.65)
Sex	
Female	Reference
Male	0.90 (0.69- 1.18)
Region of Origin	
Venezuela	Reference
Mexico/ Central America	1.76 (0.98- 3.12)
Caribbean	1.40 (0.69- 2.74)
Ecuador	1.78 (1.25- 2.56)
Other (South America)	1.07 (0.74- 1.52)
Other (Africa, Asia)	1.69 (0.86- 3.26)
Secondary Migration	
No/ Unknown	Reference
Yes	0.79 (0.45- 1.33)

Supplement 4. Multivariable logistic regression of factors associated with immunity to all tested conditions

Characteristic	Adjusted Odds Ratio (95% CI)
Age Group	
Adult (>21y)	Reference
Child (<13y)	0.83 (0.53- 1.32)
Adolescent (13- 21y)	0.96 (0.61- 1.55)
Sex	
Female	Reference
Male	0.75 (0.55- 1.01)
Region of Origin	
Venezuela	Reference
Mexico/ Central America	0.18 (0.05- 0.45)
Caribbean	0.67 (0.32-1.31)
Ecuador	0.42 (0.27- 0.65)
Other (South America)	0.82 (0.57- 1.18)
Other (Africa, Asia)	1.16 (0.59- 2.17)
Secondary Migration	
No/ Unknown	Reference
Yes	1.27 (0.80- 2.01)

Footnote:

Tested conditions include Varicella, Measles, Mumps, Rubella, hepatitis A, and hepatitis B.

Supplement References

1. Cohen BJ, Audet S, Andrews N, Beeler J. Plaque reduction neutralization test for measles antibodies: Description of a standardised laboratory method for use in immunogenicity studies of aerosol vaccination. Vaccine 2007;26(1):59–66.

2. Latner DR, Sowers SB, Anthony K, et al. Qualitative Variation among Commercial Immunoassays for Detection of Measles-Specific IgG. J Clin Microbiol 2020;58(6):e00265-20.

3. Lutz CS, Hasan AZ, Bolotin S, et al. Comparison of measles IgG enzyme immunoassays (EIA) versus plaque reduction neutralization test (PRNT) for measuring measles serostatus: a systematic review of head-to-head analyses of measles IgG EIA and PRNT. BMC Infect Dis 2023;23(1):367.

4. Centers for Disease Control and Prevention. Measles Serology. Available from: https://www.cdc.gov/measles/lab-tools/serology.html

5. Centers for Disease Control and Prevention. Serology Testing for Rubella and Congenital Rubella Syndrome (CRS). Available from: https://www.cdc.gov/rubella/lab/serology.html

6. Centers for Disease Control and Prevention. Interpreting laboratory tests. Available from: https://www.cdc.gov/chickenpox/lab-testing/lab-tests.html

7. Lee D, Weinberg M, Benoit S. Evaluation of Measles-Mumps-Rubella vaccination among newly arrived refugees. American Journal of Public Health 2017;107(5):684–6.