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REVIEW

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Vaccine hesitancy in the refugee, immigrant, and migrant population in the United States: A systematic review and meta-analysis

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ABSTRACT

Refugees, immigrants, and migrants (RIM) in the United States (US) have been identified as an underimmunized population prior to the COVID-19 pandemic. Vaccine acceptance is critical to combat the public health threat incited by COVID-19 and other vaccine-preventable disease. To better understand escalating vaccine hesitancy among US RIM, a comprehensive evaluation of the problem and solutions is necessary. In this systematic review, we included 57 studies to describe vaccination rates, barriers, and interventions addressing vaccine hesitancy over the past decade. Meta-analysis was performed among 22 studies, concluding that RIM represent an underimmunized population compared to the general US population. Narrative synthesis and qualitative methods were used to identify critical barriers, including gaps in knowledge, poor access to medical care, and heightened distrust of the medical system. Our results demonstrate the need for effective, evidence-based interventions to increase vaccination rates among diverse RIM populations.

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Introduction

Recent outbreaks of vaccine-preventable diseases (VPD) in the United States (US) reveal the critical need to combat vaccine hesitancy. The reemergence of measles and poliovirus, along with continued morbidity and mortality associated with COVID-19, emphasizes the necessity for increased vaccination efforts.[1–4] The US is home to an increasingly global community, with over 44 million refugees, immigrants, and migrants (RIM).[5] This global patient population carries risks for VPD from host countries, sociocultural and environmental influences that have significant impacts on their health.[6] Low immunization rates have been reported within RIM communities, placing them at increased risk for VPD.[7–9] This risk may be amplified during the COVID-19 pandemic amid rising vaccine hesitancy and health inequities that have been linked to a disproportionate burden of disease.[10] The health of this global community directly impacts the health of the entire nation, emphasizing the need for an effective national public health response.

The increased vulnerability of RIM to VPD results from the combination of increased exposure to disease, as well as distinct barriers to vaccination.[8] Hesitancy within the RIM population has previously been attributed to cultural norm barriers, poor access to medical care, knowledge gaps, and mistrust of institutions.[8] Additional mistrust in the healthcare system and vaccine safety concerns have developed following the introduction of the COVID-19 vaccines.[10,11] The ultimate impact of the COVID-19 pandemic on vaccine hesitancy among RIM, however, is yet to be determined. To fully understand the problem and effectively intervene, a timely understanding of vaccine hesitancy among RIM must be considered a public health priority.

While previous reviews have focused on select vaccines or a subset of the RIM community, a systematic review addressing vaccine hesitancy within the *entire* US RIM population is lacking. The inclusion of all RIM, in addition to the relevant inclusion of COVID-19 literature, distinguishes this review from previous work. To provide a comprehensive review of the problem and potential solutions, and to inform critical public health policy, this review has three objectives: 1) to quantify the burden by describing vaccination rates, 2) to identify key barriers to vaccination, and 3) to describe effective interventions addressing vaccine hesitancy in the RIM population within the US.

Materials and methods

Criteria for considering studies for review

Studies were considered for inclusion if they addressed one of the three primary objectives: 1) vaccination rates, 2) barriers to vaccination, or 3) interventions addressing vaccination among foreign-born individuals residing within the US. In addition,

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included studies were expected to meet the following criteria: 1) original research (randomized controlled trials (RCT), quasi-experimental studies, cohort studies, cross-sectional studies, and qualitative studies); 2) published between April 2012 and May 2022; 3) inclusion of adults 18 y and older; 4) inclusion of foreign-born individuals, including refugees, immigrants, migrants, and asylees, from all countries of origin resettling within the United States; and 5) conducted in English. Studies focusing on the perspective of the healthcare provider or children and adolescents alone were excluded. Non-original research pieces, such as case reports, case series, reviews, or perspectives, were also excluded.

Search strategy and article selection

The search strategy was developed in collaboration with an experienced medical librarian (ED) and conducted using the PubMed Medline electronic database. The following search term combination was used on two occasions during May 2022:

(Vaccin* OR immunization OR vaccines[mh] OR vaccination[mh] OR vaccination hesitancy[mh] OR vaccination refusal[mh] OR immunization programs[mh] OR vaccination coverage[mh] OR immunization[mh])

AND

(Immigrants OR migrants OR refugees OR asylum OR foreign-born OR internally displaced OR transients and migrants[mh] OR emigrants and immigrants[mh] OR refugees[mh] OR undocumented immigrants[mh] OR emigration and immigration[mh])

Additional review through "similar articles" and manual review of included references were used to identify potentially relevant literature.

Data collection and analysis

Selection of studies

Initial search results were screened to determine relevance based on prespecified inclusion/exclusion criteria. Following initial screening, potential articles were uploaded into Covidence, a web-based software system, for additional screening, extraction, and quality assessment.[12] Two authors independently completed title, abstract, and full-text screening using Covidence. Disagreements were settled through consensus.

Data extraction and quality assessment

Data were independently extracted in duplication using a standardized data abstraction form. The data abstraction form was previously described by Rani et al.[13] and included general publication data, methodology, and information regarding participants and outcomes.

Quality assessment for observational studies was performed using the National Institutes of Health (NIH) tools for the assessment of the risk of bias, while qualitative studies were assessed using the Critical Appraisal Skills Programme (CASP) qualitative study checklist.[14,15]

Two reviewers independently assessed each of the included studies for risk of bias. The questions provided by these tools allowed the reviewer to critically appraise each study, focusing on key concepts to evaluate the internal validity of a study and identify potential risk for bias. The quality of each quantitative article was deemed to be "good," "fair," or "poor" following reflection and consensus among reviewers.[14] Although studies were not excluded on the basis of these scores, study quality was considered when synthesizing and interpreting results.

Data synthesis

We sought to provide a comprehensive review of vaccine hesitancy within the RIM population by addressing three domains: the burden, barriers, and interventions to overcome vaccine hesitancy. We describe the methods for each of these objectives below.

To address the burden, we compared *vaccination rates* for the RIM population to the US-born population. For vaccines with two or more eligible studies, we pooled the data with the help of meta-analysis using Review Manager 5 (RevMan) software 5.4.[16] Dichotomous outcomes were pooled to obtain an odds ratio with a 95% confidence interval (CI). To account for significant heterogeneity within the studies, we used the random effects model to conduct the meta-analyses.

Statistical heterogeneity was assessed by visual inspection of forest plots, the tau^2 statistic, and the I^2 statistic. The calculated effect measure was considered significantly heterogeneous when the I^2 value was greater than 50%. Clinical heterogeneity was assessed by comparing differences among participants and outcomes, while methodological heterogeneity was considered by comparing study design and risk of bias.

Substantial heterogeneity among studies addressing *barriers and interventions* for vaccination precluded meta-analysis. To address the second and third objectives, data were collated and summarized using narrative synthesis. The process of narrative synthesis began by extraction of key results, summary statistics, confidence intervals, and *p*-values (when provided). The studies were categorized according to the vaccine they addressed, followed by their objective (describing vaccination rates, barriers, or interventions). Once categorized, preliminary summary statements were created that allowed for exploration of the relationships in the data. Finally, summary statements from individual studies were collated to describe the overall themes found within the literature.

The qualitative studies addressed the second and third objectives: barriers to vaccination and interventions to overcome vaccine hesitancy. Grounded theory methodology was applied to identify themes. The authors used an inductive process for identifying and coding themes as they emerged from the extracted data. Interrater reliability was performed among two coders to ensure reliability of the results with disagreements settled through consensus. Following discussion of disagreements, an interrater agreement of over 95% was reached.

Results

The initial PubMed search identified 2,359 records published April 2012 through May 2022. Viewing "similar articles" and reference lists of selected articles expanded retrieval, with 63

additional records considered through this approach. The initial broad screening for congruence to inclusion/exclusion criteria performed by a medical librarian was followed by focused reviewer screening, involving 350 studies imported into Covidence. Following removal of duplicates, title, abstract, and full-text screening, 57 studies were deemed eligible for inclusion (Figure 1).[18–73]

Overview of included studies

The included studies addressed human papillomavirus (HPV) (n = 25),[21,29–31,35,37,40,42,44,46–48,50,53,55,57,60,61,65–68,71,72,74] influenza (n = 14),[20,24–26,28,36,41,46,47,52,58,59,63,64] hepatitis B (n = 11),[22,27,34,39,42,43,46,49,51,56,75] COVID-19 (n = 9),[18,19,23,32,38,45,54,69,73] pneumococcal (n = 6),[26,41,46,47,58,59] tetanus, diphtheria, pertussis/tetanus diphtheria (Tdap/Td) (n = 6),[33,41,42,46,47,62] hepatitis A (n = 2),[42,46] measles, mumps and rubella (MMR) (n = 2),[42,62] and shingles (n = 1)[47] vaccines. Several of the included studies covered multiple vaccinations. All studies included data for adults aged 18 y and older and were conducted within the US (Page et al.[38] included sites outside of US; however, only US data were extracted). For studies that included minors, data specific to adults was extracted.[43,63] The majority of studies included both men and women (n = 43), while 12 focused on women,[28,40,44,48,58,51,61,66–68,70,71] and 2 on men.[50,59]

The study aims included description of vaccination rates (n = 33),[18–20,22,24–27,29,30,32–34,36,37,39,41–43,46,47,49,51,57–62,64,65,69,72] barriers to vaccination (n = 34),[18,19,21–23,28,30–33,35,38–41,44,50–53,55,60,61,63–70,73,75] and interventions to improve vaccination (n = 6).[35,36,45,48,56,71] The majority of studies were designed as cross-sectional (n = 41),[18–31,33,34,37–41,43,44,46,47,49,51,52,55,57–61,64–67,69,72,75] followed by qualitative (n = 10),[32,35,50,53,63,68,70,71,73,76] cohort (n = 3),[32,42,62] program evaluation (n = 2),[36,45] and quasi-experimental (n = 1).[56] Meta-analysis was performed for four vaccines: HPV (n = 7),[29,37,46,57,60,61,64] influenza (n = 7),[20,25,26,48,58,59,64] hepatitis B (n = 4),[27,46,49,51] and pneumococcal (n = 4).[26,46,58,59]

Critical appraisal of the 47 quantitative studies was conducted using the NIH tools for the assessment of the risk of bias. Studies were appraised after considering study design, sample size, blinding, follow-up, and intrinsic bias. Scores ranged from "poor to good," with all but two studies classified as "fair" or "good" (supplemental Table S1). Critical appraisal of the 10 qualitative studies was conducted using the Critical Appraisal Skills Programme (CASP) qualitative study checklist (supplemental Table S2). Although a score was not assigned, all 10 studies were appropriately designed to address the study objective, resulting in a clear statement of findings.

Ten qualitative studies were included.[33,36,51,54,55,64,69,71,72,74] Eight studies were conducted using focus groups (range: 16–90

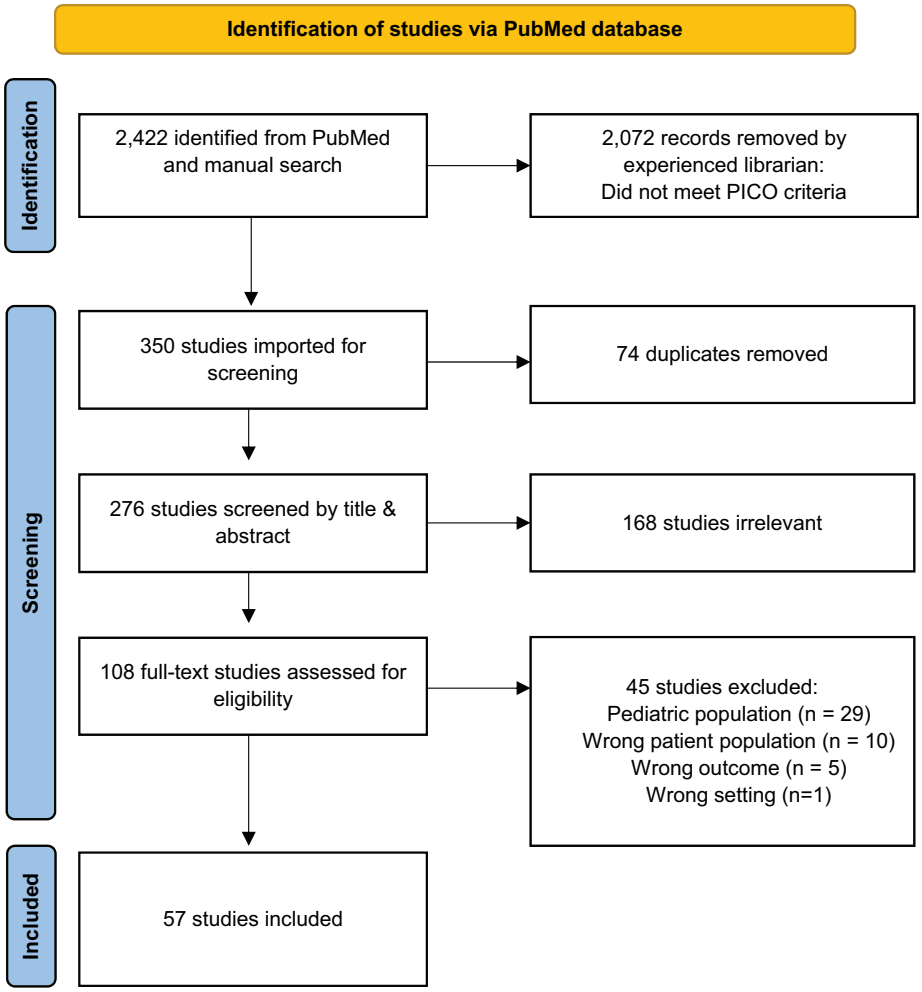

Figure 1. PRISMA diagram[17].

participants)[36,54,55,64,69,71,72,74] and 2 using semi-structured interviews (13 and 33 participants).[33,51] All ten addressed barriers to vaccination, while only six addressed potential interventions.[33,51,54,64,69,72] The majority addressed the HPV vaccine (6/10),[36,51,54,69,71,72] followed by COVID-19 vaccine (3/10),[33,55,74] and influenza vaccine (1/10).[64] Definitions and an example quote for each of the themes can be found in Table 1.

Vaccination rates in the RIM population

Meta-analysis was performed to compare vaccination rates for HPV, influenza, hepatitis B, and pneumococcal between foreign-born and US-born participants. The direction of effect was the same for all vaccines, favoring foreign-born participants as an underimmunized population (Figure 2). Pooled data showed that the odds of vaccination were 38% less for

Table 1. Themes addressing barriers and interventions from qualitative studies.

Theme	Definition	Example quote	N
Barriers			
Lack of knowledge	Knowledge gaps about vaccine preventable disease and/or not knowing that a vaccine exists to prevent the disease	"The greatest barrier to receiving the vaccine was lack of knowledge about this resource."[52 (p5)] (Q2, R2, P2)	7
Misinformation	Incorrect or misleading information resulting in vaccine hesitancy	"Lacking reliable and trustworthy information sources while having access to misinformation was common. Sources of misinformation contributed to the commonly held belief that people would get infected by going to testing sites."[74 (p9)] (Q1, R2, P2)	5
Access	Physical or logistical barriers preventing use of vaccine services, including lack of insurance coverage, lack of primary care physician, or unable to time off work to get vaccinated	"Others were remarkably consistent in their reasons for not getting the vaccine… they experienced inflexible working conditions that did not allow time off to get vaccinated…"[64 (p1114)] (Q4, R5, P1)	4
Safety concerns	Concern for harmful, unintended side effects as a result of vaccination	"Personal barriers that were commonly discussed by HNs and CLs included: (1a) Fears related to the vaccine… rumors about the potential side effects of the vaccine were quite common and traveled quickly, saying 'The bad news goes very fast that the vaccine will cause death or the vaccine will cause this symptom, the vaccine will make you sick, the vaccine will not cure the virus. So those kinds of things I often hear all the time in the community. So, it is challenging for us.'"[33 (p1233)] (Q10, R6, P2)	4
Distrust	Lack of confidence in government entities or public health authorities resulting in vaccine hesitancy	"Lack of confidence in government entities (e.g., the political administration, public health), due to the anti-immigrant political context, played a major role in the attitudes and beliefs held by community members."[74 (p9)] (Q1, R4, P1)	4
Cultural bias	Negative attitudes based on cultural norms, practices or beliefs, pressure from family or peers, or fatalism	"Participants were influenced by the people around them, including mothers, physicians, and friends, when considering undergoing a Pap test or HPV vaccination. Others' negative attitudes toward Pap tests and the HPV vaccine discouraged participants from undergoing the procedures."[71 (p356)] (Q5, R4, P1)	4
Insecurity	Loss of autonomy and stability due the inability to make independent decisions, feeling pressured due to language barriers or immigration status	"Immigration and citizenship status create barriers to COVID-19 testing services and shape ideas around anticipated vaccination. Identification and being identified as undocumented are significant concerns."[55 (p10)] (Q8, R4, P3)	2
Interventions			
Receiving information from a trusted source	Where knowledge gaps or misinformation existed, participants sought a trusted source of information to overcome these barriers. Physicians (4), family members (1), and community leaders (1) were listed trusted sources of information in the studies	"The majority of participants reported that the most influential person on their health decisions is themselves, their family, and their doctor."[69 (p58)] (Q6, R3, P2)	6
Providing culturally tailored education	Participants sought education that provides culturally sensitive, age appropriate, and language congruent content. Social media or trusted news outlets in the community were considered appropriate mediums for transmitting education	"Participants expressed a variety of ideas about the most effective methods to engage the Somali community and increase HPV immunization rates. Many mentioned advertisements in the form of flyers and pamphlets in both English and Somali … Participants suggested using community events and forums in community centers to provide information about HPV and HPV vaccination. Many felt that face-to-face outreach would be the most valuable. These interactions could be between a medical provider and patients; however, participants stressed the value of having someone from within their community, such as a Somali health care provider, involved in the communication effort."[36 (p2047)] (Q9, R6, P1)	5
Facilitating access	Eliminating physical or logistical barriers to vaccination, such as offering vaccine clinics within communities, making appointments widely available, or having language congruent services on site. This may also involve providing incentive for participation	"Both HN [health navigators] and CL [community leaders] respondents offered a variety of potential interventions or suggestions for how to increase vaccine uptake among refugees. These included… (3c) offering a vaccine clinic in the community."[33 (p1235)] (Q10, R7, P1)	3

The extracted themes address barriers and interventions to vaccination in the RIM population. The coding system was used by the reviewers through the extraction process and refers to the location of the quote within the original article (article number (Q), subheading within results section (R), and paragraph number below subheading (P)).

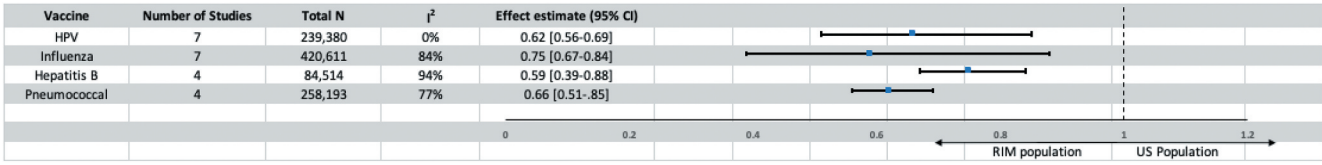

Figure 2. Summary of meta-analyses for rates of vaccination for Foreign-born participants compared to US-born. The figure shows summary estimates for meta-analysis for rates of vaccination between US-born (control) and foreign-born. The summary estimate is odds ratio and reported with 95% confidence interval. The result shows that odds of vaccination was low in a range of 25% to 38% depending on the type of vaccination offered.

HPV vaccination (OR: 0.62, 95% CI: 0.56–0.69, $I^2 = 0\%$, $Tau^2 = 0.00$, supplemental Figure S1), 25% less for influenza vaccination (OR 0.75, 95% CI: 0.67–0.84, $I^2 = 84\%$, $Tau^2 = 0.02$, supplemental Figure S2), 41% less for hepatitis B vaccination (OR 0.59, 95% CI: 0.39–0.88, $p < .0001$, $I^2 = 94\%$, $Tau^2 = 0.14$, supplemental Figure S3), and 34% less for pneumococcal vaccination (OR 0.66, 95% CI: 0.51–0.85, $p < .0001$, $I^2 = 77\%$, $Tau^2 = 0.06$, supplemental Figure S4). The characteristics for the studies included in the meta-analysis can be found in Table 2.

Heterogeneity within the remaining studies precluded meta-analysis, however a similar trend was observed. Exceptions to this trend were noted for studies evaluating tetanus[42,43] and hepatitis A.[47]

Comparisons between foreign and US-born population were not available for MMR or COVID-19. The characteristics for the studies not included in the meta-analysis can be found in Table 3.

The relative novelty of COVID-19 vaccines resulted in limited publications describing vaccination rates in RIM at the time of our review. For this reason, we included studies conducted prior to broad availability of the vaccine,[19,24,70] before and after broad availability,[33] or after broad availability.[20] Vaccine intent was measured if the study was conducted prior to availability of the COVID-19 vaccine, while vaccination coverage was measured if conducted after. Differences in vaccine intent and acceptance varied by country of origin (Table 3).

Barriers to vaccination in the RIM population

Quantitative studies describing barriers to vaccination

Commonly identified barriers to vaccination prior to the COVID-19 pandemic included knowledge gaps (regarding the vaccine and the disease it prevents),[22,31,41,45,56,67,68,75] poor access to medical care (due to lack of health insurance or infrequent visits to a physician),[23–32–34–40–42–65–75] and cultural barriers (including language discordance and religiosity)[29,31,47,62] (Table 4).

Following the introduction of the COVID-19 vaccine, unique barriers emerged while some existing barriers intensified (Table 4). Safety concerns and distrust in the healthcare system, vaccines, and government were recurring themes for those with vaccine hesitancy amid the emergence of COVID-19 vaccines.[19,20,24,39,70]

Qualitative studies describing barriers to vaccination

Similar themes emerged from the qualitative literature. Seven themes regarding barriers to vaccination were identified: lack of knowledge,[36,51,54,64,69,71,72] misinformation,[36,54,64,77] access,[33,51,65,71] safety concerns,[33,36,51,64] distrust,[36,64,74] cultural bias,[36,54,71] and insecurity.[74] Knowledge gaps existed regarding the disease process itself and a vaccine available to prevent it. This lack of awareness was a commonly identified theme among undervaccinated RIM communities. Even when awareness existed, misinformation was often identified. Many participants within the RIM community had received either incorrect or misleading information that resulted in vaccine hesitancy. This was particularly true for studies discussing COVID-19 vaccines. Access to vaccination was blocked by both physical (inaccessible location or lack of transportation) or logistical (incongruent language, lack of insurance, lack of provider, unable to take off work) barriers. Concern for safety was the result of either a personal history of vaccine side effects or safety concerns conveyed by trusted resources in the RIM community. Distrust of government or public health authorities was identified as a common barrier, which was amplified during the COVID-19 pandemic. Themes of cultural bias emerged as negative attitudes based on cultural norms, practices, or beliefs. Within certain RIM communities, the concept of "fatalism" was used to justify vaccine refusal. Finally, insecurity was a unique concern within the RIM population. Fear of deportation prevented access to healthcare services where vaccination could occur. While this barrier is unique to the RIM community, it was commonly identified across communities *within* RIM.

Interventions to address vaccine hesitancy

Quantitative study describing an intervention to address HPV vaccine hesitancy (n = 1)

One quantitative study described an intervention designed to improve HPV vaccination rates. Lee et al.[72] performed a quasi-experimental study involving 30 Korean American immigrants. They tested a mobile health intervention designed to identify barriers, develop motivators, and provide a trigger to initiate HPV vaccination among participants. Pre- and post-intervention surveys identified significant increases in HPV and HPV vaccination knowledge, and positive changes to personal barriers, culturally based attitudes, and self-efficacy toward cervical cancer prevention. Additionally, vaccine intent significantly increased (mean difference = 0.47, 95% CI: 0.21–0.72; $p < .001$), with 30% of participants receiving the HPV vaccine within 3-months of the intervention (95% CI: 9.9–42.3%).

Quantitative study describing an intervention to address influenza vaccine hesitancy (n = 1)

Ponce-Gonzalez et al.[37] conducted a study of 155 participants from Latinx families living in underserved communities.

Table 2. Characteristics of studies included within meta-analysis.

	Study	Study Design	Study Time Period	Intervention Group	Comparison Group	N	Effect measure
HPV	Budhwani 2017	Cross sectional	2008–2013, except 2010 (data from National Health Interview Survey (NHIS))	Foreign-born adults across the US	US-born adults	20,040	Adjusted odds ratio=0.812, 95% CI: 0.571–1.155 Adjusted for demographics, health variables and economic variables
	Cofie 2018	Cross sectional	2013–2015 (NHIS)	Foreign-born women across the US	US-born women	15,890	Adjusted odds ratio=0.58, 95% CI: 0.49–0.70, $p<.001$ Adjusted for age, education, race/ethnicity, income level, marriage, region, self-rated health status, and OB/GYN visit/Pap test in the past 12months
	Cofie 2022	Cross sectional	2013–2017 (NHIS)	Foreign-born Black participants in the US originating from Mexico/Central America/Caribbean Islands/South America, or Africa	US-born Black participants	5,246	Adjusted odds ratio=0.73, 95% CI: 0.53–1.01 Adjusted for survey years, sex, age at HPV vaccination eligibility, degree, FPL (federal poverty level), and marital status, insurance stats, self-reported health status, and usual source of care
	De 2017	Cross sectional	2013 (NHIS)	Foreign-born adults nationally located throughout the US	US-born adults	34,557	Adjusted odds ratio=0.617, 95%: 0.390–0.975, $p<.05$ Adjusted for race, economic and healthcare access
	Lu 2014	Cross sectional	2012 (NHIS)	Foreign- born American adults originating from Mexico/ Central America/Caribbean Islands, South America, Europe, or Asia nationally located throughout the US	US-born adults, aged 18-49	34,525	Adjusted prevalence ratio=0.6, 95% CI: 0.4–0.9 Adjusted for age, gender, race/ethnicity, marital status, education, employment status, poverty level, health insurance, number of doctor visits, self-reported health status, region of residence
	McElfish 2021	Cross sectional	2014 (NHIS)	Foreign-born Native Hawaiian and Pacific Islanders (NHPI) aged 18–26 in the US	White respondents	4,602	Prevalence ratio=0.67, 95% CI: 0.50–0.90, $p=.007$ Adjusted for race/ethnicity, nativity status, and age
	Perez 2018	Cross sectional	2011–2015 (NHIS)	Foreign- born adults nationally located throughout the US	US-born adults	39,761	Unadjusted odds ratio=0.57, 95% CI: 0.45–0.73, $p<.05$ Adjusted odds ratio: Male=0.63, 95% CI: 0.47–0.85 Female=0.57, 95% CI: 0.49–0.66 Adjusted for survey year, age at HPV vaccination eligibility, race/ethnicity, geographic region, and relationship status, educational attainment, employment status, insurance status and usual source of care

(*Continued*)

Table 2. (Continued).

	Study	Study Design	Study Time Period	Intervention Group	Comparison Group	N	Effect measure
Influenza	Budhwani 2016	Cross sectional	2013 (NHIS)	Foreign-born Asian Indians, Blacks, Whites, and other Asians adults nationally located throughout the US	US-born adults	104,520	Adjusted odds ratio=0.812, 95% CI: 0.571–1.155, $p>.05$ Adjusted for interaction between economic and health variables
	Chuey 2022	Cross sectional	2012–2018 (NHIS)	Foreign-born adults from the 2012–2018 NHIS survey nationally located in the US	US-born adults	29,673	2012–2013 US- born=43.8, 95% CI: 42.6–44.9 Foreign- born=37.5, 95% CI: 35.0–40.0, $p<.05$ 2013–2014 US-born=44.0, 95% CI: 42.8–45.3, $p<.05$ Foreign-born=38.1, 95% CI: 35.7–40.5, $p<.05$ 2014–2015 US-born=45.9, 95% CI: 44.8–47.1 Foreign- born=38.8, 95% CI: 36.5–41.3, $p<.05$ 2015–2016 US-born=44.8, 95% CI: 43.6–46.0 Foreign- born=37.5, 95% CI: 34.8–40.3, $p<.05$ 2016–2017 US-born=45.6, 95% CI: 44.4–46.8 Foreign- born=43.5, 95% CI: 40.6–46.5 2017–2018 US-born=46.9, 95% CI: 45.7–48.1 Foreign- born=42.4, 95% CI: 39.6–45.3, $p<.05$ Vaccinated: Foreign-born= 39.6% avg (2,023/5,109) US-born = 45.2% avg (11,102/24,564)
	Dallo 2015 (men)	Cross sectional	2000–2011 (NHIS)	Non-Hispanic white, foreign-born American men from Arab and European nations	Non- Hispanic white US-born men	91,636	Adjusted odds ratio: Europe born = 0.47, 95% CI: 0.36–0.62) Arab = 0.38, 95% CI: 0.21–0.67 Adjusted for demographic, socioeconomic, health access, risk factor and acculturation effects
	Dallo 2015 (women)	Cross sectional	2000–2011 (NHIS)	Non-Hispanic white, foreign-born women originating from Arab and European nations and nationally located throughout the US	Non- Hispanic White US-born women	117,893	Adjusted odds ratio: Europe born = 0.48, 95% CI: 0.38–0.60 Arab born = 0.34, 95% CI: 0.21–0.58 Adjusted for demographic, socioeconomic, health access, risk factor and acculturation effects
	Lu 2014	Cross sectional	2012 (NHIS)	Foreign- born American adults originating from Mexico/ Central America/Caribbean Islands, South America, Europe, or Asia nationally located throughout the US	US-born adults, aged 18-49	34,525	Adjusted Prevalence Ratio=1.0, 95% CI: 0.9–1.0 Adjusted for age, gender, race/ethnicity, marital status, education, employment status, poverty level, health insurance, number of doctor visits, self-reported health status, region of residence
	Tse 2018	Cross sectional	2009– 2012	Foreign-born non-Hispanic blacks, Hispanic, Chinese, Korean, Filipino, or Vietnamese American adults in New York City or Los Angeles and Orange counties in California	US-born adults in New York City or Los Angeles and Orange counties in California	14,139	Adjusted odds ratio NYC=1.0, 95% CI: 0.9–1.2, $p=.87$ LA/Orange County=1.2, 95% CI: 1.1–1.5, $p=.01$ Adjusted for sociodemographic and health-related factors
	Vashist 2018	Cross sectional	2018 (NHIS)	Foreign- born American adults from the 2018 NHIS survey	US-born adults	24,772	Adjusted odds ratio=0.91, 95% CI: 0.80–1.04 Adjusted for associations of COVID-19 priority grouping and socioeconomic and health-related factors

(*Continued*)

Table 2. (Continued).

	Study	Study Design	Study Time Period	Intervention Group	Comparison Group	N	Effect measure
Hepatitis B	Kilmer 2019	Cross sectional	2013–2015 (NHIS)	Foreign-born American women of reproductive age (aged 18–44) originating from Mexico, Central America, Caribbean, Indian subcontinent, Southeast Asia, South America, Asia, Africa, or Europe nationally located throughout the US	US-born women (aged 18–44)	24,216	Odds ratio: 1.85, 95% CI: 1.67–2.04 (Foreign-born reference)
	Lee 2013	Cross sectional	2010	Foreign-born, self-identified Asian Pacific Islander college students (aged 18+) in Boston, Massachusetts	US-born college students (aged 18+)	208	Odds ratio: 1.4, 95% CI:0.7–2.6 (Foreign-born reference)
	Lu 2014	Cross sectional	2012 (NHIS)	Foreign- born American adults originating from Mexico/ Central America/Caribbean Islands, South America, Europe, or Asia nationally located throughout the US	US-born adults, aged 18-49	34, 525	Adjusted Prevalence Ratio=0.9, 95% CI: 0.8–1.0 Adjusted for age, gender, race/ethnicity, marital status, education, employment status, poverty level, health insurance, number of doctor visits, self-reported health status, region of residence
	Tang 2018	Cross sectional	1997–2007	Foreign-born Asian American adults in NYC	US-born Asian American adults in NYC	19,816	Adjusted odds ratio: Birth China=0.22, 95% CI: 0.16–0.31 Birth other non-US=0.33, 95% CI: 0.22–0.48 Adjusted for age, sex, region of birth, language preference, insurances, reported family history of hepatitis B virus
Pneumococcal	Dallo 2015 (men)	Cross sectional	2000–2011 (NHIS)	Non-Hispanic white, foreign-born American men from Arab and European nations	Non- Hispanic white US-born men	91,636	Adjusted odds ratio: Europe born=0.42, 95% CI: 0.29–0.60 Arab=0.33, 95% CI: 0.16–0.70 Adjusted for demographic, socioeconomic, health access, risk factor and acculturation effects
	Dallo 2015 (women)	Cross sectional	2000–2011 (NHIS)	Non-Hispanic white, foreign-born women originating from Arab and European nations and nationally located throughout the US	Non- Hispanic White US-born women	117,893	Adjusted odds ratio: Europe born=0.43, 95% CI: 0.28–0.64 Arab born=0.14, 95% CI: 0.06–0.32 Adjusted for demographic, socioeconomic, health access, risk factor and acculturation effects
	Lu 2014	Cross sectional	2012 (NHIS)	Foreign-born adults (aged 18+) originating from Mexico/ Central America/Caribbean Islands, South America, Europe, or Asia nationally located through the US	US-born adults (aged 18+)	34, 525	Adjusted prevalence ratio=0.8, 95% CI: 0.7–1.0 Adjusted for age, gender, race/ethnicity, marital status, education, employment status, poverty level, health insurance, number of doctor visits, self-reported health status, region of residence
	Tse 2018	Cross sectional	2009– 2012	Foreign-born non-Hispanic blacks, Hispanic, Chinese, Korean, Filipino, or Vietnamese American adults in New York City or Los Angeles and Orange counties in California	US-born adults in New York City or Los Angeles and Orange counties in California	14,139	Adjusted odds ratio: NYC=1.3, 95% CI: 1.0–1.6, p=.046 LA/Orange County=1.1, 95% CI: 0.7–1.6, p=.81 Adjusted for sociodemographic and health-related factors)

Table 3. Characteristics of studies excluded from meta-analysis.

	Study	Study Design	Study Time Period	Target population	Comparator	N	Results
HPV	Beltran 2016	Cross sectional	2015	Hmong Americans in Minnesota	None	192	HPV initiation: 46.3% HPV completion: 32.7%
	Lee 2015	Cross sectional	2012–2013	Asian American and Pacific Islander (AAPI) college students in the Midwest US	Non-Latino white students	2,270	HPV completion: 38.6% (which was significantly higher than non-Latino white students at 60.7%, $p < .001$)
	Lu 2015*	Cross sectional	2012	Foreign-born participants age 19–26 y responding to National Health Interview Survey (NHIS)	US-born	34,218	HPV initiation: • Living in the US <10 y: aPR = 0.52, 95% CI: 0.28–0.98 • Living in the US ≥ 10 years: aPR = 0.71, 95% CI: 0.50–0.99
	Mohareb 2021	Retrospective cohort	2013–2015	Adult refugees in Connecticut	None	111	HPV initiation within 1 y of resettlement: 15%
Influenza	Lu 2015	Cross sectional	2012	Foreign-born participants responding to National Health Interview Survey (NHIS)	US-born	34,218	Influenza vaccination (past 12 months): • Living in the US <10 y, 19–64 y: aPR = 1.09, 95% CI: 0.92–1.25 • Living in the US <10 y, 65+ y: aPR = 0.84, 95% CI: 0.59–1.21 • Living in the US ≥ 10 y, 19–64 y: aPR = 1.00, 95% CI: 0.92–1.07 • Living in the US ≥ 10 y, 65+: aPR = 0.89, 95% CI: 0.80–0.98
	Morrison 2012	Cross sectional	2008	Somalian refugees in Minnesota	Non-Somalian clinic patients	91,557	Influenza vaccination: 41.45% for Somalian patients (vs. 53.73% for non-Somalian patients, $p < .001$)
	Vlahov 2012	Cross sectional	2010	Foreign-born individuals in an underserved community in New York	US-born individuals in an underserved community in New York	991	Interest in influenza vaccination: OR 4.11, 95% CI: 2.19, 7.72
Hepatitis B	Mitruka 2019	Cross sectional	2009–2011	Adult refugees in California, Massachusetts, Minnesota, and Washington	None	39,896	Of susceptible individuals (7,409), 38.3% completed the 3 dose series, 29% received 2 doses, 19.6% received 1 dose, and 13.1% received no doses
	Mohareb 2021	Retrospective cohort	2013–2015	Adult refugees in Connecticut	None	111	HBV initiation: 92% HBV completion of 3 doses 1 y following resettlement: 59%
	Ogunwobi 2019	Cross sectional	2016	African immigrants in New York	None	70	HBV initiation: 50.77%
	Raines-Milenkov 2021	Cross sectional	2014–2020	Refugee and immigrants in Texas	None	1,069	HBV initiation: 26% Uncertain of status: 53% No HBV doses: 21%
	Zhao 2015	Cross sectional	Not reported	Chinese American immigrants in California	None	179	HBV initiation: 26.4%
Pneumococcal	Lu 2015	Cross sectional	2012	Foreign-born participants responding to National Health Interview Survey (NHIS)	US-born population	34,218	Pneumococcal vaccination (ever received): • Living in the US <10 y, 19–64 y: aPR = 0.86, 95% CI: 0.53–1.38 • Living in the US <10 y, 65+ y: aPR = 1.00, 95% CI: 0.72–1.39 • Living in the US ≥ 10 y, 19–64 y: aPR = 0.87, 95% CI: 0.7–1.09 • Living in the US ≥ 10 y, 65+: aPR = 0.74, 95% CI: 0.66–0.83
	Morrison 2012	Cross sectional	2008	Somalian refugees in Minnesota	Non-Somalian clinic patients	91,557	Pneumococcal vaccination: 83.8% for Somalian patients (vs. 86.3% for non-Somalian patients, $p = .4546$)

(*Continued*)

Table 3. (Continued).

	Study	Study Design	Study Time Period	Target population	Comparator	N	Results
TDaP/Td	Chai 2013	Cross sectional	2003–2007	Asylees and refugees in District of Columbia	US-born population	781	Need for TDaP or TD: 79.9% of asylees or refugees compared to 48.4% of general US population
	Lu 2014	Cross sectional	2012	Foreign-born participants responding to National Health Interview Survey (NHIS)	US-born population	34,525	Tetanus vaccination containing pertussis (past 7 y): aPR 0.8, 95% CI: 0.7–0.9
	Lu 2015	Cross sectional	2012	Foreign-born participants responding to National Health Interview Survey (NHIS)	US-born population	34,218	Tetanus vaccination (past 10 y): • Living in the US <10 y, 19–64 y: aPR = 0.96, 95% CI: 0.90–1.03 • Living in the US <10 y, 65+ y: aPR = 1.13, 95% CI: 0.86–1.48 • Living in the US ≥ 10 y, 19–64 y: aPR = 0.89, 95% CI: 0.84–0.93 • Living in the US ≥ 10 y, 65+: aPR = 0.81, 95% CI: 0.72–0.91
	Mohareb 2021	Retrospective cohort	2013–2015	Adult refugees in Connecticut	None	111	TDaP (1 dose):96% initiated and completed within 1 y of resettlement
	Morrison 2012	Cross sectional	2008	Somalian refugees in Minnesota	Non-Somalian clinic patients	91,557	Tetanus vaccination Somali patients: 84.6% vs. 83.1% for non-Somali patients ($p = .2758$)
	Sanchez-Gonzalez 2017	Cross sectional	2012–2013	Foreign-born participants responding to National Health Interview Survey (NHIS)	None	13,154	Tdap vaccination: 9.1% Td vaccination: 49.8%
Hepatitis A	Lu 2014	Cross sectional	2012	Foreign-born participants responding to National Health Interview Survey (NHIS)	US-born population	34,525	Hepatitis A (among those endorsing travel): aPR = 1.0, 95% CI: 0.8–1.2)
	Mohareb 2021	Retrospective cohort	2013–2015	Adult refugees in Connecticut	None	111	Hepatitis A within 1 y of resettlement: 89% initiated, 83% completed 2 dose series
MMR	Chai 2013	Cross sectional	2003–2007	Asylees and refugees in District of Columbia	US-born population	781	Need for MMR: • Asylee adults: 66.6% • Refugee adults: 64%
	Mohareb 2021	Retrospective cohort	2013–2015	Adult refugees in Connecticut	None	111	MMR within 1 y of resettlement (among non-susceptible): 93% initiated, 71% completed
Shingles	Lu 2015	Cross sectional	2012	Foreign-born participants responding to National Health Interview Survey (NHIS)	US-born population	34,218	Shingles vaccination (ever received): • Living in the US <10 y: aPR = 0.88, 95% CI: 0.39–1.97 • Living in the US ≥ 10 y: aPR = 0.74, 95% CI: 0.57–0.97

(*Continued*)

Table 3. (Continued).

	Study	Study Design	Study Time Period	Target population	Comparator	N	Results
COVID-19	Abouhala 2021	Cross sectional	2020	Arab Americans	None	638	COVID-19 vaccine intent: • Yes: 56.7% • No: 7.5% • Uncertain: 35.7% aOR vaccine intent by nativity: aOR 1.70, 95% CI 1.05–2.77 (comparator foreign-born Arab Americans to US-born)
	Kheil 2022	Cross sectional	2021	Arab American immigrants across the US	None	1,746	COVID-19 vaccination: 92% by November 2021
	Shaw 2022	Cohort	2020–2021	Refugees in New York	None	244	COVID-19 vaccine intent before widespread availability: • Yes: 57.3% • No: 8.3% • Uncertain: 34.4% COVID-19 vaccine intent before widespread availability: • Yes: 57.4% • No: 25% • Uncertain: 17.6% COVID-19 vaccination after widespread availability: 44.7%
	Sudhinaraset 2022	Cross sectional	2020–2021	Undocumented immigrants in California	None	326	COVID-19 vaccine intent: 65%
	Zhang 2021	Cross sectional	2020–2021	Refugees across the US	None	435	COVID-19 vaccine intent: • Yes: 70.3% • No: 7.6% • Uncertain: 22.1% Country of origin comparison to Afghan refugees: • Somalia (aOR = 0.28; 95% CI, 0.11–0.71) • Burma/Myanmar (aOR = 0.29; 95% CI, 0.09–0.97) • South Sudan (aOR = 0.19; 95% CI, 0.06–0.57)

*Footnotes: Lu 2015 was excluded from the meta-analysis to avoid duplication of data from Lu 2014 (same dataset utilized).

Table 4. Barriers to vaccination in the RIM population from quantitative studies.

	Study	Study Design	Study Time Period	Population	Location within the US	N	Barriers & Facilitators
HPV	Ashing 2017	Cross sectional	2009–2011	Black/African descended or Hispanic/Latinx immigrants	California	393	Black immigrants • Barrier: Lack of awareness where to receive HPV (OR 0.36, $p = .007$ compared to US-born) Latinx immigrants • Barrier: Perceived cost (OR 4.75, $p = .044$ compared to US-born) • Barrier: Lack of awareness of HPV vaccine (Latinx: OR 0.37, $p = .033$ compared to US-born) • Barrier: Lack of awareness where to receive HPV (OR 0.21, $p = .001$ compared to US-born)
	Barnack-Tavlaris 2016	Cross sectional	2007–2008	Foreign and US-born women in California	California	1,672	• Barrier: Lack of awareness of HPV vaccine (OR = 1.89, CI 95%: 1.42–2.52, $p < .005$ compared to US-born) • Barrier: Lack of interest in HPV vaccine in non-US-born Latinas (OR = 0.38, CI 95%: .18–.79, $p = .009$ compared to US-born Latinas)
	Bhattacharya 2021	Cross sectional	2017–2018	Foreign and US-born adults nationally in the US	National	2,415	• Barrier: Lack of awareness of HPV infection (aOR 0.39, 95% CI = 0.26–0.61)
	Budhwani 2017	Cross sectional	2008– 2013 (except 2010 NHIS)	Asian Indian and Asian subpopulations	National	234	• Facilitator: Private insurance (aOR 1.91, 95% CI: 1.542–2.367) • Facilitator: Higher education (aOR = 1.157, 95% CI: 1.107–1.210)
	Cofie 2018	Cross sectional	2013–2015 (NHIS)	Immigrants originating from Mexico, Central America, Caribbean Islands; South America; Europe; Africa; Indian subcontinent; Asia; Southeast Asia	National	32,917	• Facilitator: US citizenship (OR = 1.60, 95% CI: 1.16–2.20 Foreign-born US citizens compared to non-citizens) • Potential barrier: Country of origin (European women 28.19%, 95% CI: 19.02, 37.35; Indian women 4.28%, 95% CI: 1.09–7.46)
	Cofie 2022	Cross sectional	2013–2017 (NHIS)	Black immigrants originating from Mexico/Central America/Caribbean Islands/South America, or Africa	National	40,646	• Facilitator: Female gender (aOR = 3.65 95% CI: 2.95, 4.50) • Facilitator: Younger age at time of eligibility (aOR = 3.44, 95% CI: 2.90, 4.07) • Facilitator: Marital status as single male (aOR = 2.30, 95% CI: 1.32, 4.01) • Facilitator: Higher education, some college attendance (aOR = 1.75, 95% CI: 1.33–2.31)
	Escobar 2021	Cross sectional	2017–2018	Mexican, Puerto Rican, Cuban, other Hispanic immigrants in the US, US-born Hispanics, and US-born non-Hispanic whites	National	4,523	• Barrier: Lack of knowledge on HPV vaccine (non-Hispanic whites aOR = 1.95 (95% CI 1.19–3.21 compared to Foreign-born Hispanic) • Facilitator: Female gender (aOR = 4.53, 95% 3.48–5.88) • Facilitator: Higher education, some college (aOR = 3.77,95% CI 2.04–6.96) • Facilitator: Having a family member aged 9–27 (aOR = 1.48, 95% CI: 1.07–2.04)
	Lee 2015	Cross sectional	2012–2013	Asian American Pacific Islander (AAPI) immigrant college students	Midwest	2,270	• Barrier: Lack of knowledge of HPV vaccine (AAPI compared to non-Latina White) 73.6% vs 90.6%, $p < .01$
	Lee 2018	Cross sectional	N/A	Korean American women immigrants	Georgia	243	• Barrier: Age was inversely related to HPV literacy (B = −0.21, SE = 0.124, $p < .05$) • Barrier: Low English proficiency (B = = 0.146, SE = 0.227, $p < .05$) • Barrier: Education (B = = 0.145, SE = 0.333, $p < .05$) • Barrier: Poor health status (B = = 0.145, SE = 0.382, $p < .05$)
	Mehta 2021	Cross sectional	2018	Undocumented and documented Hispanic immigrant women	Rhode Island	159	• Barrier: Lack of knowledge of HPV and vaccine (45% aware of HPV vaccine, but only 20% received vaccine)
	Nguyen 2012	Cross sectional	2012	Mandarin- speaking American immigrants	Northeast	71	• Barrier: Lack of Knowledge on HPV and vaccine (20.3% heard of HPV, 35.7% heard of HPV vaccine) • Facilitator: Insurance coverage (OR = 9.4, 95% CI: 1.5–60.6, $p = .019$) • Facilitator: English speaking (OR = 10.7, 95% CI: 1.8–62.3, $p = .008$)

(*Continued*)

Table 4. (Continued).

	Study	Study Design	Study Time Period	Population	Location within the US	N	Barriers & Facilitators
Influenza	Budhwani 2016	Cross sectional	2013 (NHIS)	US-born and foreign- born Asian Indians, Blacks, Whites, and other Asians adults	National	104,520	• Facilitator: Insurance coverage – After controlling for insurance coverage, there was no statistical difference in vaccine coverage between foreign and US-born (OR = 0.812, 95% CI: 0.571–1.155)
	Jih 2015	Cross sectional	2007, 2009	Latino and Asian immigrants with low English proficiency (LEP)	California	4,821	• Language discordance did not result in significant differences in vaccination rates among immigrants with LEP
	Moran 2017	Cross sectional	2012–2013	Hispanic female immigrants from Central and South America	California	1,565	• Facilitator: Higher religiosity (aOR = 1.12, $p < .007$) • Facilitator: Higher vaccine safety confidence (aOR = 2.38, $p < .001$)
	Morrison 2012	Cross sectional	2008	Somalian refugees	Minnesota	91,557	• Facilitator: Increased number of primary care visits (2.3 visits for unvaccinated vs. 6.27 visits for vaccinated, $p < .0001$)
	Ogunwobi 2019	Cross sectional	2016	African immigrants	New York	70	• Facilitator: Health insurance (Œ≤ = 2.37, $p < .01$)
	Strong 2012	Cross sectional	2009–2010	Chinese, Korean, and Vietnamese immigrants	Maryland	877	• Facilitator: Knowledge of HBV (OR = 1.20, 95% CI: 1.12–1.29) • Facilitator: Physician recommendations (OR = 2.09, 95% CI: 1.30–3.37) • Facilitator: HBV screening suggested by friends and family (OR = 2.01, 95% CI: 1.28–3.15)
	Zhao 2015	Cross sectional	NR	Chinese immigrants	California	179	• Barrier: Lack of medical problems necessitating visits (60% of sample endorsed this) • Barrier: Absence of a physician recommendation (49% of sample endorsed this)
Pneumococcal	Morrison 2012	Cross sectional	2008	Somalian refugees	Minnesota	91,557	• Facilitator: Increased healthcare visits (average number of primary care visits: 2.06 for no vaccine vs. 5.04 for vaccinated, $p = .004$)
Tetanus	Morrison 2012	Cross sectional	2008	Somalian refugees	Minnesota	91,557	• Facilitator: Increased healthcare visits (average number of primary care visits: 0.7 for no vaccine vs. 2.61 for vaccinated, $p < .001$) • Facilitator: Access to medical interpreters
	Lu 2014	Cross sectional	2012	Foreign-born individuals residing in the US	National	34,525	• Barrier: English speaking (4.6% in non-English speaking vs. 11.5% in English speaking foreign-born, $p < .05$)
	Sanchez-Gonzalez 2017	Cross sectional	2012–2013	Foreign-born individuals residing in the US	National	13,154	• Barrier: Low socio-economic status • Barrier: No or public health insurance • Facilitator: College education • Facilitator: Access to medical care (more visits to PCP)

(*Continued*)

Table 4. (Continued).

	Study	Study Design	Study Time Period	Population	Location within the US	N	Barriers & Facilitators
COVID-19	Abouhala 2021	Cross sectional	2020	Arab Immigrants	National	638	• Barrier: Female sex (aOR = 5.00, 95% CI: 1.95, 12.83, higher odds of being unlikely to receive vaccine) • Barrier: Younger age (aOR: 3.36; 95% CI: 1.34, 8.39, higher odds of being unlikely to receive the vaccine) • Facilitator: Smaller households (aOR = 0.50, 95% CI = 0.25–0.99) • Facilitator: Lower religiosity (OR = 0.35; 95% CI: 0.16–0.78) • Facilitator: Previous COVID infection (OR = 0.40; 95% CI: 0.19–0.83)
	Kheil 2022	Cross sectional	2021	Arab Immigrants	National	1,603	• Barrier: Safety concerns (86%) • Barrier: Distrust in healthcare system, vaccines, and government (70%) • Barrier: Religious or personal beliefs (31%) • Barrier: Previous infection with COVID-19 (7%)
	Page 2022	Cross sectional	2021	Migrants	International (extracted data from Maryland)	142	• Barrier: Lack of health insurance (56%) • Barrier: Not knowing where to get vaccinated (36%) • Barrier: Perceived high cost (8%) • Barrier: Perceived lack of eligibility to enroll (4%)
	Shaw 2022	Cohort	2020–2021	Refugees	New York	244	• Barrier: Previous decline of vaccinations (42.1% for history of decline vs 24% for those without history of decline, $p = .001$) • No significant association between sociodemographic factors and COVID-19 intent
	Sudhinaraset 2022	Cross sectional	2020–2021	Undocumented immigrants	California	326	• Barrier: Increase in immigration enforcement exposure (vaccine acceptance aOR = 0.88, 95% CI: 0.78–0.99) • Barrier: Health insurance (aOR = 0.46, 95% CI: 0.24–0.88) • Facilitator: Female gender (aOR = 3.11, 95% CI: 1.79–5.35) • Facilitator: Enrollment in school (aOR = 2.65, 95% CI: 1.10–6.35)
	Zhang 2021	Cross sectional	2020–2021	Refugees	National	435	• Barrier: Concern for side effects (71.3%) • Barrier: Concern for effectiveness (12.4%) • Barrier: Fear of needles (8.5%) • Facilitator: Being an essential worker (aOR = 2.37; 95% CI, 1.44–3.90) • Facilitator: Male sex (aOR = 1.87; 95% CI, 1.12–3.12) • Facilitators: Among those intending to get the COVID-19 vaccine, their main reasons were wanting to protect themselves (68.6%), family members (65.0%), and other people (54.3%)

Participants were engaged in a community health worker vaccination promotion campaign, which consisted of two-hour workshops on the importance of getting the flu vaccine. The proportion of participants who identified vaccination as effective for influenza increased from 29% pre-workshop to 47.7% post-workshop.

Quantitative study describing interventions for hepatitis B vaccination coverage (n = 1)

One quantitative study described an intervention to increase HBV vaccination rates.

Djoufack et al.[56] conducted a quasi-experimental study to determine if community outreach could improve hepatitis B knowledge among immigrants within the Greater Boston area. The study recruited 101 participants to assess knowledge before and after the intervention. The intervention consisted of six 45-min sessions hosted at trusted locations within the community. Live interpreters translated the sessions that focused on hepatitis B education and led to an insignificant increase in HBV knowledge (pre: 64% vs. Post: 75%, $p = .20$).

Quantitative study describing an intervention to address COVID-19 vaccine hesitancy (n = 1)

Malone et al.[45] described the efforts of a community-based primary care clinic in Clarkston, Georgia, in providing COVID-19 vaccination to 3,127 immigrants and refugees. They found that three main factors led to sustainability of their vaccination efforts: establishing relationships of trust in the community, using multiple avenues of access, and providing consistent vaccination location and time.

Qualitative studies describing effective intervention strategies for vaccination (n = 7)

Three themes regarding interventions emerged from the seven applicable studies: receiving information from a trusted source,[32,50,53,63,68] providing culturally tailored education,[32,50,53,63,68] and facilitating access.[32,68] A strong physician recommendation was found to be a trusted resource in most studies, while others sought family support or support from community leaders. Delivering culturally sensitive and language congruent content via social media or community platforms was thought to be an effective strategy. Finally, facilitating access to educational materials, or vaccination itself through community vaccination sites, was a desired intervention strategy.

Discussion

Vaccine hesitancy has steadily increased in the US and worldwide over the past decade. In 2019, the World Health Organization declared vaccine hesitancy as one of the top 10 threats to global health, emphasizing the urgency of the matter.[75] To address this threat, we reviewed literature published in the past decade with the inclusion of COVID-19 vaccine hesitancy, as it has not been previously systematically captured. The broad scope and timely inclusion of COVID-19 literature distinguish this review from prior work, and in doing so, highlight the gaps in existing knowledge.

Our review identifies RIMs as an underimmunized community with lower vaccination rates compared to the US-born population, thus increasing their vulnerability to VPDs. Unfortunately, the lack of comparable data relating to COVID-19 vaccination rates precluded meta-analysis. Given its novelty, literature comparing COVID-19 vaccination rates of the RIM population to the general US population is limited. We found variability in COVID-19 vaccine intent based on nativity, however intent did not necessarily translate to vaccine uptake.[23,32,69] Our results highlight the need for further research in this area, especially amid escalating vaccine hesitancy.

Common barriers to vaccination included knowledge gaps, poor access to care, cultural bias, and distrust of the medical system. Following the introduction of COVID-19 vaccines, safety concerns emerged as an increasingly cited barrier. This finding is not surprising and in congruence with what has been seen in the general US population. Rampant misinformation, coupled with distrust in the scientific community, is associated with poor COVID-19 vaccine acceptance.[77,78] To address these barriers, we searched the literature for effective interventions. Although limited, a few non-randomized studies described the importance of establishing trusted relationships within the community, facilitating access, and providing culturally sensitive education to increase vaccine uptake.[32,36,63]

Strengths and limitations

This systematic review includes 57 studies, allowing for a robust and comprehensive response to the stated objectives. The nature of the questions raised resulted in the majority of included studies being cross-sectional or qualitative in design. Thus, the results and interpretation of our results carry risk for bias inherent to these designs. Quality assessment of the included studies revealed that the vast majority were methodologically sound with low risk of bias.

Despite a fair amount of clinical heterogeneity in the studied populations, there was a remarkable statistical homogeneity for HPV vaccination. This can be partly explained by the use of the National Health Interview Survey (NHIS) database with overlapping time periods among included studies. In contrast, there was significant statistical heterogeneity for the meta-analyses for influenza, pneumococcal, and hepatitis B vaccination. Despite the noted heterogeneity, the direction of effect was the same within all meta-analyses, demonstrating that the RIM population has decreased odds of vaccination compared to the US-born population.

To minimize bias in conducting the review, we prespecified inclusion/exclusion criteria. The process of screening, quality assessment, and data extraction was conducted in duplication. Despite a comprehensive search strategy, the use of a single electronic database (PubMed) provided a possible limitation to the studies captured. Additionally, by limiting the included studies to the past 10 y, there may have been relevant studies published prior to 2012 that were excluded. With the development and distribution of new vaccines, however, vaccine hesitancy is a fluid and evolving field that requires a timely

response. As previously mentioned, the decision to limit the study period to the past decade ensured inclusion of a robust dataset during a period of growing vaccine hesitancy while maintaining relevancy to today's RIM population.

Implications for practice

Our findings have important implications for practice. The combination of limited prior experience with vaccines, low health literacy, and lack of access to local healthcare infrastructure results in a lower priority for non-required vaccinations among RIM populations. These structural and modifiable barriers remain an important reason for undervaccination.[18,38,55] Enhancing access to timely and routine care, provided in culturally sensitive settings over time builds trust and comfort with the recommendations offered.[32,35,73] Bringing vaccines closer to populations to bridge trusted voices, community health workers, and culturally aligned community sites was a way to accelerate uptake for COVID-19 vaccination among vulnerable populations.[32,45] Lack of insurance status for many RIM populations will continue to pose a barrier to obtaining regular care, proper documentation, and consistent recommendations for VPD.[31,74] Provision of affordable quality health services will require allocation of resources to meet the highly diverse needs of RIM communities.

Limited experience with vaccines and low health literacy are common barriers to engaging RIM populations in the relative importance of vaccination. For example, very few countries have systemic HPV vaccination and cervical cancer screening programs available; therefore, RIM populations do not come with a baseline knowledge and awareness of this VPD. This low baseline knowledge is correlated with negative attitudes and perceptions of the vaccine.[79] Other RIM populations have had strong sources of misinformation guiding their vaccine refusal. Rampant misinformation linking MMR vaccine to a diagnosis of autism drove down MMR vaccination rates within the Somali population in Minnesota and led to subsequent measles outbreaks.[1,2,80] Culturally aligned, trusted providers and community health interventions should be sought to overcome these barriers by establishing respectful relationships to engage health educational programs within the community.

Implications for policy

Systematic health programs designed for timely health screening and vaccination have been shown to improve vaccination rates among certain RIM.[81] Required health screenings and vaccination within 30–90 days of arrival guarantee access and interface with a health system designed to meet the needs of a culturally diverse population. Ensuring that these programs sustain federal funding will secure access for diverse RIM populations who arrive with limited health literacy. As RIM populations assimilate, proven strategies such as mandating school and employer vaccinations will improve immunization rates.[82] Finally, those with the opportunity to apply for a visa or adjust status for permanent residency will face US Citizenship and Immigration Services' policies that require administration of certain vaccines.[83] Broadening the list of required vaccines to meet the Advisory Committee on Immunization Practices (ACIP) guidelines will improve immunization rates through this process.[83]

Implications for future research

Despite a fair degree of overlap, there were important differences in vaccination barriers as a result of the cultural diversity within the RIM population. Caution should be taken when attempting to generalize these results to subsets within this population, particularly when addressing COVID-19 vaccination. Additional research is necessary to clarify these differences and tailor culturally sensitive, effective interventions amid the current pandemic.[19,24,70]

Although there is a clear risk for VPD and many barriers have been identified, strategies to overcome vaccine hesitancy within the RIM population are lacking. Technology is increasingly used to develop tailored vaccine education material to circumvent educational and cultural barriers.[49,72] The current design and scope of the studies, however, limit their widespread applicability. Randomized controlled trials involving diverse populations are necessary to truly determine their efficacy and generalizability.

Conclusions

The RIM community has lower vaccination coverage when compared to those born in the US. Barriers, such as language, poor access to medical care, and distrust for the medical system, are modifiable with increased commitment of resources. Effective interventions are only partially understood, necessitating further research to ensure improved coverage and reduced risk of VPD outbreaks. Promoting policy that will secure federal funding for health services, while adopting ACIP guidelines for recommended immunizations, will improve vaccination rates for RIM. Our review highlights the RIM population as a vulnerable group in need of unique interventions to overcome barriers to vaccination.

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