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REVIEW

Vaccine uptake and barriers to vaccination among at-risk adult populations in the US

Irina Kolobova[a], Mawuli Kwame Nyaku[a], Anna Karakusevic[b], Daisy Bridge[b], Iain Fotheringham[b], and Megan O'Brien[a]

[a]Center for Observational and Real World Evidence, Merck & Co., Inc., Kenilworth, NJ, USA; [b]Adelphi Values PROVE, Cheshire, UK

ABSTRACT

To reduce morbidity and mortality associated with vaccine-preventable diseases (VPD), it is imperative that vaccination programs are implemented and prioritized throughout all stages of life across all populations. This study aimed to determine vaccine uptake and barriers to vaccination against VPDs among at-risk adult populations in the United States. We conducted a systematic literature review for articles published between January 2010 and June 2020 and identified 153 publications. The review identified 17 at-risk populations. Vaccine uptake was suboptimal among many populations, with factors including age, gender, and disease severity, associated with uptake. This review identified several barriers that impact vaccine uptake among at-risk populations, with concerns over safety, vaccine costs, lack of insurance, and lack of provider recommendation commonly reported across populations. Embracing a national life-course immunization framework that integrates developing policies, guidelines, and education would be a step to addressing these barriers.

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Introduction

Vaccines are critical to the prevention and control of vaccine-preventable diseases (VPDs) and therefore underpin global health security.[1] Vaccination throughout life brings significant benefits at the individual, community, and socio-economic levels.[2–4] Despite the contribution of vaccination in reducing the burden of VPDs, these diseases continue to confer a significant burden on society and the healthcare system.[2,5] Furthermore, not all individuals experience the same risk of VPDs, and those defined as at-risk populations in the Advisory Committee on Immunization Practices (ACIP) recommendations due to existing health conditions, occupational risks, or behavior are classified at increased risk.[3,4,6] This is especially relevant because herd immunity is not sufficient to prevent or reduce the substantial morbidity and mortality among these populations.[2,7,8] This is of particular importance given the risk of worse clinical outcomes, including more frequent hospitalizations and increased length of stay, experienced among at-risk groups compared to the general population.[2,7,8]

To reduce morbidity and mortality associated with VPDs, it is imperative that vaccination programs are implemented and prioritized across all populations.[3–5] The concept of a life-course approach to immunization is to protect individuals against VPDs and provide health benefits including reducing hospitalizations and healthcare costs to individuals throughout their lives, at different ages and situations, including at-risk populations.[2] The World Health Organization (WHO) Immunization Agenda 2030 established life-course immunization as a strategic priority, with mobilizing support among at-risk groups as one of the key areas of focus.[1] The life-course immunization framework involves comprehensive immunization programs, with clear guidelines, vaccine access, data generation, and community partnerships.[2] Furthermore, these programs involve public demand for vaccination, engaged healthcare workers (HCWs), and robust surveillance and vaccine uptake data informing policies and programs.[1,2] Understanding vaccine uptake and the impact of VPDs among at-risk populations is critical for informing a life-course immunization framework for immunization.[2,7]

Despite the widespread and marked impact VPDs have on individual health, the healthcare system and on the economy, to the authors' knowledge, no review has thoroughly explored vaccine uptake and barriers to vaccination among at-risk populations in the United States (US). This knowledge is imperative to understand the benefits of a life-course approach to immunization among individuals in this group.

In order to support disease prevention among at-risk adults, similar to the achievement of successful vaccine recommendations and immunization frameworks among pediatric and older adult populations, this systematic literature review (SLR) sought to identify evidence related to VPDs among at-risk adult populations. The objectives of the overall SLR were therefore to (1) quantify the epidemiological burden of VPDs among the at-risk populations of interest; (2) determine the clinical, economic, and societal burden of VPDs among these populations; and (3) determine current vaccine uptake and barriers to vaccination. This review identified a substantial volume of data on disease burden and vaccine uptake and therefore focuses on determining current vaccine uptake and barriers to vaccination (objective 3). A companion article will explore the first and second objectives on quantifying the burden of VPD.

CONTACT Megan O'Brien megan_obrien@merck.com Policy Evidence Research, Merck & Co., Inc., Kenilworth, NJ 07033, USA.
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Methods

Search strategy

We searched Medline, Embase, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effects, and Cochrane Central Register of Controlled Trials for articles published between January 2010 and June 2020. The search comprised combinations of keywords and Medical Subject Headings (MeSH) terms pertaining to at-risk populations, VPDs, epidemiology, clinical, economic, and societal burden, and vaccine uptake (Table S1). We reviewed bibliographies of included publications to identify relevant publications not captured through the database searches. We performed a gray literature search of the Centers for Disease Control and Prevention (CDC), Office of Disease Prevention and Health Promotion, US Department of Health & Human Services, and Immunization Action Coalition websites.

Study selection

We reviewed all identified references for inclusion at the title and abstract level. Full-text screening was conducted by two reviewers using the population, comparators, outcomes, and study design (PICOS) framework (Table S2). Briefly, included articles were primary studies that met the following criteria: (1) individuals defined as at-risk by the ACIP recommendations and CDC adult immunization schedule; (2) epidemiology, economic, and social burden outcomes; (3) vaccination outcomes; (4) studies conducted with US adults (≥19 years). Following a double-blind review, all discrepancies identified were resolved by consensus with a senior researcher.

Data were extracted on the epidemiology, economic, social burden, and vaccination outcomes into a data extraction form by one reviewer and checked for accuracy by a second reviewer.

Results

Overview of results

The search, ran on July 31st, 2020, identified 6,076 articles from both database and gray literature searches, of which 458 were taken forward to full-text review. After screening against the eligibility criteria, 196 publications were included (Figure 1). As this paper aims to evaluate vaccine uptake and barriers to vaccination of VPDs among at-risk populations, only studies reporting these outcomes were included ($N = 153$).

The SLR identified publications reporting vaccination uptake for 17 at-risk populations. The greatest number of publications were identified among pregnant women ($N = 53$) and individuals with occupational exposures ($N = 31$), followed by men who have sex with men (MSM; $N = 19$). The following sections present trends among populations where ≥5 publications reported on vaccine uptake or barriers to vaccination.

Vaccine uptake and barriers to vaccination

Vaccine uptake among at-risk populations was reported in 150 studies, with over a third reporting on pregnant women ($N = 53$). Barriers to vaccination among at-risk populations were reported in 107 studies; the greatest number reported on pregnant women ($N = 46$). There was variation in available data, with limited (<5 publications) or no data available for 13 at-risk populations (Table S2). Frequently reported barriers to vaccination included concerns regarding vaccine safety or efficacy, vaccine hesitancy, lack of insurance, cost of vaccination, perceived lack of risk, and lack of guidelines or education and HCW recommendation. The entire dataset for all populations is reported in Tables S4 and S5 in the appendices.

Occupational exposures

Vaccine uptake. Thirty-three publications reported vaccine uptake in individuals with occupational exposures and notably, HCWs were the only population identified. There was large heterogeneity in the data, with 18 studies reporting influenza vaccine uptake; estimates ranged between 32.0% and 91.6% for overall vaccine uptake among HCWs.[9–23] Notably, the annual survey of HCW influenza uptake conducted by the CDC highlighted that uptake has been steadily increasing over the past 10 years (Figure 2).[24–30] Uptake was highest among HCWs working in hospitals and lowest among HCWs in long-term care settings.[15] Furthermore, HCWs with health conditions, such as asthma, diabetes, or human immunodeficiency (HIV) infection, were more likely to be vaccinated than healthy controls.[23]

Several studies evaluated the impact of mandated vaccination among HCWs for influenza and Tdap vaccines.[10,12,14,31,32] A study of HCWs in a long-term acute care facility reported that the implementation of mandated influenza vaccination increased vaccination rates from 25% ($N = 272$) in 2008–2009 to 65% ($N = 279$) in the 2010–2011 influenza season ($p < .05$).[12] A further study of HCWs during a pertussis epidemic reported that mandated Tdap vaccination improved vaccination rates from 67% to 92%.[32] However, opposition to vaccine mandates was reported with HCWs stating that mandates are an infringement on workers' rights and, in some instances, HCWs reported that they would seek employment elsewhere.[32]

Among the three studies reporting on tetanus, diphtheria, and pertussis (Tdap) vaccine, uptake estimates among HCWs ranged between 39.0% and 97.0%.[31–33] Notably, a study of HCWs in California reported that Tdap uptake improved with increased influenza vaccination (2008–2009: 60%; 2009–2010: 63%).[31,32]

A study of Native Hawaiian and Pacific Islanders reported a hepatitis B virus (HBV) vaccine uptake of 65.6% among HCWs.[34] Furthermore, HBV vaccination for HCWs was 4.8 (95% CI; OR 1.7–14.0) times higher than for non-providers.[34] A second study reported suboptimal hepatitis A virus (HAV) vaccine uptake among HCWs in Texas (28.9%: $N = 60/207$), with only half receiving the full vaccination series.[35]

Barriers to vaccination. Cost and perceived safety of vaccination were identified as barriers to vaccination among HCWs. Among HCWs who did not receive the pertussis vaccination (61%), 55% ($N = 83$) cited concerns about the safety of the vaccine, while 14% cited their physicians not recommending it, and 14% cited lack of awareness of current guidelines.[33]

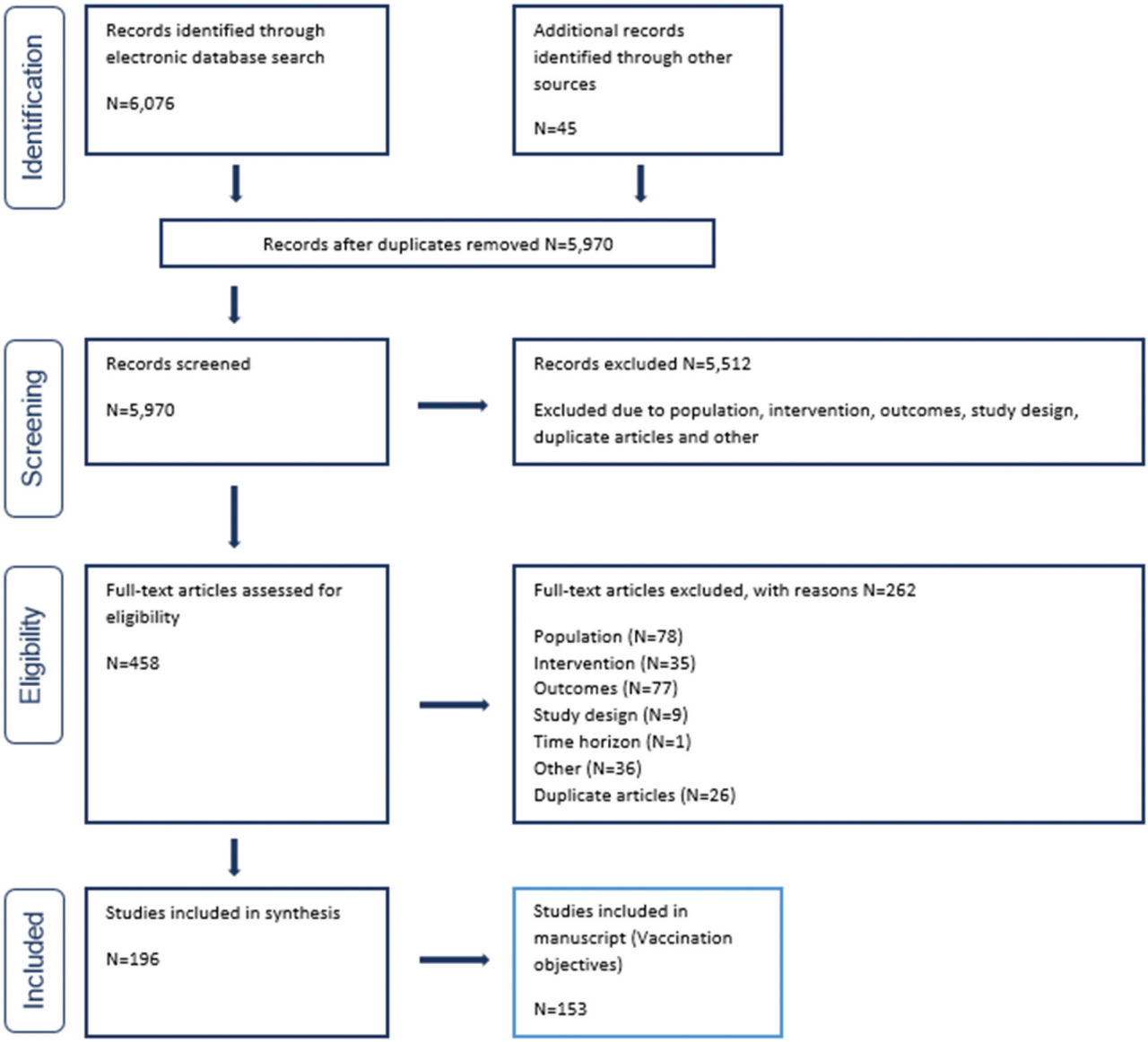

Figure 1. PRISMA diagram.

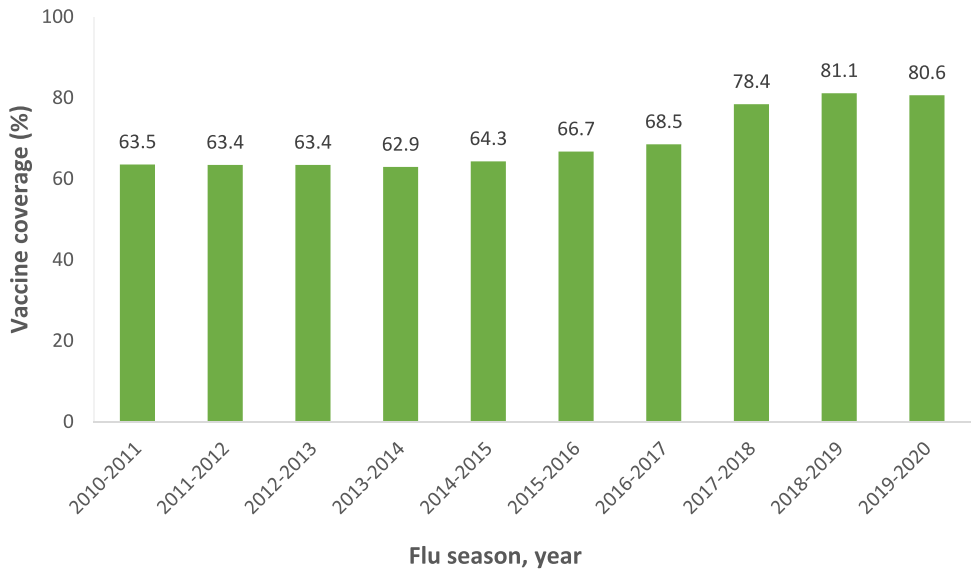

Figure 2. Influenza vaccine uptake among HCWs, by year.[22–28]

Furthermore, there is evidence indicating that, when cost is removed as a barrier, vaccine uptake among HCWs increases. Vaccine uptake among HCWs who worked in locations where their employer made vaccination available on-site at no cost for >1 day was 83.9%.[15] Uptake was 59.5% among HCWs who worked in locations where their employer did not freely provide influenza vaccination on-site, but actively promoted vaccination through other mechanisms.[15]

Tourists/travelers

Vaccine uptake. Ten publications reported on vaccine uptake among tourists and travelers. Uptake rates among tourists/travelers differed by vaccine, with estimates ranging from 36.0% to 67.0% for influenza, 25.9% to 40.2% for HBV, 18.8% to 48.3% for HAV and 23.0% to 72.0% for MMR.[34,36–42]

Notably, age, receipt of influenza vaccine, education, and health insurance, among others, were all independently associated with vaccine uptake with regional variations noted.[37,41]

Barriers to vaccination. Limited awareness about the specific vaccines recommended for different global regions, provider decisions, lack of insurance and the costs of vaccination were identified as barriers to vaccination among tourists/travelers (Table S4). For example, in a 2017 study among travelers eligible for MMR, 48% ($N = 1,689$) travelers refused the vaccine either due to not being concerned about illness, or cost concerns.[37] Furthermore, 28% of travelers ($N = 966$) did not receive the vaccine due to provider decisions.[37]

Migrants/immigrants

Vaccine uptake. Among the eight studies reporting on vaccine uptake among migrants/immigrants, suboptimal HBV uptake was identified (compared to the Healthy people 2020 goal of 60%), with estimates ranging between 8.4% and 54.7%.[43–49] Comparing vaccination between US- and foreign-born women of reproductive age, using NHIS data, lower HBV uptake was identified among foreign-born women (27.3% versus 40.9%).[45]

Initiation of human papillomavirus (HPV) vaccination was also found to be low among immigrants where a 2019 study reported only 6.7% ($N = 22$) of foreign-born US patients had initiated a vaccination series.[50]

Vaccine uptake also varied depending on country of birth. A 2014 study compared influenza and pneumococcal uptake between European-born, Arab-born and US-born individuals using NHIS data ($N = 117,893$).[51] Vaccine uptake was lower among European- and Arab-born individuals than US-born individuals for both pneumococcal (84% and 89% not vaccinated versus 78%, respectively) and influenza vaccination (71% and 74% not vaccinated versus 64%, respectively).[51]

Barriers to vaccination. Access to healthcare and educational attainment level were identified as key barriers to vaccination among Latino and Asian migrants and immigrants.[45,46,49] A study of US- and foreign-born women reported that fewer foreign-born women were insured than US-born women (68.2% versus 86.4%, respectively) and fewer foreign-born women had visited a healthcare provider in the past year (74.4% versus 85.3%, respectively).[45] Similarly, a 2013 study of Laotian immigrants in Minnesota identified limited English fluency (12%) and not knowing where to go for vaccination (22.6%) as important barriers to vaccination.[49]

Liver disease

Vaccine uptake. Six studies reported on vaccine uptake among patients with chronic liver disease (CLD). Uptake of HAV and HBV vaccination ranged from 6.7–40.5% and 8.2–53.8%, respectively, with rates increasing in recent years (Figure 3).[34,39,52–54] Over the same period, the number of individuals receiving <2 recommended doses decreased from 46.7% to 9.3% for HAV, and from 17.9% to 7.0% for HBV.[53]

A 2012 survey study utilizing data from the 2007 to 2011 National Health and Wellness Survey reported uptake rates of 34.9% for HAV and 40.5% for HBV vaccination, both of which were found to be significantly greater among patients with CLD when compared with healthy individuals ($p < .05$).[54]

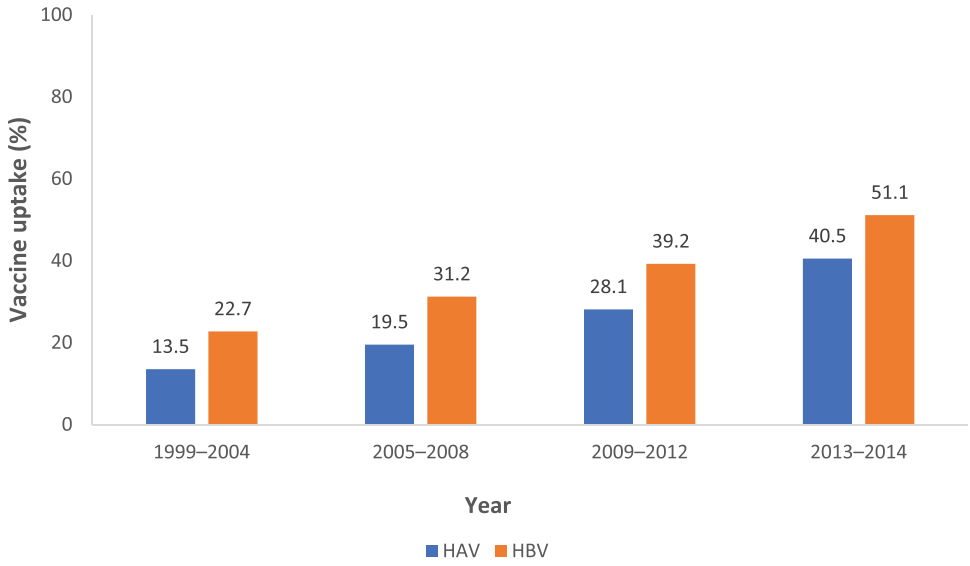

Figure 3. Vaccine uptake among individuals with chronic liver disease, by year.[51]

However, uptake has been found to vary with age.[39] A 2016 study of 32,296 individuals using NHIS data reported higher uptake among patients with CLD aged 19–49 compared with those aged ≥50 years for both HAV (18.2% versus 12.3%) and HBV (41.6% versus 25.1%).[39]

Barriers to vaccination. No publications reported on the barriers to vaccination among individuals with CLD.

People with diabetes

Vaccine uptake. Among the nine studies reporting on vaccine uptake among people with diabetes, uptake estimates ranged from 37.0% to 53.0% for pneumococcal, 9.4% to 30.7% for HAV and 13.5% to 39.0% for HBV, and 41.0% to 79.5% for influenza.[34,39,52–59] Notably, vaccine uptake was consistently lower among people with diabetes compared with the general population (15.4% versus 20.5% for HAV; 22.4% versus 34.3% for HBV in 2008).[52] A 2016 national survey of 32,296 individuals reported low HBV vaccine uptake among people with diabetes, with age negatively associated with vaccination (23.5% among those aged 19–59 years versus 13.5% for those ≥60 years).[39] Comparatively, a 2016 retrospective cohort study of 245,480 individuals reported that age was positively associated with influenza vaccination, with uptake increasing from 45.8% among those aged 18–49 to 56.6% among those aged 50–65 years with diabetes.[59]

Barriers to vaccination. No publications reported on the barriers to vaccination among people with diabetes.

End-stage renal disease

Among the ten studies reporting on vaccine uptake among patients with end-stage renal disease (ESRD), uptake estimates ranged from 18.7% to 68.7% for influenza, 39.0% to 59.7% for pneumococcal, and 21.6% to 80.1% for HBV.[54,56,60–67] Within these estimates, variation was noted according to disease severity,[61] the presence of a comorbidity[61] and according to race.[56,60,62]

Barriers to vaccination. No publications reported on the barriers to vaccination among individuals with ESRD.

People living with HIV

Fourteen publications reported vaccine uptake among people living with HIV (PLWH), among a range of vaccines, including HBV, meningococcal disease, influenza, pneumococcal disease, and HPV. Uptake of HBV vaccination ranged from 28% to 45%.[34,46,68–72] HBV uptake differed based on the location where patients received HIV care.[72] A significantly larger percentage of patients who received care at Ryan White HIV/AIDS Program (RWHAP)-funded facilities versus non-RWHAP-funded facilities were vaccinated (12.5% versus 3.7%; $p < .001$).[72] Conversely, fewer patients who received care at private practices (versus non-private) were vaccinated (5.6% versus 11.8%; $p < .001$).[72]

Influenza uptake ranged from 14.2% to 57.0%.[73–75] In a 2011 study reporting influenza uptake using data from the HIV outpatient study ($N = 5,365$), annual uptake ranged from 25.8% to 43.3%.[74] Influenza uptake in this study was highest among individuals aged 30–39 years (40.0%) and lowest in those aged ≥50 years (14.2%).[74]

Two studies reported similar rates of pneumococcal vaccination; 13.1% among PLWH in Texas and 13.8% among PLWH in California.[75,76] A third study reported that individuals aged >65 years had the highest uptake (59.7%) and those aged 18–49 years had the lowest (16.7%).[56]

Barriers. Concerns about the effectiveness of vaccination and lack of insurance or provider recommendation were identified as barriers to vaccination among PLWH.[68,72,73,77,78] A 2010 cohort study of 1,293 women living with HIV cited beliefs about the effectiveness of influenza vaccination as an important barrier to uptake.[73] Within this study, those who were vaccinated were less likely to report that they were "not at risk of influenza", "flu is not a serious disease" and that "the flu shot made [them] sick".[73]

Further, lack of health insurance and the cost of vaccination have also been cited as prohibitors to vaccine uptake among PLWH.[68,72,77] A 2018 cross-sectional study of 18,089 individuals reported that lack of access to affordable vaccines for some PLWH contributed to low vaccine uptake.[72] A 2018 cross-sectional study ($N = 18,089$) reported that lack of clinical recommendation was an important barrier to vaccine uptake.[72] Similarly, inconsistency among guideline recommendations and reports of reduced immunogenicity among patients with HIV prevented physicians from regularly offering routine vaccination to this group.[72]

Immunocompromised individuals

Among the 23 publications reporting on vaccine uptake among immunocompromised individuals, uptake estimates ranged from 27.1% to 63.7% for influenza, 7.6% to 59.7% for pneumococcal disease and 19.5% to 33.2% for Tdap.[40,54,57,61,62,79–84] While vaccination rates among those with immunocompromising conditions have increased over time, uptake remains suboptimal against the 2020 Healthy People Goal (60%).[8,61] A 2018 retrospective study of 35,696,718 individuals reported an increase in pneumococcal vaccine uptake from approximately 20% between 2012 and 2014, to 24% in 2016.[8] Similarly, a 2020 observational study of 91,520 individuals reported increased influenza vaccine uptake among those with reduced kidney function, from 53.3% to 63.7% between 2005 and 2015.[61] Notably, uptake was negatively associated with disease severity, with higher uptake observed among those with normal range kidney function (eGFR ≥60: 62.9% versus eGFR <30: 57.3%).[61]

Similarly, a 2015 retrospective cohort of kidney transplant candidates ($N = 363$) in Philadelphia reported receipt of other vaccines (OR: 10.55) and dialysis (OR: 2.00) to be significantly associated with increased vaccine uptake ($p < .05$).[62] However, within this study, both Black (OR: 0.27; <0.001) and Hispanic ethnicity (OR: 0.35; $p < .05$) were significantly associated with a reduced likelihood of pneumococcal vaccination.[62]

Barriers to recommendation. Missed opportunities for vaccination due to ongoing medical treatments were identified as barriers to vaccination.[40,54,57,61,80,81] A 2016 review reporting on vaccination of special populations, including immunocompromised individuals, identified that patients with chronic medical problems may miss routine vaccinations because of frequent hospital admissions.[57] Furthermore, these patients are likely to receive care from a specialist physician rather than a primary care provider; therefore, vaccinations may be missed if specialists assume that vaccination is the responsibility of a general practitioner.[57]

Injection drug users

Five studies reported on vaccine uptake among injection drug users (IDUs), of which four reported HBV vaccination rates, with estimates ranging from 21.6% to 45.0%.[66,68,77,85] A 2012 national cross-sectional study reported that at-risk adults tested for HIV at a drug treatment facility were more likely to be vaccinated (OR: 1.73) than IDUs not being tested.[77] A fifth study reported lower uptake of the HPV vaccine (15.3%) among females in New Orleans.[78]

Barriers to vaccination. No publications reported on the barriers to vaccination among IDUs.

Men who have sex with men

Seventeen studies reported vaccine uptake for HBV, HPV, and meningococcal vaccines among MSM. Among these, HBV vaccine uptake estimates ranged from 14.0% to 50.5%.[68,77,85–89] Conversely, HPV vaccine uptake ranged from 13.0% to 39.8% among individuals completing all three doses of the vaccination series in two separate 2015 national studies.[90,91] However, a 2019 study of MSM in Philadelphia reported that only 7.0% of the study population ($N = 5,329$) received all three vaccine doses.[92] Furthermore, a 2016 study ($N = 336$) reported that HIV-positive MSM were more than twice as likely to be vaccinated compared to HIV-negative men.[93]

A 2016 study evaluating both HPV and HBV vaccine uptake among MSM in New Orleans ($N = 358$) reported higher HBV uptake compared to HPV among males (28% versus 14.9%).[78] Among MSM, HPV vaccine uptake was associated with having been tested for a sexually transmitted disease (STD) in the past 12 months ($p = .019$) and having ever received a hepatitis vaccine ($p = .004$).[78] Other sociodemographic factors, such as education, sexual identity and having health insurance, were not significantly associated with HPV vaccine uptake, and only 22.9% of individuals received both HPV and HBV vaccines.[78]

Meningococcal vaccine uptake estimates ranged from 17.0% to 51.3%.[94–96] A 2018 cross-sectional survey in California reported that vaccine uptake was higher among HIV-positive versus HIV-negative MSM overall, and in the previous 6 months (82.6% versus 51.3% in the previous 6 months).[96]

Barriers to vaccination. Lack of insurance, education and provider recommendation were identified as barriers to vaccination.[66,77,91,93,97] A 2012 nationwide survey reported that individuals who reported being unable to see a doctor because of cost were less likely to be vaccinated against HBV (OR: 0.77, 95% CI: 0.60–0.98).[77] Data collected through the National Health and Nutrition Examination Survey (NHANES) survey also identified lack of insurance as a significant negative predictor for vaccination ($p < .001$).[66]

In a 2016 study ($N = 336$), provider recommendation predicted vaccine uptake; individuals who received a recommendation for HPV vaccine were >40 times more likely to have been vaccinated than those without.[93]

A lack of education regarding HPV vaccination may be a driver of low vaccine uptake among MSM.[93,97] A 2013 study reported limited awareness as a reason for being unvaccinated: not knowing that males are allowed to get the HPV vaccination (17%), not having heard of the HPV vaccine (12%) and not knowing enough about the HPV vaccine yet (11%).[91]

Importantly, many MSM did not disclose their sexuality to their insurance provider or at medical consultations, with one study reporting that 29% ($N = 28$) of unvaccinated MSM who were not planning on being vaccinated stated that their provider did not know their sexual identity.[93] Furthermore, 41% ($N = 29$) of men who were undecided about receiving vaccination stated that their provider was not aware of their sexuality, indicating an important proportion of at-risk individuals who are therefore not targeted for vaccination recommendation.[95]

Pregnant women

Fifty-three studies reported on vaccine uptake among pregnant women, including influenza vaccination ($N = 31$), Tdap vaccination ($N = 12$) and both influenza and Tdap ($N = 8$). Influenza vaccine uptake ranged from 35.6% to 75.0%.[13,40,98–108] The highest overall uptake (75.0%) was reported in a 2018 study of expectant parents in Texas ($N = 638$).[98] Conversely, the lowest (35.6%) was reported in a 2017 nationwide study of pregnant women ($N = 2,254$).[99] Notably, vaccine uptake differed between self-reported and medical record reported uptake, with one study highlighting a clear disparity between the two (self-reported: 71% versus medical record uptake: 36.1%).[13]

Studies investigating uptake over time typically reported that vaccine uptake has typically increased in recent years (Figure 4 and 5).[23,58,109–112] However, a 2016 study of pregnant women in Georgia ($N = 8,300$) reported that the proportion of women not receiving influenza vaccination had increased from 11.1% in 2004 to 35.8% in 2011.[113]

The annual CDC reports on influenza and Tdap vaccine uptake consistently identified that older pregnant women had higher rates of influenza vaccine uptake compared to younger women.[99–102,111]

Overall, Tdap uptake ranged from 14.3% to 58.2%.[40,114–121] Similarly to influenza, Tdap uptake among pregnant women has increased in recent years, with a 2017 study ($N = 5,606$) reporting an increase from <1% (2006–2009) to 54% in 2015.[109]

Among the eight identified studies reporting on both influenza and Tdap vaccine uptake, Tdap uptake was typically higher than influenza uptake among pregnant women (Tdap: 44.0% to 65.0%; influenza 34.0% to 63.0%).[17,102,122–124]

Of two studies reporting on hepatitis vaccine uptake in pregnant women,[40,45] a 2013 study reported HAV vaccine uptake to be 29.2% among pregnant women in Boston.[40] A 2018 study evaluating the difference in HBV vaccine uptake reported this to be higher among US-born versus foreign-born women (45.1% versus 27.6%).[45]

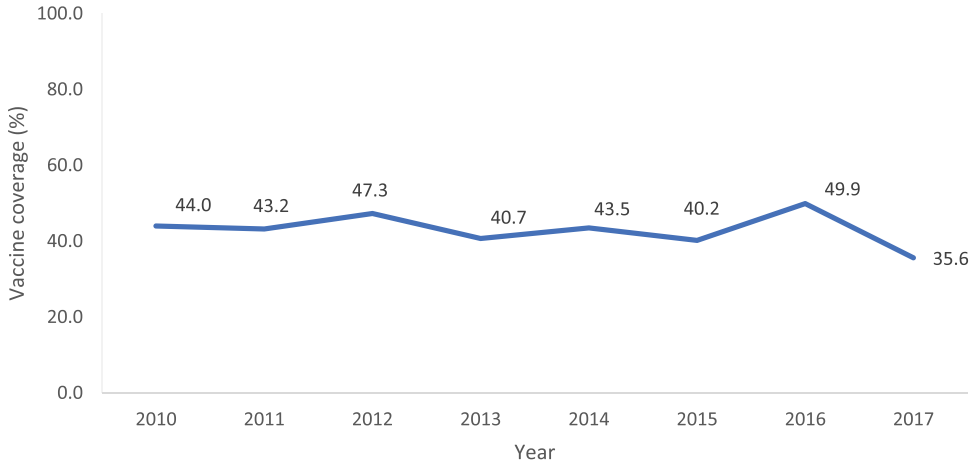

Figure 4. Influenza vaccine uptake among pregnant women, by year.[97–99,102,107,112,113]*
*Results from Nationwide Internet Panel Surveys conducted by the CDC to evaluate self-reported vaccine coverage.

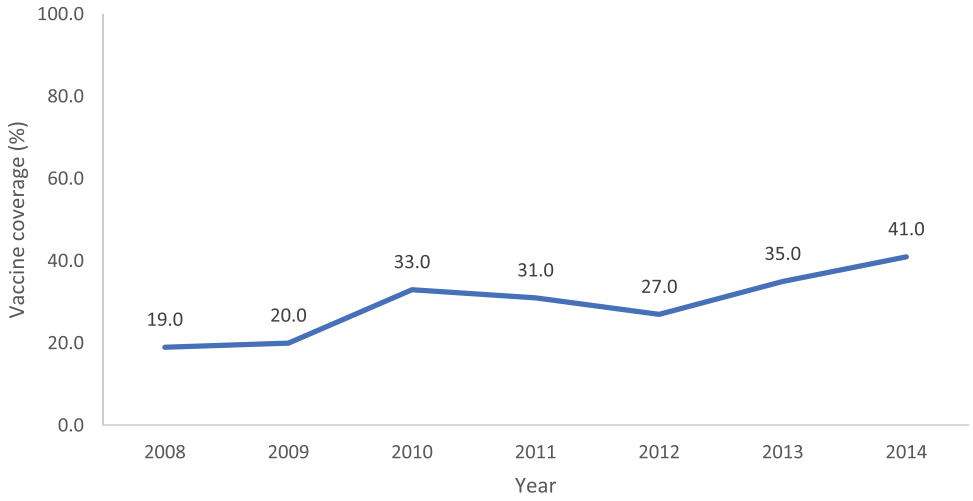

Figure 5. Tdap vaccine uptake among pregnant women, by year.[107]*
*Results from the Birth Defects study among mothers of control infants participating in the Birth Defects Study of the Slone Epidemiology Center, which included pregnant women in New York and Massachusetts and the areas surrounding Philadelphia, Pennsylvania, and San Diego, California.

Barriers to vaccination. Concerns of vaccine safety and effectiveness and lack of provider recommendation and education/guidelines were identified as vaccination barriers.[13,17,23,58,99–102,104–108,110,112,113,117,118,123–134] A yearly nationwide survey of influenza vaccination among pregnant women reported that concerns about becoming ill from the vaccine ranged from 10.4% to 21.3% between 2011–2017.[99–101,104,129,130] Notably, results from the Pregnancy Risk Assessment Monitoring System (PRAMS) survey highlighted that women who had low perceptions of influenza vaccine safety were significantly less likely to intend to receive an influenza vaccine (48% vs. 20%; $p < .001$) or a Tdap vaccine (53% vs. 33%; $p < .001$) during their current pregnancy compared to women who perceived the vaccine as safe.[127] Furthermore, a 2020 survey identified that first-time pregnant women were also more likely to be uncertain about maternal vaccines compared to women with prior children (8% vs. 19%, $p < .01$).[124]

Concerns over the safety of the vaccine for both the mother and their baby was a commonly cited barrier against vaccination. During a study of the 2009–2010 vaccine season by the CDC, among those who did not get vaccinated for influenza ($N = 2,994$), 45.2% women cited they were worried about side effects for themselves and 47.7% were worried the vaccine would harm the baby.[125] Similarly, of those who did not get the H1N1 vaccination, the majority were worried the vaccine would harm themselves (61.4%) or their baby (63.6%).[125]

Lack of provider recommendation was particularly evident among pregnant women, with a 2010 CDC study using PRAMS data reporting that 31.4%/24.8% of pregnant women did not receive the seasonal influenza vaccination/H1N1 vaccination, respectively, because their physician did not recommend it.[125] In a 2012 study investigating PH1N1 vaccine uptake among women during pregnancy ($N = 4,205$), 9.6% of individuals were not vaccinated due to a lack of recommendation from their provider.[128] Conversely, influenza vaccine uptake among pregnant women was highest among women who reported their doctor or other medical professional recommended and offered the vaccination compared to a recommendation but no offer and no recommendation or offer at all.[99,100,113] A medical provider's recommendation also increased the likelihood of accepting the vaccine by 2.6 ($p < .01$).[13]

In a 2018 nationwide internet survey ($N = 2,236$), the most common reason for not receiving Tdap during pregnancy was a lack of knowledge about the need to be vaccinated during every pregnancy (45.1%): 31.6% of women who did not receive vaccine during pregnancy reported having been vaccinated previously, and 13.5% reported not knowing they were supposed to receive Tdap during their recent pregnancy.[123]

Discussion

This review identified that, overall, vaccine uptake has increased across at-risk populations over the past 10 years. Despite this, uptake among at-risk adults was typically below the Healthy People 2020 goal of 60% uptake.[135] Several barriers to vaccination were commonly reported across populations; including, structural barriers such as cost of vaccination and lack of health insurance, and patient-centered barriers such as concerns regarding vaccine safety and lack of provider recommendation. However, there were limited data reporting on barriers to vaccination among several at-risk populations, including individuals with CLD, ESRD, and IDUs.

Studies have demonstrated that a lack of health insurance coverage and high costs can be an obstacle to vaccination, resulting in a high burden of VPDs among at-risk populations.[68,72,77] There is evidence that vaccine uptake increases when cost is removed as a barrier; therefore, it is important that there is support from State or Federal policymakers to remove these financial barriers.[15,136,137] The Affordable Care Act (ACA) mandates that ACIP-recommended vaccines are covered by private insurance plans without a copay, therefore reducing the financial barrier to insured at-risk adults receiving vaccines.[138] However, the ACA does not require State Medicaid agencies to cover all ACIP recommended vaccines for individuals on Medicaid, resulting in a disparity of coverage compared to individuals with private insurance.[138] This implies that the cost of vaccination may not be the main barrier to vaccination; however, vaccination cost barriers need to be considered in the context of the potential lack of private insurance among at-risk individuals and a reliance on Medicaid coverage.[15,136–138]

In order to support effective life-course immunization, it is imperative that HCWs are equipped with the guidelines, training, and tools to provide individualized, patient-centered care. This includes open discussions with patients about the availability of vaccination and the eligibility to receive vaccination.[139] Additionally, these data emphasize the importance of educating individuals about their increased risk of VPDs and publicly promoting the availability of vaccines to contribute in mitigating this risk.[139] Integrating vaccination with other primary health care systems, health registers, and notification systems will minimize missed vaccination encounters.[1] Moreover, telephone and digital reminders to vaccine-eligible adults have proven effective in reducing missed opportunities for vaccination, whilst also benefiting pediatric vaccine coverage.[1,140]

An important element of life-course immunization is continued education of the public and HCWs to highlight the risk of VPDs and emphasize the important role of vaccination.[2] In order to overcome barriers related to vaccine safety and effectiveness, wider vaccine education needs to be implemented throughout an individual's lifetime to reduce vaccine complacency.[2,7] The wider literature supports the need for more vaccine education materials, outlining facts about vaccines and the diseases they prevent, common misconceptions, and the risks of not getting vaccinated, as key education topics for individuals.[2–4,7,135] Studies have indicated that sessions delivering educational interventions greatly increased vaccine knowledge among target groups, such as HCWs, resulting in increased support for vaccination.[141] This review has identified the need for clear and consistent guidelines for HCWs, since HCW attitude toward vaccination has been recognized as one of the strongest influences on the decision-making of patients.[7] This is particularly important since there were mixed perceptions and a lack of knowledge around vaccination among HCWs, with some citing safety concerns as a reason for not recommending vaccines for pregnant women.[13]

Life-course immunization policies, such as the WHO Immunization Agenda 2030, focusing on increasing awareness regarding the health benefits of vaccination, together with cross-sector collaboration to prioritize vaccination, will improve vaccine uptake and reduce the burden of VPDs.[1,2,4,142] Focused polices and integrated vaccination in public and private payer access programs will promote increased uptake of adult vaccination. It is critical that key stakeholders, including HCWs, are engaged with vaccination policies and guidelines to ensure successful uptake of life-course immunization and reduce missed opportunities for vaccination.[1,2,4,142]

Strengths and limitations

This comprehensive review applied a wide timeframe to ensure all key publications and any key updates in this research area were captured, such as updates to ACIP recommendations and changes to vaccination receipt.

There are several limitations to consider. Many ($N = 44$) of the identified studies reporting on vaccine uptake were surveys that relied on self-reported individuals' vaccination history, which may have led to recall bias and a potential over- or underestimation of vaccine uptake. Despite potential biases in the estimated vaccine uptake, this literature review identified vaccine uptake data among several at-risk populations. Additionally, it should be noted that direct comparisons cannot be made between vaccine uptake rates due to the heterogeneity in sampling methods and study populations. Finally, the search was limited to the English Language; it may be possible that further evidence is published in other languages. However, this is a minor limitation, given the review was US-focused.

Conclusions

Despite the substantial burden that VPDs confer on both individuals and healthcare systems, vaccine uptake is suboptimal and remains below the Healthy People 2020 goals across many adult at-risk populations. This suboptimal vaccine uptake facilitates the continued burden of VPDs and therefore reinforces the importance of life-course immunization.

This literature review identified several key barriers to vaccination, including concerns regarding perceived vaccine safety and effectiveness, cost of vaccination, and lack of insurance and

provider recommendation. These barriers represent missed opportunities for vaccination of individuals in at-risk populations and emphasize the importance of continued education, clear guidelines, and policies to promote higher vaccine uptake. Embracing a national life-course immunization program provides opportunities to improve immunization policies and increases attention to the importance of vaccines throughout life.

Future research needs to focus on identifying the barriers to vaccination among these populations, in order to appropriately target individuals for vaccination and improve suboptimal vaccine uptake.

Disclosure statement

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Author contributions

IK, MKN, MOB, AK, DB, and IF contributed to study conception and study design. All authors contributed to the writing of the manuscript. All authors reviewed and approved the final version of the manuscript.

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