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REVIEW

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Expanding vaccination provider types and administration sites can increase vaccination uptake: A systematic literature review of the evidence in non-United States geographies

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ABSTRACT
Vaccination is a successful public health intervention; however, vaccine-preventable diseases continue to pose global health risks due to insufficient uptake. Expanding authority for "alternative" or complementary healthcare providers to administer vaccinations, as well as approving additional non-clinical vaccination sites, could improve access to and uptake of vaccines. The value of complementary providers and expanded sites has been documented in the United States; however, there is limited evidence in geographies outside the United States. To address this gap, we conducted a systematic literature review to identify studies that evaluated vaccination by complementary providers and/or at expanded sites outside of the United States. Of 943 identified records, 18 met our inclusion criteria and were conducted in Australia (4), Canada (6), the United Kingdom (3), Peru (2), Cameroon (1), or in multiple geographies (2). All studies demonstrated that expanding provider types and sites could positively impact vaccine uptake and/or provide additional benefits.

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Introduction

Vaccinations are one of the most successful public health strategies for preventing disease at the individual and population level.[1,2] However, some vaccines are still underused, particularly among adults. For example, a 2022 review of 522 studies from 68 countries/regions reported the influenza vaccination rate of 24.96% (95% CI 23.45%–26.50%) in the general population.[3] Global coverage data for other adult vaccines varies significantly due to healthcare infrastructure, vaccine policies, and availability, but evidence suggests that vaccination coverage rates (VCRs) for other adult vaccines, such as HPV, pneumococcal, and herpes zoster, are also well below coverage targets. While vaccination rates vary greatly from country to country and by vaccine, many countries are still failing to reach target vaccination coverage rates (VCRs).[4,5]

Cost, time, and inconvenient vaccination locations have been documented as barriers to accessing vaccinations and thus pose a key challenge to achieving target VCRs.[6] Offering additional locations for vaccination services and extending authorization for non-physician health professionals to administer vaccines can expand access, improve convenience, and support higher VCRs.[7–15] "Alternative" or complementary providers who could be authorized to administer vaccines may include pharmacists, pharmacy technicians, community health workers, and midwives.[12–19] The sites at which vaccines can be administered could also be expanded beyond clinical facilities, allowing both traditional and complementary providers to offer vaccination at expanded sites such as pharmacies, school-based health clinics, workplaces, dental offices, mobile clinics, assisted-living facilities, and people's homes.[20–26] Expansion of vaccine administration services to include expanded delivery sites and complementary providers must consider relevant policy and logistical factors; for example, providers must receive appropriate training and have an expanded scope of practice, and non-clinical facilities must have the space and appropriate equipment to store and administer vaccines, monitor for adverse reactions, and record vaccination events.

The value of complementary providers and expanded sites in promoting vaccine uptake has been best documented in studies from the United States (US). Many US studies have shown that expanding the types of settings in which vaccines can be administered, and the provider types authorized to administer vaccines, can increase VCRs among the target populations and provide a convenient and acceptable way to increase access to vaccination.[27–32] In contrast, there is more limited evidence on whether these or other complementary vaccination pathways can increase uptake of various types of vaccines in geographies outside the US.[33,34] Potential differences in, for example, health care systems, regulations, infrastructure, historical context (including location-specific factors related to the level of trust in vaccination and in health care providers), and the roles of pharmacists and other complementary providers in other countries may lessen the impact of expanding vaccination provider types and administration sites.[35]

To broaden our understanding of complementary vaccination strategies, we conducted a systematic literature review (SLR) on how policies that expand vaccination to complementary providers and/or sites affect vaccine uptake outside the

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US. As a secondary objective, we identified barriers to and facilitators of these expanded vaccination strategies.

Methods

We conducted an SLR using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 reporting guidelines.[36] This protocol was registered with the PROSPERO international prospective register of systematic reviews, registration number CRD42022375171.

Search strategy

We conducted a search in September 2022 in Embase and PubMed. Key search terms included *vaccination, vaccination coverage, vaccines, immunization, immunization programs, pharmacist, dentist, community health worker, allied health personnel, birth attendant, maternal care provider, nursing student, physician assistant, mobile clinic, community pharmacy*, and *drug store* (full list provided in Supplementary Table S1). We also used a snowballing search method by reviewing and screening all articles included in other SLRs and meta-analyses that met our inclusion criteria.[37,38]

Study selection

We included peer-reviewed studies conducted outside the US and published in English between January 1, 2000 and September 7, 2022, to reflect the expansion of pharmacists' scope of work to include vaccination in early-adopter countries such as the US and Canada in the mid-to-late 1990s and early 2000s. Full details of the Patient, Intervention, Comparison, Outcome, Time, and Study design (PICOTS) inclusion and exclusion criteria are presented in Table 1. Eligible studies had at least one primary outcome, defined as impact on vaccination (captured as, for example, annual vaccine uptake, cumulative VCR, or initiation or completion of a vaccination series). For studies that reported an eligible primary outcome(s), we also extracted any secondary outcomes related to barriers and facilitators of the evaluated policies and programs, including the feasibility, acceptability, and public perception of vaccination services, in general and when offered at a particular location or by a specific provider type.

The inclusion criteria for provider type captured any intervention, program, or policy change that allowed complementary (i.e., non-physician) providers to administer vaccines that are routinely recommended in the country of study, which we defined as all vaccines, except those recommended for travel, and outbreak or pandemic-related vaccines (e.g., COVID-19, Ebola). For administration sites, we included any intervention, program, or policy change that allowed or facilitated the administration of routine vaccines at expanded locations, including any non-clinical locations or other settings where vaccinations can be administered, such as pharmacies, schools, workplaces, dental offices, mobile clinics, assisted-living facilities, and in-home services. We distinguished expanded site studies of school-based health clinics for enrolled students from those

Table 1. Patient, intervention, comparison, outcome, time, and study design (PICOTS) criteria.

Study variable	Inclusion criteria	Exclusion criteria
Population	• Populations of any age in any country outside the US eligible for any routine vaccination as defined by the country in which the study took place, except vaccines used for travel, outbreaks, or pandemics such as COVID-19	• Populations in the US • Populations vaccinated with pandemic- or outbreak-related vaccines • Populations vaccinated for travel purposes, as defined by the country where the study was completed
Intervention	• Any intervention, program, or policy change that allows or facilitates non-COVID-19 vaccination or non-travel vaccinations at complementary sites, by either traditional vaccine administrators or complementary providers • Any intervention, program, or policy change that allows complementary providers to administer non-COVID-19 or non-travel vaccines	• Supplemental immunization activities • Education and advocacy campaigns that drive awareness of vaccination only • School-based vaccination of enrolled students
Comparison	• Non-COVID-19 or non-travel vaccinations administered only in clinical settings by traditional vaccination providers	• Not applicable

Outcome	• Primary outcomes (all continuous)
	  ○ Vaccination coverage rates, captured as annual uptake, cumulative coverage rates, or vaccination series initiation or completion
	• Secondary outcomes (collected only from studies with primary outcomes; all continuous)
	  ○ Feasibility of vaccinations
	  ○ Acceptability of receiving vaccinations
	  ○ Perception of vaccination services (public, healthcare providers, key opinion leaders)
		• Not applicable

Time	• Published between January 1, 2000, and September 7, 2022	• Published prior to January 1, 2000

Study design	• Randomized controlled trials
	• Non-randomized/intervention trials (including single-arm studies)
	• Observational studies
	  ○ With controls (e.g., retrospective studies, case control studies)
	  ○ Without controls (e.g., cross-sectional studies, cohort studies without controls, case series)
	• Registry studies
	• Natural history studies
	• Other systematic reviews
		• All other study types

Other	• Peer-reviewed studies published in English	• Gray literature/nonscientific reports and any other unpublished reports • Studies published in a language other than English

that assessed any other form of school-based vaccination, and included only the latter. We excluded school-based health clinics for enrolled students because this is an evidence-based vaccination strategy that has already been extensively demonstrated to improve VCRs for school-aged students[23,39–41]; further, school-based vaccination of enrolled students is already used as a standard vaccination delivery pathway for select routine vaccines in many countries.[42] We also excluded non-routine supplemental immunization activities at non-clinical locations, defined by the World Health Organization (WHO) as vaccination campaigns that aim to "deliver vaccination to all targeted individuals regardless of their vaccination status (prior history). The aim is to rapidly raise population level immunity and reduce the number of susceptibles in order to achieve disease control or elimination goals."[43]

Studies identified by our initial search were screened by two researchers, who independently reviewed all titles and abstracts and removed publications that did not meet the inclusion criteria. Articles that met these criteria were included in the full-text review, which was independently conducted by the same two researchers. Conflicts regarding study inclusion during the initial screen and after the full-text review were resolved by a third independent reviewer. We recorded rationales for excluded articles at each stage, per the PRISMA diagram guidelines.[36]

Study quality assessment in included studies

Before conducting our full analysis, we assessed each included study's quality and risk of bias using standardized quality-rating tools. We assessed randomized controlled trials (RCTs) using Cochrane's risk-of-bias tool[44] and non-RCTs using the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies.[45] After reviewing and coding each study with the respective tool, we included in our full analysis only those studies that received a high or medium quality rating (Supplementary Table S2).

Data collection

A data extraction table was used to collect key information and characteristics for each included study: i.e., study design, vaccine types, geographies, time frames, populations, outcomes measures, analysis methods, results, and secondary outcomes. We then conducted a thematic analysis to understand the frequency and outcomes of topic categories. Given the heterogeneity across study designs and objectives, a meta-analysis was not conducted.

Results

Summary of study characteristics

Of 943 identified records, 18 met the inclusion criteria, of which two were SLRs with meta-analyses,[35,46] one was an RCT,[47] and 15 were non-RCTs (Figure 1, Table 2).[48–62] The 16 non-SLR studies were conducted across five countries and five continents and evaluated the impact of complementary providers and/or expanded vaccination sites on the uptake of vaccines for human papillomavirus (HPV; 3 studies), influenza (12 studies), and pertussis (1 study). The SLRs included evidence from multiple countries and vaccine types, including influenza, HPV, pneumococcal, herpes zoster, and pertussis-containing vaccines.

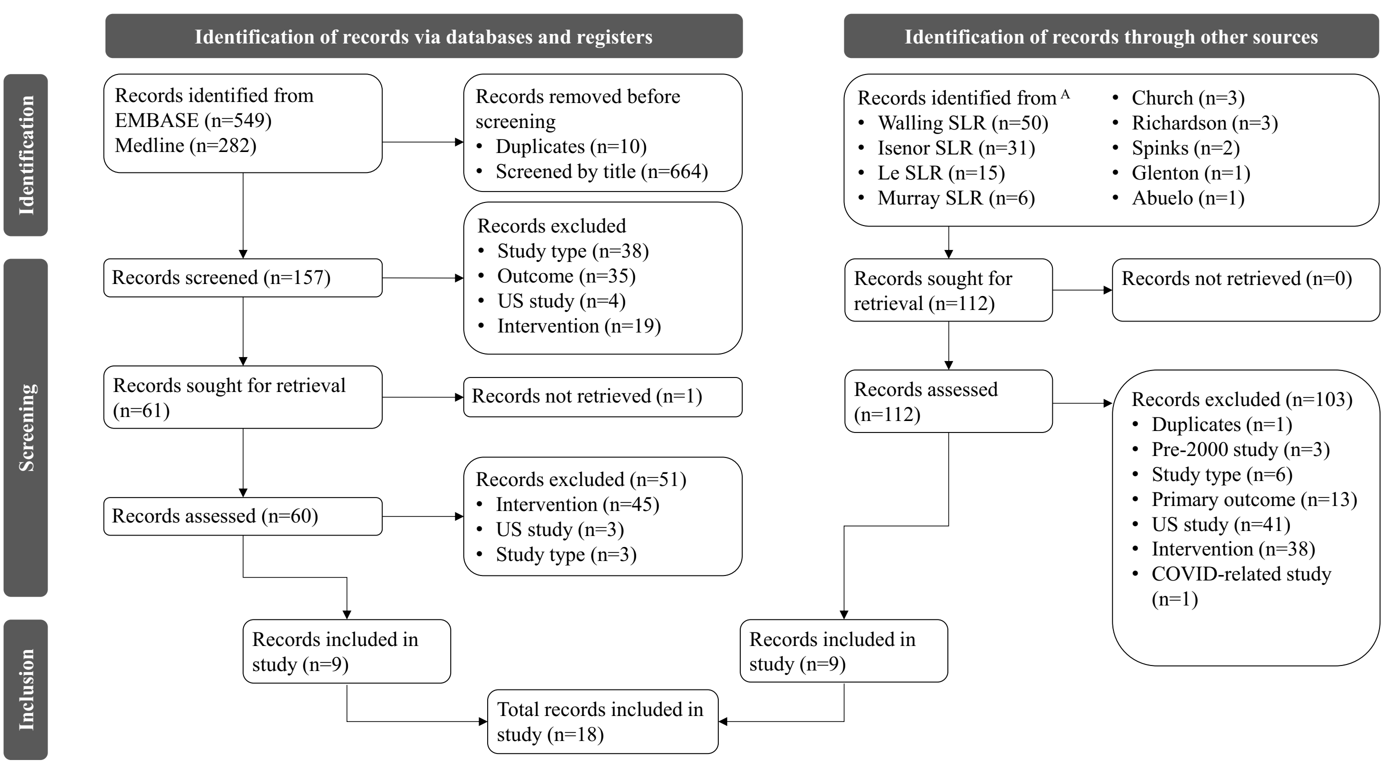

Figure 1. PRISMA flow diagram for selection of studies. SLR, systematic literature review. A References: [34,35,46,48,63–67]

Table 2. Characteristics of included studies.

Citation	Intervention: provider; vaccine; setting	Geographic location	Target population for vaccination	Sample Size	Study details: study design; study period; comparison; outcome; data collection method	Key results (primary outcome) [A]
Abuelo *et al.*, 2014	• Community health workers • HPV • Community-based settings	Rural and urban communities in the Amazon jungle, Peru	Girls 10–13 years of age	318 girls	• Non-randomized intervention • Not reported • No comparison • Vaccination series initiation and completion • Vaccination rates recorded via research study forms	• 98% of girls received the first vaccine dose via community-based vaccination program • 88% received the second dose • 65% received the third dose
Atkins *et al.*, 2016	• Pharmacists • Influenza • Community pharmacies	London, United Kingdom	Individuals ≥13 years of age	• 1,230 pharmacies • 1,406 GPs • 2013/2014: 68220 influenza doses • 2014/2015: 108,186 influenza doses	• Non-randomized intervention • 2010–2015 • Pre-post • Vaccination uptake; cost of vaccine delivery; pharmacist and GP opinions of pharmacist-administered vaccination • Vaccination uptake data via pharmacy (Sonar) and GP (ImmForm) reporting systems; survey administered to pharmacists and GPs	• No statistically significant increase in influenza vaccination uptake ($p = .36$) • Increase in proportion of eligible individuals vaccinated at pharmacies ($p < .001$) • Statistically significant increase in proportion of influenza vaccine doses administered at pharmacies between the first and second year of the initiative ($p < .001$)
Buchan *et al.*, 2017	• Pharmacists • Influenza • Community pharmacies	Canada	Individuals ≥12 years of age, excluding residents of reservations and remote regions of Quebec, people in institutions, and military personnel	481,526 individuals	• Non-randomized intervention • 2007–2014 • Province without a policy allowing pharmacists to administer influenza vaccines • Vaccination uptake • Nationally representative cross-sectional survey of Canadian residents	• 2.2% higher seasonal influenza VCR in provinces with versus without pharmacist administration policies (pooled analysis of 2007–2014 survey cycles)
Carroll & Hanrahan, 2016	• Pharmacists • Influenza • Community pharmacies	New South Wales, Australia	Individuals ≥18 years of age	• 36 pharmacists • 25 community pharmacies	• Non-randomized intervention • 2016 • No comparison • Vaccine doses administered; pharmacists' perspectives and experiences • Survey administered to pharmacists; interviews	• Pharmacists at 25 community pharmacies delivered 2,253 influenza vaccinations to adults between 17 April and 31 July 2016 • 15% of recipients had never received an influenza vaccine before
Deslandes *et al.*, 2020	• Pharmacists • Influenza • Community pharmacies	Wales, United Kingdom	Individuals ≥65 years of age, "at-risk" individuals (e.g., pregnant, living at residential care facilities, health care workers, with certain medical conditions)	103,941 influenza vaccinations	• Non-randomized intervention • 2009–2018 • Pre-post • Doses administered; proportion of vaccines administered by pharmacists; patient demographics and reason for utilizing the service • Claims data	• Strong positive correlation between vaccinations by pharmacists and total vaccination numbers during the study period ($R = 0.9316$, $p < .01$) • Community pharmacists consistently engaged individuals "at-risk" and ≥65 years of age more effectively than GPs without reducing the number of GP-administered vaccinations
Hattingh *et al.*, 2016	• Pharmacists • Influenza • Community pharmacies	Western Australia	Individuals ≥18 years of age	• Baseline survey: 86 pharmacies • Exit survey: 78 pharmacies • Computer records: 57 pharmacies • Interviews: 25 pharmacists	• Observational without controls • 2015 • No comparison • Vaccine doses administered; pharmacist experiences • Baseline and exit surveys administered to pharmacists; interviews with pharmacists; pharmacy computer records	• Pharmacists from 76 pharmacies administered 15,621 influenza vaccinations between March and October 2015 • Nearly 12% of individuals were eligible for free influenza vaccinations under the National Immunization Program but chose to be vaccinated at a pharmacy
Isenor *et al.*, 2018	• Pharmacists • Influenza • Community pharmacies	Nova Scotia, Canada	Individuals ≥6 months of age	Population of Nova Scotia, 2006–2016	• Non-randomized intervention • 2006–2016 • Pre-post • VCRs • Nova Scotia census data with aggregate immunization administration data	• 6% increase in seasonal influenza VCR following the introduction of pharmacist-administered vaccination

(*Continued*)

Table 2. (Continued).

Citation	Intervention: provider; vaccine; setting	Geographic location	Target population for vaccination	Sample Size	Study details: study design; study period; comparison; outcome; data collection method	Key results (primary outcome) [A]
Isenor *et al.*, 2016a[B]	• Pharmacists • Influenza, pneumo, herpes zoster, tetanus-containing • Community pharmacies	Multi-country	All individuals eligible to receive vaccinations in a given jurisdiction	36 studies	• Systematic literature review and meta-analysis • Inception–2015 • Multiple comparisons • VCRs • Publications from PubMed, EMBASE, Cochrane Libraries, Cumulative Index to Nursing and Allied Health Literature, International Pharmaceutical Abstracts, and Google Scholar	• All studies that evaluated pharmacists as administrators (14/36) reported an increase in vaccination coverage when compared with vaccine administration by traditional providers without pharmacist involvement
Isenor *et al.*, 2016b	• Pharmacists • Influenza • Community pharmacies	Nova Scotia, Canada	Individuals ≥5 years of age	78,102 influenza vaccinations administered by pharmacists in 2013/2014 season	• Observational without controls • 2010–2014 • Pre-post • VCRs • Immunization records recorded via 1) physician billing records; 2) pharmacist billing records; 3) district-level Public Health Services data	• 5.9% increase in seasonal influenza VCR ($p < .001$) among individuals ≥5 years of age following the introduction of pharmacist-administered vaccination • 9.8% increase in seasonal influenza VCR ($p < .001$) among individuals ≥65 years of age
Krishnaswamy *et al.*, 2018	• Midwives • Pertussis • Pregnancy care clinics	Melbourne, Australia	Pregnant women receiving maternity care at Monash Health (3 hospital sites)	• Pre: 2,848 deliveries • Post: 1,766 deliveries	• Non-randomized intervention • 2015–2017 • Pre-post • Vaccination uptake • Immunization records recorded via state-wide perinatal database	• Statistically significant increase in vaccination uptake following introduction of policy authorizing midwife standing orders to administer maternal vaccinations (91% coverage after versus 39% before policy change; $p < .001$)
Le *et al.*, 2022[B]	• Pharmacists • Influenza, pneumo, herpes zoster, Tdap, others • Community pharmacies, hospitals, clinics, other settings	Multi-country	Multiple populations	• 14 RCTs • 79 observational studies	• Systematic literature review and meta-analysis • Inception–2022 • Studies required a comparator group to be included in the review and analysis • Immunization rates • Publications from MEDLINE, Embase, and Cochrane Central Register of Controlled Trials databases	• All nine observational studies of pharmacists as immunizers reported an increased rate of vaccination associated with pharmacist involvement
Levinson *et al.*, 2013	• Community health workers • HPV • Community settings	Manchay, Peru	Girls 10–13 years of age	352 girls	• Non-randomized intervention • 2009 • No comparison • Vaccination series initiation and completion; satisfaction rates • Patient data collection; face-to-face evaluations	• Vaccination program achieved an HPV vaccine series completion rate of 93%
Marra *et al.*, 2014	• Pharmacists and nurses • Influenza • Community pharmacies	Rural communities in British Columbia, Canada	"High-risk" individuals including those ≥65 years of age and those 2–64 years of age with ≥ 1 chronic condition	• 24 communities • 2009: 1,216 individuals • 2010: 1,998 individuals	• Cluster RCT • 2009–2010 • Intervention communities (pharmacy-based influenza vaccination clinics held and promoted) versus control communities • Vaccination uptake • Immunization records captured via health authority records and local pharmacy records; population statistics recorded via national census data; chronic conditions statistics recorded via Canadian Institute for Health Information and Canadian Community Health Survey data	• Statistically significant increase in influenza vaccination rates among individuals ≥65 years of age in the 14 intervention communities with pharmacy vaccination (80.1%) compared with 15 control communities (56.9%, $p = .01$)

(*Continued*)

Table 2. (Continued).

Citation	Intervention: provider; vaccine; setting	Geographic location	Target population for vaccination	Sample Size	Study details: study design; study period; comparison; outcome; data collection method	Key results (primary outcome) [A]
McDerby *et al.*, 2019	• Pharmacists • Influenza • Residential care facility	Australia	Employees working at residential care facilities	• 2016: 71 employees • 2017: 78 employees	• Non-randomized intervention • 2016–2017 • Pre-post • VCRs • De-identified employee influenza vaccination records	• 22.7% increase in influenza vaccine uptake following introduction of an influenza vaccination program in one residential care facility, compared with previous year ($p < .01$)
Ogembo *et al.*, 2014	• Nurses • HPV • Community-based sites (e.g., mobile clinics, schools)	Yaoundé/ Northwest and Southwest Regions, Cameroon	Women 9–26 years of age	• First dose: 6,851 girls • Second dose: 6,517 girls • Third dose: 5,796 girls	• Non-randomized intervention • 2010–2012 • No comparison • Vaccination coverage series initiation and completion • Vaccination coverage recorded via Cameroon Baptist Convention Health Services research project database	• Vaccination program achieved 84.6% series completion rate among girls receiving the first HPV dose • Of those who completed the series, 31.1% received their third dose at a community-based site
O'Reilly *et al.*, 2018	• Pharmacists • Influenza • Community pharmacies	Ontario, Canada	Individuals ≥5 years of age	• 2011/2012: 2.6 million influenza vaccinations • 2014/2014: 3.1 million influenza vaccinations	• Observational with controls • 2011–2014 • Pre-post • VCRs; costs • Pharmacist and physician billing data; public health influenza vaccination distribution data	• 3% increase in seasonal influenza VCR following the introduction of pharmacist-administered vaccination • Pharmacists administered ~ 765,000 influenza vaccine doses annually
Papastergiou *et al.*, 2014	• Pharmacists • Influenza • Community pharmacies	Toronto, Canada	Individuals ≥5 years of age	• 2,498 influenza doses • 1,502 surveys	• Observational without controls • 2013 • No comparison • Vaccine doses administered; patient experiences and perceptions • Survey administered to vaccine recipients	• Pharmacists delivered 2,498 influenza vaccinations at four community pharmacies between October and November 2013 • 25% of patients surveyed were not regular annual influenza vaccine recipients • 28% and 21% of all patients and all high-risk patients, respectively, reported that they would not have received vaccinations if services were not available in pharmacies
Warner *et al.*, 2013	• Pharmacists • Influenza • Community pharmacies	Isle of Wight, United Kingdom	Individuals ≥12 years of age, except pregnant or immune-compromised individuals	• 18 community pharmacists • 2,837 individuals	• Non-randomized intervention • 2010–2011 • VCRs; patient experiences with pharmacy-based vaccination • Immunization records recorded via electronic database; survey administered to vaccine recipients	• Pharmacists administered 2,837/29,395 (9.7%) of influenza vaccines in the study population • 69.5% of vaccines administered at pharmacies were received by individuals ≥65 years of age, 21.6% by individuals <65 years of age and within a defined clinical risk group, 6.0% by frontline health care workers, and 2.9% by other carers

CI, confidence interval; GP, general practitioner; HPV, human papillomavirus vaccine; pneumo, pneumococcal vaccines; RCT, randomized controlled trial; RR, risk ratio; Tdap, tetanus, diphtheria, and acellular pertussis vaccines; VCR, vaccination coverage rate.
[A]Several studies evaluated outcomes in addition to the outcomes reported in this table. Outcomes reported in this table pertain only to the scope of this review.
[B]Systematic literature review, including US and non-US studies. Meta-analyses were included but not reported here, since the data included in the meta-analyses were derived entirely or partly from US studies.

The two SLRs evaluated the impacts of pharmacists as vaccinators, facilitators, and educators across multiple countries.[35,46] Both included data from US studies in the associated meta-analyses. The RCT estimated the impact of providing pharmacy-based vaccination clinics and outreach in rural communities in British Columbia, Canada.[47] Of the remaining 15 studies, 11 evaluated pharmacist-administered vaccination, including at community pharmacies,[49–55,59,61,62] and residential care facilities.[49–55,58,59,61,62] The remaining four studies evaluated other providers administering vaccination at expanded sites, including midwives at pregnancy care clinics,[56] community health workers in community-based settings,[48,57] and nurses at community-based sites.[60] Seven studies evaluated specific subpopulations: adolescent girls and young women in Peru[48,57] and Cameroon,[60] residential care facility employees in Australia,[58] pregnant women in Australia,[56] and individuals ≥65 years of age or "at-risk" (e.g., due to underlying medical conditions) in Canada[47] and the UK.[52]

Across the 16 non-SLRs, seven studies estimated impacts on vaccine uptake using a pre-post analysis,[49,52,54–56,58,59] whereas two compared vaccine uptake in regions with expanded vaccination services to comparison regions.[47,50] Among the seven studies with no comparison group, three estimated rates of vaccination series completion[48,57,60] and four estimated vaccine doses administered.[51,53,61,62]

Summary of study findings

Studies on the evaluation of pharmacist-administered vaccination

Two prior multi-country SLRs were included in the analysis. The first assessed the impact of pharmacists as vaccine administrators, educators, advocates, or facilitators and found that pharmacist involvement in any role increased vaccine coverage in all 36 included studies.[46] A meta-analysis of two RCTs[68,69] was also conducted, but both RCTs were conducted in the US and thus the results of the meta-analysis were excluded from the current study. A second SLR identified 12 RCTs and 67 observational studies that assessed the impact of pharmacists on vaccination, and again observed a positive association between pharmacist involvement in any role and increased vaccination rate.[35] The associated meta-analysis included one US RCT and one Canadian pooled RCT[47,68]; the Canadian study was also identified in our SLR and is discussed separately below.

Six primary studies evaluated whether there was a statistically significant impact on vaccine uptake of policies allowing pharmacists to administer vaccinations. Three of these studies evaluated how policies allowing Canadian pharmacists to be vaccinators affected seasonal influenza VCRs; one estimated a VCR increase of 5.9% among people ≥5 years of age in Nova Scotia ($p < .001$),[54] and another estimated a 2.2% increase in VCR, with an increased likelihood of uptake (prevalence ratio 1.05, $p < .05$).[50] A third study evaluated a cluster RCT of community-based vaccination clinics in rural British Columbia, Canada, and observed statistically similar mean overall influenza immunization rates in intervention versus control communities in 2009 ($p = .79$).[47] In a subgroup analysis segregated by age, among individuals ≥65 years of age the mean immunization rate in 2010 was significantly higher in the intervention communities (80.1% versus 56.9% in control communities; $p = .01$), although the reverse was true for at-risk individuals 2–64 years of age (16.3% in intervention communities versus 21.2% in control communities; $p = .04$).[47] In another study, pharmacists in a vaccination clinic in an Australian residential care facility increased the influenza VCR among staff by 22.7% ($p < .01$).[58] A longitudinal study in Wales, UK showed that although the number of vaccinations delivered by both community pharmacists and general practitioners (GPs) generally increased over time, the proportion of vaccinations delivered by community pharmacists increased from 0.3% in 2012–2013 to 5.7% in 2017–2018; this increasing proportion was positively correlated with total vaccination numbers ($R = 0.9316$, $p < .01$).[52] Another study of a pharmacist-administered influenza vaccination pilot program in London, UK did not show a statistically significant change in VCR; however, there was a rise in the proportion of eligible individuals vaccinated at pharmacies, and a statistically significant increase in the proportion of influenza vaccine doses administered at pharmacies between the first and second year of the initiative ($p < .001$).[49]

Two studies estimated the impact of pharmacists as vaccinators using methods that did not include statistical analysis. Both reported that policy changes that allowed pharmacists to administer vaccines were associated with an increase in the overall number of vaccines administered: specifically, the studies observed a 17% increase in the number of influenza vaccines administered in Ontario, Canada in the first year after the policy change compared to the previous year[59] and a 6.0% increase in the influenza VCR among individuals ≥5 years of age and a 9.8% increase among those ≥65 years of age in Nova Scotia, Canada.[54]

Four studies of complementary provider policies captured vaccine uptake but did not compare the uptake of vaccines administered by complementary providers to a comparison group or time period. These studies focused on administration of the seasonal influenza vaccine by pharmacists, and each showed that complementary providers specifically improved access to vaccination. A Canadian study showed that four community pharmacies in Toronto delivered 2,498 influenza vaccine doses over 8 weeks in 2013,[61] while another study found that pharmacists administered 9.7% of all influenza vaccinations in the Isle of Wight, UK during the first annual campaign that allowed pharmacists to participate.[62] One Australian study showed that pharmacists from 76 community pharmacies in Western Australia delivered 15,621 influenza vaccines to adults in 2015, and delivered a larger proportion of all influenza vaccines in rural than urban communities[53]; another reported that 36 pharmacists across 25 pharmacies in New South Wales administered 2,253 influenza vaccines to adults during 2016.[51]

Studies on the evaluation of other complementary providers beyond pharmacists administering vaccinations at expanded sites

Four studies evaluated the impact of non-pharmacist complementary provider types administering vaccination at expanded sites, including midwives at pregnancy care clinics, community health workers in community-based settings, and nurses at community-based sites. A study conducted in Australia assessed the impact of hospital-based administration of a maternal pertussis-containing vaccine following the implementation of an expanded standing order permitting midwives to administer the vaccine during the third trimester (postpartum vaccination by midwives was already permitted under a previous standing order).[56] The study reported that the intervention significantly increased the uptake of maternal pertussis vaccination at all three participating hospital sites: from a median of 55% of all deliveries to 68% at a hospital with a preexisting on-site, nurse-led immunization service ($p = .01$); from 39% to 91% at a hospital where the expanded standing order was introduced before the study period ($p = .003$); and from 65% to 88% at a hospital where the expanded standing order was introduced at the beginning of the study period ($p = .002$). Three additional studies lacked study designs that could be used to evaluate the statistical significance of the effects. All three studies focused on HPV vaccination; populations in which baseline vaccination rates were zero; and interventions that included educational materials, active outreach, follow-up, and vaccinations administered at schools (but accessible by all eligible populations), mobile clinics, and community venues. These initiatives achieved 3-dose series completion rates of 84.6% among 6,851 adolescent girls and young women who had received a first dose in Cameroon,[60] 93% among 331 girls who had received a first dose in Manchay, Peru,[57] and 64.1% among 312 girls who had received a first dose in urban and rural communities in the Amazon in Peru.[48]

Secondary outcomes: barriers and facilitators of vaccination services at expanded sites and by complementary providers

Facilitators

Several studies noted specific aspects of complementary vaccination strategies that contributed to their success (Supplementary Table 3). Four studies reported on advertising and other awareness campaigns that successfully promoted vaccination services, including community meetings and word-of-mouth in Peru[48]; in Australia, physical mail drops, social media posts, in-store and sidewalk signage, and word-of -mouth[51]; personalized invitation letters and local newspaper advertising in Canada[47]; and in Cameroon, multi-lingual presentations in diverse community settings.[60] The Cameroon study also highlighted the importance of education of parents/caregivers, health care workers, and other stakeholders (e.g., school staff) about the benefits and safety of vaccination, as well as extensive engagement with community leaders, whose support helped to overcome negative attitudes toward HPV vaccination and increase the acceptability of vaccination among the target population.[60] Further, the same study identified a number of logistical factors that facilitated vaccination, including peer-tracking approaches to identify and locate missing girls for second and third vaccine dose administration, a combined mother and daughter HPV screening and vaccination approach, and the use of multiple community-based sites to administer vaccinations.[60]

Another facilitator to vaccination at complementary sites and by complementary providers was positive provider perception toward these complementary delivery strategies. Three studies surveyed pharmacists about their attitudes toward policies expanding their authority to administer vaccinations.[49,51,53] Pharmacists in London, UK generally viewed pharmacy-based influenza vaccination positively, believing that it reduced the overall health care system burden, improved patient choices, and was more convenient for patients.[49] Pharmacists in New South Wales, Australia reported that respondents felt confident in counseling patients and delivering vaccination, found vaccination to be rewarding and professionally satisfying, and believed that offering these services helped to build ongoing relationships with pharmacy customers.[51] Finally, pharmacists in Western Australia expressed confidence in their ability to provide vaccination (with specific reasons for this confidence including positive feedback from patients and the availability of written procedures and guidelines), found the practice professionally satisfying, felt that offering vaccination services promoted the overall image of the profession and encouraged uptake of other in-store health care services, and perceived that pharmacist-administered vaccination reduced GP waiting times and overall health care system strain.[53]

Positive patient attitudes were also recorded. Five studies solicited patient attitudes toward pharmacist vaccinators directly.[35,47,52,61,62] The vast majority of surveyed patients reported positive attitudes: for example, 86% of respondents in one study were very comfortable and 92% were very satisfied with pharmacist-administered vaccinations, 99% would recommend pharmacist-administered vaccination to a friend or family member, and 97% of free-form comments were favorable[61]; in another study, 91% of respondents rated the pharmacy vaccination service as excellent and 98% would get vaccinated at a pharmacy again.[62] One of the included SLRs also identified a study in which the involvement of pharmacists in vaccination increased patient satisfaction with and awareness of vaccination.[35] Specific benefits of complementary vaccination pathways that were mentioned by patients in these studies included convenience and accessibility (e.g., walk-in vaccination, convenient locations, extended operating hours),[47,52,61,62] the professionalism and vaccination technique of pharmacists,[61] and the perceived reduced risk of exposure to infection while being vaccinated at a pharmacy compared to a GP's office as well as the perceived reduction in GPs' workloads.[62]

An additional four studies included provider or investigator perceptions of patient or community attitudes to vaccination.[51,53,58,60] For example, pharmacists in New South Wales reported positive patient attitudes including appreciation of the location's convenience and accessibility (e.g., ease of scheduling appointments and availability of walk-in vaccination) and a perceived lower risk of exposure to infection at a pharmacy compared to a GP's waiting room.[51] Similar positive patient attitudes (convenience and accessibility, no requirement for an appointment, convenient locations, and extended operating hours), as well as high levels of patient trust in pharmacists as vaccinators, were reported by pharmacists in Western Australia.[53] An HPV vaccination study conducted in Cameroon reported that a high level of credibility and trust in the health care organization whose staff were administering vaccines contributed to high vaccine acceptability and uptake in the community.[60] Positive patient sentiments toward alternative sites were also inferred from patients' willingness to pay for pharmacy-based vaccinations, even when free alternatives were available through GP services. Two Australian studies estimated that 12–17%[53] or 21%[51] of recipients could have received their vaccine for free from a GP, due to membership in a high-risk group under Australia's National Immunization Plan, but still chose to pay for a pharmacy-based vaccination.

Five of the included studies identified cost-related factors that facilitated vaccination by pharmacists.[35,49,50,53,59] For example, an Australian study reported that vaccination at a pharmacy cost patients less than seeing a doctor if they did not qualify for free vaccination.[53] Furthermore, a UK study estimated that each pharmacy-administered influenza vaccine dose cost the National Health Service ≤£2.35 less than a dose administered by a GP.[49] Lastly, an SLR identified a study reporting that vaccinations in a pharmacy cost ≤ 26% less to administer than in a physician's office and ≤ 20% less than in other medical settings such as emergency rooms and other inpatient/outpatient hospital settings.[35] Complementary vaccination pathways also had positive health economic effects. A study that evaluated the economic outcomes of a policy change that expanded influenza vaccination services in Ontario, Canada to include pharmacists estimated that the additional annual vaccinations delivered following the policy change averted > 20,000 cases of influenza, saving an estimated $763,158 in direct influenza-related health care costs and $7.9 M in productivity costs associated with time away from work.[59] When the costs of administering the additional vaccines were considered, the policy change was associated with a net savings of $2.3 M.[59]

Several papers included evidence of positive outcomes related to increasing uptake in populations that may not otherwise have been vaccinated. For example, favorable patient attitudes enabled complementary vaccination pathways to reach new populations: 28% of all influenza vaccine recipients and 21% of high-risk recipients in Toronto, Canada said they would not have received their vaccine if pharmacy-based vaccination had not been available[61]; 15% of pharmacy-based vaccine recipients in an Australian study said they had never received the influenza vaccine before[51]; and an estimated 8.2% of influenza vaccination recipients in the Isle of Wight, UK, were getting vaccinated for the first time and 6.8% would have gone unvaccinated without pharmacy-based services.[62]

Barriers

Seven studies identified barriers to expanded vaccination sites or complementary provider policies.[47–49,51,53,57,60] For example, pharmacists in Western Australia reported a lack of publicity for pharmacy vaccination services.[53] Logistical difficulties were also identified. In remote communities in Peru[48,57] and Cameroon,[60] community-based HPV vaccination efforts were hampered by flooding and other weather-related issues, poor road and internet infrastructure, difficulty locating and accessing girls for second and third doses, and vaccine shipping and import difficulties. Other studies reported that logistical difficulties specific to pharmacies included time-consuming and inefficient data entry systems, lack of private rooms suitable for vaccination, time and staffing constraints, language barriers with patients, and stock availability issues.[47,49,51,53]

Several studies noted negative provider attitudes, including both GPs' opinions of pharmacists as vaccinators and pharmacists' attitudes toward their own role in vaccination services. Two studies specifically highlighted potential tensions between GPs and pharmacists.[49,53] In one study, 40–50% of surveyed GPs in London, UK were concerned that pharmacy-based vaccination could lead to reduced quality of health care; in addition, 61% were concerned about loss of immunization records, 52% about personal financial loss, and 40% about patient safety.[49] Pharmacists in Western Australia also reported concerns that pharmacy-based vaccination could strain their relationships with GPs.[53] Indeed, a study of pharmacy-based seasonal influenza vaccination in the UK showed that pharmacy vaccination services did appear to shift some patients away from GP-based services.[52]

Finally, two Australian studies reported financial barriers to pharmacy-based vaccination. One study mentioned that all patients must pay for pharmacist-administered influenza vaccinations, whereas high-risk patients can receive the vaccination for free from a GP,[51] while the other mentioned the course fees required to train and certify pharmacists as vaccine administrators and the lack of government subsidies for vaccinations administered by pharmacists, in contrast to the subsidies available for nurse administrators at GP offices.[53]

Discussion

This SLR aimed to aggregate current evidence on the impacts of vaccination by complementary providers and at expanded sites on vaccine uptake in non-US geographies. The included studies evaluated vaccination delivery strategies across five countries, covering vaccines administered across the life-course, including in pregnancy, adolescence, adulthood, and older age. All 18 of the included studies demonstrated that these complementary approaches can positively impact uptake and/or provide other benefits. Findings from these non-US settings were generally consistent with US-based studies,[21,65,70,71] and address a gap in the literature on the global impacts of complementary vaccination pathways.[67] However, the variability of the included studies' program design, provider and vaccine type, target population, and country context underscores the need for continued research on this topic.

The results of this SLR add to predominantly US-based evidence[21,65,70,71] demonstrating the value of pharmacists as vaccinators in increasing vaccine accessibility and uptake. They also confirm previous non-US reports that pharmacist-administered vaccination has significant financial and economic benefits, including cost savings for vaccine recipients[24,72] and a reduction in lost work productivity.[20] The included studies also add to recent evidence that consumer confidence and trust in pharmacists as vaccinators is generally high.[73–76] Similarly, the positive impact of other providers administering vaccinations at expanded sites provides evidence for broad and diverse potential applications of complementary strategies for routine vaccine delivery.

Secondary outcome analyses assessed barriers and facilitators of complementary vaccination strategies and were consistent with studies in the US suggesting that convenience and location are key facilitators.[10,12–14,21,70,71] Specifically, several studies noted that features such as expanded operating hours and the availability of walk-in appointments at pharmacies encouraged vaccine uptake.[47,51–53,61,62] These findings are consistent with other reports that highlighted similar facilitators related to the convenience of pharmacy vaccination.[12,13,21,70,71,77] Based upon this analysis, there is strong evidence that policies that expand the availability of vaccination services through complementary vaccinators or sites can improve the convenience of vaccination, one of the "3 C's" (together with confidence and complacency) that the WHO has described as drivers of vaccine hesitancy.[78]

The included literature also provides evidence that convenience-related factors can help vaccinators access new patient populations, including first-time and other non-regular recipients of influenza vaccines.[51,61,62] Convenience may even outweigh the barrier of paying out-of-pocket for vaccination services, as observed in two Australian studies that estimated that up to 21% of recipients could have received vaccination for free from a GP, but chose to pay for their vaccination at a pharmacy.[51,53]

The included studies also identified notable barriers that should be addressed, including logistical challenges, costs incurred by providers, and providers' perceived concerns toward complementary delivery strategies. These results further highlight the need for additional resources to address vaccine supply chain and provider staffing challenges, and to reduce costs to vaccine recipients and providers. With respect to physicians' concerns over the impact of complementary vaccination pathways, further research will be needed to determine the nature and extent of any negative impacts, and to design strategies for collaborations between physicians and complementary providers, such as by delivering first doses in a vaccination series at a doctor's office and subsequent doses at a pharmacy or other site.[79]

While vaccination at pharmacies is not a new phenomenon, many countries around the world still do not offer pharmacy vaccination, or impose substantial limitations.[80] However, momentum from the successful use of pharmacies to deliver COVID-19 vaccinations in many countries has accelerated interest in these strategies. Legislation has since been passed in many jurisdictions to expand the authority of pharmacists to administer other vaccinations.[81–83] There is therefore a timely opportunity to leverage pandemic-related policies, including the expansion of complementary vaccination delivery systems at pharmacies, to reach VCR targets for other communicable diseases.

Ultimately, improved rates of vaccine administration by complementary pathways depend on multiple factors in the vaccine ecosystem. These factors include provider willingness to vaccinate and public willingness to receive vaccinations by complementary providers at expanded sites, availability and quality of provider training,[84] policies to authorize novel vaccination pathways, tools to expand patient perceptions of complementary providers' new role in vaccination,[85] and policies or supports that address structural barriers, such as stocking constraints at expanded vaccination sites.[86] Taking these factors into consideration will be paramount to effectively designing and implementing programs that expand vaccination access at expanded locations and by complementary healthcare providers.

Our research includes several known limitations. This SLR cannot account for the potential impacts of publication bias; studies finding insignificant effects may be less likely to become part of the published record and thus would not have been captured in our analysis. Similarly, our search was limited only to research articles published in English, which may limit findings in global research. The study period of 2000–2022 was selected based on the expansion of pharmacists' scope of work to include vaccination in early-adopter countries such as the US and Canada in the mid-1990s to early 2000s. Although the first included study was published in 2013, it is possible that our search strategy excluded a small number of studies published before 2000. In addition, the high proportion of influenza and HPV-related studies within our final sample limits the generalizability of our findings beyond the targeted populations and vaccines included in this review. Furthermore, since the majority of the included studies focused on adult and adolescents, the findings of this SLR cannot be generalized to all age groups. If policymakers and other health stakeholders are to develop programs that reach and exceed target VCRs for routine vaccines across the life-course, more evidence will be needed to understand how the effectiveness of these policies may vary for different vaccines and populations.

Overall, the included studies provide positive evidence for the value of complementary provider and expanded vaccination sites; however, there is a need for further research, especially related to vaccination by alternative providers other than pharmacists. For example, systematically evaluating the impact of complementary delivery strategies in diverse settings, resource-limited environments, and within vulnerable groups will be critical to determining whether these strategies can effectively improve vaccine uptake and drive vaccine equity. Similarly, provider sentiment toward vaccination (both among GPs and other complementary providers) can vary by provider type and setting and should be evaluated to inform targeted strategies for collaboration between physicians and complementary providers. In parallel, improvements must be made to immunization information systems to allow them to capture VCRs across the life-course in all settings where vaccination occurs, especially for adult programs where data monitoring systems are limited, and to assess the impact of complementary delivery strategies on VCRs across the life-course to inform evidence-based decision-making.

Conclusions

Effective strategies are needed to improve immunization program performance. One approach is to improve the accessibility of routine vaccines using complementary vaccination delivery strategies. This SLR demonstrates that expanding vaccination provider types and administration sites positively impacts vaccine coverage and can increase access among broader populations, with the bulk of the evidence relating to vaccination in pharmacies. These complementary delivery strategies should be considered as viable, evidence-based approaches to best meet patients where they are and improve vaccine accessibility and uptake.

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RM and ALE are current employees of Merck Sharp & Dohme LLC, a subsidiary of Merck & Co., Inc., Rahway, NJ, USA, and may own stock and/or stock options in the company. AL was contracted by Merck Sharp & Dohme LLC, a subsidiary of Merck & Co., Inc., Rahway, NJ, USA during the time of the study.

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Data availability statement

All data relevant to the study are included in the article or uploaded as online supplemental information.

Ethics approval

A formal ethical approval was not required for this work.

Contributions

AL, PS, RM, DV, AJL, and ALE participated in the study conception and design.
PS and AJL collected the data.
PS and AJL conducted the analysis.
AL, RM, DV, and ALE supervised data collection and analysis processes.
AL, PS, AJL, and ALE drafted the manuscript.
All authors reviewed, revised, and approved the final manuscript.

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