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Effectiveness of Pharmacy-Based Interventions in Enhancing Immunisation Coverage: A Systematic Review and Meta-Analysis

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Abstract

Low uptake of immunization services remains a major public health issue. Pharmacists serve as key facilitators and, more frequently, as vaccinators themselves. However, strong evidence regarding their effect on patient health outcomes and vaccination coverage remains limited.To assess the effect of pharmacist-led interventions on population-level vaccination rates.A systematic search was conducted in SCOPUS, PubMed, and Web of Science from database inception to April 2023 to identify both randomized controlled trials (RCTs) and non-randomized controlled trials. Studies lacking a comparator group for pharmacist involvement were excluded. Two reviewers performed data extraction and risk-of-bias evaluations, and meta-analyses were conducted using random-effects models.The review included 4 RCTs and 15 non-RCTs covering influenza, pneumococcal, herpes zoster, and tetanus-diphtheria-pertussis vaccines delivered in varied settings, including community pharmacies. Pooled analyses showed that pharmacist involvement, in any capacity, increased overall immunization uptake by up to 51% compared with usual care [RR 1.51 (1.28, 1.77)]. When pharmacists specifically functioned as advocates, immunization frequency more than doubled [RR 2.09 (1.42, 3.07)].Evidence concerning pharmacists acting directly as immunizers was inconsistent; nevertheless, their overall participation in immunization programs significantly raised public vaccination rates. Pharmacists demonstrated leadership and played essential advocacy roles in both community and hospital environments. Future studies should examine the intensity of pharmacist engagement and its impact on immunization coverage.

Keywords: Vaccination, Pharmacist, Primary prevention, Advocate, Immunisation

Introduction

Immunization forms a cornerstone of preventive health care, and vaccines are widely accepted for their role in controlling and eradicating numerous infectious diseases [1]. Benefits include reduced morbidity and mortality, lower healthcare costs, and increased economic output [2]. Vaccine-preventable diseases (VPDs) still impose a heavy health and economic toll globally, with low- and middle-income countries experiencing the greatest burden [3]. The World Health Organization (WHO) has reported that VPDs cause around 1.5 million deaths annually, disproportionately affecting children younger than five years [4]. In the United States, [5] calculated that the varicella vaccination program yielded a return of $1.70 per dollar invested over its first 25 years, with ongoing benefits projected beyond 2020. The WHO similarly emphasizes that immunization investments generate major savings in healthcare spending and enhance productivity.

Despite the existence of safe and effective vaccines, many nations report persistently low immunization coverage. Various barriers hinder vaccination uptake and thereby contribute to the continued occurrence of VPDs. Healthcare providers, including pharmacists, can make important contributions to increasing immunization rates and improving public health [6]. Leveraging their

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specialized knowledge in medications and pharmacotherapy, pharmacists are well placed to counsel patients on the advantages of vaccination, address concerns about risks, and correct misinformation. With appropriate training, they can also administer vaccines directly [7]. Pharmacists can further identify eligible individuals, screen for contraindications or drug interactions, and provide follow-up to support vaccine safety and effectiveness [8].

Across Europe, pharmacists are authorized to optimize medication use and to dispense antibiotics and antivirals to prevent infectious diseases. In countries such as Argentina, the USA, Australia, France, Ireland, Italy, Norway, Poland, Portugal, Switzerland, and the United Kingdom, pharmacists have actively supported vaccination initiatives and demonstrated their ability to raise vaccination coverage [9, 10]. During public health crises like the COVID-19 pandemic, pharmacist immunizers in these settings played a critical part in maintaining vaccination services.

The International Pharmaceutical Federation's 2016 global report on pharmacy's role in immunization highlighted training requirements for the pharmacy workforce, covering vaccine administration techniques, contraindications, adverse event management, anaphylaxis response, cardiopulmonary resuscitation, local immunization policies, and strategies to prevent communicable diseases, including those linked to HIV and hepatitis. Pharmacists are increasingly viewed as vital members of the healthcare team capable of enhancing immunization rates and other patient outcomes [11]. In high-income countries, their responsibilities have expanded to include advocacy and direct immunization roles [12]. Pharmacist-administered immunization programs began in Canada in 2012, in Ontario, with influenza vaccination [13], and were later adopted in parts of the UK, Australia, and New Zealand [14].

The COVID-19 pandemic underscored the value of engaging pharmacists in both logistical (procurement, storage, distribution) and clinical activities (reconstitution, dispensing, administration) to deliver comprehensive pharmaceutical care. Multiple studies have examined the outcomes of pharmacist participation in immunization programs and reported favorable results, particularly for influenza, pneumococcal, and herpes zoster vaccines. Earlier reviews and meta-analyses found statistically significant improvements in vaccination rates associated with pharmacist involvement; however, many relied on weaker designs such as controlled before-after studies, retrospective cohorts, or quasi-experimental approaches, which introduced heterogeneity and may have understated the true effect. Prior analyses often included few trials, carried high risk of bias, or examined only specific roles (e.g., pharmacists as immunizers) without adequate controls.

Therefore, the present study aimed to provide a comprehensive evaluation of pharmacist interventions on immunization uptake. The dual objectives were to conduct an updated systematic review and meta-analysis incorporating the latest controlled trials and to differentiate the effects of pharmacists acting as immunizers, advocates, or both. This meta-analysis was reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA-2020) guideline [15].

Materials and Methods

Eligibility criteria

We included randomized and non-randomized controlled trials that featured a comparison group. The main outcome was the number of participants vaccinated (or total doses administered when multiple vaccine types were studied). Immunization rate was calculated as the proportion of the target population that received the vaccine(s).

Non-RCTs comprised before-and-after designs and cohort or longitudinal studies with at least two groups. Control groups received usual care (routine or standard care without pharmacist involvement). Only English-language articles were considered. Editorials, letters, conference abstracts, commentaries, and reviews were excluded.

Search strategy

A systematic literature search was performed in SCOPUS, Web of Science, and PubMed from inception to 28 April 2023 using Boolean combinations of terms related to vaccination/immunization and pharmacists/pharmacy. An example string was: (immunisation OR vaccination OR booster OR inoculation) AND (pharmacist OR pharmacy OR drug store OR dispenser OR apothecarist OR druggist OR chemist OR pharmaceutical care). The reference lists of prior systematic reviews were also screened; duplicates were removed, and authors were contacted when full texts or raw data were unavailable.

Data extraction

Titles and abstracts were screened independently by two reviewers. Full-text articles were assessed independently by two reviewers (Z.Z. and S.H.M.), with a third reviewer (M.S.R.H.) consulted to resolve disagreements. A standardized form was used to extract study details including author, year, country, design, setting, pharmacist role (immuniser or advocator—defined as education, training, campaigning, recruitment, or vaccine supply), intervention type (technology-based monitoring, regulatory changes, or quality improvement/funding programs), vaccine types, outcomes (number vaccinated or doses), age groups, and sample sizes in intervention and control arms.

Risk of bias assessment

Risk of bias for RCTs and non-RCTs was evaluated using the Critical Appraisal Skills Programme (CASP) tool and the Cochrane Risk of Bias 2 (ROB 2) tool. Assessments were performed independently by two reviewers (S.H.A. and M.S.R.H.), with discrepancies resolved by discussion. Risk-of-bias findings informed interpretation of results and overall evidence quality.

Effect measures

Risk ratios (RR) were calculated from crude numbers or proportions of vaccination events. An RR greater than 1 indicated higher immunization uptake with pharmacist involvement than without. Analyses followed the intention-to-treat principle.

Synthesis methods

Studies providing sufficient data on vaccination events were included in meta-analysis. Results were summarized as risk ratios with 95% confidence intervals and displayed in tables and forest plots.

Statistical analysis

Meta-analysis was conducted in Review Manager 5.4 using the inverse-variance random-effects model. Statistical significance was set at $p \leq 0.05$.

Heterogeneity

Heterogeneity was quantified using the I^2 statistic: <25% (low), 25%–50% (moderate), 51%–75% (high), and >75% (very high) [16]. The 95% confidence interval and p-value were used to assess uncertainty.

Subgroup analyses

Subgroup analyses were performed by service setting and pharmacist role, excluding studies with a critical or serious risk of bias.

Reporting bias assessment

Publication bias was examined visually through funnel plot asymmetry.

Results and Discussion

Study selection

As shown in **Figure 1**, the search identified 1,661 records. After duplicate removal and title/abstract screening, 230 studies underwent full-text evaluation. Ultimately, 211 articles were excluded for reasons including the absence of a comparison group (n = 11), an irrelevant intervention (n = 23), an irrelevant outcome (n = 47), failure to meet inclusion criteria (n = 125), or unavailability of full text (n = 5)—the final selection comprised 4 RCTs and 15 non-RCTs.

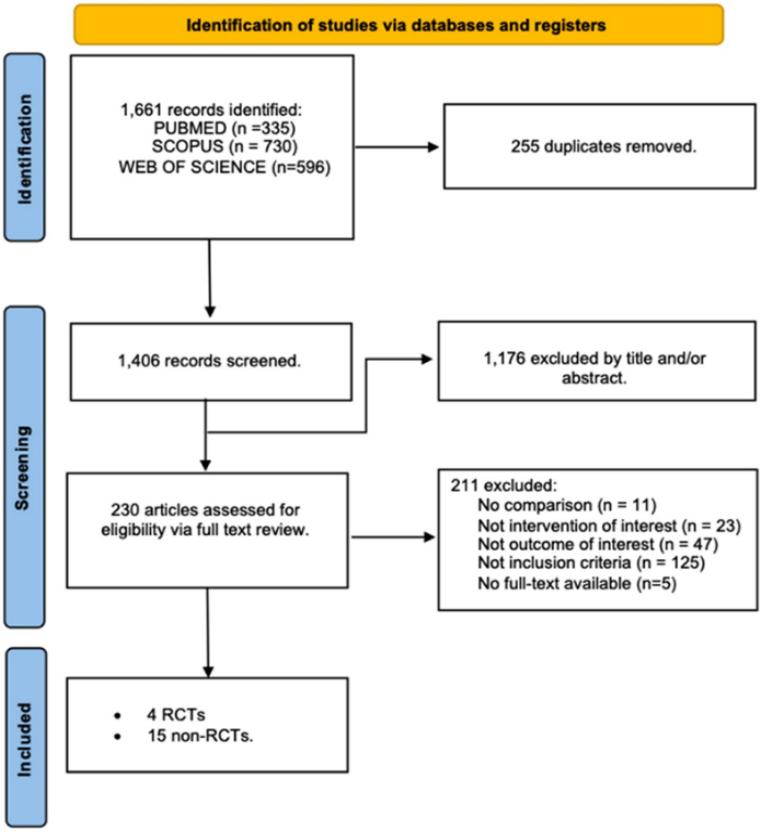


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram, showing the process followed for identifying, screening, and selecting studies for inclusion. RCT, randomised controlled trial.

Study characteristics

The main features of the included studies are summarised in **Table 1**. The review incorporated four randomised controlled trials (RCTs) [17-20] and 15 non-randomised controlled studies (non-RCTs) [21-35].

Among the RCTs, two investigations [18, 19], both performed in the USA, examined digital or technology-supported tools designed to assist pharmacists in implementing vaccine advocacy interventions and identifying individuals who could benefit from vaccination recommendations. Another RCT conducted by [17] compared two pharmacist-led educational approaches, including telephone-based counselling and mailed educational letters, to determine their effects on influenza and pneumococcal vaccination uptake in the USA. Additionally, [19] evaluated a pharmacist-delivered, in-person educational intervention to improve participants' awareness and acceptance of pneumococcal vaccination in Turkey.

The included RCTs were conducted across different healthcare environments, with three studies taking place in community pharmacy settings (75 percent) [17, 18, 20] and one study carried out within a hospital setting (25 percent) [19].

Table 1. Summary of characteristics of studies included in the meta-analysis.

Author and Year	Country	Study Design	Setting	Pharmacist Role	Intervention Type	Intervention Description	Immunisation Type(s)	Outcome Measure	Intervention Duration	Age Range	Sample Size Intervention/Control	Risk of Bias

[21]	Jordan	Non-RCT [a]	Hospital	Advocator [f]	Monitoring system [l]	Pharmacists provided vaccine-related counselling and supplied educational booklets explaining disease risks, transmission methods, indications for the pneumococcal vaccines (PPSV23 and PCV13), and possible adverse effects, in accordance with guideline recommendations. Comparison: usual care	Pneumococcal	Number of vaccine recipients	2 months	≥ 65	683/844	Moderate risk
[22]	United States	Non-RCT [b]	Community [c]	Immuniser	Monitoring system [k]	The study examined pharmacist immunisation authority across different states, including independent authority, statewide protocols, and collaborative practice agreements. Comparison: absence of pharmacist immunisation authority	Influenza	Number of vaccine recipients	1 year	≥ 18	344,126/27,681	Critical risk
[23]	United States	Non-RCT [a]	Community [c]	Advocator [i] / Immuniser	Monitoring system [j]	A technology-supported platform integrated into the pharmacy workflow enabled proactive review of immunisation records, prediction of vaccine requirements, and patient recommendations. Comparison: usual care	Influenza, Pneumococcal, Pertussis, Herpes zoster	Number of vaccine doses administered	1 year	≥ 18	84,488/84,488	Moderate risk
[24]	Turkey	Non-RCT [a]	Community [e]	Advocator [f]	Monitoring system [l]	Pharmacists provided participants with educational information related to vaccines. Comparison: usual care	Pneumococcal, Herpes zoster	Number of vaccine recipients	6 months	≥ 50	122/249	Serious risk
[25]	United States	Non-RCT [a]	Community [d]	Advocator [f,g,h,i,m] / Immuniser	Monitoring system [l]	Pharmacists supported vaccine supply, promotion, patient screening, vaccine delivery, education, and establishment of vaccination procedures for healthcare professionals through regular daily and weekly support visits. Comparison: usual care	Human papillomavirus	Number of vaccine doses administered	2 months	18–26	80/241	Serious risk
[26]	United Kingdom	Non-RCT [b]	Community [c]	Immuniser	Monitoring system [l]	Pharmacists participated as immunisers within the NHS Seasonal Flu Vaccination Programme. Comparison: vaccinations provided by community pharmacists during six influenza seasons versus vaccinations delivered in other healthcare facilities (GP, etc.)	Influenza	Number of vaccine recipients	6 years	≥ 18	635,957/552,966	Critical risk

[27]	Australia	Non-RCT [a]	Community [c]	Advocator [f,i]	Monitoring system [l]	Consultant pharmacists identified patients with delayed influenza and pneumococcal vaccinations, referred them to GPs during the first visit, and provided vaccination reminders during later visits. Comparison: usual care	Influenza, Pneumococcal	Number of vaccine recipients	6 months	40–80	27/37	Serious risk
[28]	United States	Non-RCT [a]	Community [c]	Advocator [i] / Immuniser	Monitoring system [j]	A vaccination tracking system identified patients who received the first herpes zoster vaccine dose and generated reminders for the second dose after at least 8 weeks. Alerts continued until completion or for 6 months after. Pharmacists contacted patients after receiving alerts. Comparison: usual care	Herpes zoster	Number of vaccine doses administered	8 months	≥ 50	71,459/41,982	Moderate risk
[29]	United States	Non-RCT [a]	Community [d]	Advocator [f,i]	Monitoring system [l]	Pharmacists conducted telephone-based outreach to evaluate vaccination status, answer questions, address concerns, and support vaccine administration. Comparison: usual care	Pneumococcal, Influenza	Number of vaccine recipients	2 months	≥ 19	398/1591	Low risk
[30]	United States	Non-RCT [a]	Community [d]	Advocator [f,g,h]	Monitoring system [l]	A pharmacist programme leader supervised the intervention. The healthcare team promoted influenza vaccination, educated staff, and assisted with implementation of new clinic procedures. Comparison: usual care	Influenza	Number of vaccine recipients	4 months	≥ 18	2623/2885	Moderate risk
[17]	United States	RCT	Community [c]	Advocator [i] / Immuniser	Monitoring system [j]	A technology system enabled pharmacists to access patient immunisation records from state immunisation information systems to identify vaccine recommendations. Comparison: no intervention	Influenza, Pneumococcal, Herpes zoster,	Number of vaccine doses administered	3 months	≥ 19	16,841/17,062	Some concerns
[31]	New Zealand	Non-RCT [a]	Community [c]	Advocator [i] / Immuniser	Monitoring system [n]	Pharmacies received funding and promoted pertussis vaccination during pregnancy across three regions included in the intervention group. Comparison: usual care	Tdap	Number of vaccine doses administered	3 years	12–50	11,748/3581	Low risk

[18]	United States	RCT	Community [c]	Advocator [f,i]	Monitoring system [l]	Participants were randomly assigned to telephone calls, mailed letters, or no intervention. Both communication methods referred to the 2014 CDC immunisation schedule and guidelines. Comparison: no intervention	Influenza, Pneumococcal	Number of vaccine recipients	1 month	≥ 18	280/140	Some concerns
[19]	Turkey	RCT	Institution	Advocator [f,i]	Monitoring system [l]	Pharmacists delivered face-to-face vaccine education sessions. Comparison: usual care	Pneumococcal	Number of vaccine recipients	3 months	≥ 18	114/107	High risk
[32]	United States	Non-RCT [b]	Community [c]	Advocator [i] / Immuniser	Monitoring system [l]	Pharmacists identified diabetic patients without previous vaccination records, provided education, and recommended vaccination. Comparison: usual care	Pneumococcal	Number of vaccine recipients	4 months	≥ 19	68/351	Serious risk
[33]	United States	Non-RCT [a]	Hospital	Advocatori	Monitoring system [j]	A pharmacy-based electronic tracking system enabled pharmacists to record and monitor vaccination status in EMR systems, ensuring appropriate vaccines were provided to asplenic patients. Comparison: usual care	Pneumococcal, Meningococcal, Haemophilus influenzae	Number of vaccine doses administered	2 years	≥ 18	119/242	Moderate risk
[34]	United States	Non-RCT [a]	Hospital	Advocator [f, i]	Monitoring system [l]	Pharmacists provided post-splenectomy counselling explaining recommended vaccines and their role in disease prevention. Patients received vaccine information handouts. Comparison: usual care	Pneumococcal, Meningococcal ACWY,	Number of vaccine doses administered	6 months	≥ 18	31/95	Moderate risk
[20]	United States	RCT	Community [c]	Immuniser	Monitoring system [j]	A vaccine reminder system informed eligible patients that they could receive pneumococcal vaccine, herpes zoster vaccine, or both. Accepted notifications were forwarded to pharmacists. Comparison: no intervention	Pneumococcal, Herpes zoster	Number of vaccine doses administered	10 months	≥ 65	11,009/10,962	Some concerns
[35]	Spain	Non-RCT [b]	Hospital	Advocator [f,i]	Monitoring system [l]	Cohort A (hospital A intervention) received telephone communication from the pharmacist and nurse about the importance of influenza vaccination, campaign dates, and appointment arrangements. Comparison: Cohort B (hospital B) without intervention	Influenza	Number of vaccine recipients	1 month	≥ 65	148/207	Moderate risk

Abbreviations: RCT = randomised controlled/clinical trial; dTap = tetanus, diphtheria, pertussis; Td = tetanus, diphtheria.

Non-RCT: [a] Before and after, [b] Cohort/longitudinal with minimum two groups.
Community: [c] Community pharmacy, [d] Primary healthcare clinics, [e] Community centre.
Advocator: [f] Education, [g] Training, [h] Campaign, [i] Recruitment, [m] Stocking vaccine.
Monitoring system: [j] Technology-based, [k] State law regulations, [l] Quality improvement programme, [n] Funding.

Eleven non-RCTs employed a before-and-after design. Among these, three studies [23, 28] examined technology-driven systems that assisted pharmacists in implementing strategies to raise vaccination rates. One study [31] examined the provision of financial support to community pharmacies to increase vaccine uptake. The remaining seven studies [21, 24, 25, 27, 29, 30, 34] assessed the effects of pharmacist-implemented quality improvement initiatives on immunization coverage. Across these investigations, 20 different comparator approaches were contrasted with pharmacist-led interventions.

Pharmacist-led strategies encompassed reviewing patients' vaccination records and recommending vaccines to eligible individuals or their physicians (recruitment) in eight studies (40 percent) [21, 24, 25, 27, 29, 30, 33, 34], patient education in seven studies (35 percent) [21, 24, 25, 27, 29, 30, 34], staff training in two studies (10 percent) [25, 30], awareness campaigns in two studies (10 percent) [25, 30], and ensuring adequate vaccine supplies in one study (5 percent) [25].

The majority of these before-and-after studies originated from the USA (7 studies, 63.6 percent) [23, 25, 28-30, 33, 34], with one study each from Turkey (9.1 percent) [24], New Zealand (9.1 percent) [31], Jordan (9.1 percent) [21], and Australia (9.1 percent) [27]. These were mainly conducted in community settings: community pharmacies (4 studies, 36.3 percent) [23, 27, 28, 31], primary healthcare clinics (3 studies, 27.2 percent) [25, 29, 30], community centres (1 study, 9.1 percent) [29], and hospitals (3 studies, 27.2 percent) [21, 33, 34].

The other four non-RCTs were cohort or longitudinal studies with at least two comparison groups [22, 26, 35]. Three of these [26, 32, 35] evaluated pharmacist-led quality improvement programs aimed at increasing immunization rates, while one [22] explored the consequences of granting pharmacists legal authority to administer vaccines across multiple states. Pharmacist roles examined included acting as immunizers (3 studies, 50%) [22, 26, 32], reviewing vaccination histories and making recommendations to patients or physicians (recruitment – 2 studies, 33.3%) [32, 35], and delivering patient education (1 study, 16.7 percent) [35].

Two of these studies were conducted in the USA (50 percent) [22, 32], with one each from Spain (25 percent) [35] and the UK (25 percent) [26]. The primary settings were community pharmacies (3 studies, 75 percent) [22, 26, 32] and hospitals (1 study, 25%) [35].

Quality of evidence

Risk of bias was evaluated for all 19 included studies (both RCTs and non-RCTs) that featured a range of interventions. The CASP checklist was used to appraise methodological quality. For the non-RCTs, two studies (13.3 percent) were rated as high quality, ten (66.7%) as moderate quality, and three (20%) as low quality. Among the RCTs, 2 (50%) were judged high-quality, and 2 (50%) were judged poor-quality.

Application of the Cochrane ROB 2 tool revealed varying levels of bias risk across the 15 non-RCTs: one study (6.7%) had low risk, eight (53.3%) had moderate risk, four (26.7%) had serious risk, and two (13.3%) had critical risk. For the RCTs, no study was rated as having low overall risk of bias. All four RCTs showed unclear risk regarding selective reporting. One RCT [19] was judged to have high overall risk of bias, while the other three [17, 18, 20] raised some concerns.

In the domain of randomization, several studies lacked details on allocation concealment [17-20]. Two trials used stratified randomization [17, 20] and the others applied simple randomization [18, 19]. Blinding of participants and pharmacists was not feasible due to the nature of the interventions, yet this did not appear to cause meaningful deviations from the intended protocols in the four RCTs.

Although some loss to follow-up occurred across all RCTs, the proportion of participants with missing outcome data was small, resulting in a low risk of bias in this domain. Three studies demonstrated low risk of bias in outcome measurement because knowledge of the intervention was unlikely to influence assessment. However, one study showed high risk in this domain owing to possible influence from prior awareness of the assigned intervention.

The CASP checklist identified fewer "yes" responses for validity items in the studies by [27] and [25]. This aligned

with the ROB 2 findings, which classified both as having serious risk of bias.

Detailed ROB 2 assessments for the RCTs are presented in **Figures 2 and 3**. Risk of bias evaluations for the non-RCTs are shown in **Figures 4 and 5**. These appraisals provided valuable insight into the methodological strengths and limitations of the included studies, enabling findings to be interpreted with appropriate caution regarding risk of bias and overall evidence quality.

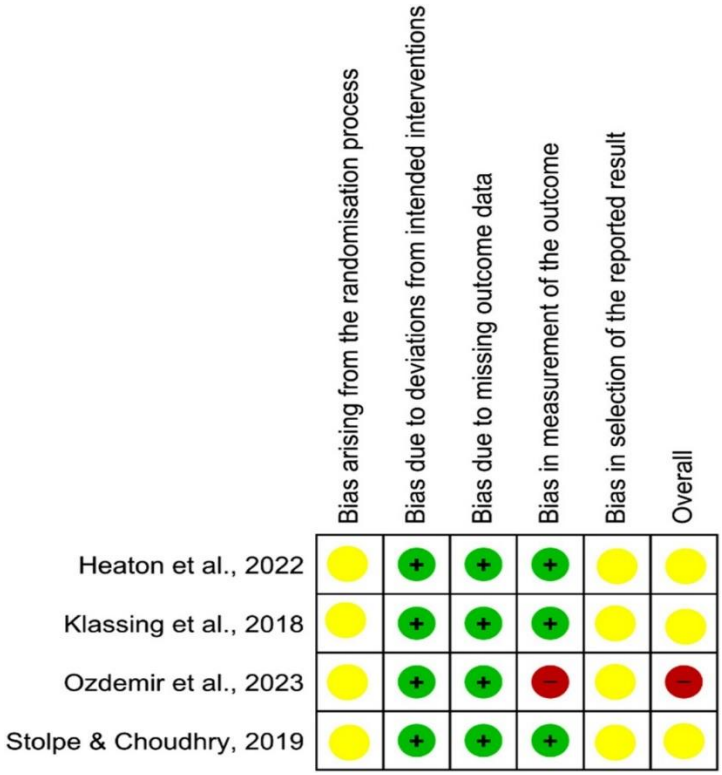


Figure 2. A detailed description of the ROB assessment for RCTs.

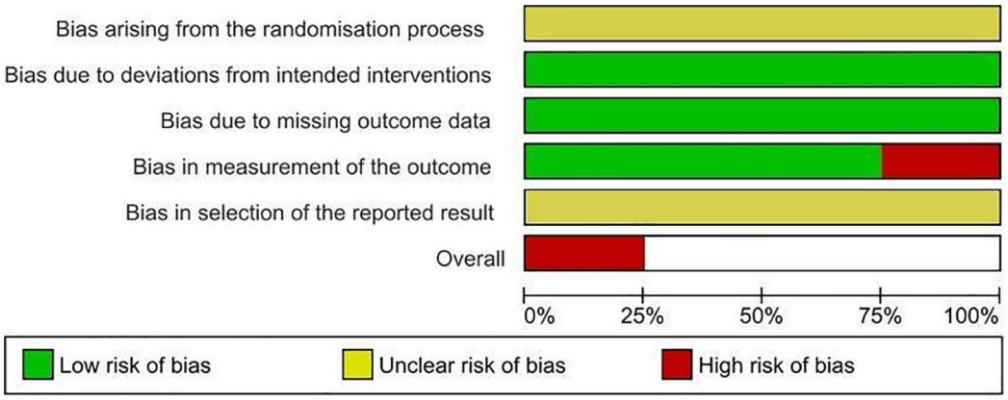


Figure 3. Summary plot of ROB assessment for RCTs.

Risk of Bias Domains / Studies	D1	D2	D3	D4	D5	D6	D7	Overall
(Fathima et al., 2021)								
(Goode et al., 2022)								
(Cebollero et al., 2020)								
(Villaverde Piñeiro et al., 2022)								
(Howe et al., 2022)								
(Gatwood et al., 2022)								
(Deslandes et al., 2020)								
(Bayraktar-Ekincioglu et al., 2022)								
(Bacci et al., 2019)								
(Scherrer et al., 2020)								
(Goldsworthy et al., 2022)								
(Abu-rish & Barakat, 2021)								
(Page et al., 2020)								
(Are et al., 2022)								
(Rihtarchik et al., 2018)								

Figure 4. A detailed description of the ROB assessment for non-RCTs.

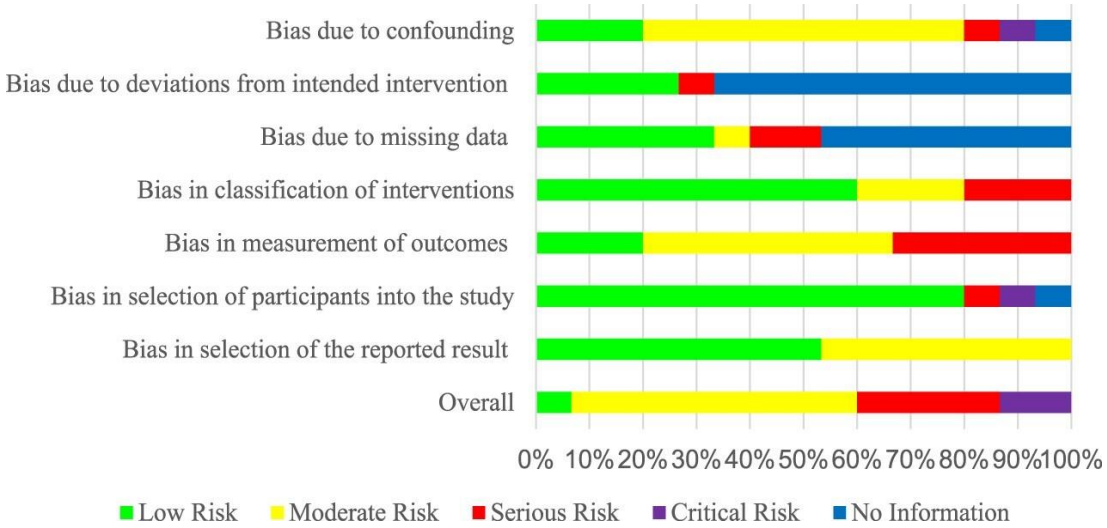


Figure 5. Summary plot of ROB assessment for non-RCTs.

Effect size analysis

A total of 19 studies were considered eligible for the quantitative synthesis. The relative impact of pharmacist-led interventions on vaccination uptake was evaluated using risk ratios (RRs) with 95% confidence intervals. Individual study estimates and the combined effect obtained from an inverse-variance random-effects model are presented in the revised **Table 2**.

Table 2. Recalculated summary of the association between pharmacist interventions and immunisation uptake

Included study	Risk ratio (95% CI) using random-effects inverse variance model
[21]	1.03 [0.86, 1.23]
[22]	0.98 [0.97, 0.99]
[23]	1.20 [1.19, 1.21]
[24]	0.18 [0.09, 0.37]

[25]	1.44 [1.05, 1.99]
[26]	20.10 [19.11, 21.13]
[27]	1.73 [1.23, 2.43]
[28]	1.05 [1.04, 1.05]
[29]	1.99 [1.76, 2.25]
[30]	1.56 [1.46, 1.67]
[17]	1.19 [1.11, 1.27]
[31]	1.01 [0.99, 1.03]
[18]	0.68 [0.52, 0.89]
[19]	3.29 [1.47, 7.35]
[32]	1.11 [0.79, 1.55]
[33]	1.35 [0.94, 1.96]
[34]	5.04 [2.14, 11.87]
[20]	1.04 [0.87, 1.25]
[35]	5.31 [2.74, 10.32]
Overall pooled risk ratio	**1.51 [1.28, 1.77]**

Heterogeneity: $\tau 2 = 0.10$; $\chi 2 = 14230.16$, df = 18 ($P < 0.00001$); $I^2 = 100\%$
Test for overall effect: Z = 4.99 ($P < 0.00001$)

Meta-analyses

Pooled risk ratios (RRs)

The meta-analysis yielded an overall pooled risk ratio of 1.51 (95% CI: 1.28 to 1.77), indicating that pharmacist involvement was associated with a statistically significant improvement in immunization rates compared with usual care. However, the analysis revealed very high heterogeneity among the studies ($I^2 = 100\%$, $p < 0.05$), meaning the findings should be interpreted with considerable caution (**Figure 6**).

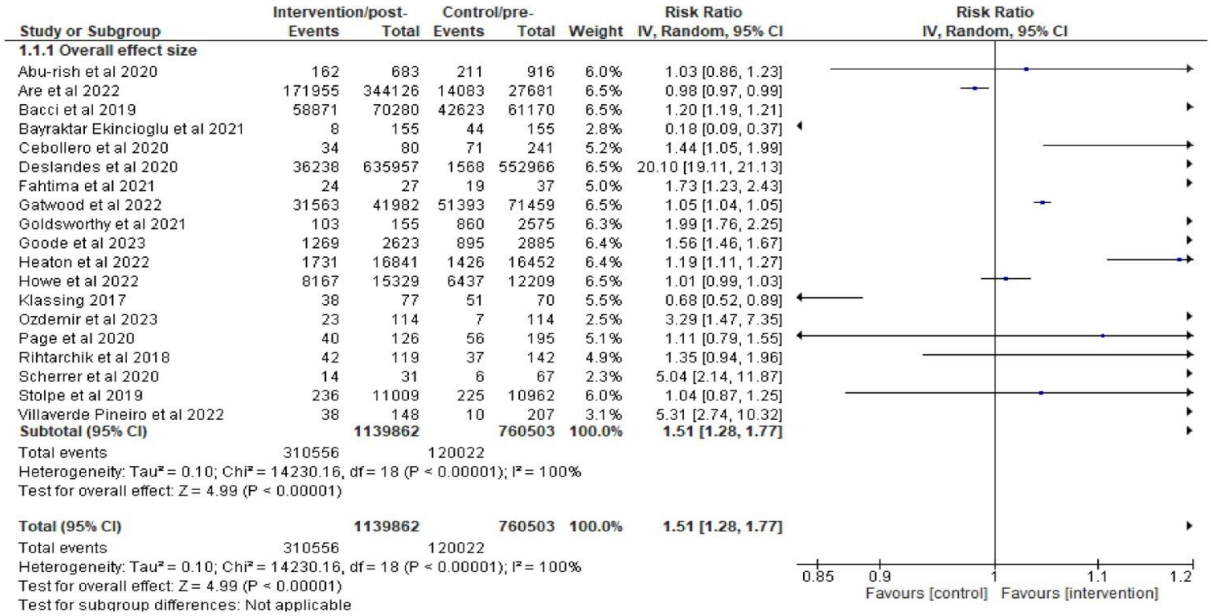


Figure 6. Overall effect of pharmacist involvement on immunization uptake.

Subgroup analyses

To help explain the high heterogeneity observed across studies, subgroup analyses were conducted, beginning with classification by pharmacists' specific role (**Figure 7).**

Results showed that when pharmacists served as advocates—through activities such as patient education, staff training, public campaigns, patient recruitment, or ensuring vaccine availability—the interventions produced a strong positive effect on immunization uptake with notably reduced heterogeneity [RR 2.09 (95% CI 1.42–3.07; I^2 = 69%)]. This subgroup analysis included five studies [19, 21, 30, 33]

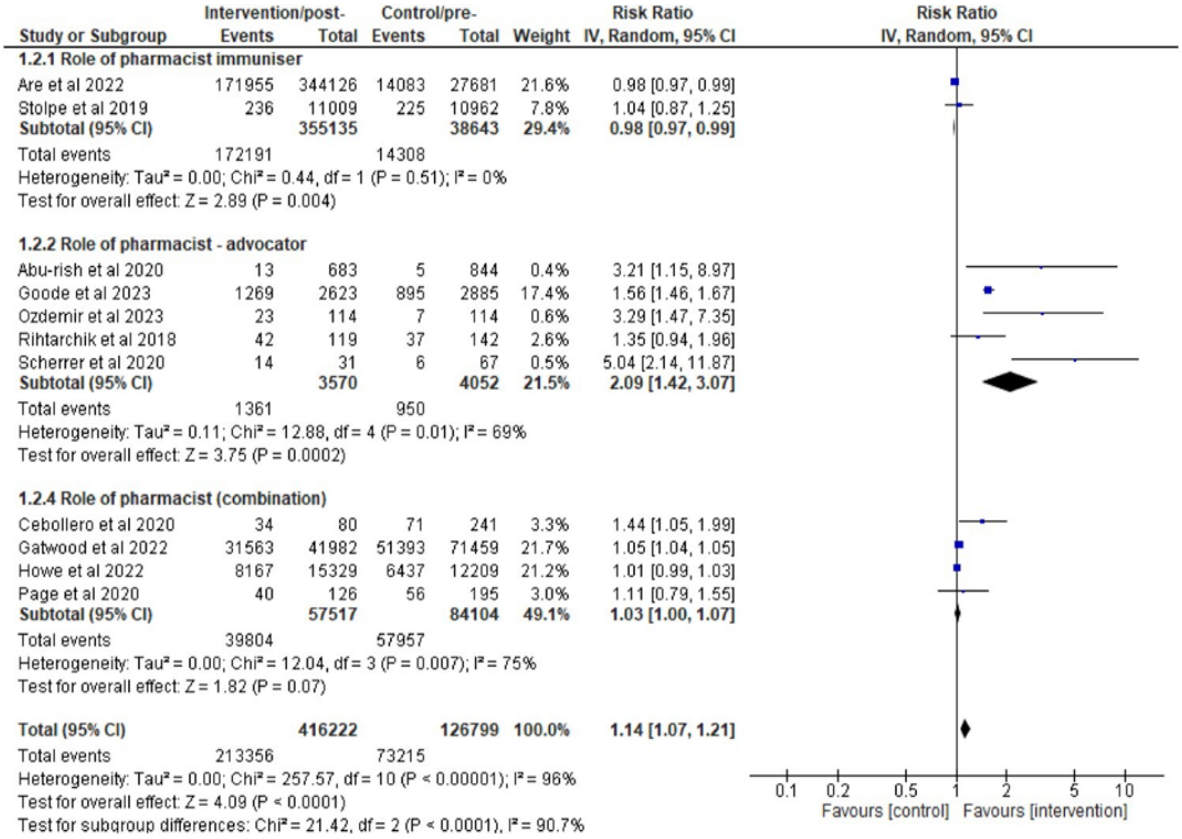


Figure 7. Subgroup analysis of the effects of pharmacist interventions on immunization rates, according to whether they served as immunizers, advocates, or in combined roles.

An initial subgroup evaluation involving four studies where pharmacists performed both immunisation and advocacy functions [25, 28, 31, 32] found a clear improvement in vaccination uptake with somewhat reduced inconsistency across results [RR 1.03 (95% CI 1.00–1.21; I^2 = 75%)]. On the other hand, when looking only at trials in which pharmacists acted exclusively as immunisers, there was no overall meaningful increase in immunization rates.

A separate subgroup analysis based on the location of the interventions indicated strong positive effects linked to pharmacist participation in community environments [RR 1.20 (95% CI 1.11–1.30)] and in hospitals [RR 3.15 (95% CI 1.39–7.18)], both reaching statistical significance ($P < 0.05$). These outcomes appear in **Figure 8**. No pooled result was produced for institutional settings because only a single study was included in that category. All subgroup analyses exhibited persistently high heterogeneity ($I^2 > 80\%$)

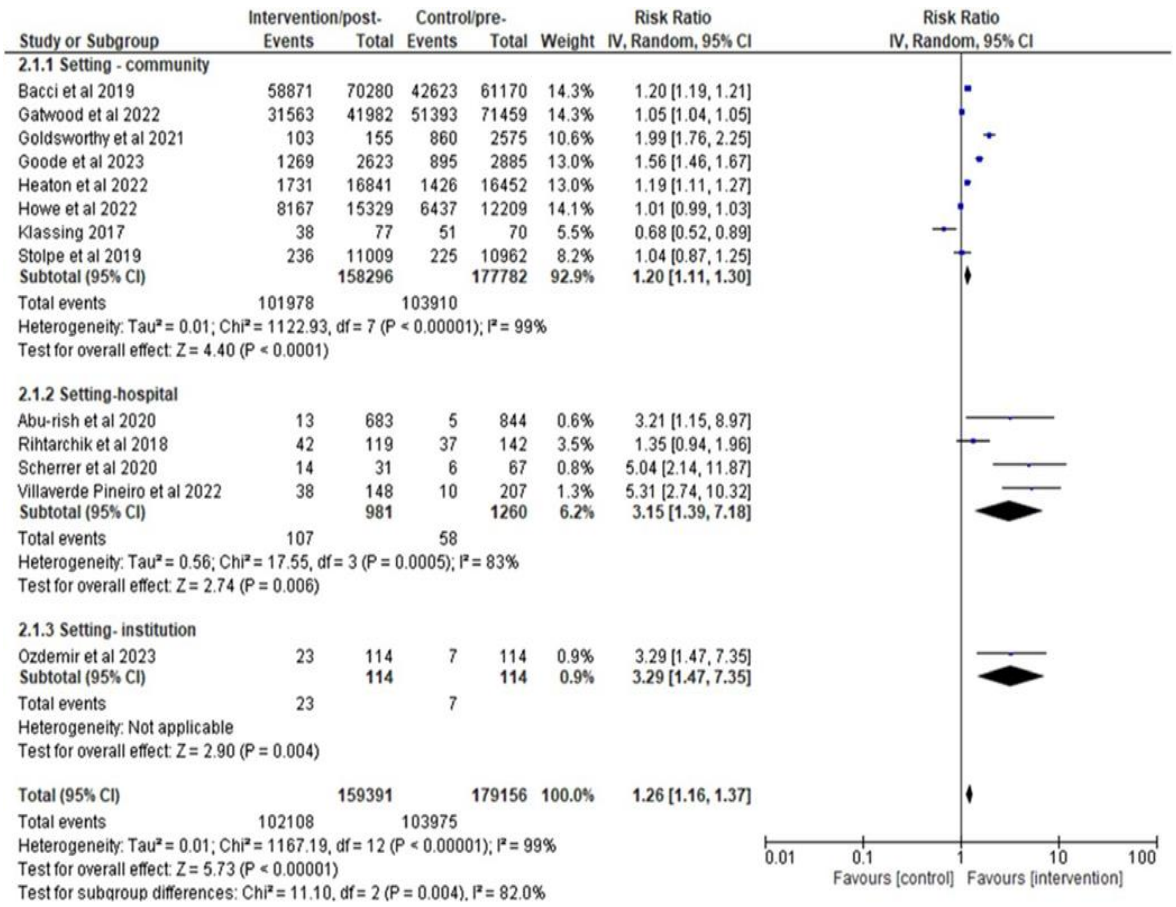


Figure 8. Subgroup evaluation of pharmacist-led interventions on vaccination rates, stratified by different healthcare environments (hospital, community, and institution).

Publication bias

Evaluation for publication bias relied on funnel plots. All plots exhibited noticeable asymmetry, including the one for the main pooled analysis (**Figure 9**), the subgroup by pharmacist role (**Figure 10**), and the subgroup by study setting (**Figure 11**). These patterns suggest the possibility of publication bias in the body of evidence.

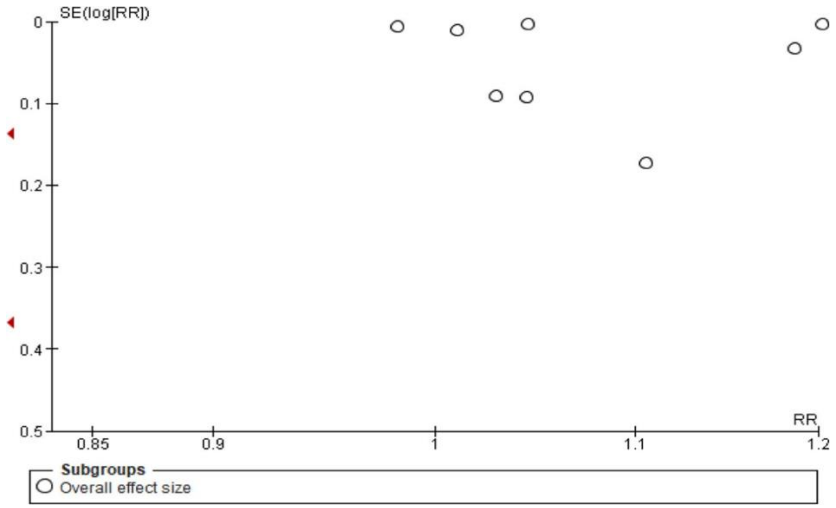


Figure 9. Funnel plot illustrating evidence of publication bias for the overall pooled effect size.

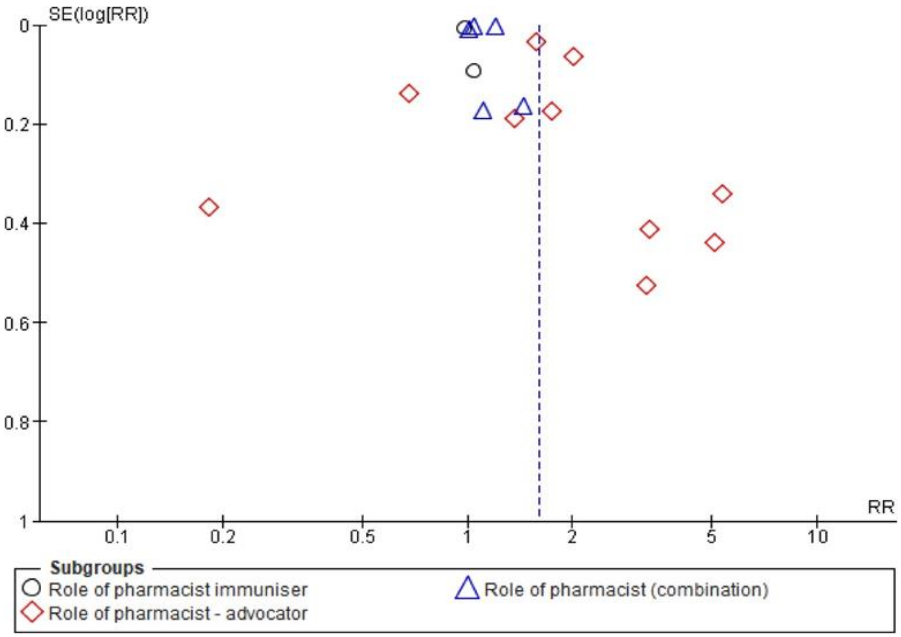


Figure 10. Funnel plot indicating publication bias in the subgroup analysis by pharmacist role.

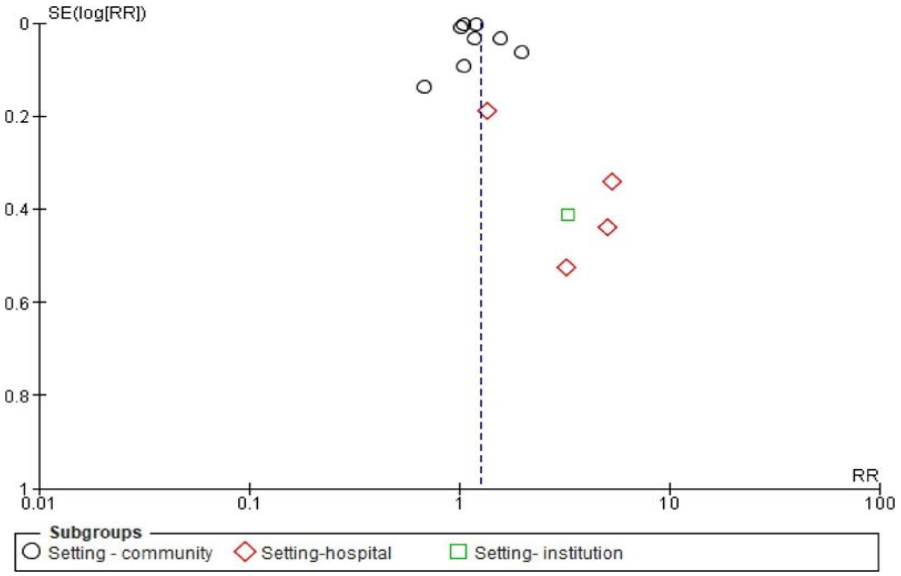


Figure 11. Funnel plot highlighting evidence of publication bias in the subgroup analysis according to study setting.

Multiple studies have shown the benefits of pharmacist-led initiatives for population-wide vaccination efforts. Results from both randomized controlled trials (RCTs) and non-randomized studies consistently showed that pharmacists—whether serving as facilitators, promoters, or direct vaccinators—achieved markedly higher immunization coverage than with standard care. Their involvement increased vaccination rates by up to 51% compared with usual care or programs without pharmacist participation.

In the present meta-analysis, the combined effect showed a statistically significant increase in immunization uptake when pharmacists served as advocates (through activities such as patient education, training sessions, awareness campaigns, patient recruitment, and vaccine stock management). This aligns closely with the findings of

[36], who reported a 31% improvement in vaccination rates from pharmacist advocacy programs (RR 1.31 [1.17, 1.48]). Similarly, another systematic review and meta-analysis indicated a strong positive effect on immunization rates when pharmacists acted as educators (categorized here as advocates), yielding an RR of 2.96 [1.02, 8.59] compared with routine care [37].

Regarding pharmacists acting as immunizers or vaccine administrators, both [36] and [37] documented notable gains in vaccination rates (RRs of 1.14 [1.12–1.15] and 2.64 [1.81, 3.85], respectively). In contrast, the current analysis found that pharmacists working solely as immunizers did not achieve a statistically significant improvement in vaccination rates compared with usual care.

A separate systematic review and meta-analysis by [36] confirmed the advantages of pharmacists operating as immunizers, advocates, or in dual capacities, especially for influenza vaccination in the United States and other high-income nations. Earlier, [38] observed a 24% increase in vaccination uptake (RR 1.24 [1.05, 1.47]) [38]. likewise identified a substantial positive influence of pharmacist engagement on immunization rates compared with standard care, with an RR of 2.95 (2.25, 3.87) [16]. Consistent with the present work, both of those studies also noted considerable heterogeneity across the included trials [16, 38].

Data drawn exclusively from RCTs indicated that pharmacist participation in immunization activities within community and hospital environments positively influenced vaccination coverage, particularly for influenza vaccines delivered in community pharmacies. A range of sensitivity analyses conducted across all studies confirmed the robustness of these results. These analyses further highlighted that pharmacists in both hospital and community settings made important contributions to population immunization rates. Comparable findings were reported by [36], with significant benefits observed in community settings [RR 1.17 (1.06, 1.28)] and hospital settings [RR 2.82 (1.13, 7.03)] [36].

Recommendations for policy and practice

These results reinforce the important position of pharmacists as key members of the vaccination team. Their active involvement in immunization programs—whether as immunizers, advocates, or in combined roles—helps strengthen and validate their professional contributions. The success of community pharmacist-managed vaccination services in raising immunization and vaccine delivery rates while enhancing patient satisfaction has been clearly established [39]. Achieving broader national and global immunization targets will require that, before being authorized to administer vaccines, pharmacist immunizers complete specialized immunization training and maintain current certification in cardiopulmonary resuscitation and first aid [13]. In Malaysia, pharmacists were integrated into the mass immunization effort as vaccinators during the COVID-19 pandemic under the National COVID-19 Immunisation Program (PICK). To adequately prepare them, Universiti Sains Malaysia (USM), working with the Malaysia Pharmacists Society (MPS), developed the Certified Training Programme on Immunisation for Pharmacists (CTPIP) [40].

It is also vital to identify and address the obstacles and difficulties associated with delivering immunization programs. Such insights will support the design of more targeted and effective pharmacist-led strategies that can further elevate vaccination coverage. Notably, diminished confidence in vaccines and mistrust of government initiatives ranked among the primary reasons individuals declined vaccination. The limited success of certain government-led programs may help explain gaps between expected and observed levels of vaccine hesitancy [41, 42].

Future studies should investigate patients' perceived need for immunization alongside patient-centered health outcomes.

Strengths and limitations

Although the risk of bias could not be eliminated, incorporating both RCTs and non-RCTs increased the likelihood of capturing high-quality evidence. This approach offered an advantage over several earlier meta-analyses on the topic.

The larger proportion of non-RCTs (including before-and-after, cohort, and longitudinal designs with at least two comparison groups) compared with RCTs introduced a greater overall risk of bias. However, these non-randomized studies better represent everyday clinical practice, where randomization and blinding are frequently impractical in routine pharmaceutical care delivery.

Additionally, the analyses revealed substantial heterogeneity (>80%). This made it difficult to pinpoint the precise mechanisms or strategies most responsible for the observed increases in immunization rates. Subgroup

analyses were performed, some of which reduced but did not eliminate heterogeneity. Previous authors have similarly noted the difficulties of interpreting heterogeneous data in this field [16, 36, 37].

Finally, the meta-analysis results should be applied with careful attention to local regulations, healthcare systems, and regional contexts.

Conclusion

Although findings regarding pharmacists acting purely as immunizers were inconsistent, their overall participation in immunization initiatives enhanced public vaccination rates. Pharmacists exhibited leadership and played essential advocacy roles in both community and hospital environments. Regardless of their specific functions, pharmacist interventions were associated with increases in public vaccination rates of up to 51% compared with control groups receiving standard care. Future research could delve deeper into the intensity of pharmacist engagement and its corresponding effects on immunization uptake.

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