UK Health Security Agency

# Effectiveness and cost-effectiveness of intervention strategies to increase vaccination uptake

## A rapid systematic review

# Contents

# Main messages

1. This rapid systematic review (search from 1 January 2020 to 18 July 2025) identified and summarised systematic review evidence relating to the effectiveness and cost-effectiveness of strategies to increase vaccination uptake. Only systematic reviews were included; primary studies were excluded. Twenty reviews met the inclusion criteria. Fifteen reviews were systematic reviews with meta-analysis (1 to 15), 4 were systematic reviews with narrative synthesis (16 to 19) and one review, published as a preprint, was a systematic review with a network meta-analysis (20).

2. Eight reviews included only adults (5 to 8, 14 to 16, 19), 7 included adults and children (2, 3, 10, 13, 17, 18, 20) and 3 included only children (4, 9, 11). The 2 reviews that did not specify study population age, were conducted in pregnant people (1, 12).

3. Evidence in this report has been structured by intervention category as synthesised in the included, individual systematic reviews. As this rapid systematic review was limited to systematic review evidence only, we were limited by groupings per the included reviews. We did not separately review the primary studies underlying the included systematic reviews.

4. Whilst primary studies included in systematic reviews may have focused on certain groups such as adolescents or those with concurrent conditions, if the review did not group or present its findings this way, then it could not be analysed in this review. We did however seek to highlight systematic reviews that included both pregnant people and healthcare workers as vaccine recipients, as these were prespecified in our protocol. Some reviews looked at interventions targeted at specific populations rather than a specific intervention type, and so results have also been grouped this way.

5. Of the included studies, 5 reviews assessed a variety of different interventions rather than a specific category (6, 17 to 20). These have been called reviews of ‘mixed interventions’ in this report. Interventions in this category were delivered on their own in some studies, or as multicomponent interventions, and examples of this can be found in the review by Davies and others (20). These reviews generally reported increased vaccine uptake compared to control (usual care, no intervention, wait list, attention placebo or an alternative format or delivery of intervention), though results varied by outcome, as well as the included population. Subgroup analyses and a low risk of bias network meta-analysis found multicomponent interventions to be the most effective.

6. Three reviews looked at digital interventions (3, 13, 16) for example text or email reminders, or online education. They showed a general increase in vaccine uptake, but this differed depending on what the intervention was compared to. For example, one review found email communication increased vaccine uptake compared to no intervention,

but when email reminders were compared to traditional or other digital methods, there was no clear increase in vaccine uptake (16). The risk of bias in these reviews was generally high, with concerns around data extraction not being completed in duplicate and a lack of an assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis.

7. Two reviews looked at educational and motivational interventions (2, 7), for example teaching people about and motivating people to take the vaccine. They showed a mixed effect, with one study showing a stronger effect for educational interventions than motivational (7) and the other study showing a positive effect when gender neutral educational or motivational interventions were used, but not when the interventions were gender specific interventions (2). These reviews had a moderate risk of bias, with concerns over the potential impact of risk of bias in individual studies on the results of the meta-analysis not being discussed.

8. Evidence of financial incentives (giving money or vouchers after receiving the vaccine) and reminders (one single written message in the form of letters, postcards, patient portal messages, brochures, mobile applications and text messages) was limited to a single review for each (10, 15). They both suggested an increase in vaccine uptake from the interventions.

9. Decision aids were also considered by one review (14) and defined as ‘tools designed to help individuals make a vaccine related decision, including information on differing health care options, and help individuals communicate personal values’ (14). No increase in vaccine uptake was observed.

10. Reviews focusing on financial incentives and decision aids had varying risks of bias. The number of studies for each of these interventions was also very small, with some being conducted in specific subgroups of the population, and therefore firm conclusions could not be drawn.

11. Reviews looking at interventions delivered by healthcare practitioners as vaccine providers (4, 5, 8), (including pharmacists, clinicians, nurses and health educators) all showed an increase in vaccine uptake after intervention compared to control. These included communication training and education for clinicians, nurses and health educators, or pharmacists either providing the vaccine or advocating for it. Risk of bias ranged from moderate to high, with concerns over data extraction not being fully completed in duplicate and no assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis.

12. Reviews of interventions specifically targeted at parents (9, 11) (including motivational interviews, education and reminder messages) showed mixed results. The risk of bias of

these reviews varied due to incomplete participant descriptions, a lack of consideration of publication bias and a lack of interpretation of the study findings in light of the risk of bias.

13. Two reviews included pregnant people as potential vaccine recipients (1, 12), which was a pre identified group at risk of health inequalities. The interventions included mainly education or reminder and recall messages; and showed a mixed effect with uptake varying by vaccine type. No direct comparisons to non-pregnant people were made, so we were not able to assess whether interventions to increase vaccine uptake differed in this groups.

14. One study (6) looked for and found no significant association between intervention and vaccine uptake for healthcare workers as potential vaccine recipients (as opposed to vaccine providers as mentioned earlier), which like pregnant people was a pre identified group at risk of health inequalities. Like pregnant people, this review had no direct comparisons to non-healthcare workers so we were unable to assess whether interventions had any difference in vaccine uptake in this group.

15. We found no studies meeting our eligibility criteria that reported on cost effectiveness of interventions to increase vaccine uptake. This was mainly due to exclusion of cost effectiveness evidence from the USA as these would not be comparable to the UK costs or healthcare system. Reviews that did not contain 80% RCT evidence and grey literature were also excluded.

16. No evidence was identified for system-level approaches or changes in service delivery to improve vaccine uptake. This is likely due to the challenges in conducting system-level trials and a lack of available evidence.

17. Evidence suggested that most interventions aimed to increase vaccine uptake at a provider or individual level had a positive effect, which appeared greatest when multi-component interventions were used. However, there was some variation in effect in some individual interventions or specific groups. The included reviews differed in their target population, setting and vaccine, as well as in their reported outcomes. The amount of evidence, as well as risk of bias of the reviews varied across interventions and there was no available evidence on system level approaches or cost-effectiveness of any intervention. Therefore, whilst firm conclusions cannot be made on the most effective intervention, our findings suggest that multicomponent interventions work well to increase vaccine uptake. This is consistent with the network meta-analysis (20) which was rated as low risk of bias.

# Purpose

The purpose of this rapid systematic review was to identify and summarise the available systematic review evidence of the effectiveness and cost-effectiveness of strategies to increase vaccination uptake.

The review question was:

1. What is the effectiveness and cost-effectiveness of strategies to increase vaccination uptake?

# Methods

A rapid systematic review was conducted, following streamlined systematic methods to accelerate the review process. A literature search was undertaken to look for relevant systematic reviews (with or without meta-analysis) published or available as preprint, from 1 January 2020 up to 18 July 2025. Search dates were limited to after 2020 due to the COVID-19 pandemic, which changed the climate and context around vaccine uptake.

A protocol was produced before the literature search was conducted, including the review question, the eligibility criteria, and all other methods. The following criteria were used to answer the review question:

1. Population: adults and children
2. Context: strategies intended to increase uptake of any vaccination covered by the United Kingdom routine immunisation schedule (21)
3. Intervention: any strategy explicitly aimed at improving vaccination uptake (for prevention, that is, pre-exposure) including system level approaches addressing supply and demand
4. Comparator: usual care, active or inactive control, no treatment or wait-list control
5. Outcome: change in vaccine uptake rates or coverage and cost-effectiveness (health service and personal social service perspective)
6. Search dates: limited to systematic reviews published after 2020
7. Study designs: systematic reviews with or without meta-analysis (including network meta-analysis) including randomised controlled trials or cluster randomised controlled trials. At least 80% of included studies need to be RCTs, the remaining 20% can be any other design

Pregnant people and healthcare workers were included as groups who may be at risk of health inequalities, and therefore evidence should be specifically considered for these groups. This was pre specified in the review protocol.

Two protocol deviations were made during the review process to clarify inclusion criteria of systematic reviews with protocols that differed to this rapid review protocol. Systematic reviews needed to meet the following criteria:

- at least 80% of included studies had to be randomised control trials (RCTs). Reviews that did not contain 80% RCTs were excluded as 'wrong inclusion criteria'
- at least 80% of included studies had to be from high-income countries according to the World Bank lending classification list (22). Reviews that did not contain 80% of studies from high income countries were excluded as 'wrong inclusion criteria'

A clarification was made that sub-group analysis of meta-analysis must be pre-specified in the systematic review protocol for inclusion in this review. Full details of the methodology are provided in the protocol in Annexe A.

Screening on title and abstract was undertaken in duplicate by 2 reviewers for 20% of the eligible studies, with the remainder completed by one reviewer. Screening on full text was undertaken by one reviewer and checked by a second. Data extraction was performed by one reviewer and checked by a second.

Risk of bias assessment was conducted in duplicate by 2 reviewers using AMSTAR2 'A MeaSurement Tool to Assess Systematic Reviews' (23). Where systematic reviews presented Grading of Recommendations Assessment, Development and Evaluation (GRADE) (24) assessment of the evidence, quantitative or qualitative findings from the review have been presented and interpreted in light of the authors GRADE assessment. A new GRADE assessment was not conducted as part of this review.

# Evidence

In total, 4,157 studies were screened at title and abstract and 132 studies were screened at full text. Of these, 20 studies met the inclusion criteria. A PRISMA diagram showing the flow of studies through the review is shown in Annexe B, and studies excluded on full text screening are available with the reasons why in Annexe C. Study characteristics are available in Annexe D, and risk of bias assessments are available in Annexe E.

Evidence has been structured by intervention category as synthesised in the individual reviews.

Fifteen reviews were systematic reviews with meta-analysis (1 to 15), 4 were systematic reviews with narrative synthesis (16 to 19), and one review published as a preprint, was a systematic review with a network meta-analysis (20). As per the protocol, all systematic reviews contained at least 80% of primary studies from high income countries, with studies often set in the United States of America, Canada, Australia and the United Kingdom, alongside other countries.

Demographics of the included participants were unclear in the majority of the systematic reviews due to a lack of reporting in the primary studies. Eight studies included only adults (5 to 8, 14 to 16, 19), 7 included adults and children (2, 3, 10, 13, 17, 18, 20), 3 included only children (4, 9, 11) and 2 were unclear (1, 12) (both conducted in pregnant people, but age range not consistently reported within primary studies). Six studies included but were not limited to healthcare workers (3, 6, 7, 14, 16, 18). Only one review that included but was not limited to these groups separated them out in their analysis. Two studies were conducted in pregnant people only (1, 12), and 3 included but were not limited to pregnant people (7, 14, 20).

## Change in vaccine uptake or coverage

Table 1 shows the general direction and intensity of effect, as well as the risk of bias, of the different intervention categories found in our included studies.

**Table 1. Direction of effect tables**
Abbreviations: OR=odds ratio, RR=relative risk, RD=risk difference

| Intervention type | Number of reviews | General direction of effect | Intensity of effect (for example RR/OR) | Risk of bias rating |
|---|---|---|---|---|
| Mixed | 5 | ↑ (Increased) | Effect estimates between 1.23 to 2.09 (OR) in meta-analysis | Low to high |
| Digital | 3 | ↑ (Increased) | Effect estimates between 1.25 to 2.23 (OR) in meta-analysis | Moderate to high |

| Intervention type | Number of reviews | General direction of effect | Intensity of effect (for example RR/OR) | Risk of bias rating |
|---|---|---|---|---|
| Educational or motivational | 2 | ↔ (Mixed effect) | Effect estimates between 0.025 and 0.057 (RD) and 1.07 to 1.10 (RR) | Moderate |
| Decision aids | 1 | X (No effect) | 1.56 (OR) | High |
| Reminders | 1 | ↑ (Increased) | 1.16 (RR) | Moderate |
| Financial incentives | 1 | ↑ (Increased) | 2.26 (RR) | Moderate |
| Interventions delivered by healthcare practitioners | 3 | ↑ (Increased) | Effect estimates 0.052 (RD) and between 1.14 to 1.58 (RR) | Moderate to high |
| Interventions targeted towards parents | 2 | ↔ (Mixed effect) | Effect estimates between 1.23 to 1.49 (OR) | Moderate to high |
| Interventions targeted towards pregnant people | 2 | ↔ (Mixed effect) | Effect estimates between 0.98 and 1.07 (RR) and 1.78 (OR) | Low to high |

## Mixed interventions

Reviews that looked at ‘mixed interventions’ did not focus on a specific intervention category and included primary studies assessing a range of different interventions. The term ‘multicomponent’ refers to interventions delivered in conjunction with each other. Some of the interventions in this category were delivered singularly, or as multicomponent. Like other intervention categories, most reviews of mixed interventions did not enable a robust assessment of the relative effectiveness of individual components.

Five reviews; one systematic review with meta-analysis (6), one systematic review with network meta-analysis (20), and 3 systematic reviews with narrative synthesis (17 to 19) looked at mixed interventions to increase vaccine uptake.

### Systematic reviews with meta-analysis

One systematic review with meta-analysis by Kafadar and others (6) looked at the effect of mixed, different interventions on influenza, human papillomavirus (HPV) and hepatitis B vaccine uptake. The review included 50 studies but did a separate meta-analysis on only RCTs which included 9 studies and 138,169 people. All studies had to be conducted in the United Kingdom

for inclusion in the review. Interventions included reminders, staff offering vaccines at other appointments, financial incentives, home letters (sometimes with home visits), campaigns, and educational visits. Participants were all over the age of 17, but 55% of included studies had participants over 65. It also included healthcare workers, those described as being in at risk groups (including those with chronic heart, respiratory, liver, kidney or neurological disease and those with diabetes) or those on opioid substitution therapy. The review reported an odds ratio (OR) of 1.23 (95% CI 1.07 to 1.41) showing an increase in vaccine uptake after intervention compared to no intervention, or alternative intervention methods (for example other campaign formats or vaccine interventions using letters). However, there was substantial heterogeneity ($I^2$=94.9%) in the estimate. A pre specified sensitivity analysis exploring possible reasons for the heterogeneity was conducted by population subgroup (ages 75 plus, 65 plus, 18 to 64 at risk, low risk ages 65 to 74, 17 to 18, those on opioid substitution therapy, healthcare workers and those over 65 at risk). This demonstrated that the association between increased vaccine uptake after intervention remained for all population groups other than those aged over 65 in a high-risk group (p=0.7525), and healthcare workers (p=0.7506). The authors also reported that visual inspection of funnel plots was suggestive of publication bias. Our risk of bias assessment of this systematic review highlighted a number of concerns, including a lack of a clear inclusion criteria, no excluded studies list, no reporting of sources of funding for included studies and no assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis. The overall risk of bias was high.

### Systematic review with network meta-analysis

Davies and others (20) conducted a Bayesian random effects network meta-analysis looking at the effect of mixed interventions on vaccine uptake for a variety of different vaccines. There were 268 studies included in the review, however the network meta-analysis only included 223 studies, conducted internationally with 6,234,118 people. Interventions were grouped into multicomponent interventions (15 studies), affordability such as payment to cover costs or incentives (14 studies), access (14 studies), education and reminders (54 studies), reminders (78 studies) and education (85 studies). Participants were of all ages and included pregnant people, but results were not separated by population groups in the analysis. The OR for all intervention categories showed significant increases in vaccine uptake compared to control (no intervention, usual care, waitlist, attention placebo or alternative eligible intervention), with the most effective being when multicomponent interventions were used:

- multicomponent interventions, OR 2.09 95%, Credible interval (CrI) 1.66 to 2.63
- affordability OR 1.87 95%, CrI 1.47 to 2.40
- access OR 1.74 95%, CrI 1.35 to 2.26
- education and reminder OR 1.47 95%, CrI 1.29 to 1.67
- reminder OR 1.36 95%, CrI 1.22 to 1.50
- education OR 1.33 95%, CrI 1.19 to 1.49

Heterogeneity was moderate (tau=0.42 [0.37 to 0.49]). Sensitivity analysis removing studies with high risk of bias showed results similar to the primary analysis, however this had not been prespecified as part of the analysis.

Subgroup analysis of intervention effect by age group showed education and reminder interventions were most effective compared to control in adolescents (OR 1.92 95%, CrI 1.49 to 2.48) than young children (6 estimates, OR 1.21 95% CrI 0.79 to 1.84) and education may be more effective for young children (15 estimates, OR 1.50 95% CrI 1.12 to 1.99) than for adults (22 estimates, OR 1.07 95% CrI 0.86 to 1.33).

The authors also performed subgroup analysis to look at the effect of COVID-19 by separating studies conducted before or after 2020. This showed that the pandemic may have led to differences in effectiveness of interventions to address affordability compared to control (pre 2020=OR 2.32 95% CrI 1.72 to 3.19, post 2020=1.35 95%, CrI 0.94 to 1.94) and multicomponent interventions (pre 2020=2.50 95%, CrI 1.89 to 3.33, post 2020=1.45 95%, CrI 1.00 to 2.10) with both appearing less effective since the start of the pandemic. Other interventions did not show a significant difference in effectiveness before and after the COVID-19 pandemic.

The authors GRADE assessment of the certainty of evidence rated the effect estimates from all interventions as moderate. Evidence was downgraded due to concerns about heterogeneity, within study bias and incoherence.

Our risk of bias assessment of this systematic review highlighted that there was no reporting of sources of funding for included studies. The overall risk of bias is low. However, this study is a pre-print and has not yet been peer reviewed, therefore findings should be interpreted with caution as it may be subject to change following peer review.

### Systematic reviews with narrative synthesis

Two systematic reviews looked at the effect of different interventions either delivered by healthcare practitioners as vaccine providers or targeted to people eligible for the vaccine on vaccine uptake (18, 19). Wheeler and others (19) conducted a systematic review of interventions delivered in outpatient settings to improve uptake rate of a variety of different vaccines. The review referred to physicians, doctors and nurses as the intervention providers. It included 44 studies from international settings (total number of people and demographics was not reported). Interventions included healthcare practitioner education and reminders as well as patient reminders, education, increased access or in person contact with a healthcare practitioner. Some were single interventions involving no face-to-face contact (n=24), whilst others had multiple components (n=9). The review found that face-to-face contact with patients, such as home visits or speaking with a nurse or physician directly, and multicomponent interventions such as increasing access, giving reminders and providing education for both healthcare practitioners and patients, increased vaccination rates consistently, whilst single interventions or interventions without face-to-face contact were less effective. It was unclear

whether interventions were compared to no intervention, usual care, or to a historical comparison or pre intervention. Our risk of bias assessment of this review highlighted a lack of a complete description of the included studies, not detailing a list of excluded studies, no reporting on the sources of funding for the studies included in the review and a lack of interpretation of the study findings in light of the risk of bias. The overall risk of bias is high.

Another systematic review with narrative synthesis by Mavundza and others (18) looked at the effect of different interventions targeted towards healthcare practitioners as vaccine providers and those eligible for the vaccine on HPV vaccine initiation, completion and receipt of any dose. They included 35 studies with 346,184 people, 32 of which were RCTs and were conducted mainly in the USA, as well as Australia and the Netherlands. Interventions targeted towards people eligible for vaccines included education, reminder systems, financial incentives, motivational behaviour interventions and health messaging whilst interventions targeted towards healthcare practitioners as providers included training, prompts to offer vaccines, assessment and feedback, funding and provider consultations in person and through webinars. The specific role of healthcare practitioners is not defined. Participants included children and adults (parents or healthcare practitioners of children). Healthcare workers were included as a group eligible for the vaccine, but results were not reported separately for this group. The review had mixed results, with some interventions targeted at people eligible for vaccines being effective compared to standard of care, no intervention, alternative interventions, waitlist control or multiple comparisons for some outcomes but not others. For example, tailored education led to an increase in vaccine completion but had no effect on vaccine initiation. For healthcare practitioners as providers, prompts, training, training with assessment and feedback, consultation, funding and interventions that combined a mixture of these increased vaccine initiation and completion, whereas assessment and feedback alone had no effect. Three studies within this systematic review also reported on the cost of interventions, however these were all conducted in the USA, and the authors did not separately analyse this outcome. Authors reported the certainty of evidence from their GRADE assessment as being very low to moderate due to risk of bias, indirectness and imprecision. Our risk of bias assessment of the systematic review found no reporting of the sources of funding for the studies included in the review and a lack of discussion of heterogeneity. The overall risk of bias was moderate.

Lott and others (17) reported a systematic review of intervention studies to increase HPV vaccine initiation and completion in minority populations with 9 included studies and 9,722 people. 8 of the studies were RCTs. Whilst not restricted by inclusion criteria, all studies were conducted in the USA. Several of the included studies were also present in the review by Mavundza and others (18). Interventions included education, vaccine reminders and interviews about barriers to vaccine uptake. Participants were children and young people aged 9 to 26 years old and all a part of racial or sexual minority groups. Seven studies reported on vaccine initiation, and seven reported on vaccine completion. The review found mixed results for vaccine initiation, with 5 out of 7 studies reporting no change compared to no intervention or usual care. However, vaccine completion was reported to have increased by 5.6 to 74.2% (no measure of variance reported) in all 7 studies compared to control. Our risk of bias assessment

of this systematic review highlighted a lack of a complete description of the control or comparison group, no reporting on the sources of funding for the studies included in the review and a lack of interpretation of the study findings in light of the risk of bias when discussing the results. The overall risk of bias was high.

## Digital interventions

Three reviews: 2 systematic reviews with meta-analysis (3, 13) and one systematic review with narrative synthesis (16) looked at digital interventions. The interventions were sometimes given individually for example only digital reminders, or sometimes in conjunction with other interventions, for example digital reminders and digital education.

### Systematic reviews with meta-analysis

Chandeying and others (3) conducted a systematic review with meta-analysis on the effectiveness of digital interventions on HPV vaccine uptake (including vaccine initiation and completion). Thirty-four studies were included, set internationally, containing 281,280 people. Interventions included digital education or reminders aimed at either healthcare practitioners as providers or those eligible for the vaccine. The specific role of healthcare practitioners is not defined. Participants included children, young adults, their parents and healthcare workers (mean age 15 years, range 9 to 45 years). Some primary studies also included men who have sex with men. Associations for different population groups were included in subgroup analysis, however this had not been pre specified. The review reported an OR for vaccine uptake of 1.25 (95% CI 1.16 to 1.34) showing a significant increase in vaccine uptake after intervention compared to usual care, no intervention or alternative treatment. There was moderate heterogeneity in the analysis ($I^2$=57%) which was explored in pre-planned subgroup analysis.

Subgroup analysis of the effect of the different, individual intervention types on vaccine uptake showed that the benefit of interventions compared to control remained for the categories labelled client reminder, provider reminder, client education plus provider reminders and provider education, but client education alone did not show a clear difference between intervention and control. Subgroup analysis results are reported below:

- client reminder: OR 1.41 (95% CI 1.23 to 1.63)
- provider reminder: OR 1.39 (95% CI 1.11 to 1.75)
- client education plus reminder: OR 1.29 (95% CI 1.04 to 1.59)
- provider education: OR 1.18 (95% CI 1.05 to 1.34)
- client education OR: 1.08 (95% CI 0.92 to 1.28)

Egger's test and visual interpretation of funnel plots showed no evidence of publication bias. Our risk of bias assessment of this systematic review highlighted concerns relating to a lack of an excluded studies list, no reporting on the sources of funding for included studies in the review and a lack of a consideration of risk of bias of the studies within the meta-analysis. The overall risk of bias is moderate.

Sandi and others (13) also conducted a systematic review with meta-analysis on the effectiveness of digital education and reminders for people eligible for HPV vaccines. They included 12 studies, 5 of which reported the outcome of vaccine completion, containing 1,997 people aged 9 to 26 years old. Some primary studies also included men who have sex with men, but results for different population groups were not separated in the analysis. Studies were not restricted by inclusion criteria, but all were set in USA. Four of the primary studies included were also included in the review by Chandeying and others (3) in the 'client reminder', 'client education' or 'client reminder and client education' categories. Both studies had similar aims, but reasons for the difference in included studies could be the difference in outcome measurement (initiation and completion compared to completion only), not including parents or healthcare workers, not including interventions aimed at providers, and a difference in study settings. The reported OR for vaccine completion after intervention compared to control (usual care or alternative formats of interventions) was 2.23 (95% CI 1.11 to 4.47) and the authors reported moderate heterogeneity ($I^2$=56%) in the analysis. Our risk of bias assessment of the systematic review highlighted concerns due to data extraction not being performed in duplicate, no list of excluded studies, no reporting on the sources of funding for included studies in the review, no assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis and no test for publication bias. The overall risk of bias is high.

### Systematic reviews with narrative synthesis

Frascella and others (16) conducted a systematic review with narrative synthesis with 11 primary studies. 8 of these were RCTs conducted in a high income setting (number of people was unclear). The review looked at the effect of digital interventions; specifically email reminders, on influenza and HPV vaccine uptake. Whilst not restricted by inclusion criteria, most studies were conducted in the USA, with one being done in the Netherlands. Interventions consisted of email reminders with or without traditional reminders, or different email models. Participants were all adults over 18 years, including parents and healthcare workers. Results were not reported separately for different population groups. The review found email communication increased vaccine uptake compared to no intervention, but when email reminders were compared to traditional or other digital methods, there was no clear increase in vaccine uptake. Our risk of bias of the systematic review highlighted concerns due to no excluded studies list, no reporting of the sources of funding for included studies within the review and no account for risk of bias in individual studies when interpreting and discussing the results of the review. The overall risk of bias is high.

## Educational or motivational interventions

Two reviews; both systematic reviews with meta-analysis (2, 7), looked at educational or motivational interventions. These interventions were aimed at a broad population and were not limited to specific groups (specific evidence is discussed later in this report). The interventions were sometimes given individually, for example education alone, or in conjunction with other interventions, for example education alongside motivational interventions.

Chandeying and others (2) conducted a systematic review with meta-analysis on the effect of educational or motivational interventions on HPV vaccine uptake. The review included 17 RCTs, and 7 studies with 10,991 people reporting an outcome within our review eligibility criteria. The analysis was separated according to whether the intervention was specifically targeted at females (gender specific), or all genders (gender neutral). All interventions included an educational component, and some also had motivational interviewing, decisional support or logistical strategies. Participants were children and young people aged between 12 and 24 years in educational settings internationally. The meta-analysis found a significant increase in vaccine uptake after gender neutral interventions compared to either usual practice, no intervention or a different format of intervention (2 studies, RD 0.057 95% CI 0.028 to 0.087) and no evidence of heterogeneity ($I^2$=0%), but there was not a clear difference from gender specific interventions compared to usual practice, no intervention or a different format of intervention in vaccine uptake (5 studies, RD 0.025 95% CI -0.009 to 0.059). There was substantial heterogeneity in this effect estimate ($I^2$=79.85%), but there was no exploration by the review authors as to the potential reasons for this heterogeneity. Visual inspection of funnel plots indicated no presence of publication bias, but the number of studies was likely too low to reliably inform this. Our risk of bias assessment of the systematic review highlighted concerns due to there being no reporting on the sources of funding for the studies included in the review, no excluded studies list, no exploration of heterogeneity and no assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis. It was also unclear if the authors used a fixed effects or random effects model for their meta-analysis due to discrepancies in reporting, despite there being substantial heterogeneity. The overall risk of bias is moderate.

Labbe and others (7) conducted a systematic review with meta-analysis on the effect of educational or motivational interventions on uptake of a variety of different vaccines. One hundred and eighteen studies were included in the review, 70 of which were RCTs and 59 reporting vaccine uptake were included in the meta-analysis. The meta-analysis had 28,602 people from international settings. Two studies included in this review are also present in the review by Chandeying and others (2), but this review had a wider context and inclusion criteria. All participants were adults and included parents, the elderly, pregnant people, those with underlying health conditions and healthcare workers (age range not reported). Results for these groups were not separated out in the analysis. Studies were international setting, but a large proportion were conducted in the USA. The authors reported a relative risk (RR) from the meta-analysis for educational interventions compared to usual care or a different intervention format of 1.10 (95% CI 1.04 to 1.16) showing a small but significant effect of educational interventions in increasing vaccine uptake. The RR for motivational interventions was 1.07 (95% CI 0.78 to 1.45) suggesting no difference in vaccine uptake between intervention and usual care or different intervention format as the confidence intervals crossed the line of no effect. However, the authors reported no significant difference in the mean effect of vaccine rates between educational and motivational interventions (Q=0.031, p=0.861). There was a substantial level of heterogeneity in the estimates of effect for both the educational interventions ($I^2$=84%) and motivational interventions ($I^2$=99%,). Subgroup analysis, sensitivity analysis and meta

regression were not conducted on the meta-analysis of RCTs. Visual inspection of funnel plots suggested the presence of publication bias for both educational and motivational interventions.

Our risk of bias assessment of this systematic review highlighted concerns due to no reporting on the sources of funding for the studies included in the review, no excluded studies list and a lack of consideration for risk of bias in individual studies when discussing the results of the review. The overall risk of bias is moderate.

## Decision aids

One systematic review with meta-analysis by Vujovich-Dunn and others (14) explored the effect of decision aids on uptake of a variety of different vaccines. The review included 5 studies but, only 4 studies with 1,565 people were included in the meta-analysis. Decision aids were defined as 'tools designed to help individuals make a vaccine related decision, including information on differing health care options, and help individuals communicate personal values'. Studies were set in the UK, USA and New Zealand. Participants were adults, including parents, pregnant people and healthcare workers (age range not reported). Results were not separated in the analysis by population group. The systematic review reported an OR for vaccine uptake after use of a decision aid compared to no intervention or usual care of 1.56 (95% CI 0.75 to 3.27). Although this is suggestive of increased vaccine uptake with decision aids, it was not significant as the confidence intervals cross the line of no effect. There was moderate heterogeneity in the analysis ($I^2$=46.7%). The authors explored this by removing studies they did not consider to have true randomisation, however this was not prespecified in the review protocol and did not explain the heterogeneity. Our risk of bias assessment of this systematic review highlighted concerns due to screening not being completed in duplicate, a lack of any test for publication bias, no reporting on the sources of funding for the studies included in the review and a lack of a complete description of the population. The overall risk of bias is high.

## Reminders

One systematic review with meta-analysis from Murphy and others (10) looked at the effect of different formats of a single written reminder on influenza uptake. They included 27 studies from international settings with 652,235 people. Reminder formats included letters, postcards, patient portal messages, brochures, mobile apps and SMS messaging. Participant age ranged from under 6 months to over 65, and some of the primary studies included participants in at risk groups (including those with asthma, chronic obstructive pulmonary disease and renal failure). Results were separated in the analysis by age group, but not by other population groups. The review reported an RR of 1.16 (95% CI 1.13 to 1.20) for vaccine uptake after intervention compared to usual care or no intervention. There was substantial heterogeneity in the estimate however ($I^2$=91%). A sensitivity analysis by study design (removing a cluster RCT) was conducted, but this was not pre specified in the protocol and did not explain the heterogeneity. However, authors conducted several subgroup analysis to explore this.

Subgroup analysis on the effect of different formats of written messages on vaccine uptake showed significant RRs ranging from 1.04 to 1.35 for letters, postcards, portal messaging and smart phone messaging. Postcards had the greatest effect out of all intervention formats (RR 1.35 95% CI 1.15 to 1.60). Letters or postcard with brochures no longer showed a significant difference in the subgroup analysis, with confidence intervals crossing the line of no effect (RR 1.17 95% CI 0.87 to 1.58). Heterogeneity was high amongst subgroups ($I^2$=93%). Significant differences were found between groups, with portal messaging being less effective than postcards ($chi^2$=8.81 p=0.003) and letters ($chi^2$=13.54, p<0.01).

A second prespecified analysis on the effect of written messages on vaccine uptake by age group didn't show any significant difference between groups ($chi^2$=1.85, p=0.17) with adults having an RR of 1.09 (95% CI 1.01 to 1.18) and older adults having an RR of 1.16 (96% CI 1.12 to 1.20). Heterogeneity was high ($I^2$=89%).

A final prespecified analysis on the effect of written messages on vaccine uptake by level of risk of bias present in the study showed a significant difference between groups ($chi^2$=16.27 p=0.0003) with studies with a high risk of bias having an RR of 1.42 (95% CI 1.26 to 1.61), studies with an unclear risk of bias having an RR of 1.17 (95% CI 1.12 to 1.22) and studies with a low risk of bias having an RR of 1.09 (95% CI 1.04 to 1.15). Heterogeneity was high ($I^2$=91%). This implies that the true effect of reminders is likely to be less than demonstrated by the overall meta-analysis, although it is still likely that there is a small positive effect on vaccine uptake.

Authors GRADE assessment rated the certainty of evidence as moderate due to high risk of bias in several studies, substantial heterogeneity, and high publication bias (shown by funnel plots and Egger's test). Our risk of bias assessment of the systematic review highlighted concerns over the inclusion criteria for the review not being clear, no reporting of the sources of funding for the studies included in the review and no excluded studies list. The overall risk of bias was moderate.

## Financial incentives

One systematic review with meta-analysis from Wang and others (15) looked at the effect of financial incentives on hepatitis B vaccine coverage. They included 6 studies (one of which was a non-randomised trial) with 3,964 people from the UK, USA and Australia. Financial incentives were in the form of cash and/or vouchers of varying amounts, with some interventions also including regular counselling sessions. Participants were all substance users (those who inject drugs or use cocaine), which was an inclusion criteria of the review. The review reported an RR of 2.26 (95% CI 1.33 to 3.85) for financial incentives compared to usual care demonstrating increased vaccine coverage. There was high heterogeneity in the effect estimate ($I^2$=93.7%). Prespecified sensitivity analysis removing one study at a time supported the effectiveness of financial incentives in increasing vaccine coverage for substance abusers. Heterogeneity was explored in subgroup analysis. Prespecified analysis of the effect of financial incentives on vaccine coverage showed a RR of 2.37 (95% CI 0.32 to 17.62) for having a single dose of the hepatitis B vaccine, and an RR of 2.30 (95% CI 1.23 to 4.29) for completing the vaccine series.

There was high heterogeneity across subgroups ($I^2$=93.7%). Tests for between group differences showed a p value of 0.977, indicating there is no significant difference between having a single dose of the vaccine and vaccine completion.

Another prespecified subgroup analysis of the effect of financial incentives with a regular pattern on vaccine uptake showed an RR of 1.58 (0.69 to 3.63) for interventions that gave a regular incentive or an incentive at each dose and an RR of 3.53 (95% CI 1.02 to 12.22) for studies with a different incentive pattern. There was high heterogeneity across subgroups ($I^2$=93.7%). Tests for between group differences showed a p value of 0.293, indicating there is no significant difference between using a regular incentive or any other incentive pattern.

Authors GRADE assessment rated the certainty of evidence as very low due to high risk of bias in several studies, substantial heterogeneity, imprecision (shown by wide confidence intervals) and high publication bias. Our risk of bias assessment of the systematic review highlighted concerns due to no reporting on the sources of funding for the studies included in the review and no excluded studies list. The overall risk of bias was moderate. The review was also conducted on a specific population (substance users), and therefore may not be generalisable to a wider population.

## Interventions delivered by healthcare practitioners

Three systematic reviews with meta-analysis (4, 5, 8), looked at the effectiveness of interventions delivered by healthcare practitioners. Two of these reviews specifically focused on pharmacist led interventions (5, 8), while the third looked at healthcare practitioners more widely (clinicians, nurses and health educators) (4). The interventions were sometimes delivered individually for example through an advocacy campaign, or sometimes in conjunction with other health care practitioner interventions for example communication training and education.

Chandeying and others (4) conducted a systematic review with meta-analysis on the effect of healthcare practitioner training for clinicians, nurses and health educators on HPV vaccine uptake in children (11 to 17 years old). Clinicians included paediatricians, family medicine clinicians and those in family or primary care practices. Six studies were included with 245,295 people. All studies were conducted in the USA, but this was not a requirement of the review. The intervention included communication training (educational training, presumptive communication and motivational interviewing) both in person and online. Whilst the focus of the review was communication training and all primary studies included this, some studies also had additional interventions such as education or text message reinforcements. The risk difference (RD) for vaccine uptake after intervention compared to standard practice or wait list control was 0.052 (95% CI 0.019 to 0.085, p=0.002) indicating that there was a slight increase in vaccine uptake after intervention. Heterogeneity was high ($I^2$=77%) and was explored in pre-specified subgroup analysis looking at type of intervention (interventions involving presumptive communication or interventions using a conversation strategy).

Interventions that used presumptive communication led to a 9.1% increase in vaccine uptake. In contrast, those that used a conversation-based approach led to a 2.3% increase**.** This difference was statistically significant (Q=8.235, p=004). Interventions that used audit and feedback led to a 9.4% increase in vaccine uptake compared to a 2.4% increase when audit and feedback was not involved in the intervention. This difference was also statistically significant (Q=4.107, p=0.043). A final subgroup analysis found that interventions with presumptive strategies and audit and feedback increased vaccine uptake by 11.4% compared to all other intervention types, where vaccine uptake increased by 2.5%. This difference was also statistically significant (Q=14.095, p=0.001).

Visual inspection of funnel plots found no suggestion of publication bias. Our risk of bias assessment of this systematic review highlighted some concerns due to there being no excluded studies list, no reporting of sources of funding for included studies and no assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis. The overall risk of bias was moderate.

Elghanam and others (5) conducted a systematic review with meta-analysis on the effect of pharmacist led interventions on uptake of a variety of different vaccines. The review included 22 studies, but only 17 studies were included in the meta-analysis with 214,556 people from international settings. The intervention consisted of pharmacists either acting as an immuniser, educator or as an advocator (for example through campaigns). Participants were adults aged between 18 and 89, and participants within 3 of the primary studies had chronic health conditions such as asthma or COPD, cardiac disease or diabetes mellitus. Results were not separately analysed for these population groups. The systematic review reported an RR of 1.58 (95% CI 1.40 to 1.79) showing an increase in vaccine uptake after pharmacist led interventions compared to usual care or interventions without pharmacist participation. There was substantial heterogeneity ($I^2$=93%) however pre-specified sensitivity analysis showed results remained stable after removal of each individual study, but heterogeneity was not reduced. Excluding studies that had a high risk of bias also only reduced heterogeneity in studies conducted in in a hospital setting.

The authors also pre-specified subgroup analysis according to whether the pharmacists were immunisers or advocators (analysis did not include any studies with educators only), by infection (influenza or pneumonia) and by setting (hospital, pharmacy, primary care, or social media platforms). This analysis of pharmacist role showed both groups improved vaccine uptake with pharmacists as advocators having an RR of 1.59 (95% CI 1.41 to 1.90) and immunisers having an RR of 1.76 (95% CI 1.07 to 2.88), but there were no significant between group differences ($chi^2$=0.14, p=0.70).

Subgroup analysis looking at only influenza or pneumonia vaccines showed that pharmacist interventions increased vaccine uptake for both vaccines (influenza: RR 1.24 (95% CI 1.11 to 1.39 and pneumonia: RR 1.36 95% CI 1.07 to 1.72), with no significant differences between groups ($chi^2$=0.44, p=0.51). It is not clear why authors only conducted subgroup analysis for

influenza and pneumonia, as they were only listed as examples in the protocol. The final subgroup analysis by setting showed an increase in vaccine uptake for all interventions conducted in hospital settings (RR 3.02 95% CI 1.22 to 7.43), pharmacy settings (RR 1.29 95% CI 1.15 to 1.45), primary healthcare centres (RR 2.64 95% CI 1.46 to 4.78) and social media platforms (RR 9.62 95% CI 4.82 to 19.20), however the latter 2 settings only included one study, which is not considered a robust estimate for subgroup analyses. Significant differences were found between groups ($p<0.00001$) which may explain the heterogeneity observed in the pooled analysis.

Visual inspection of funnel plots also suggested the presence of publication bias. Our risk of bias assessment of this systematic review highlighted concerns due to there being no list of excluded studies, no reporting on the sources of funding for included studies in the review and data extraction not being clearly conducted in duplicate. The overall risk of bias is high.

Another systematic review with meta-analysis from Le and others (8) also looked at the effect of pharmacist led interventions on uptake for a variety of different vaccines. The review contained 93 studies, but there were only 14 RCTs. Eleven of these RCTs reported vaccine uptake and were included in the meta-analysis. There were 175,550 people in the advocator group and 135,350 people in the immuniser group; all participants were adults aged over 18, with 7 of the 11 studies containing participants over 60. All of the included primary studies were also included in the review by Elghanam and others (5) which is more recent than this review, and therefore the results of Le and others have not been reported separately here but can be found in Annexe D.

## Parent-focused interventions

Two systematic reviews with meta-analysis (9, 11), looked at parent-focused interventions. The interventions were sometimes given individually for example parent reminders, or sometimes in conjunction with other interventions for example parent reminders and parent education.

Norman and others (11) conducted a systematic review with meta-analysis on the effect of interventions to increase influenza vaccine coverage in children with comorbidities. The review included a range of study types and had 35 studies in total, however the meta-analysis only included 5 RCTs with 5,976 people. All studies within the meta-analysis focused on parent centred interventions, and all were conducted in the USA despite this not being part of the inclusion criteria. Interventions included reminders in the form of postal letters or mobile reminders. Participants were parents of children aged from 1 to 18 years, with the outcome being vaccine coverage in children. The children either had asthma or other comorbidities, which was an inclusion criteria of the review. The review reported an OR of 1.49 (95% CI 1.07 to 2.08) for vaccine coverage after parental reminders compared to control (not described). There was substantial heterogeneity in the estimate however ($I^2$=89%). Authors did not explore potential reasons for this but stated that they were not able to conduct subgroup analysis as stated in the protocol (by age group and high risk condition) due to the heterogeneity of studies. Our risk of bias assessment of this systematic review highlighted concerns due to not describing the included studies in adequate detail as information on control groups was missing, no

excluded studies list, no reporting of sources of funding for included studies and no discussion of potential publication bias. The overall risk of bias is high.

Mohammed and others (9) conducted a systematic review with meta-analysis from 13 studies (total number of people not reported) on the effect of interventions specifically aimed at parents on HPV vaccine initiation and completion. The review was limited to studies set in the USA. Interventions included motivational interviews, education or reminder or recall messages. Some studies considered single interventions while others had interventions with multiple components. Participants were parents of 9 to 18 year olds, with the outcome being measured in the child.

The review reported an OR of 1.24 (95% CI 0.86 to 1.77) for vaccine initiation, suggesting no significant effect from the intervention compared to usual care or active control as the confidence intervals cross the line of no effect. There was substantial heterogeneity ($I^2$=89.1), which was explored through pre specified subgroup analysis. Pre specified subgroup analysis by intervention type found no significant between group differences between reminder or recall interventions and non-reminder or recall interventions (statistical test not reported). However, the reminder or recall group had a within group significant difference (OR 1.19 95% CI 1.16 to 1.22) compared to the non-reminder or recall group who had a non-significant difference (OR 1.62 95% CI 0.76 to 3.44). There was substantial heterogeneity in the non-reminder or recall group ($I^2$=82.1%) but authors reported none in the reminder or recall group ($I^2$=0%).

For vaccine completion, the review reported an OR of 1.23 (95% CI 0.78 to 1.96), also suggesting no significant effect from the intervention compared to usual care or active control as the confidence intervals cross the line of no effect. Substantial heterogeneity was also present in this analysis ($I^2$=82.8 %), and the same subgroup analysis as for the outcome of vaccine initiation was conducted to explore this. The effect of interventions on vaccine completion by intervention type showed a significant between group difference in favour of reminder or recall interventions (statistical test not reported), with reminder or recall interventions having an OR of 1.52 (95% CI 1.04 to 2.21) compared to non-reminder or recall interventions with an OR of 1.06 (95% CI 0.40 to 2.81). There was substantial heterogeneity in both subgroups ($I^2$=75.1% and 87.9% respectively).

Asymmetrical distribution of results in funnel plots was suggestive of publication bias.
Our risk of bias assessment of this systematic review highlighted concerns relating to a lack of a complete description of the population due to not including the number of participants and a lack of interpretation of the study findings in light of the risk of bias when discussing the results of the review. The overall risk of bias is moderate.

## Interventions tailored to pregnant people

Two reviews; both systematic reviews with meta-analysis (1, 12), looked at interventions targeted at pregnant people. The interventions were sometimes given individually, or sometimes in conjunction with other interventions.

Brillo and others (1) conducted a systematic review with meta-analysis of interventions to increase influenza vaccine uptake in pregnant people. Seven studies were included with 2,809 people. Interventions included text message reminders, educational interventions, or bundled interventions. Bundled interventions included pregnant people focused interventions (tutorials, maps to local pharmacies), provider level interventions (discussion, vaccine promotion education) and practice level interventions (vaccine champions, posters and brochures). Studies were from international settings. Age was not consistently reported within primary studies, but where reported ranged between 26.8 to 33.8 years. The OR of vaccine uptake after any of the included interventions was 1.78 (95% CI 1.25 to 2.54) compared to standard care, with moderate heterogeneity ($I^2$=67%). Pre specified sensitivity analysis excluding each study one by one to assess its impact on the overall effect showed no change after exclusion of any study. Visual inspection of funnel plots by authors showed no evidence of publication bias. Our risk of bias assessment of the systematic review showed no excluded studies list and no reporting of sources of funding for included studies. The overall risk of bias was low.

Razai and others (12) conducted a systematic review with meta-analysis on the effect of interventions to increase uptake of influenza or pertussis vaccination in pregnant people. The review included 39 studies including observational studies, however a separate meta-analysis was conducted which included 14 RCTs with 86,424 people. Six of the included primary studies were also present in the systematic review and meta-analysis by Brillo and others (1). There was no restriction on the country setting of included studies, however most were in the USA with one each in Hong Kong and Canada. Interventions were education, prompting or multimodal. Ages were not consistently reported within primary studies but where reported mean age ranged between 20 and 35 years. The RR for vaccine uptake for influenza (12 studies) was 1.07 (95% CI 1.03 to 1.12) showing a small but significant increase in vaccine uptake after intervention compared to usual care or no intervention. The RR for vaccine uptake for pertussis (6 studies) was 0.98 (95% CI 0.84 to 1.03) showing that intervention most likely had no effect as the confidence intervals cross the line of no effect. No heterogeneity was observed in either analysis ($I^2$=0% and $I^2$=0.1%). Our risk of bias assessment of this systematic review showed no excluded studies list was reported, no reporting of sources of funding for included studies, no assessment of the potential impact of risk of bias in individual studies on the results of the meta-analysis and no exploration of potential publication bias. The overall risk of bias was high.

# Cost effectiveness

We found no studies meeting our eligibility criteria that reported on cost effectiveness of interventions to increase vaccine uptake. This was mainly due to the restriction of cost effectiveness outcomes needing to be from countries where healthcare costs would be applicable to the UK setting, which excluded USA. One of our included systematic reviews (18) reported on the cost of interventions, but this was set in the USA.

# Health inequalities

Our review protocol pre specified healthcare workers and pregnant people as important populations to identify evidence of effective interventions for vaccine uptake for. Although several reviews were focused on or included pregnant people or healthcare workers, few separated the groups in their analysis. Two reviews that specifically looked at interventions targeted at pregnant people showed a mixed result, as vaccine uptake varied by vaccine type (1, 12). One study looked for but found no significant association between vaccine uptake after intervention and healthcare workers (6).

No direct comparisons to non-pregnant people or non-healthcare workers were made, so we were not able to assess whether interventions to increase vaccine uptake differed in these groups.

Age, deprivation and ethnicity were also pre specified as important demographics to consider when looking at the effectiveness of interventions to increase vaccine uptake. Systematic reviews in this analysis included both children and adults spanning all age groups. Three reviews conducted a pre specified subgroup or sensitivity analysis to understand how intervention effects may differ by age group. One network meta-analysis (20) looking at mixed interventions found that education and reminder interventions were more effective for adolescent vaccinations than for vaccinations for young children and education may be more effective for young children than for adults. Another meta-analysis (6) looking at mixed, different interventions did a sensitivity analysis and found significant association between vaccine uptake after intervention for all population groups other than those aged 65 in a high-risk group. A third meta-analysis (10) looking at the effect of reminder interventions on different age groups found no significant difference between adults and older adults. No conclusions on ethnicity or deprivation can be found, as this information was not consistently reported within studies.

One study included participants who were all part of racial or sexual minority groups and showed a mixed result, with increases in vaccine completion after intervention but not vaccine initiation (17).

Women were more frequently represented in the studies. Several studies included participants with chronic health conditions, or men who have sex with men.

# Limitations

This rapid systematic review used streamlined systematic methods to accelerate the review process. Sources of evidence searched included databases of peer-reviewed and preprint research, but an extensive search of other sources was not conducted and most article screening was completed without duplication, so it is possible relevant evidence may have been missed. Only systematic reviews published after 2020 were included to understand the effectiveness of interventions post the COVID-19 pandemic, which changed the climate and context around vaccine uptake. However, systematic reviews did include primary studies conducted prior to 2020 which therefore introduces a risk of bias, and an inconsistency in how the date cut off has been applied.

Several of the systematic reviews included primary studies that did not meet our eligibility criteria, by not being set in a high-income country or not being a randomised control trial. However, this was a minimal amount, and the impact from non RCTs or studies not in high income countries on the overall effect estimates is low.

Reviews differed in their inclusion criteria with variations of populations, settings and vaccine types, as well as in their outcome ranging between vaccine uptake, vaccine coverage, vaccine initiation and vaccine completion. Many didn’t clearly report demographics and very few reported length of follow up. There were therefore many reasons findings may have differed between reviews which cannot be explored in this report.

Where possible, when primary studies appeared in multiple reviews this was highlighted. However, this was not always feasible, particularly when primary studies were included in systematic reviews that examined different intervention categories. As a result, some primary studies may have contributed to multiple effect estimates, potentially inflating the overall impact. Caution is therefore advised when interpreting the findings of this review.

Risk of bias was present in all included reviews, and very few systematic reviews assessed the certainty of evidence, usually only assessing risk of bias at the study level. Many meta-analyses did not assess the potential impact of risk of bias in individual studies on the results of the meta-analysis or pre specified how they were going to explore causes of heterogeneity. Reviews also rarely provided a list of excluded studies with exclusion justifications or reported on the sources of funding for the studies included in the review.

# Evidence gaps

No evidence was identified on the cost-effectiveness of intervention strategies aimed at increasing vaccine uptake, and as such, this review was unable to address that review question. Additionally, as previously noted, there was no conclusive evidence regarding the effectiveness of interventions targeting healthcare workers.

All of the available evidence was at the level of the provider or targeted at vaccine recipients. No evidence was identified for system-level approaches or changes in service delivery to address vaccine uptake.

Several reviews contained evidence on interventions that included mixed interventions, digital interventions and interventions delivered by healthcare practitioners, but there was limited evidence on the effect of financial incentives, decision aids, reminders, educational or motivational interventions or interventions aimed at parents or pregnant people. These specific interventions may have been a part of the mixed interventions category but understanding the effect of them as standalone interventions was limited by the available evidence.

Studies were often unclear on the detail of what each intervention included, however, we found no clear evidence on:

- community and cultural engagements
- policy, for example: policy change (eligibility to have a vaccine)
- translation of written materials and interpreting services during consultations for those with English as a second language
- whole system work, for example financing Quality and Outcomes Framework for GPs or other provider financial incentives to drive service change, pay for performance
- medicine or commodities (supply chain or logistics considerations and aspects of product design)
- health workforce (task shifting to enable other workforce cadres to administer vaccination, training interventions)
- mass models deployed for defined or discrete time periods, for example: mass vaccination centres, national campaigns

# Conclusion

This rapid systematic review identified 20 systematic reviews published since 2020 which provide evidence on the effectiveness of intervention strategies to improve vaccine uptake. We found no studies meeting our eligibility criteria that reported on cost effectiveness of interventions to increase vaccine uptake and no evidence on system level approaches to increase vaccine uptake.

Evidence indicated that most interventions aiming to increase vaccine uptake or coverage tend to have a positive effect. Evidence suggested that when multicomponent interventions, digital interventions, reminders, financial incentives and interventions delivered by healthcare practitioners (including pharmacists, clinicians, nurses and health educators) were used there was a general increase in vaccine uptake after intervention compared to control (usual care, no intervention, wait list, attention placebo or an alternative format or delivery of intervention). In contrast, evidence that looked at pregnant people or parent-targeted interventions, and educational or motivational approaches showed mixed results, while decision aids showed no measurable impact.

Evidence included in this review does not enable firm conclusions on which the most effective interventions were for vaccine uptake as included reviews differed in their populations, setting and vaccine type, as well as in their outcome ranging between vaccine uptake, vaccine coverage, vaccine initiation and vaccine completion. Additionally, the amount of evidence, as well as risk of bias present in reviews varied across interventions. This review aimed to inform effectiveness of interventions for the general population, and a number of the included systematic reviews focussed on interventions targeted at specific groups, which may not be generalisable to a wider population. However, our findings align with the network meta-analysis which was rated as low risk of bias (20), in that multicomponent interventions work well to increase vaccine uptake.

# Acknowledgments

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# Disclaimer

UKHSA's rapid systematic reviews and evidence summaries aim to provide the best available evidence to decision makers in a timely and accessible way, based on published peer-reviewed scientific papers, and papers on preprint servers. Note that the reviews:

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# Annexe A. Protocol

## Review question

The review question is:

1. What is the effectiveness and cost-effectiveness of strategies to increase vaccination uptake?

A search for systematic reviews to answer this review question will be conducted up to 18 July 2025.

Systematic reviews that meet the Cochrane Collaboration definition of a systematic review will be included: “A systematic review attempts to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing more reliable findings from which conclusions can be drawn and decisions made”. The key characteristics of a systematic review are:

- a clearly stated set of objectives with pre-defined eligibility criteria for studies
- an explicit, reproducible methodology
- a systematic search that attempts to identify all studies that would meet the eligibility criteria
- an assessment of the validity of the findings of the included studies, for example through the assessment of risk of bias; and
- a systematic presentation, and synthesis, of the characteristics and findings of the included studies

# Eligibility criteria

**Table A.1. Inclusion and exclusion criteria**

| | Included | Excluded |
|---|---|---|
| Population | Any | Animals |
| Context | Strategies intended to increase uptake of any vaccination covered by the United Kingdom routine immunisation schedule (21) | Systematic reviews or meta-analysis including any vaccine that is not present in the United Kingdom routine immunisation schedule |
| Settings | Systematic reviews including at least 80% of studies from high-income countries using the World Bank lending classification list (22) (where details of included studies are not stated, these will be included and considered in risk of bias assessment) | Low and middle-income countries |
| Intervention or exposure | Any strategy explicitly aimed at improving vaccination uptake (for prevention, that is, pre-exposure) including the system level approaches addressing supply and demand, for example:<br>• reminder or recall systems for example: phone messages, telephone, postal<br>• educational and behaviour-change programmes, for example motivational interviewing<br>• financial or non-financial incentives (at the individual level) individually targeted interventions to stimulate demand at patient-level<br>• community and cultural engagements<br>• policy, for example: policy change (eligibility to have a vaccine)<br>• translation of written materials and interpreting services during consultations for those with English as a second language<br>• interventions aimed at giving recommendations to specific job roles such | |

| | Included | Excluded |
|---|---|---|
| | as midwife, GP or other recommendation for prenatal vaccinations<br>• interventions specifically aimed at countering misinformation or conspiracy theories<br>• direct recommendation/confirmation of suitability of vaccination by a healthcare professional (particularly pertinent for selective programmes for example influenza for those with underlying medical conditions)<br>• whole system work for example, financing Quality and Outcomes Framework for GPs or other provider financial incentives to drive service change, pay for performance<br>• medicine and commodities (supply chain or logistics considerations and aspects of product design)<br>• health workforce (task shifting to enable other workforce cadres to administer vaccination, training interventions)<br>• service delivery models, for example: primary care via general practice (or equivalent), extended primary care, for example pharmacies, home visits including a primary healthcare professional administering the vaccine in the person's own home, or visiting a residential nursing home to vaccine residents<br>• secondary or specialist settings, for example: outpatient clinics<br>• community outreach models, for example: mobile clinics and so on<br>• mass models deployed for defined/discrete time periods, for example: mass vaccination centres, national campaigns<br>• prenatal and ante-natal clinics<br>• digital exclusion interventions (barriers to accessing digital services), for example: using online consent forms for school-based programmes, improving digital literacy among older adults, providing mobile data | |

| | Included | Excluded |
|---|---|---|
| | plans for recently arrived migrants, approaches to information relay to overcome digital exclusion such as peer networks or leaflets | |
| Comparator | For example: usual care, active or inactive control, no treatment control, wait-list control | |
| Outcomes | Change in vaccine uptake rates or coverage<br>Cost-effectiveness (health service and personal social service) | Cost-effectiveness outcomes in the United States |
| Language | English | Reviews in any other language |
| Date of publication | From 2020 up to 18 July 2025 | |
| Study design | Systematic reviews with or without meta-analysis (including network meta-analysis) including randomised controlled trials or cluster randomised controlled trials<br><br>At least 80% of included studies need to be RCTs, the remaining 20% can be any other design<br><br>Individual participant data meta-analyses | Narrative reviews<br><br>Systematic reviews or any type of meta-analyses of observational evidence, or reviews of mixed study designs with more than 20% not RCTs<br><br>Any primary study<br>• experimental studies including randomised-controlled trials, quasi-experimental studies, cross-over designs, before-and-after studies<br>• observational studies including cohort studies, case control studies, cross sectional studies<br>• descriptive studies including case series or case reports<br>• modelling studies<br>• qualitative studies<br>• mixed methods |

| | Included | Excluded |
|---|---|---|
| Publication type | Peer-reviewed published research<br>Preprints | Conference abstracts<br>Editorials<br>Letters<br>News articles<br>Grey literature<br>Primary evidence |

# Identification of studies

The following databases will be searched for studies published up to TBC: Ovid Medline, Ovid Embase, Ovid PsycInfo, Epistemonikos and Web of Science Preprint Citation Index. The search is presented in Search strategy below.

# Screening

Title and abstract screening will be undertaken in duplicate by 2 reviewers for at least 20% of the eligible studies, with the remainder completed by one reviewer. Disagreement will be resolved by discussion or with involvement of a third reviewer where necessary. Screening full text will be undertaken by one reviewer and checked by a second.

# Data extraction

Summary information from each review will be extracted and reported in tabular form. Information to be extracted will include number of included studies, details of the review protocol including study designs (for example randomised controlled trials, cluster randomised controlled trial), interventions, and outcomes of interest (and those reported). A summary of participants characteristics, relevant results, certainty of evidence (where available), or risk of bias of included studies if certainty of evidence not available, and any relevant contextual data. This will be undertaken by one reviewer and checked by a second. When a systematic review provides both a meta-analytic data and a narrative synthesis of the evidence, only the meta-analytic data will be extracted. Individual study results will not be extracted for reporting. Unless prespecified in the systematic review's protocol, subgroup analyses will not be extracted.

# Risk of bias assessment

Two reviewers will independently complete a risk of bias assessment for included studies, with disagreements resolved by discussion or with a third reviewer. Reviews will be assessed using the quality assessment tool AMSTAR 2: a critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both.

# Synthesis

Where systematic reviews present data in a consistent format, a narrative synthesis will be produced to interpret the findings. The number of studies, the overall number of participants in each review, effect size and variance and the certainty of evidence (where available) or summary of the risk of bias across studies will be summarised and presented.

As each review may have synthesised evidence using different selection criteria, results are expected to be presented at the review level rather than synthesised across reviews. Where systematic reviews present Grading of Recommendations Assessment, Development and Evaluation (GRADE) results, quantitative or qualitative findings from the review will be presented and interpreted in light of GRADE assessment.

# Health inequalities

Variations in the outcomes between pregnant and non-pregnant people as well across healthcare workers will be considered. Deprivation, ethnicity, and age will also be used to explore whether they affect the outcomes.

# Search strategy

## Use of AI

Microsoft Copilot was used to suggest terms during the development of the Medline search strategy. Details of the prompt entered, and the output provided are given below. All terms suggested by Copilot were reviewed by the Information Scientist developing the search. If terms were deemed to be appropriate and useful additions, and did not duplicate any existing search terms, they were integrated into the existing structure of the search.

Date of AI tool use: 18 June 2025

**Prompt entered**
Can you suggest some synonymous terms for increasing vaccine uptake that would be used in health research?

**Response**
In health research literature, several synonymous or related terms are commonly used in place of "increasing vaccine uptake". These terms often vary slightly depending on the context (for example, public health policy, clinical practice, behavioural science). Here are some widely used alternatives:

- improving vaccination coverage
- enhancing immunization rates
- boosting vaccine acceptance
- promoting vaccine adherence
- increasing immunization uptake
- raising vaccination rates
- encouraging vaccine compliance
- facilitating vaccine access and utilization
- expanding immunization reach
- strengthening vaccine delivery and uptake

These terms are often used interchangeably in academic and policy discussions, though some may emphasize different aspects (for example, "acceptance" focuses on attitudes, while "coverage" is more quantitative).

**Use of proposed terms**
The following terms were lifted from the Copilot output, modified with appropriate search syntax and integrated into the search:

- raise*
- enchanc*
- boost*
- promot*
- coverage
- accept*
- facilitat*
- strengthen*
- delivery

## Ovid MEDLINE(R) ALL 1946 to 16 July 2025

1. exp Immunization/ (225,454)
2. exp Vaccines/ (300,163)
3. exp Immunization Programs/ (17,130)
4. (vaccin* or immuni#ed or immuni#ation*).tw,kf. (554,243)
5. or/1-4 (663,205)
6. ((enhanc* or improv* or increas* or boost* or promot*) adj3 coverage).tw,kf. (20,012)
7. ((enhanc* or improv* or increas* or boost* or promot*) adj3 accept*).tw,kf. (19,122)
8. ((enhanc* or improv* or increas* or boost* or promot* or strengthen*) adj3 delivery).tw,kf. (50,226)
9. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 uptake).tw,kf. (70,408)
10. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 take up).tw,kf. (236)
11. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 adherence).tw,kf. (35,760)
12. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 compliance).tw,kf. (25,104)
13. ((reduc* or decreas*) adj3 hesitancy).tw,kf. (627)
14. ((reduc* or decreas*) adj3 dropout*).tw,kf. (769)
15. vaccin* hesitancy.tw,kf. (8,438)
16. ((increas* or improv* or raise or enhanc* or boost* or promot*) adj3 literacy).tw,kf. (6,899)
17. ((increas* or improv* or facilitat* or enhanc* or boost* or promot*) adj3 access*).tw,kf. (82,734)
18. exp "Patient Acceptance of Health Care"/ (247,289)
19. exp Vaccination Refusal/ (2,827)
20. or/6-19 (529,227)
21. intervention*.ti. (237,619)
22. Reminder Systems/ (3,982)
23. exp Telephone/ or Electronic Mail/ or Text Messaging/ or Letter/ (1,343,233)
24. exp Internet/ (107,382)
25. alert*.tw,kf. (55,511)
26. follow-up.tw,kf. (1,365,593)
27. recall*.tw,kf. (103,514)
28. reminder*.tw,kf. (18,884)
29. (chat bot* or chatbot*).tw,kf. (3,303)
30. SMS.tw,kf. (9,566)
31. ((text or mobile or personal*) adj messag*).tw,kf. (7,885)
32. (mobile phone* or smart phone*).tw,kf. (19,062)
33. (mobile app* or web app*).tw,kf. (19,211)
34. (digital* inclu* or digital* exclu* or digital poverty or digital* poor*).tw,kf. (573)
35. mak* every contact count.tw,kf. (74)
36. exp Communication/ (391,714)
37. exp Consumer Health Information/ (16,264)

38. (information adj3 (objective* or provi* or access* or campaign*)).tw,kf. (324,165)
39. (enhance* adj3 (demand* or information)).tw,kf. (6,298)
40. (foreign language* adj7 information).tw,kf. (35)
41. (native language adj7 information).tw,kf. (80)
42. (english language adj7 information).tw,kf. (359)
43. communication.tw,kf. (372,826)
44. (communit* adj5 (champion* or embassador* or ambassador* or representative* or engagement or advocate*)).tw,kf. (16,689)
45. exp Health Personnel/ed (68,824)
46. (staff adj3 train*).tw,kf. (16,589)
47. (workforce adj3 train*).tw,kf. (1,928)
48. (doctor* adj3 train*).tw,kf. (5,500)
49. ((general practitioner* or GP or GPs) adj3 train*).tw,kf. (3,289)
50. (nurse* adj3 train*).tw,kf. (13,071)
51. Health Knowledge, Attitudes, Practice/ (138,228)
52. exp "Patient Education as Topic"/ (91,259)
53. (educat* or litera*).tw,kf. (2,168,747)
54. (motivation* adj5 intervention*).tw,kf. (4,570)
55. ((increas* or improv*) adj3 awareness).tw,kf. (52,169)
56. Information Systems/ (19,580)
57. Health Information Systems/ (1,781)
58. Medical Records/ (66,513)
59. (medical record* or health record*).tw,kf. (210,837)
60. ((vaccin* or immuni#ation*) adj3 (status or history)).tw,kf. (15,664)
61. (miss* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (1,149)
62. (catch up* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (1,054)
63. (outstanding adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (72)
64. ((gap or gaps) adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (908)
65. Health Services Accessibility/ (94,111)
66. exp "Delivery of Health Care"/ (1,418,557)
67. Primary Health Care/ (99,247)
68. (Vaccin* adj3 (produc* or suppl* or access* or distrib*)).tw,kf. (19,748)
69. (immuni#ation* adj3 (produc* or suppl* or access* or distrib*)).tw,kf. (3,224)
70. (vaccin* adj3 (clinic or clinics or appointment* or service*)).tw,kf. (3,060)
71. (immuni#ation* adj3 (clinic or clinics or appointment* or service*)).tw,kf. (2,392)
72. (immuni#ed* adj3 (clinic or clinics or appointment* or service*)).tw,kf. (20)
73. Community Health Workers/ (7,268)
74. outreach.tw,kf. (21,711)
75. mobile clinic*.tw,kf. (872)
76. social mobili#ation.tw,kf. (613)
77. (Home visit* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (42)
78. (mobile adj3 (clinic or vaccin* or immuni#ation*)).tw,kf. (933)
79. (pop-up adj3 (clinic* or vaccin* or immuni#ation*)).tw,kf. (54)

80. ((vaccin* or immuni#ation*) adj5 record*).tw,kf. (4,260)
81. ((vaccin* or immuni#ation*) adj5 information).tw,kf. (8,771)
82. exp Behavioral Sciences/ (272,033)
83. (behavio?r* adj (science* or chang*)).tw,kf. (61,664)
84. behavio?r* modif*.tw,kf. (6,202)
85. exp Motivation/ (206,607)
86. ((financial or monetary or cash) adj incentive*).tw,kf. (8,612)
87. coercive measure*.tw,kf. (646)
88. (mandatory adj3 (vaccin* or immuni#ation*)).tw,kf. (1,624)
89. ((vaccin* or immuni#ation or service*) adj2 delivery).tw,kf. (32,840)
90. ((co-deliver* or codeliver*) adj3 (vaccin* or immuni#ation*)).tw,kf. (121)
91. delivery model*.tw,kf. (5,114)
92. (hospital* or pharmac* or outpatient* or general practice* or GP or antenatal* or ante natal* or prenatal* or pre natal* or school* or communit* or workplace*).tw,kf. (4,353,385)
93. (maternal health or maternity care).tw,kf. (21,039)
94. ((secondary or primary or tertiary or speciali*) adj care).tw,kf. (252,785)
95. ((secondary or primary or tertiary or speciali*) adj setting*).tw,kf. (1,329)
96. (setting adj2 deliver*).tw,kf. (728)
97. (mass adj (vaccination* or centre* or center* or model*)).tw,kf. (4,972)
98. School Health Services/ (19,134)
99. exp Community Health Services/ (345,675)
100. ((education* or college* or universit*) adj5 deliver*).tw,kf. (12,873)
101. exp Health Services/ (2,575,522)
102. Health Personnel/ (73,989)
103. Health Workforce/ (15,040)
104. (health* adj (worker* or workforce* or provider* or staff* or personnel)).tw,kf. (137,079)
105. (intervention* adj (worker* or workforce* or provider* or staff* or personnel)).tw,kf. (776)
106. ((organi#ation* or manager*) adj7 programme).tw,kf. (2,734)
107. ((provider* or organi#ation*) adj3 intervention*).tw,kf. (6,045)
108. (vaccin* adj5 (production* or suppl*)).tw,kf. (11,254)
109. exp Vaccines/sd (3,081)
110. (governance or government*).tw,kf. (192,997)
111. implementation.tw,kf. (431,167)
112. (Vaccin* adj7 prioriti#ation).tw,kf. (643)
113. (Policy or policies).tw,kf. (423,899)
114. (Strategy or strategies).tw,kf. (1,851,290)
115. (Multi* adj3 intervention*).tw,kf. (33,353)
116. (vaccin* adj5 (Administration or acquisition or planning or organi#ation)).tw,kf. (13,470)
117. exp Government/ (165,842)
118. Health Policy/ (75,490)
119. Fiscal Policy/ or (Policy/ or Public Policy/) (44,555)
120. Social Responsibility/ (21,036)
121. (Service* adj5 (integrat* or deliver* or perform*)).tw,kf. (67,183)

122. ((Health* or whole) adj system*).tw,kf. (155,135)
123. ((Report* or monitor* or hardware or software or perform*) adj5 system*).tw,kf. (326,201)
124. Cold-chain.tw,kf. (2,428)
125. Financ*.tw,kf. (170,816)
126. Incentiv*.tw,kf. (46,318)
127. Healthcare Financing/ (1,400)
128. exp Economics/ (757,836)
129. exp Immunization Programs/ec (1,757)
130. exp Immunization/ec (3,923)
131. exp Vaccines/ec (5,591)
132. System* level.tw,kf. (16,087)
133. Financing, Government/ (21,616)
134. (Vaccin* adj5 (produc* or distrib* or access* or suppl*)).tw,kf. (28,129)
135. Technology, Pharmaceutical/ (16,871)
136. exp Drug Industry/ (48,507)
137. ((Health or vaccine) adj5 technolog*).tw,kf. (37,913)
138. Occupational Health/ (38,053)
139. occupational health.tw,kf. (22,513)
140. ((employee* or staff or workplace) adj health).tw,kf. (4,543)
141. House Calls/ (4,393)
142. (home visit* or house call*).tw,kf. (12,862)
143. ((vaccin* or immuni#ation*) adj3 home*).tw,kf. (630)
144. exp Residential Facilities/ (61,015)
145. (mobile data adj3 (immigrant* or migrant* or asylum or asylee*)).tw,kf. (0)
146. (peer adj3 (network* or disseminat* or information)).tw,kf. (5,396)
147. leaflet*.tw,kf. (28,548)
148. conspirac*.tw,kf. (2,248)
149. misinform*.tw,kf. (9,135)
150. ((Vaccin* or immuni#ation*) adj3 recommend*).tw,kf. (14,110)
151. ((Vaccin* or immuni#ation*) adj3 eligib*).tw,kf. (1,848)
152. (Pay adj2 performance*).tw,kf. (2,658)
153. Supply chain.tw,kf. (9,066)
154. Logistic*.tw,kf. (570,954)
155. or/21-154 (13,479,170)
156. 5 and 20 and 155 (29,359)
157. ((enhanc* or improv* or increas* or boost* or promot*) adj3 coverage).ti. (1,235)
158. ((enhanc* or improv* or increas* or boost* or promot*) adj3 accept*).ti. (929)
159. ((enhanc* or improv* or increas* or boost* or promot* or strengthen*) adj3 delivery).ti. (7,691)
160. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 uptake).ti. (5,743)
161. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 take up).ti. (10)
162. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 adherence).ti. (4,540)

163. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 compliance).ti. (2,060)
164. ((reduc* or decreas*) adj3 hesitancy).ti. (37)
165. ((reduc* or decreas*) adj3 dropout*).ti. (62)
166. vaccin* hesitancy.ti. (2,827)
167. ((increas* or improv* or raise or enhanc* or boost* or promot*) adj3 literacy).ti. (966)
168. ((increas* or improv* or facilitat* or enhanc* or boost* or promot*) adj3 access*).ti. (6,719)
169. or/157-168 (32,579)
170. 5 and 169 (4,471)
171. 156 or 170 (29,677)
172. systematic review.pt. (299,051)
173. "systematic review"/ (299,051)
174. "Scoping Review as Topic"/ or "Systematic Reviews as Topic"/ (16,504)
175. ("Cochrane Database of Systematic Reviews" or evidence report technology assessment or evidence report technology assessment summary).jn. (17,326)
176. ((((comprehensive or comprehensively) adj (analysis or review or reviewed)) or ((literature or scoping) adj (search or searches))).ti,ab,kf,kw. not "narrative review".ti.) and (database or databases or cinahl or cochrane or embase or psycinfo or pubmed or medline or scopus or (web adj1 science) or ((bibliographic or literature) adj (review or reviews)) or (((electronic adj (database or databases)) or (databases adj3 searched)) and (eligibility or excluded or exclusion or included or inclusion))).ti,ab,kf,kw. (76,448)
177. (((comparative adj effectiveness) and (effectiveness adj review)) or ((critical adj interpretive) and ((interpretive adj review) or (interpretive adj synthesis)))).ti,ab,kf,kw. (384)
178. ((diagnostic adj test) and ((accuracy adj review) or (accuracy adj reviews) or (accuracy adj studies) or (accuracy adj study)) and (meta-analysis or scoping or systematic)).ti,ab,kf,kw. (749)
179. ((evidence adj assessment) and GRADE).ti,ab,kf,kw. (120)
180. ((evidence adj2 gap) and (gap adj map)).ti,ab,kf,kw. (232)
181. ((evidence adj mapping) or (evidence adj review) or (exploratory adj review) or (framework adj synthesis) or (mapping adj review)).ti,ab,kf,kw. (4,536)
182. ((meta adj (epidemiological or ethnographic or ethnography or interpretation or narrative or review or study or synthesis or summary or theory)) or metaethnographic or metaethnography or metasynthesis).ti,ab,kf,kw. (4,948)
183. (((methodological or methodology) adj1 review) or ((mixed adj methods) and (methods adj1 (review or synthesis)))).ti,ab,kf,kw. (4,458)
184. ((narrative adj1 synthesis) or (overview adj4 reviews) or ("PRISMA" adj4 (guideline or guidelines or preferred or reporting or requirements)) or (PRISMA adj "P")).ti,ab,kf,kw. (46,073)
185. (((prognostic or psychometric) adj1 review) or ((qualitative adj (evidence or research)) and ((evidence or research) adj synthesis))).ti,ab,kf,kw. (1,066)

186. (((rapid adj evidence) and (evidence adj assessment)) or (rapid adj realist) or (rapid adj2 (review or reviews)) or (realist adj2 (review or reviews or syntheses or synthesis))).ti,ab,kf,kw. (5,294)
187. (((review adj economic) and (economic adj1 (evaluation or evaluations))) or ((scoping or systematic) adj2 (review or reviews or studies or study))).ti,ab,kf,kw. (459,135)
188. ((review adj1 reviews) or ((systematic adj evidence) and (evidence adj map)) or (systematic adj2 mapping) or (systematic adj2 literature) or (systematic adj2 (Embase or Medline or PsycInfo or PubMed)) or (systematic adj2 (review or reviews)) or ((systematical or systematically) adj2 (review or reviewed reviews)) or (systematically adj identified) or (systematized adj review) or (umbrella adj (review or reviews))).ti,ab,kf,kw. (424,958)
189. "Meta-Analysis".pt. (215,398)
190. exp meta analysis/ (26,850)
191. (meta adj2 (analyse or analyser or analyses or analysis or analytic or analytical or analytics or analyze or analyzed or analyzes)).ti,ab,kf,kw. (354,842)
192. (metaanalyse or Metaanalysen or metaanalyser or metaanalyses or metaanalysis* or metaanalytic or metaanalytical or metaanalytics or metaanalyze or metaanalyzed or metaanalyzes).ti,ab,kf,kw. (3,005)
193. "network meta-analysis"/ or (network adj1 (meta or metaanalyses or metaanalysis or metaregression)).ti,ab,kf,kw. (13,692)
194. (systematic and ((meta adj regression) or metagression)).ti,ab,kf,kw. (11,847)
195. or/172-194 (695,544)
196. 171 and 195 (1,391)
197. limit 196 to yr="2020 -Current" (988)
198. limit 197 to (comment or editorial or letter or news or newspaper article) (4)
199. 197 not 198 (984)

## Embase (1974 to 15 July 2025)

1. exp immunization/ (433,056)
2. exp vaccine/ (486,701)
3. (vaccin* or immuni#ed or immuni#ation*).tw,kf. (658,928)
4. or/1-3 (832,930)
5. ((enhanc* or improv* or increas* or boost* or promot*) adj3 coverage).tw,kf. (24,494)
6. ((enhanc* or improv* or increas* or boost* or promot*) adj3 accept*).tw,kf. (24,876)
7. ((enhanc* or improv* or increas* or boost* or promot* or strengthen*) adj3 delivery).tw,kf. (67,575)
8. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 uptake).tw,kf. (90,354)
9. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 take up).tw,kf. (305)
10. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 adherence).tw,kf. (58,636)
11. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 compliance).tw,kf. (43,932)

12. ((reduc* or decreas*) adj3 hesitancy).tw,kf. (745)
13. ((reduc* or decreas*) adj3 dropout*).tw,kf. (1,029)
14. vaccin* hesitancy.tw,kf. (9,126)
15. ((increas* or improv* or raise or enhanc* or boost* or promot*) adj3 literacy).tw,kf. (8,160)
16. ((increas* or improv* or facilitat* or enhanc* or boost* or promot*) adj3 access*).tw,kf. (112,422)
17. exp patient attitude/ (593,407)
18. vaccination refusal/ (1,656)
19. or/5-18 (956,094)
20. intervention*.ti. (329,535)
21. reminder system/ (3,509)
22. telephone/ or e-mail/ or text messaging/ (94,615)
23. exp Internet/ (144,820)
24. alert*.tw,kf. (92,334)
25. follow-up.tw,kf. (2,266,672)
26. recall*.tw,kf. (137,717)
27. reminder*.tw,kf. (32,560)
28. (chatbot* or chat bot*).tw,kf. (3,501)
29. SMS.tw,kf. (13,853)
30. ((text or mobile or personal*) adj messag*).tw,kf. (12,469)
31. (mobile phone* or smart phone*).tw,kf. (24,416)
32. (mobile app* or web app*).tw,kf. (26,057)
33. (digital* exclu* or digital* inclu* or digital poverty or digital* poor*).tw,kf. (646)
34. mak* every contact count.tw,kf. (145)
35. exp interpersonal communication/ (881,799)
36. medical information/ (97,490)
37. (information adj3 (objective* or provi* or access* or campaign*)).tw,kf. (421,476)
38. (enhance* adj3 (demand* or information)).tw,kf. (7,431)
39. (foreign language* adj7 information).tw,kf. (55)
40. (native language adj7 information).tw,kf. (109)
41. (english language adj7 information).tw,kf. (436)
42. communication.tw,kf. (472,576)
43. (communit* adj5 (champion* or embassador* or ambassador* or representative* or engagement or advocate*)).tw,kf. (20,598)
44. (health care personnel/ and education/) or staff training/ (40,184)
45. (staff adj3 train*).tw,kf. (28,368)
46. (workforce adj3 train*).tw,kf. (2,410)
47. (doctor* adj3 train*).tw,kf. (8,933)
48. ((general practitioner* or GP or GPs) adj3 train*).tw,kf. (4,506)
49. (nurse* adj3 train*).tw,kf. (19,348)
50. "attitude to health"/ (141,848)
51. patient education/ (136,118)
52. (educat* or litera*).tw,kf. (2,802,972)

53. (motivation* adj5 intervention*).tw,kf. (6,813)
54. ((increas* or improv*) adj3 awareness).tw,kf. (77,514)
55. exp information system/ (215,656)
56. exp medical information system/ (26,146)
57. exp medical record/ (387,813)
58. (medical record* or health record*).tw,kf. (363,293)
59. ((vaccin* or immuni#ation*) adj3 (status or history)).tw,kf. (21,419)
60. (miss* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (1,440)
61. (catch up* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (1,346)
62. (outstanding adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (88)
63. ((gap or gaps) adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (1,092)
64. health care access/ or health care availability/ (120,225)
65. exp health care/ (7,527,560)
66. health care delivery/ (224,055)
67. (Vaccin* adj3 (produc* or suppl* or access* or distrib*)).tw,kf. (23,332)
68. (immuni#ation* adj3 (produc* or suppl* or access* or distrib*)).tw,kf. (3,609)
69. (vaccin* adj3 (clinic or clinics or appointment* or service*)).tw,kf. (4,058)
70. (immuni#ation* adj3 (clinic or clinics or appointment* or service*)).tw,kf. (2,754)
71. (immuni#ed* adj3 (clinic or clinics or appointment* or service*)).tw,kf. (26)
72. outreach.tw,kf. (32,392)
73. mobile clinic*.tw,kf. (1,117)
74. social mobili#ation.tw,kf. (765)
75. (Home visit* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw,kf. (51)
76. (mobile adj3 (clinic or vaccin* or immuni#ation*)).tw,kf. (1,264)
77. (pop-up adj3 (clinic* or vaccin* or immuni#ation*)).tw,kf. (109)
78. ((vaccin* or immuni#ation*) adj5 record*).tw,kf. (6,045)
79. ((vaccin* or immuni#ation*) adj5 information).tw,kf. (10,971)
80. exp behavioral science/ (607,225)
81. (behavio?r* adj (science* or chang*)).tw,kf. (79,737)
82. behavio?r* modif*.tw,kf. (8,796)
83. exp motivation/ (294,481)
84. ((financial or monetary or cash) adj incentive*).tw,kf. (11,104)
85. coercive measure*.tw,kf. (801)
86. (mandatory adj3 (vaccin* or immuni#ation*)).tw,kf. (2,1046)
87. ((vaccin* or immuni#ation or service*) adj2 delivery).tw,kf. (40,484)
88. ((co-deliver* or codeliver*) adj3 (vaccin* or immuni#ation*)).tw,kf. (143)
89. delivery model*.tw,kf. (6,994)
90. (hospital* or pharmac* or outpatient* or general practice* or GP or antenatal* or ante natal* or prenatal* or pre natal* or school* or communit* or workplace*).tw,kf. (6,261,604)
91. (maternal health or maternity care).tw,kf. (22,672)
92. ((secondary or primary or tertiary or speciali*) adj care).tw,kf. (395,230)
93. ((secondary or primary or tertiary or speciali*) adj setting*).tw,kf. (2,222)
94. (setting adj2 deliver*).tw,kf. (1,129)

95. (mass adj (vaccination* or centre* or center* or model*)).tw,kf. (5,856)
96. exp school health service/ (22,269)
97. exp community care/ (142,735)
98. ((education* or college* or universit*) adj5 deliver*).tw,kf. (18,759)
99. exp health service/ (8,060,732)
100. exp health care personnel/ (2,261,525)
101. health workforce/ (15,239)
102. (health* adj (worker* or workforce* or provider* or staff* or personnel)).tw,kf. (175,117)
103. (intervention* adj (worker* or workforce* or provider* or staff* or personnel)).tw,kf. (1,135)
104. ((organi#ation* or manager*) adj7 programme).tw,kf. (3,293)
105. ((provider* or organi#ation*) adj3 intervention*).tw,kf. (9,580)
106. (vaccin* adj5 (production* or suppl*)).tw,kf. (13,229)
107. (governance or government*).tw,kf. (232,611)
108. implementation.tw,kf. (573,143)
109. (Vaccin* adj7 prioriti#ation).tw,kf. (706)
110. (Policy or policies).tw,kf. (498,194)
111. (Strategy or strategies).tw,kf. (2,312,868)
112. (Multi* adj3 intervention*).tw,kf. (51,483)
113. (vaccin* adj5 (Administration or acquisition or planning or organi#ation)).tw,kf. (17,616)
114. government/ (186,282)
115. policy/ or public policy/ or health care policy/ (342,765)
116. fiscal policy/ (579)
117. exp social responsibility/ (4,434)
118. (Service* adj5 (integrat* or deliver* or perform*)).tw,kf. (87,827)
119. ((Health* or whole) adj system*).tw,kf. (217,683)
120. ((Report* or monitor* or hardware or software or perform*) adj5 system*).tw,kf. (425,680)
121. Cold-chain.tw,kf. (3,149)
122. Financ*.tw,kf. (245,393)
123. Incentiv*.tw,kf. (57,441)
124. health care financing/ or exp economic aspect/ (3,060,821)
125. System* level.tw,kf. (20,010)
126. public finance/ (366)
127. (Vaccin* adj5 (produc* or distrib* or access* or suppl*)).tw,kf. (33,344)
128. drug industry/ (97,159)
129. ((Health or vaccine) adj5 technolog*).tw,kf. (48,254)
130. exp occupational health/ (281,951)
131. occupational health.tw,kf. (27,720)
132. ((employee* or staff or workplace) adj health).tw,kf. (5,575)
133. home visit/ (7,442)
134. (home visit* or house call*).tw,kf. (18,033)
135. ((vaccin* or immuni#ation*) adj3 home*).tw,kf. (782)
136. residential home/ (8,441)
137. (mobile data adj3 (immigrant* or migrant* or asylum or asylee*)).tw,kf. (0)

138. exp information dissemination/ or exp "access to information"/ (67,462)
139. conspirac*.tw,kf. (2,161)
140. misinform*.tw,kf. (9,734)
141. ((Vaccin* or immuni#ation*) adj3 recommend*).tw,kf. (19,178)
142. ((Vaccin* or immuni#ation*) adj3 eligib*).tw,kf. (2,736)
143. (Pay adj2 performance*).tw,kf. (3,333)
144. Supply chain.tw,kf. (10,312)
145. Logistic*.tw,kf. (816,039)
146. supply chain/ (354)
147. eligibility/ or eligibility criteria/ (15,906)
148. conspiracy theory/ (630)
149. exp misinformation/ (6,552)
150. or/20-149 (18,802,899)
151. 4 and 19 and 150 (37,288)
152. ((enhanc* or improv* or increas* or boost* or promot*) adj3 coverage).ti. (1,470)
153. ((enhanc* or improv* or increas* or boost* or promot*) adj3 accept*).ti. (1,146)
154. ((enhanc* or improv* or increas* or boost* or promot* or strengthen*) adj3 delivery).ti. (9,838)
155. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 uptake).ti. (6,873)
156. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 take up).ti. (17)
157. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 adherence).ti. (7,311)
158. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 compliance).ti. (3,520)
159. ((reduc* or decreas*) adj3 hesitancy).ti. (48)
160. ((reduc* or decreas*) adj3 dropout*).ti. (78)
161. vaccin* hesitancy.ti. (3,007)
162. ((increas* or improv* or raise or enhanc* or boost* or promot*) adj3 literacy).ti. (1,143)
163. ((increas* or improv* or facilitat* or enhanc* or boost* or promot*) adj3 access*).ti. (9,422)
164. or/152-163 (43,535)
165. 4 and 164 (5,188)
166. 151 or 165 (37,735)
167. systematic review.pt. (0)
168. "systematic review"/ (538,591)
169. "systematic review (topic)"/ or scoping review/ (45,422)
170. ("Cochrane Database of Systematic Reviews" or evidence report technology assessment or evidence report technology assessment summary).jn. (18,469)
171. ((((comprehensive or comprehensively) adj (analysis or review or reviewed)) or ((literature or scoping) adj (search or searches))).ti,ab,kf,kw. not "narrative review".ti.) and (database or databases or cinahl or cochrane or embase or psycinfo or pubmed or medline or scopus or (web adj1 science) or ((bibliographic or literature) adj (review or reviews)) or (((electronic adj (database or databases)) or (databases adj3 searched)) and (eligibility or excluded or exclusion or included or inclusion))).ti,ab,kf,kw. (92,698)

172. (((comparative adj effectiveness) and (effectiveness adj review)) or ((critical adj interpretive) and ((interpretive adj review) or (interpretive adj synthesis)))).ti,ab,kf,kw. (355)
173. ((diagnostic adj test) and ((accuracy adj review) or (accuracy adj reviews) or (accuracy adj studies) or (accuracy adj study)) and (meta-analysis or scoping or systematic)).ti,ab,kf,kw. (870)
174. ((evidence adj assessment) and GRADE).ti,ab,kf,kw. (166)
175. ((evidence adj2 gap) and (gap adj map)).ti,ab,kf,kw. (157)
176. ((evidence adj mapping) or (evidence adj review) or (exploratory adj review) or (framework adj synthesis) or (mapping adj review)).ti,ab,kf,kw. (5,106)
177. ((meta adj (epidemiological or ethnographic or ethnography or interpretation or narrative or review or study or synthesis or summary or theory)) or metaethnographic or metaethnography or metasynthesis).ti,ab,kf,kw. (5,371)
178. (((methodological or methodology) adj1 review) or ((mixed adj methods) and (methods adj1 (review or synthesis)))).ti,ab,kf,kw. (5,030)
179. ((narrative adj1 synthesis) or (overview adj4 reviews) or ("PRISMA" adj4 (guideline or guidelines or preferred or reporting or requirements)) or (PRISMA adj "P")).ti,ab,kf,kw. (52,028)
180. (((prognostic or psychometric) adj1 review) or ((qualitative adj (evidence or research)) and ((evidence or research) adj synthesis))).ti,ab,kf,kw. (1,233)
181. (((rapid adj evidence) and (evidence adj assessment)) or (rapid adj realist) or (rapid adj2 (review or reviews)) or (realist adj2 (review or reviews or syntheses or synthesis))).ti,ab,kf,kw. (6,109)
182. (((review adj economic) and (economic adj1 (evaluation or evaluations))) or ((scoping or systematic) adj2 (review or reviews or studies or study))).ti,ab,kf,kw. (542,177)
183. ((review adj1 reviews) or ((systematic adj evidence) and (evidence adj map)) or (systematic adj2 mapping) or (systematic adj2 literature) or (systematic adj2 (Embase or Medline or PsycInfo or PubMed)) or (systematic adj2 (review or reviews)) or ((systematical or systematically) adj2 (review or reviewed reviews)) or (systematically adj identified) or (systematized adj review) or (umbrella adj (review or reviews))).ti,ab,kf,kw. (507,978)
184. exp meta analysis/ (368,108)
185. (meta adj2 (analyse or analyser or analyses or analysis or analytic or analytical or analytics or analyze or analyzed or analyzes)).ti,ab,kf,kw. (443,074)
186. (metaanalyse or Metaanalysen or metaanalyser or metaanalyses or metaanalysis* or metaanalytic or metaanalytical or metaanalytics or metaanalyze or metaanalyzed or metaanalyzes).ti,ab,kf,kw. (14,705)
187. "network meta-analysis"/ or (network adj1 (meta or metaanalyses or metaanalysis or metaregression)).ti,ab,kf,kw. (18,715)
188. (systematic and ((meta adj regression) or metagression)).ti,ab,kf,kw. (13,893)
189. or/167-188 (969,418)
190. 166 and 189 (2,113)
191. limit 190 to yr="2020 -Current" (1,443)

192. limit 191 to (conference abstract or conference paper or "conference review" or editorial or letter) (128)
193. 191 not 192 (1,315)

## APA PsycInfo (1806 to July 2025 Week 1)

1. exp Immunization/ (8,644)
2. (vaccin* or immuni#ed or immuni#ation*).tw.. (15,030)
3. or/1-2. (15,154)
4. ((enhanc* or improv* or increas* or boost* or promot*) adj3 coverage).tw. (1,718)
5. ((enhanc* or improv* or increas* or boost* or promot*) adj3 accept*).tw. (6,558)
6. ((enhanc* or improv* or increas* or boost* or promot* or strengthen*) adj3 delivery).tw.. (4,740)
7. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 uptake).tw. (3,889)
8. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 take up).tw. (79)
9. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 adherence).tw.. (8,127)
10. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 compliance).tw.. (4,440)
11. ((reduc* or decreas*) adj3 hesitancy).tw. (98)
12. ((reduc* or decreas*) adj3 dropout*).tw. (751)
13. vaccin* hesitancy.tw. (1,230)
14. ((increas* or improv* or raise or enhanc* or boost* or promot*) adj3 literacy).tw. (5,168)
15. ((increas* or improv* or facilitat* or enhanc* or boost* or promot*) adj3 access*).tw. (23,352)
16. Vaccination Attitudes/. (1,626)
17. or/4-16. (58,696)
18. intervention*.ti. (99,231)
19. exp internet/ or text messaging/ (37,045)
20. exp mobile devices/ (13,266)
21. exp conversational agents/ (1,288)
22. exp computer mediated communication/ (52,327)
23. alert*.tw. (15,383)
24. follow-up.tw. (154,383)
25. recall*.tw. (69,728)
26. reminder*.tw. (8,066)
27. (chat bot* or chatbot*).tw. (1,081)
28. SMS.tw. (2,199)
29. ((text or mobile or personal*) adj messag*).tw. (3,799)
30. (mobile phone* or smart phone*).tw.. (6,836)
31. (mobile app* or web app*).tw.. (4,685)
32. (digital* inclu* or digital* exclu* or digital poverty or digital* poor*).tw. (413)
33. mak* every contact count.tw. (18)
34. exp communication/ (426,698)

35. exp Information/ (57,491)
36. (information adj3 (objective* or provi* or access* or campaign*)).tw.. (77,384)
37. (enhance* adj3 (demand* or information)).tw.. (2,082)
38. (foreign language* adj7 information).tw. (90)
39. (native language adj7 information).tw.. (68)
40. (english language adj7 information).tw. (161)
41. communication.tw. (228,358)
42. (exp health personnel/ and education/) or exp personnel training/ (22,211)
43. (communit* adj5 (champion* or embassador* or ambassador* or representative* or engagement or advocate*)).tw. (9,071)
44. (staff adj3 train*).tw. (7,894)
45. (workforce adj3 train*).tw. (786)
46. (doctor* adj3 train*).tw. (2,522)
47. ((general practitioner* or GP or GPs) adj3 train*).tw. (658)
48. (nurse* adj3 train*).tw.. (3,083)
49. health knowledge/. (10,365)
50. (educat* or litera*).tw.. (1,081,287)
51. (motivation* adj5 intervention*).tw. (4,160)
52. ((increas* or improv*) adj3 awareness).tw. (17,796)
53. exp information systems/. (88,488)
54. exp medical records/ (5,779)
55. (medical record* or health record*).tw. (18,361)
56. ((vaccin* or immuni#ation*) adj3 (status or history)).tw. (842)
57. (miss* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw. (75)
58. (catch up* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw.. (57)
59. (outstanding adj3 (vaccin* or immuni#ation* or immuni#ed)).tw. (0)
60. ((gap or gaps) adj3 (vaccin* or immuni#ation* or immuni#ed)).tw. (61)
61. exp health care access/ (12,217)
62. exp health care delivery/ (145,204)
63. (Vaccin* adj3 (produc* or suppl* or access* or distrib*)).tw. (655)
64. (immuni#ation* adj3 (produc* or suppl* or access* or distrib*)).tw. (88)
65. (vaccin* adj3 (clinic or clinics or appointment* or service*)).tw. (270)
66. (immuni#ation* adj3 (clinic or clinics or appointment* or service*)).tw. (196)
67. (immuni#ed* adj3 (clinic or clinics or appointment* or service*)).tw. (1)
68. community health/ (6,459)
69. exp community services/. (58,489)
70. outreach.tw.. (10,206)
71. mobile clinic*.tw.. (102)
72. social mobili#ation.tw. (174)
73. (Home visit* adj3 (vaccin* or immuni#ation* or immuni#ed)).tw. (2)
74. (mobile adj3 (clinic or vaccin* or immuni#ation*)).tw.. (129)
75. (pop-up adj3 (clinic* or vaccin* or immuni#ation*)).tw.. (9)
76. ((vaccin* or immuni#ation*) adj5 record*).tw.. (2,278)

77. ((vaccin* or immuni#ation*) adj5 information).tw. (1,008)
78. exp behavioral sciences/. (271,632)
79. exp behavior change/. (17,232)
80. (behavio?r* adj (science* or chang*)).tw.. (43,784)
81. behavio?r* modif*.tw. (6,790)
82. exp motivation/ (208,831)
83. monetary incentives/ (2,077)
84. ((financial or monetary or cash) adj incentive*).tw. (4,100)
85. coercive measure*.tw. (531)
86. (mandatory adj3 (vaccin* or immuni#ation*)).tw. (129)
87. ((vaccin* or immuni#ation or service*) adj2 delivery).tw. (18,865)
88. ((co-deliver* or codeliver*) adj3 (vaccin* or immuni#ation*)).tw. (0)
89. delivery model*.tw.. (2,469)
90. (hospital* or pharmac* or outpatient* or general practice* or GP or antenatal* or ante natal* or prenatal* or pre natal* or school* or communit* or workplace*).tw.. (1,214,414)
91. (maternal health or maternity care).tw.. (3,646)
92. ((secondary or primary or tertiary or speciali*) adj care).tw. (44,465)
93. ((secondary or primary or tertiary or speciali*) adj setting*).tw. (737)
94. (setting adj2 deliver*).tw. (228)
95. (mass adj (vaccination* or centre* or center* or model*)).tw.. (293)
96. ((education* or college* or universit*) adj5 deliver*).tw.. (6,064)
97. exp health personnel/ (294,931)
98. (health* adj (worker* or workforce* or provider* or staff* or personnel)).tw.. (36,137)
99. (intervention* adj (worker* or workforce* or provider* or staff* or personnel)).tw. (495)
100. ((organi#ation* or manager*) adj7 programme).tw. (744)
101. ((provider* or organi#ation*) adj3 intervention*).tw. (4,233)
102. (vaccin* adj5 (production* or suppl*)).tw.. (196)
103. (governance or government*).tw.. (88,206)
104. implementation.tw.. (129,693)
105. (Vaccin* adj7 prioriti#ation).tw. (52)
106. (Policy or policies).tw. (228,450)
107. (Strategy or strategies).tw.. (421,653)
108. (Multi* adj3 intervention*).tw. (11,215)
109. (vaccin* adj5 (Administration or acquisition or planning or organi#ation)).tw. (407)
110. government/. (12,567)
111. clinical governance/. (377)
112. policy making/ or exp government policy making/ or exp health care policy/. 104,384
113. exp social responsibility/ (6,838)
114. (Service* adj5 (integrat* or deliver* or perform*)).tw. (38,579)
115. ((Health* or whole) adj system*).tw. (26,909)
116. ((Report* or monitor* or hardware or software or perform*) adj5 system*).tw (39,269)
117. Cold-chain.tw. (21)
118. Financ*.tw.. (78,657)

119. Incentiv*.tw.. (28,121)
120. health care costs/ (12,689)
121. exp economics/ (104,575)
122. System* level.tw. (4,800)
123. (Vaccin* adj5 (produc* or distrib* or access* or suppl*)).tw. (916)
124. pharmaceutical industry/ (2,084)
125. ((Health or vaccine) adj5 technolog*).tw. (7,059)
126. Occupational Health/ (5,233)
127. occupational health.tw. (4,617)
128. ((employee* or staff or workplace) adj health).tw. (2,303)
129. home visiting programs/ (2,260)
130. (home visit* or house call*).tw. (5,731)
131. ((vaccin* or immuni#ation*) adj3 home*).tw. (47)
132. Residential Care Institutions/ (12,223)
133. (mobile data adj3 (immigrant* or migrant* or asylum or asylee*)).tw.. (1)
134. (peer adj3 (network* or disseminat* or information)).tw. (2,320)
135. leaflet*.tw. (1,145)
136. conspirac*.tw. (2,194)
137. misinform*.tw. (4,778)
138. ((Vaccin* or immuni#ation*) adj3 recommend*).tw. (867)
139. ((Vaccin* or immuni#ation*) adj3 eligib*).tw. (131)
140. (Pay adj2 performance*).tw. (1,100)
141. Supply chain.tw. (2,949)
142. Logistic*.tw.. (96,923)
143. Conspiracy Theories/ (609)
144. Conspiracy Beliefs/. (462)
145. Misinformation/ (1,903)
146. Supply Chains/ (1,402)
147. or/18-146 (3,378,855)
148. 3 and 17 and 147 (2,876)
149. ((enhanc* or improv* or increas* or boost* or promot*) adj3 coverage).ti. (69)
150. ((enhanc* or improv* or increas* or boost* or promot*) adj3 accept*).ti. (364)
151. ((enhanc* or improv* or increas* or boost* or promot* or strengthen*) adj3 delivery).ti.. (284)
152. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 uptake).ti. (274)
153. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 take up).ti. (2)
154. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 adherence).ti.. (1,098)
155. ((increas* or improv* or raise* or enhanc* or boost* or promot*) adj3 compliance).ti. (477)
156. ((reduc* or decreas*) adj3 hesitancy).ti. (9)
157. ((reduc* or decreas*) adj3 dropout*).ti. (64)
158. vaccin* hesitancy.ti.. (433)
159. ((increas* or improv* or raise or enhanc* or boost* or promot*) adj3 literacy).ti. (773)
160. ((increas* or improv* or facilitat* or enhanc* or boost* or promot*) adj3 access*).ti.. (1,417)

161. or/149-160 (5,229)
162. 3 and 161 (556)
163. 148 or 162 (2,914)
164. "systematic review"/. (925)
165. ((((comprehensive or comprehensively) adj (analysis or review or reviewed)) or ((literature or scoping) adj (search or searches))).ti,ab. not "narrative review".ti.) and (database or databases or cinahl or cochrane or embase or psycinfo or pubmed or medline or scopus or (web adj1 science) or ((bibliographic or literature) adj (review or reviews)) or (((electronic adj (database or databases)) or (databases adj3 searched)) and (eligibility or excluded or exclusion or included or inclusion))).ti,ab. (20,412)
166. (((comparative adj effectiveness) and (effectiveness adj review)) or ((critical adj interpretive) and ((interpretive adj review) or (interpretive adj synthesis)))).ti,ab. (137)
167. ((diagnostic adj test) and ((accuracy adj review) or (accuracy adj reviews) or (accuracy adj studies) or (accuracy adj study)) and (meta-analysis or scoping or systematic)).ti,ab.. (38)
168. ((evidence adj assessment) and GRADE).ti,ab.. (9)
169. ((evidence adj2 gap) and (gap adj map)).ti,ab. (21)
170. ((evidence adj mapping) or (evidence adj review) or (exploratory adj review) or (framework adj synthesis) or (mapping adj review)).ti,ab. (670)
171. ((meta adj (epidemiological or ethnographic or ethnography or interpretation or narrative or review or study or synthesis or summary or theory)) or metaethnographic or metaethnography or metasynthesis).ti,ab. (3,056)
172. (((methodological or methodology) adj1 review) or ((mixed adj methods) and (methods adj1 (review or synthesis)))).ti,ab.. (1,511)
173. ((narrative adj1 synthesis) or (overview adj4 reviews) or ("PRISMA" adj4 (guideline or guidelines or preferred or reporting or requirements)) or (PRISMA adj "P")).ti,ab.. (7,644)
174. (((prognostic or psychometric) adj1 review) or ((qualitative adj (evidence or research)) and ((evidence or research) adj synthesis))).ti,ab. (339)
175. (((rapid adj evidence) and (evidence adj assessment)) or (rapid adj realist) or (rapid adj2 (review or reviews)) or (realist adj2 (review or reviews or syntheses or synthesis))).ti,ab.. (1,140)
176. (((review adj economic) and (economic adj1 (evaluation or evaluations))) or ((scoping or systematic) adj2 (review or reviews or studies or study))).ti,ab. (77,253)
177. ((review adj1 reviews) or ((systematic adj evidence) and (evidence adj map)) or (systematic adj2 mapping) or (systematic adj2 literature) or (systematic adj2 (Embase or Medline or PsycInfo or PubMed)) or (systematic adj2 (review or reviews)) or ((systematical or systematically) adj2 (review or reviewed reviews)) or (systematically adj identified) or (systematized adj review) or (umbrella adj (review or reviews))).ti,ab. (69,371)
178. meta analysis/ (5,580)
179. (meta adj2 (analyse or analyser or analyses or analysis or analytic or analytical or analytics or analyze or analyzed or analyzes)).ti,ab. (60,865)
180. (metaanalyse or Metaanalysen or metaanalyser or metaanalyses or metaanalysis* or metaanalytic or metaanalytical or metaanalytics or metaanalyze or metaanalyzed or metaanalyzes).ti,ab. (864)

181. "network meta-analysis"/ or (network adj1 (meta or metaanalyses or metaanalysis or metaregression)).ti,ab. (1,038)
182. (systematic and ((meta adj regression) or metagression)).ti,ab. (1,657)
183. or/164-182 (135,011)
184. 163 and 183. (163)
185. limit 184 to yr="2020 -Current" (130)
186. limit 185 to ("comment/reply" or dissertation or editorial or letter or obituary or poetry). (11)
187. 185 not 186 (119)

## Epistemonikos

Date of search: 27 June 2025

(title:("vaccin* uptake" OR "vaccin* refusal*" OR "vaccin* hesitan*" OR “vaccin coverage” OR “vaccine accept*” OR “vaccine take up” OR “vaccin* adherence” OR “vaccin* compliance” OR “vaccin* drop out*”) OR abstract:("vaccin* uptake" OR "vaccin* refusal*" OR "vaccin* hesitan*" OR “vaccin coverage” OR “vaccine acceptance” OR “vaccine take up” OR “vaccin* adherence” OR “vaccin* compliance” OR “vaccin* drop out*”))

## Web of Science Preprint Citation Index (1990 to current)

Date of search: 11 July 2025

TS=((vaccin* or immuni?ed or immuni?ation*))

AND

TS=(((enhanc* or improv* or increas* or boost* or promot*) NEAR/2 coverage)) OR TS=(((enhanc* or improv* or increas* or boost* or promot*) NEAR/2 acceptance)) OR TS=(((enhanc* or improv* or increas* or boost* or promot* or strengthen*) NEAR/2 delivery)) OR TS=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 uptake)) OR TS=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 "take up")) OR TS=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 adherence)) OR TS=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 compliance)) OR TS=(((reduc* or decreas*) NEAR/2 hesitancy)) OR TS=(((reduc* or decreas*) NEAR/2 dropout*)) OR TS=("vaccin* hesitancy") OR TS=(((increas* or improv* or raise or enhanc* or boost* or promot*) NEAR/2 literacy)) OR TS=(((increas* or improv* or facilitat* or enhanc* or boost* or promot*) NEAR/2 access*))

AND

TI=(intervention*) OR TS=(alert*) OR TS=(follow-up) OR TS=(recall*) OR TS=(reminder*) OR TS=(chatbot*) OR TS=(SMS) OR TS=(((text or mobile or personal*) NEAR/0 messag*)) OR TS=(("mobile phone*" or "smart phone*")) OR TS=(("mobile app*" or "web app*")) OR

TS=("digital* exclu*") OR TS=("make every contact count") OR TS=((information NEAR/2 (objective* or provi* or access* or campaign*))) OR TS=((enhance* NEAR/2 (demand* or information))) OR TS=(("foreign language*" NEAR/6 information)) OR TS=(("native language" NEAR/6 information)) OR TS=(("english language" NEAR/6 information)) OR TS=(communication) OR TS=((communit* NEAR/4 (champion* or embassador* or representative* or engagement or advocate*))) OR TS=((staff NEAR/2 train*)) OR TS=((workforce NEAR/2 train*)) OR TS=((doctor* NEAR/2 train*)) OR TS=((("general practitioner*" or GP or GPs) NEAR/2 train*)) OR TS=((nurse* NEAR/2 train*)) OR TS=((educat* or litera*)) OR TS=((motivation* NEAR/4 intervention*)) OR TS=(((increas* or improv*) NEAR/2 awareness)) OR TS=(("medical record*" or "health record*")) OR TS=(((vaccin* or immuni?ation*) NEAR/2 (status or history))) OR TS=((miss* NEAR/2 (vaccin* or immuni?ation* or immuni?ed))) OR TS=(("catch up*" NEAR/2 (vaccin* or immuni?ation* or immuni?ed))) OR TS=((outstanding NEAR/2 (vaccin* or immuni?ation* or immuni?ed))) OR TS=(((gap or gaps) NEAR/2 (vaccin* or immuni?ation* or immuni?ed))) OR TS=((Vaccin* NEAR/2 (produc* or suppl* or access* or distrib*))) OR TS=((immuni?ation* NEAR/2 (produc* or suppl* or access* or distrib*))) OR TS=((vaccin* NEAR/2 (clinic or clinics or appointment* or service*))) OR TS=((immuni?ation* NEAR/2 (clinic or clinics or appointment* or service*))) OR TS=((immuni?ed* NEAR/2 (clinic or clinics or appointment* or service*))) OR TS=(outreach) OR TS=("mobile clinic*") OR TS=("social mobili?ation") OR TS=(("Home visit*" NEAR/2 (vaccin* or immuni?ation* or immuni?ed))) OR TS=((mobile NEAR/2 (clinic or vaccin* or immuni?ation*))) OR TS=((pop-up NEAR/2 (clinic* or vaccin* or immuni?ation*))) OR TS=(((vaccin* or immuni?ation*) NEAR/4 record*)) OR TS=(((vaccin* or immuni?ation*) NEAR/4 information)) OR TS=((behavio$r* NEAR/0 (science* or chang*))) OR TS=("behavio$r* modif*") OR TS=(((financial or monetary) NEAR/0 incentive*)) OR TS=("coercive measure*") OR TS=((mandatory NEAR/2 (vaccin* or immuni?ation*))) OR TS=(((vaccin* or immuni?ation or service*) NEAR/1 delivery)) OR TS=(((co-deliver* or codeliver*) NEAR/2 (vaccin* or immuni?ation*))) OR TS=("delivery model*") OR TS=((hospital* or pharmac* or outpatient* or "general practice*" or GP or antenatal* or "ante natal*" or prenatal* or "pre natal*" or school* or communit* or workplace*)) OR TS=(("maternal health" or "maternity care")) OR TS=(((secondary or primary or tertiary or speciali*) NEAR/0 care)) OR TS=(((secondary or primary or tertiary or speciali*) NEAR/0 setting*)) OR TS=((setting NEAR/1 deliver*)) OR TS=((mass NEAR/0 (vaccination* or centre* or center* or model*))) OR TS=(((education* or college* or universit*) NEAR/4 deliver*)) OR TS=((health* NEAR/0 (worker* or workforce* or provider* or staff* or personnel))) OR TS=((intervention* NEAR/0 (worker* or workforce* or provider* or staff* or personnel))) OR TS=(((organi?ation* or manager*) NEAR/6 programme)) OR TS=(((provider* or organi?ation*) NEAR/2 intervention*)) OR TS=((vaccin* NEAR/4 (production* or suppl*))) OR TS=((governance or government*)) OR TS=(implementation) OR TS=((Vaccin* NEAR/6 prioriti?ation)) OR TS=((Policy or policies)) OR TS=((Strategy or strategies)) OR TS=((Multi* NEAR/2 intervention*)) OR TS=((vaccin* NEAR/4 (Administration or acquisition or planning or organi?ation))) OR TS=((Service* NEAR/4 (integrat* or deliver* or perform*))) OR TS=(((Health* or whole) NEAR/0 system*)) OR TS=(((Report* or monitor* or hardware or software or perform*) NEAR/4 system*)) OR TS=(Cold-chain) OR TS=(Financ*) OR TS=(Incentiv*) OR TS=("System* level") OR TS=((Vaccin* NEAR/4 (produc* or distrib* or

access* or suppl*))) OR TS=(((Health or vaccine) NEAR/4 technolog*)) OR TS=("occupational health" OR ((employee* OR staff OR workplace) NEAR/0 health)) OR TS=("home visit*" OR "house call*") OR TS=((vaccin* OR immuni$ation) NEAR/3 home*) OR TS=("mobile data" NEAR/3 (immigrant* OR migrant* OR asylum OR asylee*)) OR TS=(peer NEAR/3 (network* OR disseminat* OR information)) OR TS=(leaflet* OR conspirac* OR misinform*) OR TS=((vaccin* OR immuni$ation*) NEAR/3 recommend*) OR TS=((vaccin* OR immuni$ation*) NEAR/3 eligib*) OR TS=(pay NEAR/2 performance*) OR TS=("supply chain*" OR logistic*)

OR

TS=((vaccin* or immuni?ed or immuni?ation*))

AND

TI=(((enhanc* or improv* or increas* or boost* or promot*) NEAR/2 coverage)) OR TI=(((enhanc* or improv* or increas* or boost* or promot*) NEAR/2 accept*)) OR TI=(((enhanc* or improv* or increas* or boost* or promot* or strengthen*) NEAR/2 delivery)) OR TI=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 uptake)) OR TI=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 "take up")) OR TI=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 adherence)) OR TI=(((increas* or improv* or raise* or enhanc* or boost* or promot*) NEAR/2 compliance)) OR TI=(((reduc* or decreas*) NEAR/2 hesitancy))or TI=(((reduc* or decreas*) NEAR/2 dropout*)) OR TI=("vaccin* hesitancy") OR TI=(((increas* or improv* or raise or enhanc* or boost* or promot*) NEAR/2 literacy)) OR TI=(((increas* or improv* or facilitat* or enhanc* or boost* or promot*) NEAR/2 access*))

# Deviations

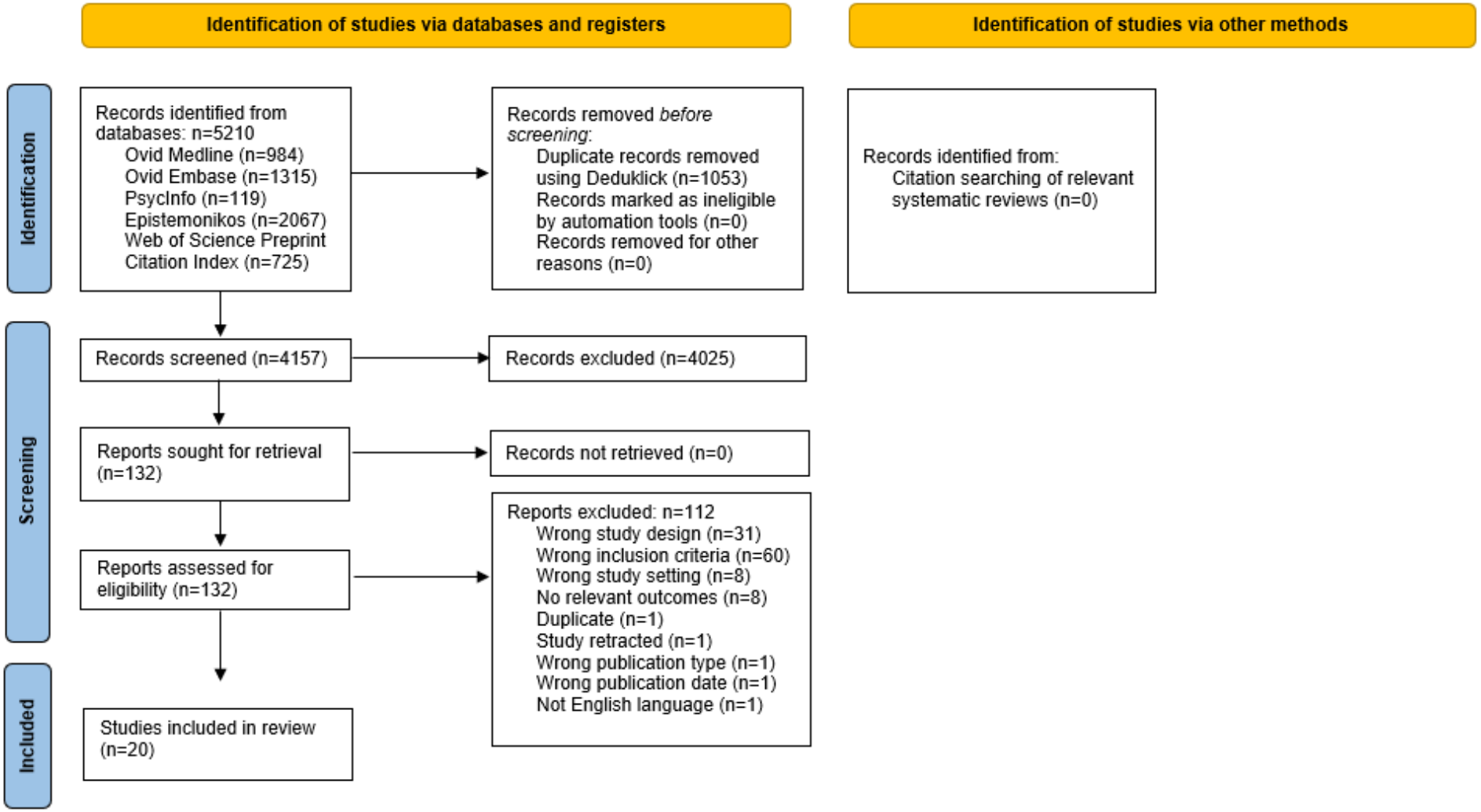
For inclusion, systematic reviews need to meet the following criteria:

- at least 80% of included studies should be RCTs
- systematic reviews including at least 80% of studies from high-income countries using the World Bank lending classification list World Bank Country and Lending Groups – World Bank Data Help Desk

A clarification was made that sub-group analysis must be pre-specified in the systematic review protocol for inclusion in this review.

# Annexe B. Study selection flowchart

**Figure B.1. PRISMA diagram**



**Text version of Figure B.1. PRISMA diagram**

A PRISMA diagram showing the flow of studies through this review, ultimately including 23 studies.

From identification of studies via databases and registers, n=5210 records identified from databases:

- Ovid Medline (n=984)
- Ovid Embase (n=1315)
- PsycInfo (n=119)
- Epistemonikos (n=2067)
- Web of Science Preprint Citation Index (n=725)

From these, records removed before screening:

- duplicate records removed using Deduklick (n=1053)
- duplicate records removed manually (n=0)
- records marked as ineligible by automation tools (n=0)
- records removed for other reasons (n=0)

n=4157 records screened, of which n=4025 were excluded, leaving n=132 papers sought for retrieval, of which n=0 was not retrieved.

No studies were identified from identification of studies via other methods: n=0 studies were identified from expert consultation.

Of the n=132 papers assessed for eligibility, n=112 reports were excluded:

- Wrong study design (n=31)
- Wrong inclusion criteria (n=60)
- Wrong study setting (n=8)
- No relevant outcomes (n=8)
- Duplicate (n=1)
- Study retracted (n=1)
- Wrong publication type (n=1)
- Wrong publication date (n=1)
- Not English language (n=1)

n=20 papers included in the review.

# Annexe C. Excluded full texts

## Wrong study design (31 studies)

Adusei-Mensah F and others. 'Boosting COVID-19 vaccine inoculation and booster shots: a systematic review and meta-analysis of factors that influence Coronavirus vaccine uptake in practice' African health sciences 2023: volume 23, issue 2, pages 3 to 22

Alahmad G. 'Ethical Challenges Involved in COVID-19 Vaccine Mandates for Children: A Systematic Review' Vaccines 2023: volume 11, issue 3

Argyris YA and others. 'Do social media campaigns foster vaccination adherence? A systematic review of prior intervention-based campaigns on social media' Telematics and informatics 2023: volume 76, 101918

Aslam F and others. 'Building evidence for improving vaccine adoption and uptake of childhood vaccinations in low- and middle-income countries: a systematic review' Drugs & Therapy Perspectives : for rational drug selection and use 2022: volume 38, issue 3, pages 133 to 145

Bakare D and others. 'Healthcare worker practices for HPV vaccine recommendation: A systematic review and meta-analysis' Human Vaccines and Immunotherapeutics 2024: volume 20, issue 1, 2402122

Bhanu C and others. 'Vaccination uptake amongst older adults from minority ethnic backgrounds: A systematic review' PLOS Medicine 2021: volume 18, issue 11, e1003826

Bianchi FP and others. 'Immunization coverage among asplenic patients and strategies to increase vaccination compliance: a systematic review and meta-analysis' Expert Review of Vaccines 2021: volume 20, issue 3, pages 297 to 308

Bianchi FP and others. 'COVID-19 vaccination hesitancy in pregnant and breastfeeding women and strategies to increase vaccination compliance: a systematic review and meta-analysis' Expert Review of Vaccines 2022: volume 21, issue 10, pages 1,443 to 1,454

Bianchi FP and others. 'COVID-19 vaccination hesitancy in people affected by diabetes and strategies to increase vaccine compliance: A systematic narrative review and meta-analysis' Vaccine 2023: volume 41, issue 7, pages 1,303 to 1,309

Bianchi FP and others. 'Effectiveness of on-site influenza vaccination strategy in Italian healthcare workers: a systematic review and statistical analysis' Expert Review of Vaccines 2023: volume 22, issue 1, pages 17 to 24

Cheuyem FZL and others. 'COVID- 19 vaccine uptake and its determinants in Cameroon: a systematic review and meta-analysis (2021-2024)' BMC Infectious Diseases 2025: volume 25, issue 1, page 525

Crawshaw AF and others. 'Defining the determinants of under-vaccination in migrant populations in Europe to improve routine and COVID-19 vaccine uptake: A systematic review' medRxiv 2021

Cui M and others. 'The awareness and acceptance of HPV vaccines among parents of primary and junior high school students in China: a meta-analysis' Infectious Medicine 2023: volume 2, issue 4, pages 273 to 282

de Koning R and others. 'Strategies used to improve vaccine uptake among healthcare providers: A systematic review' Vaccine: X 2024: volume 19, 100519

Efua Sackey M and others. 'Healthcare professional's promotional strategies in improving Human papillomavirus (HPV) vaccination uptake in adolescents: A systematic review' Vaccine 2022: volume 40, issue 19, pages 2,656 to 2,666

Felsher M and others. 'A systematic literature review of human papillomavirus vaccination strategies in delivery systems within national and regional immunization programs' Human Vaccines and Immunotherapeutics 2024: volume 20, issue 1, 2319426

Goldsmith LP and others. 'Use of social media platforms by migrant and ethnic minority populations during the COVID-19 pandemic: a systematic review' BMJ Open 2022: volume 12, issue 11, e061896

Julio C and others. 'Multiple mail reminders to increase adherence to influenza vaccination' Recordatorio a traves de multiples cartas para vacunacion contra influenza. 2020: volume 20, issue 6, e7963

Kazi B and others. 'Quality Improvement Interventions to Enhance Vaccine Uptake in Cancer Patients: A Systematic Review' Journal for Healthcare Quality: official publication of the National Association for Healthcare Quality 2024: volume 46, issue 2, pages 81 to 94

Khalid K and others. 'Recommended Interventions to Improve Human Papillomavirus Vaccination Uptake among Adolescents: A Review of Quality Improvement Methodologies' Vaccines 2023: volume 11, issue 8

Krokidi E and others. 'The impact of health education interventions on HPV vaccination uptake, awareness, and acceptance among people under 30 years old in India: a literature review with systematic search' Frontiers in Reproductive Health 2023: volume 5, 1151179

Effectiveness and cost-effectiveness of intervention strategies to increase vaccination uptake: a rapid systematic review

Kuznetsova L and others. 'Effectiveness of Mandatory and Incentive-Based Routine Childhood Immunization Programs in Europe: A Systematic Review of the Literature' Vaccines 2021: volume 9, issue 10

Lawes-Wickwar S and others. 'A Rapid Systematic Review of Public Responses to Health Messages Encouraging Vaccination against Infectious Diseases in a Pandemic or Epidemic' Vaccines 2021: volume 9, issue 2

Locatelli G and others. 'Determinants and Motivations of Vaccination Hesitancy and Uptake in Nurses: A Systematic Review and Meta-Analysis' Journal of Clinical Nursing 2025

Mohammed H and others. 'A rapid global review of strategies to improve influenza vaccination uptake in Australia' Human Vaccines and Immunotherapeutics 2021: volume 17, issue 12, pages 5,487 to 5,499

Oh NL and others. 'Provider communication and HPV vaccine uptake: A meta-analysis and systematic review' Preventive Medicine 2021: volume 148, 106554

Oketch SY and others. 'Communication strategies to improve human papillomavirus (HPV) immunisation uptake among adolescents in sub-Saharan Africa: a systematic review and meta-analysis' BMJ open 2023: volume 13, issue 4, e067164

Scalia P and others. 'Shared decision-making interventions: An overview and a meta-analysis of their impact on vaccine uptake' Journal of Internal Medicine 2022: volume 291, issue 4, pages 408 to 425

Trusinska D and others. 'Real-world uptake of nirsevimab, RSV maternal vaccine, and RSV vaccines for older adults: a systematic review and meta-analysis' eClinicalMedicine 2025: volume 84, 103281

Yemeke TT and others. 'A systematic review of the role of pharmacists in vaccination services in low-and middle-income countries' Research in Social and Administrative Pharmacy: RSAP 2021: volume 17, issue 2, pages 300 to 306

Zhou X and others. 'Effectiveness of Educational Intervention on Influenza Vaccine Uptake: A Meta-Analysis of Randomized Controlled Trials' Iranian journal of public health 2020: volume 49, issue 12, pages 2,256 to 2,263

# Wrong inclusion criteria design (60 studies)

Abdullahi LH and others. 'Improving vaccination uptake among adolescents' The Cochrane Database of Systematic Reviews 2020: volume 1, CD011895

Adeagbo M and others. 'Improving COVID-19 Vaccine Uptake among Black Populations: A Systematic Review of Strategies' International Journal of Environmental Research and Public Health 2022: volume 19, issue 19

Amare SN and others. 'Impact of pharmacist-led interventions on COVID-19, herpes zoster, influenza, pneumococcal, and respiratory syncytial virus vaccines uptake in people aged 60 years and older: Systematic review and meta-analysis' Research in Social and Administrative Pharmacy: RSAP 2025

Aidalina M and others. 'COVID-19 vaccination: a systematic review of vaccination strategies based on economic evaluation studies' The Medical Journal of Malaysia 2023: volume 78, issue 3, pages 411 to 420

Akumbom AM and others. 'Cost and effectiveness of HPV vaccine delivery strategies: A systematic review' Preventive Medicine Reports 2022: volume 26, 101734

Balzarini F and others. 'Does the use of personal electronic health records increase vaccine uptake? A systematic review' Vaccine 2020: volume 38, issue 38, pages 5,966 to 5,978

Batteux E and others. 'The Effectiveness of Interventions for Increasing COVID-19 Vaccine Uptake: A Systematic Review' Vaccines 2022: volume 10, issue 3

Bechini A and others. 'Utility of Healthcare System-Based Interventions in Improving the Uptake of Influenza Vaccination in Healthcare Workers at Long-Term Care Facilities: A Systematic Review' Vaccines 2020: volume 8, issue 2

Bhattacharya A and others. 'Systematic review investigating mHealth and digital health interventions for increasing vaccination uptake in 19 Sub-Saharan African countries: Recommendations for the malaria vaccine rollout' medRxiv 2025

Buja A and others. 'Use of Information and Communication Technology Strategies to Increase Vaccination Coverage in Older Adults: A Systematic Review' Vaccines 2023: volume 11, issue 7

Ceccarelli A and others. 'Effectiveness of General Practitioners' Involvement in Adult Vaccination Practices: A Systematic Review and Meta-Analysis of International Evidence' Vaccines 2024: volume 12, issue 12

Chan PS-F and others. 'Effectiveness of chatbots in increasing uptake, intention, and attitudes related to any type of vaccination: A systematic review and meta-analysis' Applied Psychology. Health and Well-Being 2024: volume 16, issue 4, pages 2,567 to 2,597

Chen S and others. 'Effectiveness of stage-of-change (SOC)-tailored interventions in increasing uptake of any type of vaccination: A systematic review and meta-analysis' Applied psychology. Health and well-being 2025: volume 17, issue 2, e70022

Choi J and others. 'Digital Health Interventions to Improve Adolescent HPV Vaccination: A Systematic Review' Vaccines 2023: volume 11, issue 2

Clari M and others. 'Effectiveness of interventions to increase healthcare workers' adherence to vaccination against vaccine-preventable diseases: a systematic review and meta-analysis, 1993 to 2022' Euro surveillance: bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin 2024: volume 29, issue 9

Constable C and others. 'Clinician communication strategies associated with increased uptake of the human papillomavirus (HPV) vaccine: A systematic review' CA: A Cancer Journal for Clinicians 2022: volume 72, issue 6, pages 561 to 569

Currie GE and others. 'SMS-based interventions for improving child and adolescent vaccine coverage and timeliness: a systematic review' BMC public health 2024: volume 24, issue 1, page 1,753

de Cock C and others. 'Use of Apps to Promote Childhood Vaccination: Systematic Review' JMIR mHealth and uHealth 2020: volume 8, issue 5, e17371

Du P and others. 'Strategies to increase the coverage of influenza and pneumonia vaccination in older adults: a systematic review and network meta-analysis' Age and Ageing 2024: volume 53, issue 3

Ekezie W and others. 'A Systematic Review of Behaviour Change Techniques within Interventions to Increase Vaccine Uptake among Ethnic Minority Populations' Vaccines 2023: volume 11, issue 7

Escoffery C and others. 'A systematic review of interventions to promote HPV vaccination globally' BMC Public Health 2023: volume 23, issue 1, page 1,262

Eze P and others. 'Acceptability of mobile-phone reminders for routine childhood vaccination appointments in Nigeria - a systematic review and meta-analysis' BMC Health Services Research 2021: volume 21, issue 1, page 1,276

Fallucca A and others. 'Effectiveness of Catch-Up Vaccination Interventions Versus Standard or Usual Care Procedures in Increasing Adherence to Recommended Vaccinations Among Different Age Groups: Systematic Review and Meta-Analysis of Randomized Controlled Trials and Before-After Studies' JMIR Public Health and Surveillance 2024: volume 10, e52926

Gobbo ELS and others. 'Do peer-based education interventions effectively improve vaccination acceptance? a systematic review' BMC Public Health 2023: volume 23, issue 1, page 1,354

Hansen RK and others. 'Social media as an effective provider of quality-assured and accurate information to increase vaccine rates: Systematic review' Journal of Medical Internet Research 2023: volume 25, e50276

Huang Y and others. 'The Effectiveness of Nonfinancial Interventions and Monetary Incentives on COVID-19 Vaccination: A Meta-Analysis' Health Psychology 2023: volume 42, issue 6, pages 411 to 424

Hutchinson AF and others. 'Effectiveness of strategies to increase uptake of pertussis vaccination by new parents and family caregivers: A systematic review' Midwifery 2020: volume 87, 102734

Iannizzi C and others. 'Communication-based interventions to increase COVID-19 vaccine willingness and uptake: a systematic review with meta-analysis' BMJ Open 2025: volume 15, issue 5, e072942

Ilozumba O and others. 'Can mHealth interventions contribute to increased HPV vaccination uptake? A systematic review' Preventive Medicine Reports 2021: volume 21, 101289

Iwami M and others. 'Defining drivers of human papillomavirus (HPV) vaccine uptake in migrant populations globally and strategies and interventions to improve coverage: a systematic review' medRxiv 2025

Khazanov GK and others. 'The effectiveness of financial incentives for COVID-19 vaccination: A systematic review' Preventive Medicine 2023: volume 172, 107538

Konstantinou E and others. 'Postpartum Interventions to Increase Maternal Vaccination Uptake: Is It Worth It?' Vaccines 2024: volume 12, issue 10

Larson A and others. 'Expanding vaccination provider types and administration sites can increase vaccination uptake: A systematic literature review of the evidence in non-United States geographies' Human Vaccines and Immunotherapeutics 2025: volume 21, issue 1, 2463732

Lee D and others. 'Increasing Seasonal Influenza Vaccination among University Students: A Systematic Review of Programs Using a Social Marketing Perspective' International Journal of Environmental Research and Public Health 2022: volume 19, issue 12

Li L and others. 'Vaccine hesitancy and behavior change theory-based social media interventions: a systematic review' Translational Behavioral Medicine 2022: volume 12, issue 2, pages 243 to 272

Limbu YB and others. 'Communication Strategies to Promote COVID-19 Vaccination Intention: How Effective are Source, Appeal, Framing, and Evidence Type Approaches?' Health Communication 2025: volume 40, issue 3, pages 429 to 444

Liu S and others. 'A systematic review and meta-analysis of strategies to promote vaccination uptake' Nature Human Behaviour 2024: volume 8, issue 9, pages 1,689 to 1,705

Lo Moro G and others. 'Countering vaccine hesitancy: a systematic review of interventions to strengthen healthcare professionals' action' European Journal of Public Health 2023: volume 33, issue 5, pages 905 to 915

Louw GE and others. 'Mobile Phone Text Message Reminders to Improve Vaccination Uptake: A Systematic Review and Meta-Analysis' Vaccines 2024: volume 12, issue 10

Machado AA and others. 'Effective interventions to increase routine childhood immunization coverage in low socioeconomic status communities in developed countries: A systematic review and critical appraisal of peer-reviewed literature' Vaccine 2021: volume 39, issue 22, pages 2,938 to 2,9648

Malik AA and others. 'Behavioral interventions for vaccination uptake: A systematic review and meta-analysis' Health policy (Amsterdam, Netherlands) 2023: volume 137, 104894

Mardi P and others. 'Impact of incentives on COVID-19 vaccination; A systematic review' Frontiers in medicine 2022: volume 9, 810323

Martinez-Serrano A and others. 'Immunity Awareness-Strategies to Improve the Degree of Acceptance of Vaccines: A Systematic Review' Vaccines 2025: volume 13, issue 6

Muchangi JM and others. 'Influence of government policies on handwashing and vaccine uptake in Kenya, Uganda, and Tanzania to prevent and control COVID-19: a systematic review' Frontiers in Public Health 2024: volume 12, 1417866

Murray E and others. 'Impact of pharmacy intervention on influenza vaccination acceptance: a systematic literature review and meta-analysis' International Journal of Clinical Pharmacy 2021: volume 43, issue 5, pages 1,163 to 1,172

Okpani AI and others. 'Are COVID-19 vaccination mandates for healthcare workers effective? A systematic review of the impact of mandates on increasing vaccination, alleviating staff shortages and decreasing staff illness' Vaccine 2024: volume 42, issue 5, pages 1,022 to 1,033

Ou L and others. 'The Role of Vaccination Interventions to Promote HPV Vaccine Uptake Rates in a College-Aged Population: a Systematic Review' Journal of Cancer Education: the official

Journal of the American Association for Cancer Education 2022: volume 37, issue 2, pages 244 to 250

Panickar R and others. 'The use of technology in vaccine safety communication: A systematic review of randomised controlled trials' Patient Education and Counseling 2023: volume 112, 107707

Patel J and others. 'Interventions Increase Vaccination Rates in Inflammatory Bowel Disease and Rheumatoid Arthritis: A Systematic Review and Meta-Analysis' Digestive Diseases and Sciences 2023: volume 68, issue 7, pages 2,921 to 2,935

Patel KM and others. 'Strategies to increase uptake of maternal pertussis vaccination' Expert Review of Vaccines 2021: volume 20, issue 7, pages 779 to 796

Rahim MHA and others. 'Impact of pharmacist interventions on immunisation uptake: a systematic review and meta-analysis' Journal of Pharmaceutical Policy and Practice 2024: volume 17, issue 1, 2285955

Rani U and others. 'Public Education Interventions and Uptake of Human Papillomavirus Vaccine: A Systematic Review' Journal of Public Health Management and Practice: JPHMP 2022: volume 28, issue 1, pages E307 to E315

Regan AK and others. 'Systematic review and meta-analysis of interventions to increase the uptake of vaccines recommended during pregnancy' NPJ Vaccines 2025: volume 10, issue 1, page 76

Reifferscheid L and others. 'Effectiveness of hospital-based strategies for improving childhood immunization coverage: A systematic review' Vaccine 2023: volume 41, issue 36, pages 5,233 to 5,244

Renosa MDC and others. 'Nudging toward vaccination: a systematic review' BMJ Global Health 2021: volume 6, issue 9

Terrell R and others. 'Interventions for COVID-19 Vaccine Hesitancy: A Systematic Review and Narrative Synthesis' International Journal of Environmental Research and Public Health 2023: volume 20, issue 12

Tinessia A and others. 'Strategies to address COVID-19 vaccine hesitancy in First Nations peoples: a systematic review' Global Health Action 2024: volume 17, issue 1, 2384497

Tuckerman J and others. 'Interventions for increasing the uptake of immunisations in healthcare workers: A systematic review' Vaccine 2023: volume 41, issue 38, pages 5,499 to 5,506

Effectiveness and cost-effectiveness of intervention strategies to increase vaccination uptake: a rapid systematic review

Wang Y and others. 'Cost-Effectiveness Analyses of Digital Health Technology for Improving the Uptake of Vaccination Programs: Systematic Review' Journal of Medical Internet Research 2023: volume 25, e45493

Zhang J and others. 'Interventions involving nudge theory for COVID-19 vaccination: A systematic review and meta-analysis' Health psychology : official journal of the Division of Health Psychology, American Psychological Association 2024: volume 43, issue 11, pages 779 to 790

# Wrong study setting (8 studies)

Eze P and others. 'Short message service (SMS) reminders for childhood immunisation in low-income and middle-income countries: a systematic review and meta-analysis' BMJ Global Health 2021: volume 6, issue 7

Jain M and others. 'Use of community engagement interventions to improve child immunisation in low- and middle-income countries: A systematic review and meta-analysis' Campbell systematic reviews 2022: volume 18, issue 3, e1253

Khan T and others. 'Facilitators and barriers to maternal immunization and strategies to improve uptake in low-income and lower-middle income countries: A systematic review' Human Vaccines and Immunotherapeutics 2024: volume 20, issue 1, 2411823

Nor SFS and others. 'A Systematic Review and Meta-Analysis of Mobile Phone Messaging Intervention on Vaccine Preventable Diseases' Infektsionnye Bolezni 2022: volume 20, issue 1, pages 82 to 90

Perroud JM and others. 'Adult vaccination uptake strategies in low- and middle-income countries: A systematic review' Vaccine 2022: volume 40, issue 36, pages 5,313 to 5,321

Yitbarek K and others. 'Impact of measles vaccination strategies on vaccination rates in low-income and middle-income countries: a systematic review and meta-analysis' BMJ Global Health 2025: volume 10, issue 2

Yunusa U and others. 'Mobile phone reminders for enhancing uptake, completeness and timeliness of routine childhood immunization in low and middle income countries: A systematic review and meta-analysis' Vaccine 2021: volume 39, issue 2, pages 209 to 221

Zarekar M and others. 'The impact of information and communication technology on immunisation and immunisation programmes in low-income and middle-income countries: a systematic review and meta-analysis' EBioMedicine 2025: volume 111, 105520

# No relevant outcomes (8 studies)

Desjardins C and others. 'Communicating effectively with patients about vaccination: A systematic review of randomized controlled trials' Canada communicable disease report = Releve des maladies transmissibles au Canada 2023: volume 49, issue 7, pages 331 to 341

Hong K and others. 'Costs of Interventions to Increase Vaccination Coverage Among Children in the United States: A Systematic Review' Academic Pediatrics 2021: volume 21, issue 4, pages S67 to S77

Maness SB and others. 'Health Equity and Human Papillomavirus Vaccine Interventions for Adolescents: A Systematic Review' Vaccines 2025: volume 13, issue 5

Meredith NR and others. 'Cost-effectiveness of herpes zoster vaccines in the U.S.: A systematic review' Preventive Medicine Reports 2022: volume 29, 101923

Olaoye O and others. 'A systematic review of interventions to promote human papillomavirus (HPV) vaccination in Africa' Public Health 2024: volume 234, pages 47 to 57

S AK and others. 'Effectiveness of interventions to improve vaccine efficacy: a systematic review and meta-analysis' Systematic Reviews 2025: volume 14, issue 1, page 105

Tobaiqy M and others. 'A Systematic Review of Human Papillomavirus Vaccination Challenges and Strategies to Enhance Uptake' Vaccines 2024: volume 12, issue 7

Yacouba A and others. 'Fractional dosing to improve vaccination coverage, vaccine hesitancy, and cost-effectiveness in Africa: a systematic review' medRxiv 2023

# Wrong date of publication (1 study)

Nowak GJ and others. 'Promoting influenza vaccination: insights from a qualitative meta-analysis of 14 years of influenza-related communications research by U.S. Centers for Disease Control and Prevention (CDC)' Vaccine 2015: volume 33, issue 24, pages 2,741 to 2,756

# Duplicate (1 study)

Jain M and others. 'Use of community engagement interventions to improve child immunisation in low-income and middle-income countries: a systematic review and meta-analysis' BMJ open 2022: volume 12, issue 11, e061568

Effectiveness and cost-effectiveness of intervention strategies to increase vaccination uptake: a rapid systematic review

# Study retracted (1 study)

Chan YT and others. 'Effect of vaccine education intervention on vaccine uptake and vaccine knowledge among older adults: A systematic review with meta-analysis' Vaccine 2025: volume 56, 127182

# Wrong publication type (1 study)

Castro-Barbudo D and others. 'Communication interventions to promote vaccination uptake: A systematic review protocol' medRxiv 2022

# Not English language (1 study)

Pesheva M and others. 'THE ROLE OF THE PHARMACISTS IN VACCINATION PROGRAMS - A SYSTEMATIC REVIEW' General Medicine 2022: volume 24, issue 2, pages 29 to 42

# Annexe D. Data extraction tables

**Table D.1. Demographics and details of included studies**

Abbreviations: RCT: randomised control trial, USA: United States of America, HPV: Human Papillomavirus, CDC: Centre for Disease Control and Prevention, COPD: chronic obstructive pulmonary disease, NA: not applicable, SIV: Simian Immunodeficiency Virus, Tdap: Tetanus, Diphtheria and Pertussis, UK: United Kingdom, MMR: Meases, Mumps, Rubella

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| Brillo and others, 2023 (1) | Until August 2021 | Study design: systematic review with meta-analysis.<br><br>Number of included primary studies: 7 (of 7 total)<br><br>Number of studies in meta-analysis: 7<br><br>Inclusion criteria: pregnant people in any trimester, included RCTs with parallel or cross over groups | Total number of participants: 2,809<br><br>Age: overall range not reported. Where available for included studies means ranged from 26.9 to 33.8 years<br><br>Gender: women only<br><br>Ethnicity: not reported<br><br>Health inequalities: all women were pregnant, as required in inclusion criteria<br><br>Country: USA, Canada, Australia and Hong Kong | Pregnant people targeted interventions | 1. Text messages (n=3)<br><br>2. Educational intervention (pamphlet, informative website) (n=3)<br><br>3. Bundled intervention (n=1)<br>a. Pregnant people focused – interactive tutorial, maps to local pharmacies<br>b. Provider level intervention – discussion, vaccine promotion education<br>c. Practice level intervention- vaccine champions, lapel button, posters and brochures | Standard care including or involving prenatal routine care, automated telephone reminders, pamphlets or other forms of education (n=7) | Influenza | Vaccine uptake<br><br>Length of follow up not reported |
| Chandeying and others, 2023 (3) | Unclear | Study design: systematic review with meta-analysis.<br><br>Number of included primary studies:34 (of 34 total)<br><br>Number of studies in meta-analysis: 34 | Total number of participants: 281,280<br><br>Age: mean 15 years (range 9 to 45) including parents, adolescents and healthcare providers<br><br>Gender: women only (n=13), men only (n=3), mixed (n=18) | Digital interventions (education/reminders aimed at both providers and clients) | All technological/software<br>1. Client education (n=11)<br>2. Client reminder (n=9)<br>3. Client education plus reminder (n=9)<br>4. Provider education (n=4)<br>5. Provider reminder (n=8)<br><br>Average duration of interventions= 8 months (range 1 to 24) | All face-to-face contact<br>1.Usual care or no intervention (n=23)<br>2. Alternative treatment (n=11) | HPV | Vaccine uptake (completion or initiation)<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Inclusion criteria: girls or boys aged 9 to 26 years old, their parents or their healthcare workers, included RCTs | Ethnicity: not reported<br><br>Health inequalities: includes 3 studies on men who have sex with men, one on uninsured or Medicare patients and involves healthcare workers<br><br>Country: USA, Australia, Netherlands, China, Japan and Israel | | | | | |
| Chandeying and others, 2024 (4) | January 2006 to December 2023 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 6 (of 6 total)<br><br>Number of studies in meta-analysis: 6<br><br>Inclusion criteria: healthcare providers such as clinicians, nurses or health educators directly involved in administering vaccines, included RCTs | Total number of participants: 245,195<br><br>Age: 11 to 17 years<br><br>Gender: not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: not reported<br><br>Country: USA | Interventions delivered by healthcare practitioners | Communication training for clinicians (educational interventions, presumptive communication and motivational interviewing) both onsite and online (n=6) | 1. Standard practice (n=4)<br>2. No training (n=1)<br>3. Wait list control (n=1) | HPV | Vaccine uptake (initiation, completion, subsequent dose)<br><br>Length of follow up not reported |
| Chandeying and others, 2025 (2) | January 2006 to December 2023 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 7 (of 17 total) | Total number of participants: 10,991 students<br><br>Age: 12 to 24 years in educational settings | Educational/motivational interventions | 1. Online educational tailored intervention (n=1)<br>2. Face to face structured information from school nurses (n=1)<br>3. Narrative intervention (n=1) | 1. Standard CDC factsheet (n=1)<br>2. Regular health interview (n=1)<br>3. Informational video with campus website, no message (n=1 | HPV | Vaccine uptake (rates)<br><br>Length to follow up between 2 months until end of school year |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Number of studies in meta-analysis: 7<br><br>Inclusion criteria: adolescents and young adults in education settings, included RCTs | Gender: women only (n=5), not reported (n=2)<br><br>Ethnicity: not reported<br><br>Health inequalities: not reported<br><br>Country: USA, Sweden, China, and Australia | | 4. Story telling video intervention (n=1)<br>5. Online IMB model-based education (n=1)<br>6. Standard messaging service reminder to parent (n=1)<br>7. 7 day web based health education (n=1)<br><br>Duration: 1 to 3 months<br><br>Gender neutral and gender specific interventions<br><br>*(Gender-specific (GS) strategies primarily target females, aiming to prevent cervical cancer by educating and vaccinating girls.*<br>*Gender Neutral (GN) strategies were those aiming to inform and involve all genders, often emphasizing male and female vaccination equally, aiming to protect everyone from HPV-related cancers and promote wider vaccination coverage)* | 4. Information based written material (n=1)<br>5. General health tips (n=1)<br>6. No SMS (n=1)<br>7. Non-HPV related material (n=1) | | (unknown length of time) |
| Davies and others, 2025 (20) | 2000 to April 2024 | Study design: systematic review with network meta-analysis<br><br>Number of included primary studies: 268 (of 268 total) | Total number of participants: 6,243,118<br><br>Age: all ages (grouped into child, adolescent, adults, older adults and pregnant people) | Multiple interventions (access, affordability, reminder/recall systems, educational programme) | 1. Access (different delivery models for example, opportunistic vaccinations, clinics in community settings, extended clinic hours, or providing accelerated dosing schedules) (n=14) | 1. No intervention (n=unclear)<br>2. Usual care (n=unclear)<br>3. Waitlist (n=unclear)<br>4. Attention placebo or an alternative | All routine and selective/targeted vaccinations on the UK immunisation schedule, including seasonal vaccinations | Vaccine uptake (single vaccination or completion)<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Number of studies in meta-analysis: 223 (170 RCTs and 53 cluster RCTs)<br><br>Inclusion criteria: all population groups living in the community and eligible for vaccination or carers of those eligible for vaccination (excluding specific clinical risk groups, healthcare workers, hospital inpatients, prisoners and those in residential institutions excluded), excludes multicomponent interventions aimed at both recipients of vaccines and providers or systems unless data available for recipients alone, included RCTs | Gender: men (39%), women (61%)<br><br>Ethnicity: ethnicity of trial participants was reported in 39% of studies, but exact number not reported<br><br>Health inequalities: includes pregnant people<br><br>Country: USA, UK, Australia and China | | 2. Affordability (for example, payment to cover costs, or as an incentive) (n=14)<br>3. Education (for example, letters, leaflets, educational campaigns, mainstream and social media campaigns, or face to face and so on) (n=85)<br>4. Reminder (delivered by any means, for example, phone calls, text messages, letters) (n=78)<br>5. Education + Reminder (where both were equally prominent) (n=54)<br>6. Multicomponent (interventions with features of 2 or more categories without one being prominent) (n=15) | eligible intervention (n=unclear) | | |
| Elghanam and others, 2025 (5) | Until November 2024 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 18 (of 22)<br><br>Number of studies in meta-analysis: 17<br><br>Inclusion criteria: any population, included RCTs | Number of participants: 214,556<br><br>Age: range 18 to 89 years<br><br>Gender: women only (n=14); not reported (n=2)<br><br>Ethnicity: not reported<br><br>Health inequalities: cardiac disease (n=4), pulmonary conditions (COPD, asthma) (n=3), | Interventions delivered by healthcare practitioners (pharmacist led interventions) | 1. Pharmacists as advocates (n=15)<br>2. Pharmacists as immunizers (n=5)<br><br>Duration: range 1 to 24 months | 1. Usual or standard care (n=15)<br>2. Other interventions without pharmacist participation (n=2) | Influenza (n=4), pneumococcal (n=1), influenza and pneumococcal (n=4), herpes zoster (n=2), pneumococcal and herpes zoster (n=2), HPV (n=1), multiple (n=2), COVID-19 (n=1) | Vaccine uptake (vaccine rate)<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | | diabetes mellitus (n=3), stroke (n=1), chronic kidney disease (n=2), cancer (various types) (n=2), asthma (self-reported) (n=1)<br><br>Country: USA, Canada, Japan and Puerto Rico | | | | | |
| Frascella and others, 2020 (16) | Not reported | Study design: systematic review.<br><br>Number of included primary studies: 8 (of 11 total)<br><br>Number of studies in meta-analysis: NA<br><br>Inclusion criteria: children, adolescents, adults, elderly population, at risk groups, international travellers and healthcare professionals, included any study with a clear comparison group | Total number of participants: unclear<br><br>Age: adults (above 18 years), including parents of adolescents and healthcare workers<br><br>Gender: 1 study women only, otherwise not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: includes healthcare workers<br><br>Country: USA and the Netherlands | Digital interventions (email-based reminders) | 1. Different email models (n=2)<br>2. Email reminders (n=4)<br>3. Email and traditional reminders (n=2)<br><br>Range of different settings responsible for data system management including health services and clinical practices, workplace and schools<br><br>One study had multiple interventions | 1.Different email models (n=2)<br>2. No reminders (n=4)<br>3. Traditional reminders (n=4)<br>4. Digital reminders (n=3)<br><br>Multiple comparison groups within studies | Influenza (n=5), HPV (n=3) | Vaccine uptake (all measures, immunisation coverage)<br><br>Length of follow up not reported |
| Kafadar and others, 2024 (6) | May 2000 to September 2023 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 9 (of 50 total)<br><br>Number of studies in meta-analysis: 9 | Number of participants: 138,169<br><br>Age: general population (>17 years) with large majority of studies over 65 | Multiple interventions (reminder/recall systems, educational programme, financial incentive) | 1. Staff offering at other appointments (n=2)<br>3. Poster, letters, text messages reminders (n=1)<br>4. Campaign (n=1)<br>5. Beneficence (n=1)<br>6. Sent invitation letters (with either home visits or incentives (n=2))<br>7. Educational visit (n=1) | 1. No intervention (n=4)<br>2. Invitation with letters (n=3)<br>3. Other campaign formats (n=2) | Influenza (n=7), HPV (n=1), hepatitis B (n=1) | Vaccine uptake<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Inclusion criteria: adults (over 18), studies set in the UK, included observational studies and RCTs | Gender: men (n=5), women (n=1), not reported (n=3)<br><br>Ethnicity: not reported<br><br>Health inequalities: at risk groups (n=2) Individuals receiving opioid substitution therapy (n=1), healthcare workers (n=1)<br><br>Country: UK, as a requirement of the review | | 8. Financial incentive (n=1) | | | |
| Labbe and others, 2025 (7) | Up to November 2022 | Study design: systematic review with meta-analysis.<br><br>Number of included primary studies: 70 (of 118 total)<br><br>Number of studies in meta-analysis: 59<br><br>Inclusion criteria: any patient with or without a medical condition and any parents having a child eligible to vaccinate, included RCTs, quasi experimental, pre post studies | Total number of participants: 28,602 in meta-analysis (n=21,749 for educational interventions and n=6853)<br><br>Age: adults, parents/caregivers, healthcare workers, elderly<br><br>Gender: not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: includes pregnant people, healthcare workers and those with | Educational or motivational interventions | 1. Educational interventions: referred to interventions seeking to increase knowledge or awareness about vaccines (like its benefits, the risks of not being vaccinated, and its safety) using different delivery formats (for example, face-to-face consultations, using paper materials, or electronic mediums such as online information or access to videos, n=64)<br><br>2. Motivational interviewing/communication interventions: referred to interventions seeking to increase internal motivation for getting vaccinated by taking into consideration | 1. Usual care (n=56)<br>2. Standard care (n=8)<br>3. Reminders (n=1)<br>4. Educational interventions (n=7)<br>5. Motivational interventions (n=1) | Influenza, tuberculosis (BCG), diphtheria, hepatitis, herpes zoster, HPV, infant immunization, varicella, rotavirus, tetanus diphtheria-pertussis, meningococcal, measles-mumps-rubella (MMR) pneumococcal, tetanus and COVID-19, n=unclear | Vaccine uptake<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | | medical or chronic conditions<br><br>Country: international setting but majority in USA | | patients' personal health goals and objectives and how their current behaviour (for example, refusing vaccination) may be misaligned with those objectives (n=6) | | | |
| Le and others, 2022 (8) | Up to February 28, 2022 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 11 (of 93 total)<br><br>Number of primary studies in meta-analysis: 11<br><br>Inclusion criteria: individuals of any age with any health condition who received services from pharmacists for immunisation, in a community or clinical setting, included observational studies, before and after studies, quasi experimental and RCTs | Total number of participants: total number unclear, n=135,350 as immunisers, 175,550 as advocates<br><br>Age: 7 studies on over 60s only, 4 on aged 18+<br><br>Gender: not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: not reported<br><br>Country: USA, Canada, Japan and Jordan | Interventions delivered by healthcare practitioners (pharmacist led interventions) | Range of different variations, durations and formats of pharmacist led interventions as either immunisers or advocators or both involving sharing information and education in the form of personalised letters, text messages, leaflets and other sources (n=11) | 1. Usual care (n=9)<br>2. Letter containing different information (n=1)<br>3. Unclear (n=1) | Influenza and pneumococcal (n=3), influenza pneumological herpes and Tdap (n=1), influenza (n=4), herpes (n=1), Pneumological (n=1), influenza, pneumococcal, tetanus, hepatitis A and B, MMR, varicella, meningococcal, HPV and shingles (n=1) | Vaccine rate<br><br>Length of follow up not reported |
| Lott and others, 2020 (17) | Up to November 12, 2018 | Study design: systematic review.<br><br>Number of included primary studies: 8 (of 9 total)<br><br>Number of primary studies in meta-analysis: NA | Total number of participants: 9,722<br><br>Age: 5 studies included age 9 to 26 years only, 4 studies included parents and minors<br><br>Gender: 77% women only | Multiple interventions | 1. Educational interventions (n=3)<br>2. Vaccination reminders (n=1)<br>3.Education and reminders (n=3)<br>4.Education and other services (n=1)<br>5. Barrier interviews (n=1) | Routine care (n=unclear),<br>no intervention (n=unclear) | HPV | Vaccine coverage (defined as initiation and completion)<br><br>Length of follow up one to 12 months |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Inclusion criteria: minority populations in high income countries as defined by World Bank, included RCTs, cohort and pre post studies | Ethnicity:<br>Black or African American n=1,716<br>Hispanic or Latinx n=6,556<br>Asian n=1,154<br>American Indian or Alaska native n=97<br>Not specified n=53<br><br>Health inequalities: all studies in racial (n=9,576) or sexual minority groups (n=173), as a requirement of the review<br><br>Country: USA | | | | | |
| Mavundza and others, 2021 (18) | Up to July 9, 2019 | Study design: systematic review<br><br>Number of included primary studies: 32 (of 35 total)<br><br>Number of primary studies in meta-analysis: NA<br><br>Inclusion criteria: all individuals eligible for HPV vaccines and their parents/legal guardians or healthcare providers, included RCTs | Total number of participants: 346,184<br><br>Age: adolescents, students and young adults, to parents/guardians and healthcare providers<br><br>Gender: 7 studies women only, one study men only, one study both, others reported as age category/parental status<br><br>Ethnicity: not reported | Multiple interventions (recipient and provider based) | 1.Recipient orientated interventions including education, reminder systems, financial incentives, motivational behaviour interventions, health messaging (n=26)<br>2. Provider orientated interventions including training, prompts, assessment and feedback, consultations, funding (n=9) | 1. Standard of care / usual practice / No intervention (n=16)<br>2. Alternative format / delivery (n=13)<br>3. Alternative intervention (n=3)<br>4. Waitlist control (n=2)<br>5. Multiple comparator (standard of care + alternate format) (n=1) | HPV | Vaccine initiation, vaccine completion and receipt of any vaccine dose<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | | Health inequalities: includes healthcare providers<br><br>Country: USA, Australia and the Netherlands | | | | | |
| Mohamed and others, 2022 (9) | 2006 to January 2022 | Study design: systematic review with meta-analysis.<br><br>Number of included primary studies: 13 (of 13 total)<br><br>Number of primary studies in meta-analysis: 10 and 11<br><br>Inclusion criteria: parents or guardians of adolescents aged 9 to 18 years, set in only the USA, included RCTs | Total number of participants: not reported<br><br>Age: children and adolescents (9 to 18 years)<br><br>Gender: parents of both boys and girls, 2 studies mothers only, otherwise not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: not reported<br><br>Country: USA, as a requirement of the review | Parent centred interventions | 1. Motivational interviews (n=4)<br>2. Reminder/recall text or phone (n=7)<br>3. Educational materials (n=5)<br><br>Multicomponent (n=7), single intervention (n=6) | 1. Usual care (n=6)<br>2. Active control (n=7) | HPV | Vaccine initiation and vaccine completion<br><br>Length of follow up 6 to 13 months |
| Murphy and others, 2021 (10) | Up to 19, August 2021 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 28 (covering 45 interventions in total 28 studies)<br><br>Number of primary studies in meta-analysis: 27 | Total number of participants: 652,234<br><br>Age: range from children under 6 months to those over 65<br><br>Gender: not reported<br><br>Ethnicity: not reported | Written message reminders (multiple different formats within each study) | 1. Letters (n=26)<br>2. Postcard (n=10)<br>3. Patient portal message (n=3)<br>4. Educational brochure (n=1)<br>4. Lottery (n=1)<br>5. Brochure and lottery (n=1)<br>6. Mobile app (n=2)<br>7. SMS (n=1) | 1. Usual care (n=7)<br>2. No intervention (n=21) | Influenza | Vaccine uptake<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Inclusion criteria: population not stated, but not specific to health care workers conducted in Organisation for Economic Co-operation and Development countries, included RCTs | Health inequalities: 11 studies conducted in risk groups or medical condition groups including asthma, COPD, patients with renal failure, 4 on Medicare<br><br>Country: USA, Canada, Spain, Denmark, New Zealand, South Korea, Germany and Australia | | Personal and tailored (n=26), generic (n=19) | | | |
| Norman and others, 2021 (11) | January 1976 to March 2019 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 5 (of 35 total)<br><br>Number of primary studies in meta-analysis: 5<br><br>Inclusion criteria: children from developed countries aged 6 months to 18 years with medical conditions that increase related risks from and for influenza infections, included observational studies, quasi experimental studies and RCTs | Total number of participants: 5,976<br><br>Age: all children, range between 1 to 18 years<br><br>Gender: not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: children in 3 studies had asthma and 2 studies had other comorbidities, which was a requirement of the review<br><br>Country: USA | Parental centred interventions | 1. Postal letter reminders (n=4)<br>2. Mobile reminder (n=1) | Control not described | Influenza | Vaccine coverage<br><br>Length of follow up not reported |
| Razai and others, 2023 (12) | January 1, 2012 to December 15, 2022 | Study design: systematic review with meta-analysis | Total number of participants: 86,424<br><br>Age: pregnant people but ages often not | Pregnant people targeted interventions | 1.Multimodal (n=3)<br>2. Patient education and prompting (n=4)<br>3. Patient education (n=7) | Usual care or no intervention (n=unclear, reported in protocol) | Influenza (n=12) and pertussis (n=6) | Vaccine uptake<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | Number of included primary studies: 14 (of 39 total)<br><br>Number of primary studies in meta-analysis: 14<br><br>Inclusion criteria: pregnant people in high income countries according to World Bank, included RCTs, observational studies and quasi experimental studies | reported, reported means usually between 20 and 35<br><br>Gender: all women<br><br>Ethnicity: unclear<br><br>Health inequalities: all women were pregnant or recent postpartum (12 weeks)<br><br>Country: USA, one study each in Hong Kong and one Canada | | | | | |
| Sandi and others, 2025 (13) | Up to April 9, 2024 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 5 (of 12 total)<br><br>Number of primary studies in meta-analysis: 5<br><br>Inclusion criteria: adolescents and young adults in clinic, community or school settings, included RCTs | Total number of participants: 1,997<br><br>Age: ages 9 to 26 years old in the community, health clinics and university<br><br>Gender: 3 studies conducted in men, one in women, one mixed<br><br>Ethnicity: one study states African American women, others not reported<br><br>Health inequalities: 3 of 5 studies conducted in young (18 to 25) gay or bisexual men, or men who have sex with men<br><br>Country: USA | Digital interventions (education or reminders) | Single or multi component digital education or reminders of various durations of:<br>1. interactive video (n=1)<br>2. email/text message (n=1)<br>3. website/email (n=1)<br>4. SMS (n=1)<br>5. website (n=1) | 1. Viewing health promotion media on nutrition and physical activity (n=1)<br>2. Receiving a paper card appointment reminder (n=1)<br>3. Receiving basic information on sexual health practices and receiving one vaccination method (n=1)<br>4. Receiving standard information on HPV on website or vaccine information sheet (n=2) | HPV | Vaccination completion<br><br>Length of follow up not reported |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| Vujovich-Dunn and others, 2021 (14) | Up to July 31, 2019 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 4 (of 5 total)<br><br>Number of primary studies in meta-analysis: 4<br><br>Inclusion criteria: all including parents, adolescents themselves, adults in the general population and healthcare workers, included RCTs | Total number of participants: 1,565<br><br>Age: adults and healthcare workers<br><br>Gender: study reports majority women<br><br>Ethnicity: not reported<br><br>Health inequalities: one primary study included pregnant people, one study included healthcare workers, and 2 studies included parents<br><br>Country: UK, USA and New Zealand | Decision aids (meeting definition from the International Patient Decision Aid Standards) | Tools designed to help individuals make a decision, including information on differing health care options, and help individuals communicate personal values.<br><br>1. Web based delivery mode (n=2)<br>2. Paper based delivery mode (n=2) | 1. No intervention (n=2)<br>2. Usual care (n=2)<br><br>Usual care refers to standard information on vaccines or not reported | Influenza (n=1), MMR (n=1), hepatitis b (n=1), diphtheria, tetanus, pertussis, polio and haemophiles influenzae type b (n=1) | Vaccine uptake (initiation and completion)<br><br>Length of follow up not reported |
| Wang and others, 2024 (15) | Up to January 2024 | Study design: systematic review with meta-analysis<br><br>Number of included primary studies: 5 (of 6 total)<br><br>Number of primary studies in meta-analysis: 6 (one non RCT)<br><br>Inclusion criteria: current substance users defines as individuals actively using substances at the time of the study, studies who focus on former substance users were | Total number of participants: 3,964<br><br>Age: 18 to 65 years<br><br>Gender: study reports higher prevalence of men across primary studies<br><br>Ethnicity: not reported<br><br>Health inequalities: study conducted in substance users, as a requirement of the review | Financial incentives | 1. Monetary incentives in the form of cash (n=3)<br>2. Monetary incentives with cash and vouchers (n=1)<br>3. Monetary incentive with cash and with having regular meetings with researchers (n=1)<br>4. Monetary incentive with cash and meeting with counsellors (n=1) | Usual care (n=6)<br><br>Included standard practices for encouraging HBV vaccinations without financial incentives, and could include educational interventions, reminders and other non-monetary methods | Hepatitis B | Vaccine coverage<br><br>Length of follow up only reported in one study (28 days) |

| Study | Search period | Study details | Population demographics | Intervention category (as per protocol) | Intervention description | Comparator | Vaccine/disease | Outcomes |
|---|---|---|---|---|---|---|---|---|
| | | excluded, included quasi experimental studies and RCTs | Country: UK, USA and Australia | | | | | |
| Wheeler and others, 2025 (19) | Up to 31 May 2023 | Study design: systematic review<br><br>Number of included primary studies: 44 (of 44 total)<br><br>Number of primary studies in meta-analysis: NA<br><br>Inclusion criteria: adults (excluding pregnant people and healthcare workers), included RCTs | Total number of participants: not reported, targeted to both clinicians and patients<br><br>Age: adults only<br><br>Gender: not reported<br><br>Ethnicity: not reported<br><br>Health inequalities: not reported, pregnant people and healthcare workers were excluded<br><br>Country: USA, UK, Netherlands and Australia | Multiple interventions (outpatient clinics) | Interventions delivered by primary care in outpatient settings<br>1. Single interventions involving no face-to-face contact (n=24) either targeted at clinician through clinician education and clinician reminders to order vaccines or targeted at patients through patient reminders to get vaccinated, patient education or increased access<br>2. Multicomponent interventions including those mentioned above (n=9)<br>3. In person contact with physician (n=unclear) | 1. Usual care (n=unclear)<br>2. No intervention (n=unclear) | Influenza (n=20), influenza and pneumococcus (n=10), pneumococcus (n=5), tetanus (n=3), influenza pneumococcus and tetanus (n=3), hepatitis B influenza and tetanus (n=1), COVID-19 (n=2) | Vaccine rate<br><br>Length of follow up not reported |

**Table D.2. Findings of systematic reviews with meta-analysis**

Abbreviations: OR: odds ratio, df=degrees of freedom, CI: confidence interval, RR: relative risk, RD: risk difference, Q: Cochran's Q, SE: standard error, CrI: credible interval, ICC: intraclass correlation coefficients, NA: not applicable

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| Brillo and others, 2023 (1) | Random effects meta-analysis<br><br>Sensitivity analysis: pre specified removal of each study one by one to assess each studies influence on overall effect<br><br>Pre specified subgroup analysis: none | Vaccine uptake<br>Increased influenza vaccine uptake in intervention group compared to control | OR 1.78 (95% CI 1.25 to 2.54, p=0.001) favouring intervention<br>Heterogeneity: $I^2$=67%, p=0.002, $tau^2$=0.17, $chi^2$=23.98, df=8 (p=0.002)<br>Test for overall effect: Z=3.20, p=0.001<br>Sensitivity analysis: no significant change after exclusion of any study | None | Not assessed appropriately | Most studies had a high risk of bias and failed to include methods for adequate reporting of allocation concealment and blinding of outcome assessment. Selective reporting frequently raised concerns<br><br>Funnel plots found no evidence of publication bias |
| Chandeying and others, 2023 (3) | Random effects meta-analysis<br><br>Sensitivity analysis: none<br><br>Pre specific subgroup analysis: by intervention type | Vaccine uptake<br>Increased vaccine uptake after all interventions across all comparisons | OR 1.25 (95% CI 1.16 to 1.34, p<0.001) favouring intervention<br>Heterogeneity: $I^2$=57%, tau=0.17, $tau^2$=0.029, Q=93.4, df=40, p<0.01 | Effect of different intervention types on vaccine uptake (n=34, 41 effect estimates) favouring client reminder and provider reminder<br>1. Client reminder (n=9)<br>Effect estimate: OR=1.41, 95% CI=1.23 to 1.63, p<0.001<br>Heterogeneity: $I^2$=42%, tau=0.136, $tau^2$=0.064, Q=13.8, df=13.8<br><br>2. Provider reminder (n=5, 8 effect estimates)<br>Effect estimate: OR=1.39, 95% CI=1.11 to 1.75, p=0.005<br>Heterogeneity: $I^2$=59%, tau=0.25, $tau^2$=0.06, Q=17.1, df=7<br><br>3. Client education plus provider reminder (n=8, 9 effect estimates)<br>Effect estimate: OR=1.29, 95% CI=1.04 to 1.59, p=0.007 | Not reported | No studies had low risk in all domains, and more than half of the studies were judged as having some concerns as there were issues with the randomization process and deviation from the intended intervention<br><br>Twelve trials failed to provide information on the generation and concealment of random allocation sequences. Nine studies lacked information regarding blinding of participants and interventionists<br><br>Funnel plots and Egger's test found no evidence of publication bias (Egger's |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Heterogeneity: $I^2$=50%, tau=0.198, $tau^2$=0.039, Q=16.03, df=8<br><br>4. Provider education (n=4)<br>Effect estimate: OR=1.18, 95% CI=1.05 to 1.34, p=0.007<br>Heterogeneity: $I^2$=0%, tau=0, $tau^2$=0, Q=1.77, df=3<br><br>5. Client education (n=10, 11 effect estimates)<br>Effect estimate: OR=1.08, 95% CI=0.92 to 1.28, p=0.35<br>Heterogeneity: $I^2$=15%, tau=0.11, $tau^2$=0.013, Q=11.8, df=10 | | test: intercept=1.35, 95% CI 0.78 to 1.92, p<0.001), funnel plot: symmetrical distribution, trim and fill: OR 1.08 (95% CI 1.03 to 1.12)) |
| Chandeying and others, 2024 (4) | Random effects meta-analysis<br><br>Sensitivity analysis: none<br><br>Pre specified subgroup analysis: by communication mode, presence of audit and feedback within the intervention, a combination of the above | Vaccine uptake<br>Increased vaccine uptake after intervention compared to control | RD 0.052 (95% CI 0.019 to 0.085, p=0.002) favouring intervention<br>Heterogeneity: $I^2$=77%, Q=30.03, df=7, p<0.001 | Effect of clinician communication training modalities on vaccine uptake (n=6, 8 effect estimates) favouring presumptive communication<br>1. Presumptive communication (5 effect estimates): 9.1% (95% CI 6.3% to 11.9%, p<0.001, $I^2$ 47%)<br><br>2. Conversation strategy (3 effect estimates): 2.3% (95% CI 0.9% to 3.7%, p=0.001, $I^2$ 54%)<br><br>Difference in effectiveness between these strategies was statistically significant (Q=8.235, df=1, p=0.004)<br><br>Effect of integrating audit and feedback mechanisms on vaccine uptake (k=6, 8 effect estimates) favouring audit and feedback<br>1. Audit and feedback (4 effect estimates)=9.4% (95% CI 3.0% to 15.9%, p=0.001, $I^2$=82%) | Not reported | The majority of studies had a low risk of bias in randomization and outcome measurement however some concerns were noted in the domains of participant identification and recruitment, deviations from intended interventions, missing outcome data, and selective reporting. The overall low risk of bias suggests that the study findings are robust<br><br>Funnel plot showed symmetrical uniform distribution and no systematic skewing suggesting no publication bias |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | 2. No audit and feedback (4 effect estimates) = 2.4% (95% CI 0.8% to 3.9%, p=0.004, $I^2$=42%)<br><br>Impact of audit and feedback was significant (Q=4.107, df=1, p=0.043)<br><br>Effect of combined strategy (presumptive communication alongside audit and feedback) on vaccine uptake, (k=6, 8 effect estimate) favouring presumptive strategy with audit and feedback<br>1. Presumptive strategy with audit and feedback (3 effect estimates) = 11.4% (95% CI 8.0% to 14.8%, p=0.001, I2=22%<br><br>2. Other interventions (5 effect estimates) = 2.5% (95% CI 1.1% to 3.9%, p=0.001, $I^2$=24%)<br><br>Significant impact of combined strategy (Q=14.095, df=1, p=0.001) | | |
| Chandeying and others, 2025 (2) | Unclear if fixed or random effects meta-analysis due to differences in reporting<br><br>Sensitivity analysis: none<br><br>Pre specified subgroup analysis: by gender in protocol but not in report | Vaccine uptake<br>Increased vaccine uptake after intervention using gender neutral strategies compared to control, non-significant difference for gender specific interventions | Effect of intervention by gender neutral or gender specific target, favouring gender neutral<br>1. Gender neutral strategies (n=2)<br>RD 0.057, 95% CI 0.028 to 0.087, SE=0.015, variance=0.00022<br>Heterogeneity: $I^2$=0%, Q=0.559, df=1, p=0.455<br>Test for overall effect: Z=3.841, p=0.00012<br><br>Gender specific strategies (n=5)<br>RD 0.025, 95% CI -0.009 to 0.059, SE=0.017, variance=0.00030, | None | Not reported | Risk of bias assessment revealed that most studies had low risk in several domains, with some concerns primarily arising from randomization and deviations from intended interventions<br><br>Funnel plot showed symmetrical distribution, no significant signs of publication bias |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | Heterogeneity: $I^2$=79.85%, Q=19.8, df=4, p=0.00053<br>Test for overall effect: Z=1.444, p=0.149<br><br>Subgroup analysis: no significant difference between groups (Q=2.046, df=1, p=0.153) | | | |
| Davies and others, 2025 (20) | Bayesian random effects network meta-analysis with fixed effects sensitivity analysis<br><br>Sensitivity analysis: excluding studies judged to be high risk of bias, any outlying results and exploring assumed intraclass correlation coefficients values<br><br>Prespecified subgroup analysis: by age group (range but not reported but split into categories of young children, children, adolescents, adults, older adults and pregnant people) and pre and post 2020 | Vaccine uptake<br>Increased vaccine uptake compared to control across all categories, with access, affordability and multiple components having highest ORs | Effect of multiple interventions on vaccine uptake<br>1. Access (n=14): OR 1.74 (95%CrI 1.35 to 2.26)<br>2. Affordability (n=14): OR 1.87 (95%CrI 1.47 to 2.40)<br>3. Reminder (n=78): OR 1.36 (95%CrI 1.22 to 1.50)<br>4. Education (n=85): OR 1.33 (95%CrI 1.19 to 1.49)<br>5. Education + Reminder (n=54): OR 1.47 (95%CrI 1.29 to 1.67)<br>6. Multicomponent (n=15): OR 2.09 (95% CrI 1.66 to 2.63)<br><br>Heterogeneity: tau = 0.42 (0.37 to 0.49)<br><br>Sensitivity analysis: performed excluding studies judged to be at high risk of bias which gave the same effect. Also excluded any studies with strongly outlying results, findings remained the same. Findings were also robust to sensitivity analyses exploring assumed intraclass correlation coefficients values, showing the same pattern both without cluster adjustment and with large ICCs | Effect of intervention by age group.<br>1. Access:<br>Young children (n=1): OR = 1.15 (95% CrI: 0.43 to 2.94)<br>Children (n=4): OR = 1.77 (95% CrI: 1.10 to 2.84)<br>Adolescents (n=1): OR = 1.83 (95% CrI: 0.68 to 4.89)<br>Adults (n=6): OR = 1.53 (95% CrI: 1.03 to 2.27)<br>Older adults (n=2): OR = 3.28 (95% CrI: 1.62 to 6.81)<br>Interaction (ROR): not reported<br><br>2. Affordability:<br>Young children (n=1): OR 1.72 (95% CrI: 0.69 to 3.99)<br>Adolescents (n=2): OR = 3.59 (95% CrI: 1.62 to 8.18)<br>Adults (n=11): OR = 1.70 (95% CrI: 1.30 to 2.24)<br>Interaction (ROR): not reported<br><br>3. Reminder:<br>Young children (n=13): OR = 1.35 (95% CrI: 1.04 to 1.76)<br>Children (n=9): OR = 1.25 (95% CrI: 0.94 to 1.66) | GRADE reported | Moderate for all the 6 categories.<br><br>Rated the confidence in all 6 effect estimates comparing intervention with control as ‘Moderate’. Authors downgraded by one level due to a combination of some concerns about heterogeneity (for all 6 interventions) and some concerns about within study bias (access and affordability interventions) or incoherence (affordability, education and reminder interventions))<br><br>Funnel plot asymmetry gave evidence of small study effects (p<0.0001) in all interventions except multicomponent. Authors state the asymmetry cannot be assumed to arise from publication bias since it is consistent with true differences between intervention effects in small versus large studies |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Adolescents (n=22): OR 1.46 (95% CI 1.20 to 1.78)<br>Adults (n=26): OR = 1.32 (95% CrI: 1.10 to 1.57)<br>Older adults (n=9): OR = 1.26 (95% CrI: 0.93 to 1.70)<br>Pregnant people (n=1): OR = 1.86 (95% CrI: 0.52 to 6.71)<br>Interaction (ROR): not reported<br><br>4. Education:<br>Young children (n=15): OR = 1.50 (95% CrI: 1.12 to 1.99)<br>Children (n=4): OR = 1.33 (95% CrI: 0.88 to 2.01)<br>Adolescents (n=19): OR = 1.22 (95% CrI: 0.97 to 1.55)<br>Adults (n=22): OR = 1.07 (95% CrI: 0.86 to 1.33)<br>Older adults (n=16): OR = 1.50 (95% CrI: 1.19. to 1.90)<br>Pregnant people (n=9): OR = 1.47 (95% CrI: 1.04 to 2.06)<br>Interaction (ROR): 0.71 (95% CrI: 0.50 to 1.03)<br><br>5. Education and reminder:<br>Young children (n=6): OR = 1.21 (95% CrI: 0.79 to 1.84)<br>Children (n=9): OR = 1.28 (95% CrI: 0.96 to 1.72)<br>Adolescents (n=15): OR = 1.92 (95% CrI: 1.49 to 2.48)<br>Adults (n=12): OR = 1.48 (95% CrI: 1.13 to 1.94)<br>Older adults (n=10): OR = 1.46 (95% CrI: 1.09 to 1.98) | | |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Pregnant people (n=2): OR = 1.22 (95% CI 0.47 to 3.20)<br>Interaction (ROR): 1.59 (95% CrI: 0.98 to 2.63)<br><br>6. Multicomponent:<br>Young children (n=2): OR = 2.67 (95% CrI: 1.24 to 5.79)<br>Children (n=1): OR = 4.09 (95% CrI: 1.68 to 10.04)<br>Adolescents (n=3): OR = 1.59 (95% CrI: 0.96 to 2.61)<br>Adults (n=8): OR = 1.70 (95% CrI: 1.25 to 2.34)<br>Older adults (n=2): OR = 3.82 (95% CrI: 1.96 to 7.46)<br>Interaction (ROR): not reported<br><br>Effect of intervention whether pre or post 2020<br>1. Access<br>pre-2020 (n=11): OR = 1.84 (95% CrI: 1.38 to 2.47)<br>2020 onwards (n=3): OR = 1.39 (95% CrI: 0.81 to 2.38)<br>Interaction (ROR): 0.75 (95% CrI: 0.41 to 1.39)<br><br>2. Affordability<br>pre-2020 (n=8): OR = 2.32 (95% CrI: 1.72 to 3.19)<br>2020 onwards (n=6): OR = 1.35 (95% CrI: 0.94 to 1.94)<br>Interaction (ROR): 0.58 (95% CrI: 0.36 to 0.93) | | |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | 3. Education<br>pre-2020 (n=65): OR = 1.34 (95% CrI: 1.18 to 1.51)<br>2020 onwards (n=20): OR = 1.31 (95% CrI: 1.02 to 1.68)<br>Interaction (ROR): 0.98 (95% CrI: 0.75 to 1.28)<br><br>4. Education and reminder<br>pre-2020 (n=41): OR = 1.40 (95% CrI: 1.22 to 1.63)<br>2020 onwards (n=13): OR = 1.70 (95% CrI: 1.32 to 2.22)<br>Interaction (ROR): 1.21 (95% CrI: 0.90 to 1.63)<br><br>5. Multicomponent<br>pre-2020 (n=10): OR = 2.50 (95% CrI: 1.89 to 3.33)<br>2020 onwards (n=5): OR = 1.45 (95% CrI: 1.00 to 2.10)<br>Interaction (ROR): 0.58 (95% CrI: 0.36 to 0.92)<br><br>6. Reminder<br>pre-2020 (n=54): OR = 1.39 (95% CrI: 1.23 to 1.58)<br>2020 onwards (n=24): OR = 1.25 (95% CrI: 1.05 to 1.50)<br>Interaction (ROR): 0.90 (95% CrI: 0.72 to 1.12) | | |
| Elghanam and others, 2025 (5) | Random effects meta-analysis<br><br>Sensitivity analysis: exclusion of studies one by one, and | Vaccine uptake<br>Increased vaccine uptake after pharmacist interventions compared to control | RR 1.58 (95% CI 1.40 to 1.79, p<0.00001) favouring intervention<br>Heterogeneity: $I^2$=93%, p<0.00001<br><br>Sensitivity analysis: exclusion of studies one by one showed results remained stable but did not reduce | Effect of pharmacist interventions on vaccination rate according to their role favouring neither advocates or immunizers with no significant differences | Not reported | Most studies had either a high risk of bias or raised some concerns. The main issues were lack of blinding, high dropout rates in some cases, and missing pre-specified analysis plans. |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | removal of studies with high risk of bias<br><br>Prespecified subgroup analysis: by pharmacist role, vaccine type and setting | | heterogeneity. Removal of studies with high risk of bias reduced heterogeneity only in studies conducted in hospital settings across all vaccination types | 1. Advocates (n=16):<br>Effect estimate: RR 1.59 (95% CI 1.41 to 1.80, p<0.00001)<br>Heterogeneity: $I^2$=93%, $tau^2$=0.04, $chi^2$=216.05, df=15 (p<0.00001)<br>Test of overall effect: Z=7.30, p<0.00001<br><br>2. Immunizers (n=5):<br>Effect estimate: RR 1.76 (95% CI 1.07 to 2.88, p=0.03)<br>Heterogeneity: $I^2$=96%, $tau^2$=0.27, $chi^2$=91.28, df=4 (p<0.00001)<br>Test for overall effect: Z=2.24, p=0.03<br><br>Overall<br>Effect estimate: RR 1.44 (95% CI 1.34 to 1.55)<br>Heterogeneity: $I^2$=93%, $tau^2$=0.01, $chi^2$=307.34, df=20 (p<0.00001)<br>Test for overall effect: Z=9.79, p<0.00001<br><br>Test for subgroup differences: $chi^2$ 0.14, df=1, p=0.70<br><br>Effect of pharmacist interventions on vaccination rate according to vaccine type favouring no group with no significant differences<br>1. Influenza (n=10):<br>Effect estimate: RR=1.24 (95% CI 1.11 to 1.39, p<0.00001)<br>Heterogeneity: $I^2$=87%, $tau^2$=0.01, chi2=69.76, df=9 (p<0.00001)<br>Test for overall effect: Z=3.75 (p=0.01) | | Randomization and outcome measurement were generally well managed<br><br>Funnel plot showed asymmetrical distribution suggesting small study effect |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | 2. Pneumonia (n=9):<br>Effect estimate: RR=1.36 (95% CI 1.07 to 1.72, p<0.00001)<br>Heterogeneity: $I^2$=80%, $tau^2$=0.08, chi2=40.09, df=8 (p<0.00001)<br>Test for overall effect: Z=2.50 (p=0.01)<br><br>Overall<br>Effect estimate: RR=1.25 (95% CI 1.14 to 1.37, p<0.00001)<br>Heterogeneity: $I^2$=84%, $tau^2$=0.02, chi2=109.53, df=18 (p<0.00001)<br>Test for overall effect: Z=4.66 (p=0.51)<br>Test for subgroup differences: $chi^2$=0.44, df=1, p=0.51<br><br>Effect of pharmacist interventions on vaccination rate according to study settings showing significant group differences<br><br>1. Hospital (n=5):<br>Effect estimate: RR=3.02 (95% CI 1.22 to 7.43, p<0.00001)<br>Heterogeneity: $I^2$=95%, $tau^2$=0.95, chi2=75.49, df=4 (p<0.00001)<br>Test for overall effect: Z=2.40 (p=0.02)<br><br>2. Community pharmacy (n=10):<br>Effect estimate: RR=1.29 (95% CI 1.15 to 1.45, p<0.00001)<br>Heterogeneity: $I^2$=92%, $tau^2$=0.02, $chi^2$=115.46, df=9 (p<0.00001)<br>Test for overall effect: Z=4.37 (P<0.0001) | | |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | 3. Primary health centre (n=1):<br>Effect estimate: RR=2.64 (95% CI 1.46 to 4.78, p<0.00001)<br>Heterogeneity: not applicable<br>Test for overall effect: Z=3.22 (P=0.001)<br><br>4. Social media platforms (n=1):<br>Effect estimate: RR=9.62 (95% CI 4.82 to 19.20, p<0.00001)<br>Heterogeneity: not applicable<br>Test for overall effect: Z=6.42 (p<0.00001)<br><br>Overall:<br>Effect estimate: RR=1.58 (95% CI 1.40 to 1.79, p<0.00001)<br>Heterogeneity: $I^2$=93%, $tau^2$=0.04, chi2=228.23, df=16 (p<0.00001)<br>Test for overall effect: Z=7.15 (p<0.00001)<br>Test for subgroup differences: $I^2$=92.3%, $chi^2$=38.89, df=3 (p<0.00001) | | |
| Frascella and others, 2020 (16) | Narrative synthesis | Vaccine uptake<br>Mixed result on vaccine uptake after intervention compared to control | Email communication successfully increased vaccine uptake compared to no intervention, but data is weaker in supporting email reminders compared to traditional methods or other digital reminders with evidence not supporting superiority of email reminders as studies often failed to show effectiveness in vaccine uptake compared to these control groups | | Not reported | Two studies were assessed as having a high risk of bias, 2 had a medium risk. Among the cluster randomised trials, 2 were rated as high risk and 2 as medium risk |
| Kafadar and others, 2024 (6) | Random effects meta-analysis<br><br>Sensitivity analysis: prespecified for population groups | Vaccine uptake<br>Increased vaccine uptake after intervention compared to control, with significant associations for most population groups bar health | OR=1.23 (95% CI 1.07 to 1.41) favouring intervention<br>Heterogeneity: $I^2$=94.9%, $tau^2$=0.03, $H^2$=19.61, p=0.01<br>Test for overall effect: Z=2.87, p=0.00<br>Meta regression: not reported | None | Not reported | All studies were of moderate or high quality, with a lack of clarity on assessment, detection and measurement of outcomes as well as the |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | Pre-specified subgroup analysis: not reported | care workers and those aged 65 and over in a risk group | Subgroup analysis: not reported<br><br>Sensitivity analysis for population groups: moderate heterogeneity among studies with low variability (total heterogeneity=0.1388 (SE=0.7933), $I^2$=6.10%)<br><br>Association between vaccine uptake and populations: statistically significant (OR=0.9915, 95% CI 0.0619 to 1.9210, p=0.0366)<br>a) Aged 75+: p<0.0001<br>b) 65+: p=0.0100<br>c) 18 to 64 at risk group: p<0.0001<br>d) Low risk patients aged 65 to 74: p=0.0147<br>e) 17 to 18 years: p=0.0182<br>f) OST group: p<0.0001<br>g) HCW: p=0.7525<br>h) Aged 65+ at risk group: p=0.7506<br><br>Sensitivity analysis for vaccine type: substantial heterogeneity with significant variability (total heterogeneity=5.1584, SE=2.6105, $I^2$=99.97%)<br><br>Substantial impact of vaccine type on vaccine uptake: OR=2.0443, p=0.0073 | | | administration of the intervention<br><br>Funnel plot showed asymmetrical distribution suggestive of publication bias |
| Labbe and others, 2025 (7) | Random effects meta-analysis with mixed effects analysis showing between group differences | Vaccine uptake<br>Increased vaccine uptake after educational interventions only | Effect of interventions on vaccine uptake favouring educational studies<br>1.Educational intervention studies:<br>Effects size: RR 1.10 (95% CI, 1.03 to 1.16)<br>Heterogeneity: $I^2$=84%, $tau^2$=0.084, Q=774.30, p<0.001 | None | Not reported | Risk of bias of included studies could not be properly inferred because quality assessment was conducted using the Down and Black checklist, with no markings in |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | Sensitivity analysis: only reported for pre post comparisons<br><br>Pre specified subgroup analysis: only reported for pre post comparisons | | 2.MI/MC intervention studies:<br>Effects size: RR 1.07 (95% CI 0.78 to 1.45)<br>Heterogeneity: $I^{2=}$9%, $tau^2$=1.09, Q=25.37, p<0.001<br>Mean effect size of vaccine rates between educational and MI/MC interventions (Q=0.031, p=0.861) | | | the figure or information provided in the text<br><br>Authors state funnel plot asymmetry showed both funnel plots for MI/MC and educational studies RCTs revealed the presence of risk of bias |
| Le and others, 2022 (8) | Random effects meta-analysis<br><br>Sensitivity analysis: removal of studies with high risk of bias and overlapping roles<br><br>Pre specified subgroup analysis: by influenza only, setting, and combined | Vaccine rate<br>Increased vaccine rate after intervention compared to control | Effect of interventions on immunisation rate by pharmacist role favouring no group<br><br>1.Immunizer (n=2)<br>Effect estimate (95% CI): RR 1.14 (1.12 to 1.15)<br>Heterogeneity: $I^2$=0%, p=0.786<br><br>2,Advocator (n=10)<br>Effect estimate (95% CI): RR 1.31 (1.17 to 1.48)<br>Heterogeneity: $I^2$=89.6%, p=0.00<br><br>3.Both (n=1)<br>Effect estimate (95% CI): RR 1.14 (1.12 to 1.15)<br>Heterogeneity: NA<br><br>Heterogeneity between groups p=0.057<br><br>Sensitivity analysis<br>RR remained with similar effect; or higher in role of advocator, after removing study with high risk of bias and excluding study with interventions using pharmacists in both roles | Effect of interventions on immunisation rate for influenza only by pharmacist role favouring no group<br><br>1.Immunizer (n=2)<br>Effect estimate (95% CI): RR 1.14 (1.11 to 1.17)<br>Heterogeneity: $I^2$=0%, p=0.495<br><br>2.Advocator (n=8)<br>Effect estimate (95% CI): RR 1.19 (1.07 to 1.32)<br>Heterogeneity: $I^2$=83%, p=0.00<br><br>Heterogeneity between groups p=0.698<br><br>Sensitivity analysis<br>RR remained with similar effect; or slightly lower in role of advocator after removing study with high risk of bias, rising to slightly higher when excluding study with interventions using pharmacists in both roles<br><br>Effect of interventions on immunisation rate by setting favouring community pharmacy and hospital | Outcome marked as MODERATE for immuniser role, LOW for advocator role (no breakdown provided)<br><br>Other GRADE findings reported but do not align with reporting of outcomes<br><br>Study reports Egger's test and funnel plot asymmetry was assessed, but not reported | GRADE reported |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | 1.Community pharmacy (n=6)<br>Effect estimate (95% CI): RR 1.17 (1.06 to 1.28)<br>Heterogeneity: $I^2$=86.3%, p=0.786<br><br>2.Hospital (n=4)<br>Effect estimate (95% CI): RR 2.82 (1.13 to 7.03)<br>Heterogeneity: $I^2$=92.6%, p=0.00<br><br>3.Primary health care (n=1)<br>Effect estimate (95% CI): RR 1.30 (0.49 to 3.48)<br>Heterogeneity: NA<br><br>Heterogeneity between groups p=0.167<br><br>Sensitivity analysis<br>RR reduced to non-significant slight change after removing study with high risk of bias in community pharmacy settings, but increased in hospital setting<br><br>Effect of interventions on immunisation rate by setting for influenza only favouring community pharmacy<br><br>1.Community pharmacy (n=6)<br>Effect estimate (95% CI): RR 1.17 (1.06 to 1.28)<br>Heterogeneity: $I^2$=84.5%, p=0.00<br><br>2.Hospital (n=2)<br>Effect estimate (95% CI): RR 4.78 (0.93 to 24.58)<br>Heterogeneity: $I^2$=40.1%, p=0.196 | | |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Heterogeneity between groups p=0.200<br><br>Sensitivity analysis<br>RR reduced in community pharmacy setting after removal of study with high risk of bias, no change to hospital setting | | |
| Lott and others, 2020 (17) | Narrative synthesis | Vaccine coverage (defined as initiation and completion)<br>Increased vaccine uptake for completion but not initiation | **By outcome**<br>In 2 studies, vaccine initiation increased 11.1% to 84% following intervention (both educational content) compared to control however in 5 studies there was no change<br><br>In 7 studies vaccine completion increased 5.6% to 74.2% compared to control<br><br>**By intervention**<br>Education only interventions (n=3) increased 0% to 22.7% in vaccine series initiation<br>Education only interventions (n=1) increased 4.4% in vaccine series completion<br>Reminder only interventions (n=1) increased 9.9% to 14% in series completion for Asian black and Hispanic participants<br>Education and reminder interventions (n=3) increased 0 to 19% in vaccine series initiation<br>Education and reminder interventions (n=4) increased 3.7 to 37.4% in vaccine series completion<br>Interviewing interventions (n=1) increased vaccine series initiation and completion | | Not reported | All studies bar one had a domain with serious risk of bias, most commonly around random sequence generation, incomplete outcome data/bias in measurement of outcomes or another bias. Reporting bias wasn't present in any study |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | **By population**<br>Conflicting results existed across studies due to differences in inclusion criteria | | | |
| Mavundza and others, 2021 (18) | Narrative synthesis | Vaccine initiation, completion and receipt of any dose<br>Increased vaccine uptake with most intervention types | **Vaccine initiation**<br>**Recipient orientated interventions**<br>Narrative education, reminders, outreach plus reminders, education plus reminders, financial incentives plus reminders, and brief motivational behavioural interventions increased vaccine initiation.<br><br>Tailored education, outreach and education and brief health messaging had no effect on vaccine initiation.<br><br>**Provider orientated interventions**<br>Prompts, training, training plus assessment and feedback, consultation, funding and multicomponent interventions increased vaccine initiation.<br><br>Assessment and feedback alone had no impact on vaccine initiation<br><br>**Vaccine completion**<br>**Recipient orientated interventions**<br>Tailored education, outreach and education, education plus reminders, reminders, financial incentives plus reminders, and brief motivational behavioural interventions increased vaccine completion.<br><br>Brief health messaging had no effect on vaccine completion. | | Recipient orientated interventions<br>Outreach plus reminders = moderate<br>Reminders = low<br>Education, financial incentives plus reminders, brief motivational interviewing = very low<br><br>Provider orientated interventions<br>Provider prompts = moderate<br>Funding = low<br>Training, consultation, training plus assessment and feedback, multicomponent interventions = very low<br><br>GRADE assessment breakdown not reported | GRADE reported |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | **Provider orientated interventions**<br>Prompts, funding and multicomponent interventions increased vaccine completion.<br><br>Assessment and feedback alone had no impact on vaccine initiation.<br><br>**Receipt of any dose**<br>**Recipient orientated**<br>Tailored education, untailored education, reminders and multicomponent education had no effect on receipt of any vaccine dose | | | |
| Mohamed and others, 2022 (9) | Random effects meta-analysis<br><br>Sensitivity analysis: removal of study with largest weight, cluster RCTs and those with active control<br><br>Prespecified subgroup analysis: by intervention type<br><br>Cumulative analysis | Vaccine initiation and completion<br>No significant increase in vaccine initiation or completion after intervention compared to control | Vaccine initiation<br>OR 1.24 (95% CI 0.86 to 1.77) not favouring intervention<br>Heterogeneity: $I^2$=89.1%, $tau^2$=0.047, Q=92.11 p<0.001<br><br>Sensitivity analysis<br><br>Removal of cluster RCTs showed a statistically significant improvement of 19% in vaccine initiation<br><br>Removal of studies with active control showed a statistically significant improvement of 55% in vaccine initiation<br><br>Cumulative analysis<br>Results ranked by year were statistically significant from 2015 to 2018 but not thereafter<br><br>Vaccine completion | Vaccine initiation<br>Effect of interventions on HPV vaccine initiation by intervention type, k=10, 11 estimates favouring reminder/recall interventions but no significant between group differences<br>1. Non reminder/recall interventions (n=6 estimates)<br>Effect estimate (95% CI): OR 1.62 (0.76 to 3.44)<br>Heterogeneity: $I^2$=82.1%<br><br>2. Reminder/recall interventions (n=5 estimates)<br>Effect estimate (95% CI): OR 1.19 (1.16 to 1.22)<br>Heterogeneity: $I^2$=0%<br><br>Vaccine completion<br>Effect of interventions on HPV vaccine completion by intervention type, k=11,12 estimates favouring reminder/recall interventions | Not reported | 77% of studies had either some concerns or high risk of bias. Domains with high risk or some concerns were often reporting bias (for example, reporting changes in vaccination status instead of reporting initiation and completion rates separately) and measurement bias (studies reporting the outcome at different lag times from stated in the protocol)<br><br>Funnel plots showed asymmetrical distribution suggestive of small study effect |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | OR 1.23 (95% CI 0.78 to 1.96) not favouring intervention<br>Heterogeneity: $I^2$=82.8 %, $tau^2$=0.203, $chi^2$=64 p=0.001<br>Meta regression: not reported<br><br>Sensitivity analysis<br>Removal of study with 46% of the weight shows parental interventions improved vaccine initiation OR 1.47 (0.99 to 2.20)<br><br>Removal of cluster RCTs or studies with active control showed no statistically significant differences<br><br>Cumulative analysis<br>Results ranked by year were statistically significant from 2013 to 2018 but not thereafter | 1. Non reminder/recall interventions (n=4 estimates)<br>Effect estimate (95% CI): OR 1.06 (0.40 to 2.81)<br>Heterogeneity: $I^2$=87.9%<br><br>2. Reminder/recall interventions (n=8 estimates)<br>Effect estimate (95% CI): OR 1.52 (1.04 to 2.21)<br>Heterogeneity: $I^2$=75.1% | | |
| Murphy and others, 2021 (10) | Random effects meta-analysis<br><br>Sensitivity analysis: removal of cluster RCTs<br><br>Prespecified subgroup analysis: by intervention type, population and overall risk of bias | Vaccine uptake<br>Increased vaccine uptake after intervention compared to control | RR 1.16 (95% CI 1.13 to 1.20) favouring intervention<br>Heterogeneity: $I^2$=91%, $tau^2$=0.01, df=40 p<0.001, $chi^2$=428.71<br>Test for overall effect: Z=9.25, p=0.001<br><br>Sensitivity analysis<br>Removal of cluster RCT retained but marginally reduced RR 1.13 (1.09 to 1.16, Z=7.99, p<0.001, $I^2$=86%) | Effect of interventions on influenza vaccine uptake by intervention type, n=27, 38 effect estimates favouring postcard and letter over portal messaging<br>1. Letter (n=14, 21 estimates)<br>Effect estimate (95% CI): RR 1.18 (1.12 to 1.24)<br>Heterogeneity: $I^2$=93%, $tau^2$=0.01, $chi^2$=280.99, df=20 p<0.00001<br>Test for overall effect: Z=6.62 p<0.0001<br><br>2. Postcard (k=n, 9 estimates)<br>Effect estimate (95% CI): RR 1.35 (1.15 to 1.60)<br>Heterogeneity: $I^2$=89%, $tau^2$=0.04, $chi^2$=55.70, df=8 p<0.00001<br>Test for overall effect: Z=3.58, p=0.0003 | Number of studies: 27<br>Risk of bias: serious (selection bias, performance bias, detection bias)<br>Inconsistency: serious (substantial heterogeneity)<br>Indirectness: not serious<br>Imprecision: not serious<br>Other considerations: serious (high publication bias)<br>Certainty: moderate | GRADE reported |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | 3. Letter/postcard and brochure (n=2)<br>Effect estimate (95% CI): RR 1.17 (0.87 to 1.58)<br>Heterogeneity: $I^2$=86%, $tau^2$=0.04, $chi^2$=9.42, df=1 p=0.002<br>Test for overall effect: Z=1.02, p=0.31<br><br>4. Portal message (n=3)<br>Effect estimate (95% CI): RR 1.04 (1.00 to 1.09)<br>Heterogeneity: $I^2$=75%, $tau^2$=0.00, $chi^2$=8.14, df=2 p=0.002<br>Test for overall effect: Z=1.94, p=0.05<br><br>5. Smartphone message (n=2, 3 estimates)<br>Effect estimate (95% CI): RR 1.14 (1.02 to 1.28)<br>Heterogeneity: $I^2$=93%, $tau^2$=0.01, $chi^2$=28.58, df=2 p<0.00001<br>Test for overall effect: Z=2.27, p=0.02<br><br>Total<br>Effect estimate (95% CI): RR 1.16 (1.12 to 1.20)<br>Heterogeneity: $I^2$=91%,$tau^2$=0.01, $chi^2$=414.28, df=37 p<0.00001<br>Test for overall effect: Z=8.76, p<0.00011<br>Test for subgroup differences: $chi^2$=19.52, df=4 (p=0006), $I^2$=79.5%<br><br>Significant differences between subgroups were found ($chi^2$=19.52, p<0.01) specifically portal messaging being less effective than a postcard ($chi^2$=8.81 p=0.003) or letter ($chi^2$=13.54, p<0.01) | Egger's test and funnel plots indicated publication bias or small study effects (Egger's test: 3.18, p<0.001, funnel plot: asymmetry present, trim and fill: analysis by inputting effect size of 13 hypothetical missing studies, RR adjusted to 1.09 (1.05 to 1.12)) | |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Effect of interventions on influenza vaccine uptake by population, n=27, 42 effect estimates showing no significant between group differences<br>1. Adult (n=5, 9 estimates)<br>Effect estimate (95% CI): RR 1.09 (1.01 to 1.18)<br>Heterogeneity: $I^2$=81%, $tau^2$=0.00, $chi^2$=42.55, df=8 p<0.00001<br>Test for overall effect: Z=2.33 p=0.02<br><br>2. Older adult (n=19, 33 estimates)<br>Effect estimate (95% CI): RR 1.16 (1.12 to 1.20)<br>Heterogeneity: $I^2$=91%,$tau^2$=0.01, $chi^2$=342.82, df=32 p<0.00001<br>Test for overall effect: Z=7.73, p<0.00001<br><br>Total<br>Effect estimate (95% CI): RR 1.14 (1.11 to 1.18)<br>Heterogeneity: $I^2$=89%,$tau^2$=0.01, $chi^2$=386.48, df=37 p<0.00001<br>Test for overall effect: Z=8.17, p<0.00011<br>Test for subgroup differences: $chi^2$=1.85, df=1 (p=0.17), $I^2$=46%<br><br>Effect of interventions on influenza vaccine uptake by risk of bias, n=27, 40 effect estimates showing significant between group differences<br>1. Low risk of bias (n=7, 8 estimates)<br>Effect estimate (95% CI): RR 1.09 (1.04 to 1.15)<br>Heterogeneity: $I^2$=86%, $tau^2$=0.00, $chi^2$=48.96, df=7 p<0.00001 | | |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Test for overall effect: Z=3.82 p=0.00001<br><br>2. Unclear risk of bias (n=13, 23 estimates)<br>Effect estimate (95% CI): RR 1.17 (1.12 to 1.22)<br>Heterogeneity: $I^2$=92%, $tau^2$=0.01, $chi^2$=261.86, df=22 p<0.00001<br>Test for overall effect: Z=6.71, p<0.00001<br><br>3. High risk of bias. (n=5, 9 estimates)<br>Effect estimate (95% CI): RR 1.42 (1.26 to 1.61)<br>Heterogeneity: $I^2$=91%,$tau^2$=0.02, $chi^2$=87.96, df=39 p<0.00001<br>Test for overall effect: Z=5.58, p<0.00001<br><br>Total<br>Effect estimate (95% CI): RR 1.16 (1.13 to 1.20)<br>Heterogeneity: $I^2$=91%,$tau^2$=0.01, $chi^2$=424.29, df=37 p<0.00001<br>Test for overall effect: Z=9.08, p<0.00001<br>Test for subgroup differences: $chi^2$=16.37, df=2 (p=0.0003), $I^2$=87.8% | | |
| Norman and others, 2021 (11) | Random effects meta-analysis<br><br>Sensitivity analysis: none<br><br>Prespecified subgroup analysis: none | Vaccine coverage<br>Increased vaccine coverage after intervention compared to control | RR 1.49 (95% CI 1.07 to 2.08) favouring intervention<br>Heterogeneity: $I^2$=89%, $tau^2$=0.10, $chi^2$=37.94, df=4 p<0.00001, | None | Study states GRADE reported but domains (not GRADE domains) only reported per study, no overall outcome assessment | High or unclear risk of bias in several domains was present in all studies, with blinding of participants and outcomes often not present, as well as issues with incomplete outcome data<br><br>Publication bias not assessed |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| Razai and others, 2023 (12) | Random effects meta-analysis<br><br>Sensitivity analysis: none<br><br>Prespecified subgroup analysis: none | Vaccine uptake<br>Increased vaccine uptake favouring intervention in influenza vaccines only, not for pertussis | Influenza vaccine uptake only (n=12, 18 effect estimates) favouring intervention<br>Effect estimate (95% CI): RR 1.07 (1.03 to 1.12)<br>Heterogeneity: $I^2$=0%, $tau^2$=0.00, $H^2$=1.00<br>Test for overall effect: Z=3.11, p=0.00<br><br>Pertussis vaccine uptake only (n=6, 10 effect estimates) not favouring intervention<br>Effect estimate (95% CI): RR 0.98 (0.94 to 1.03)<br>Heterogeneity: $I^2$=0.1%, $tau^2$=0.00, $H^2$=1.00<br>Test for overall effect: Z=0.64, p=0.52 | None | Not reported | Unable to assess risk of bias of only studies included in the meta-analysis, however 18% of studies rated as having strong global rating, 54% moderate and 28% as weak. Domains with highest number of studies rated as weak were selection bias and confounding<br><br>Publication bias not assessed |
| Sandi and others, 2025 (13) | Random effects meta-analysis<br><br>Sensitivity analysis: none<br><br>Prespecified subgroup analysis: none | Vaccination completion<br>Increased vaccination completion favouring intervention compared to control | OR 2.23 (1.11 to 4.47) favouring intervention<br>Heterogeneity: $I^2$=56%, $tau^2$=0.30, $chi^2$=9.16, df=4, p=0.06)<br>Test for overall effect: Z=2.26, p=0.02 | None | Not reported | Several studies had multiple domains with an unclear risk of bias, with one lacking specificity in describing the randomization method, one study having unclear risk of bias due to limited data on allocation concealment and 3 studies having insufficient explanation of their blinding protocol. No studies had high risk of bias in any domain. All studies<br>had no bias in selective reporting<br><br>Publication bias not assessed |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| Vujovich-Dunn and others, 2021 (14) | Random effects meta-analysis<br><br>Sensitivity analysis: inclusion of studies only with true randomisation<br><br>Prespecified subgroup analysis: none | Vaccine uptake<br>No significant increase in vaccine uptake after intervention compared to control | OR 1.56 (95% CI 0.75 to 3.27) not favouring intervention<br>Heterogeneity: $I^2$=46.7%, p=0.131)<br><br>Sensitivity analysis (effect of decision aids on vaccine uptake in studies with true only randomisation, k=3)<br>Effect estimate (95% CI): OR 1.32 (0.36 to 4.86)<br>Heterogeneity: $I^2$=50.3%, p=0.134 | None | Not reported | All studies contained domains with high or unclear risk of bias, with random sequence generation, blinding of outcome assessment and incomplete outcome data being the domains with highest risk of bias and blinding of participants and selective reporting being the domains with unclear risk of bias<br><br>Publication bias not assessed |
| Wang and others, 2024 (15) | Random effects meta-analysis<br><br>Sensitivity analysis: removal of studies one by one<br><br>Prespecified subgroup analysis: by number of vaccines completed and type of incentive provision | Vaccine coverage<br>Increased vaccine coverage after intervention compared to control | RR 2.26 (95% CI 1.33 to 3.85) favouring intervention<br>Heterogeneity: $I^2$=93.7%, Q=79.48, p=<0.0001<br>Overall effect test: Z=3.002, p=0.003<br><br>Sensitivity analysis: Combined RR from 1.77 to 2.90, supporting effectiveness of financial incentives in increasing vaccination uptake | Effect of financial interventions on number of vaccines completed, k=6 favouring vaccine completion but between group heterogeneity indicating no significant difference between single dose vaccine and vaccine completion<br>1. Single dose (n=2)<br>Effect estimate (95% CI): RR 2.37 (0.32 to 17.62)<br>Heterogeneity: $I^2$=97.5%, p<0.0000<br><br>2. Vaccine completion (n=4)<br>Effect estimate (95% CI): RR 2.30 (1.23 to 4.29)<br>Heterogeneity: $I^2$=83.3%,p<0.0000<br><br>Overall<br>Effect estimate (95% CI) RR: 2.26 (1.33 to 3.85)<br>Heterogeneity: $I^2$=93.7%, p<0.0000<br>Heterogeneity between groups p=0.977 | Number of studies: 6 (includes one non RCT)<br>Risk of bias: serious (rob high in fewer studies)<br>Inconsistency: very serious (substantial heterogeneity)<br>Indirectness: not serious<br>Imprecision: serious (broad confidence intervals)<br>Other considerations: serious (high publication bias)<br>Certainty: very low<br><br>LFK index was 6.42 suggesting major asymmetry | GRADE reported |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | | Effect of type of incentive provision on vaccine uptake favouring different incentive patterns but between group heterogeneity indicating no significant difference between incentive types<br>1. Incentive for each dose or regularly (n=3)<br>Effect estimate (95% CI): RR 1.58 (0.69 to 3.63)<br>Heterogeneity: $I^2$=90.6%, p<0.0000<br><br>2. Different incentive pattern (n=3)<br>Effect estimate (95% CI): RR 3.53 (1.02 to 12.22)<br>Heterogeneity: $I^2$=94.1%, p<0.0000<br><br>Overall<br>Effect estimate (95% CI) RR: 2.26 (1.33 to 3.85)<br>Heterogeneity: $I^2$=93.7%, p<0.0000<br>Heterogeneity between groups p=0.293 | | |
| Wheeler and others, 2025 (19) | Narrative synthesis | Vaccine rate<br>Mixed result indicating multicomponent interventions with face to face contact were more effective in increasing vaccine rate than single interventions without face to face contact | Face to face contact with patients for example, home visits or speaking with nurse or physician directly, and multicomponent interventions for example, increasing access, giving reminders and providing education for both clinicians and patients increased vaccination rates consistently whilst single interventions or interventions without face-to-face contact were less effective.<br><br>Electronic health record prompts were minimally effective<br>Clinician reminders increased uptake 4 to 32% | | Not reported | Seven included studies were rated as high risk of bias, 23 unclear risk of bias and 14 a low risk of bias. Unclear domains were most commonly blinding of outcome assessment and selective reporting. Studies had the highest risk of bias in the allocation concealment domain |

| Study | Methods | Outcomes | Results | Subgroup analysis | GRADE certainty of evidence | Risk of bias of included studies (if GRADE not reported) |
|---|---|---|---|---|---|---|
| | | | Electronic health record prompts to clinicians and patients increased uptake 1 to 16%<br>Multicomponent interventions increased uptake 4 to 42%<br>Face to face contact with patients increased uptake 6 to 17%<br>Group outpatient visits increased uptake 13 to 17%<br>Home visits increased uptake 6 to 17%<br>Physician or nurse recommendation increased uptake 15%<br><br>Unclear whether comparisons are to usual care, no intervention or historical comparison | | | |

# Annexe E. Risk of bias assessment

**Table E.1. Critical appraisal of studies**

| Study | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brillo E and others, 2023 | Yes | Yes | No | Partial Yes | Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Chandeying N and others, 2023 | Yes | Yes | No | Partial Yes | Yes | Yes | No | Partially Yes | Yes | No | Yes | No | No | Yes | Yes | Yes |
| Chandeying N and others, 2024 | Yes | Yes | Yes | Partial Yes | Yes | Yes | No | Partial Yes | Partial Yes | No | Yes | No | Yes | Yes | Yes | Yes |
| Chandeying N and others, 2025 | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes |
| Davies SR and others, 2025 | Yes | Partial Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Elghanam Y and others, 2025 | Yes | Yes | Yes | Partial Yes | Yes | No | No | Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Frascella B and others, 2020 | Yes | Partial Yes | Yes | Partial Yes | Yes | Yes | No | Yes | Yes | No | No meta-analysis | No meta-analysis | No | Yes | No meta-analysis | Yes |
| Kafadar AH and others, 2024 | No | Partial Yes | No | Partial Yes | Yes | Yes | No | Partial Yes | Yes | No | Yes | No | No | Yes | Yes | Yes |
| Labbe S and others, 2025 | Yes | Partial Yes | No | Partial Yes | Yes | Yes | No | Partial Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Le LM and others, 2022 | Yes | Yes | No | Partial Yes | Yes | Yes | No | Partial Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Lott BE and others, 2020 | Yes | Yes | Yes | Partial Yes | Yes | Yes | Yes | No | Yes | No | No meta-analysis | No meta-analysis | No | Yes | No meta-analysis | Yes |
| Mavundza EJ and others, 2021 | Yes | Yes | No | Yes | Yes | Yes | Yes | Partial Yes | Yes | No | No meta-analysis | No meta-analysis | Yes | No | No meta-analysis | Yes |
| Mohamed R and others, 2022 | Yes | Yes | Yes | Partial Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | No | No | Yes | Yes | Yes |
| Murphy RP and others, 2021 | No | Yes | No | Partial Yes | Yes | Yes | No | Partial Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Norman DA and others, 2021 | Yes | Yes | No | Partial Yes | Yes | Yes | No | No | Yes | No | Yes | Yes | Yes | Yes | No | Yes |
| Razai MS and others, 2023 | Yes | Yes | Yes | Yes | Yes | Yes | No | Partial Yes | Yes | No | Yes | No | No | Yes | No | Yes |

| Study | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sandi YDL and others, 2025 | Yes | Partial Yes | No | Partial Yes | Yes | No | No | Yes | Yes | No | Yes | No | Yes | Yes | No | Yes |
| Vujovich-Dunn C and others, 2021 | Yes | Yes | No | Partial Yes | No | Yes | Yes | Partial Yes | Yes | No | Yes | Yes | Yes | Yes | No | Yes |
| Wang W and others, 2024 | Yes | Yes | No | Partial Yes | Yes | Yes | No | Partial Yes | Yes | No | Yes | Yes | Yes | Yes | Yes | Yes |
| Wheeler SG and others, 2025 | Yes | Yes | Yes | Partial Yes | Yes | Yes | No | No | Yes | No | No meta-analysis | No meta-analysis | No | Yes | No meta-analysis | Yes |

Q = question. The AMSTAR2 tool was used.

Q1: Did the research question and inclusion criteria for the review include the components of PICO?
Q2: Did the report of the review contain an explicit statement that the review methods were established prior to the conduct of the review and did the report justify any significant deviations from the protocol?
Q3: Did the review authors explain their selection of the study designs for inclusion in the review?
Q4: Did the review authors use a comprehensive literature search strategy?
Q5: Did the review authors perform study selection in duplicate?
Q6: Did the review authors perform data extraction in duplicate?
Q7: Did the review authors provide a list of excluded studies and justify the exclusions?
Q8: Did the review authors describe the included studies in adequate detail?
Q9: Did the review authors use a satisfactory technique for assessing the risk of bias in individual studies that were included in the review?
Q10: Did the review authors report on the sources of funding for the studies included in the review?
Q11: If meta-analysis was performed did the review authors use appropriate methods for statistical combination of results?
Q12: If meta-analysis was performed, did the review authors assess the potential impact of RoB in individual studies on the results of the meta-analysis or other evidence synthesis?
Q13: Did the review authors account for RoB in individual studies when interpreting or discussing the results of the review?
Q14: Did the review authors provide a satisfactory explanation for and discussion of any heterogeneity observed in the results of this review?
Q15: If they performed quantitative synthesis, did the review authors carry out an adequate investigation of publication bias (small study bias) and discuss its likely impact on the results of the review?
Q16: Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?

# About the UK Health Security Agency

UK Health Security Agency (UKHSA) prevents, prepares for and responds to infectious diseases and environmental, radiological and chemical hazards, to keep all our communities safe, save lives and protect livelihoods. We provide scientific and operational leadership, working with local, national and international partners to protect the public's health.

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