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## Interventions for improving coverage of childhood immunisation in low- and middle-income countries (Review)

Oyo-Ita A, Wiysonge CS, Oringanje C, Nwachukwu CE, Oduwole O, Meremikwu MM

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[Intervention Review]

# Interventions for improving coverage of childhood immunisation in low- and middle-income countries

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## ABSTRACT

### Background

Immunisation is a powerful public health strategy for improving child survival, not only by directly combating key diseases that kill children but also by providing a platform for other health services. However, each year millions of children worldwide, mostly from low- and middle-income countries (LMICs), do not receive the full series of vaccines on their national routine immunisation schedule. This is an update of the Cochrane review published in 2011 and focuses on interventions for improving childhood immunisation coverage in LMICs.

### Objectives

To evaluate the effectiveness of intervention strategies to boost and sustain high childhood immunisation coverage in LMICs.

### Search methods

We searched the Cochrane Central Register of Controlled Trials (CENTRAL) 2016, Issue 4, part of *The Cochrane Library*. [www.cochranelibrary.com](http://www.cochranelibrary.com), including the Cochrane Effective Practice and Organisation of Care (EPOC) Group Specialised Register (searched 12 May 2016); MEDLINE In-Process and Other Non-Indexed Citations, MEDLINE Daily and MEDLINE 1946 to Present, OvidSP (searched 12 May 2016); CINAHL 1981 to present, EbscoHost (searched 12 May 2016); Embase 1980 to 2014 Week 34, OvidSP (searched 2 September 2014); LILACS, VHL (searched 2 September 2014); Sociological Abstracts 1952 - current, ProQuest (searched 2 September 2014). We did a citation search for all included studies in Science Citation Index and Social Sciences Citation Index, 1975 to present; Emerging Sources Citation Index 2015 to present, ISI Web of Science (searched 2 July 2016). We also searched the two Trials Registries: ICTRP and ClinicalTrials.gov (searched 5 July 2016)

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Interventions for improving coverage of childhood immunisation in low- and middle-income countries (Review) |

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## Selection criteria

Eligible studies were randomised controlled trials (RCT), non-RCTs, controlled before-after studies, and interrupted time series conducted in LMICs involving children aged from birth to four years, caregivers, and healthcare providers.

## Data collection and analysis

We independently screened the search output, reviewed full texts of potentially eligible articles, assessed risk of bias, and extracted data in duplicate; resolving discrepancies by consensus. We then conducted random-effects meta-analyses and used GRADE to assess the certainty of evidence.

## Main results

Fourteen studies (10 cluster RCTs and four individual RCTs) met our inclusion criteria. These were conducted in Georgia (one study), Ghana (one study), Honduras (one study), India (two studies), Mali (one study), Mexico (one study), Nicaragua (one study), Nepal (one study), Pakistan (four studies), and Zimbabwe (one study). One study had an unclear risk of bias, and 13 had high risk of bias. The interventions evaluated in the studies included community-based health education (three studies), facility-based health education (three studies), household incentives (three studies), regular immunisation outreach sessions (one study), home visits (one study), supportive supervision (one study), information campaigns (one study), and integration of immunisation services with intermittent preventive treatment of malaria (one study).

We found moderate-certainty evidence that health education at village meetings or at home probably improves coverage with three doses of diphtheria-tetanus-pertussis vaccines (DTP3: risk ratio (RR) 1.68, 95% confidence interval (CI) 1.09 to 2.59). We also found low-certainty evidence that facility-based health education plus redesigned vaccination reminder cards may improve DTP3 coverage (RR 1.50, 95% CI 1.21 to 1.87). Household monetary incentives may have little or no effect on full immunisation coverage (RR 1.05, 95% CI 0.90 to 1.23, low-certainty evidence). Regular immunisation outreach may improve full immunisation coverage (RR 3.09, 95% CI 1.69 to 5.67, low-certainty evidence) which may substantially improve if combined with household incentives (RR 6.66, 95% CI 3.93 to 11.28, low-certainty evidence). Home visits to identify non-vaccinated children and refer them to health clinics may improve uptake of three doses of oral polio vaccine (RR 1.22, 95% CI 1.07 to 1.39, low-certainty evidence). There was low-certainty evidence that integration of immunisation with other services may improve DTP3 coverage (RR 1.92, 95% CI 1.42 to 2.59).

## Authors' conclusions

Providing parents and other community members with information on immunisation, health education at facilities in combination with redesigned immunisation reminder cards, regular immunisation outreach with and without household incentives, home visits, and integration of immunisation with other services may improve childhood immunisation coverage in LMIC. Most of the evidence was of low certainty, which implies a high likelihood that the true effect of the interventions will be substantially different. There is thus a need for further well-conducted RCTs to assess the effects of interventions for improving childhood immunisation coverage in LMICs.

## PLAIN LANGUAGE SUMMARY

### Interventions that will increase and sustain the uptake of vaccines in low- and middle-income countries

#### What is the aim of this review?

The aim of this Cochrane review was to evaluate the effect of different strategies to increase the number of children in low-and-middle-income countries who are vaccinated to prevent infection by a disease. Researchers in Cochrane collected and analysed all relevant studies to answer this question and found 14 relevant studies.

#### Do strategies to improve childhood vaccination work?

Giving information about vaccination to parents and community members, handing out specially designed vaccination reminder cards, offering vaccines through regular immunisation outreach with and without household incentives (rewards), identifying unvaccinated children through home visits and referring them to health clinics, and integrating vaccination services with other services may lead to more children getting vaccinated. However, offering parents money to vaccinate their children may not improve vaccination uptake. Most of these findings were of low-certainty, and we need more well-conducted research in this area.

#### What was studied in the review?

Millions of children in low-and-middle-income countries still die from diseases that could have been prevented with vaccines. There are a number of reasons for this. Governments and others have tried different strategies to increase the number of children vaccinated.

**What are the main results of the review?**

The review authors found 14 relevant studies from Georgia, Ghana, Honduras, India, Mali, Mexico, Nicaragua, Nepal, Pakistan, and Zimbabwe. The studies compared people receiving these strategies to people who only received the usual healthcare services. The studies showed the following:

**Giving information and discussing vaccination with parents and other community members at village meetings or at home** probably leads to more children receiving three doses of diphtheria-tetanus-pertussis vaccine (moderate-certainty evidence).

**Giving information to parents about the importance of vaccinations during visits to health clinics combined with a specially designed participant reminder card and integration of vaccination services with other health services** may improve the uptake of three doses of diphtheria-tetanus-pertussis vaccine (low-certainty evidence).

**Offering money to parents on the condition that they vaccinate their children** may make little or no difference to the number of children that are fully vaccinated (low-certainty evidence).

**Using vaccination outreach teams to offer vaccination to villages** on fixed times monthly may improve coverage for full vaccination (low-certainty evidence).

**How up-to-date is this review?**

The review authors searched for studies that were published up to May 2016.

## SUMMARY OF FINDINGS FOR THE MAIN COMPARISON *[Explanation]*

<b>Population:</b> children aged < 24 months <b>Setting:</b> Pakistan (2 studies) <b>Intervention:</b> health education in the community (2 studies) <b>Comparison:</b> standard care					
Outcomes	Anticipated absolute effects (95% CI)*		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Standard care	Health education			
DTP3 (Follow-up: 4-9 months)	577 per 1000	969 per 1000 (629 to 1000)	RR 1.68 (1.09 to 2.59)	1692 (2 studies) <sup>3</sup>	⊕⊕⊕○ Moderate <sup>1,2</sup>
<p>*The effect in the 'health education' group (and its 95% CI) was based on the assumed risk in the 'standard care' group and the <b>relative effect</b> of the intervention (and its 95% CI).</p> <p>CI: Confidence interval; DTP3: 3 doses of diphtheria-tetanus-pertussis containing vaccines; RR: risk ratio.</p>					
<b>GRADE Working Group grades of evidence</b> <b>High certainty:</b> This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low <b>Moderate certainty:</b> This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate <b>Low certainty:</b> This research provides some indication of the likely effect. However, the likelihood that it will be substantially different is high <b>Very low certainty:</b> This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different is very high 'Substantially different' implies a large enough difference that it might affect a decision					

<sup>1</sup> We rated down by 1 level because we judged the included studies at high risk of bias.

<sup>2</sup> We rated down by 1 level because of unexplained heterogeneity of effects across studies, P value < 0.00001, I<sup>2</sup> = 68%.

<sup>3</sup> Andersson 2009; Owais 2011.

## BACKGROUND

Immunisation is a powerful public health tool for improving child survival, not only by directly combating some of the key diseases and causes of child mortality, but also by providing a platform for broader health services (Andre 2008; Bloom 2011; CDC 1999; Clements 2008; JAMA 2006; Okwo-Bele 2012; Wiysonge 2006). The concerted global effort to use immunisation as a public health strategy began when the World Health Organization (WHO) launched the Expanded Programme on Immunization (EPI) in 1974, following the successful global smallpox eradication programme (Wiysonge 2013). When the EPI was launched, WHO recommended a standard immunisation schedule covering six basic antigens (i.e. tuberculosis (Bacille Calmette-Guérin (BCG)), polio, diphtheria, tetanus, pertussis, and measles), which are generally referred to as traditional EPI vaccines. With the emergence of new vaccines, more killer diseases can be prevented in infancy and adolescence. These vaccines include (but are not limited to) hepatitis B, *Haemophilus influenzae* type b (Hib), human papilloma virus, pneumococcal conjugate, rotavirus, yellow fever, meningococcal meningitis A, Japanese encephalitis, and rubella vaccines (WHO 2012a).

The proportion of children who receive the full series of three doses of diphtheria-tetanus-pertussis containing vaccines (DTP3) by 12 months of age is traditionally used as a standard measure of the programme's ability to reach the target population, and is used as an indicator of the overall performance of EPI programmes (Okwo-Bele 2011; WHO-UNICEF 2009). The traditional EPI vaccines are estimated to prevent 2.5 million child deaths annually (mainly from measles, pertussis, tetanus, and diphtheria), as well as to prevent severe morbidity for millions more children around the world from devastating diseases such as poliomyelitis and tuberculous meningitis (CDC 1999; Liu 2012; Machingaidze 2013a; Okwo-Bele 2011; Rainey 2011; Wiysonge 2005). However, immunisation has the potential to do more; increasing coverage with existing vaccines, as well as the introduction and increased uptake of a portfolio of newly available vaccines in EPI programmes in low- and middle-income countries (LMICs), could save the lives of millions more children each year (Andre 2008; Brown 2011; Chopra 2013; Duclos 2009; Liu 2012; Machingaidze 2013a; WHO-UNICEF 2009; Wiysonge 2012a). Despite these huge potentials, the vaccination achievements so far have been described as 'fragile', given the outbreaks of some of these infectious diseases in LMICs (Duclos 2009; SAGE 2015; Siegfried 2010), and in high-income countries (Dubé 2013; SAGE 2015). These outbreaks reflect the existence of communities with partially vaccinated or unvaccinated children (Dubé 2013; SAGE 2015), which are communities whose herd immunity is not high enough to stall the transmission of these diseases.

In order to overcome these weaknesses and realise the full potential of immunisation, the 'Decade of Vaccines Collaboration' developed the Global Vaccine Action Plan (GVAP), which was endorsed

by the World Health Assembly in May 2012. The plan envisions "a world in which all individuals and communities enjoy lives free from vaccine-preventable diseases". The mission of the GVAP is to extend, by 2020 and beyond, the full benefit of immunisation to all people, regardless of where they are born, who they are, or where they live (WHO 2012a).

## Description of the condition

Global DTP3 coverage hovered around 5% in 1974, when EPI was launched, and increased very slowly to 17% in 1980 (WHO 2012b). Through the 1980s, WHO and the United Nations Children Fund (UNICEF) led an aggressive global campaign to achieve universal childhood immunisation, by vaccinating at least 80% of all children with the six traditional EPI vaccines by 1990 (Machingaidze 2013a; Okwo-Bele 2011). The global DTP3 coverage reached 76% in 1990 (WHO 2015). However, the progress in LMICs was slow as DTP3 coverage was only 57% in Africa and 70% in South-East Asia (UNICEF 2015a). Up to 2006, only 27% of LMICs had DTP3 coverage above the 80% target (Rainey 2011). A significant improvement was reported in 2007 in LMICs, particularly in sub-Saharan Africa and South-East Asia although these two regions did not reach the 80% DTP3 coverage (Duclos 2009). WHO and UNICEF estimated that DTP3 coverage increased to 86% globally in 2014 (WHO 2015).

In spite of this improvement, about 18.7 million children under one year of age were said to be unvaccinated with DTP3 globally in 2014. Close to 70% of these children live in just 10 LMICs in Africa and South-East Asia: Democratic Republic of Congo, Ethiopia, India, Indonesia, Kenya, Mexico, Nigeria, Pakistan, South Africa, and Viet Nam (WHO 2015). As a consequence of this continued failure to reach optimal immunisation coverage, 1.5 million children die each year from diseases preventable by vaccines currently recommended by WHO. These include 476,000 deaths from pneumococcal disease, 453,000 from rotavirus diarrhoea, 199,000 from Hib, 195,000 from pertussis, 118,000 from measles, and 59,000 from neonatal tetanus (WHO 2015). Factors associated with low immunisation coverage are linked to the health system, healthcare providers, and healthcare recipients (Bloom 2005; Rainey 2011; Wiysonge 2012b).

Some experts have observed growing concerns about vaccines, which has influenced vaccine acceptance (Bloom 2005; Dubé 2013; Feemster 2013; Larson 2014). Vaccine acceptance spans a spectrum from complete rejection to total acceptance (Feemster 2013). Along the spectrum is an emerging phenomenon: vaccine hesitancy (Larson 2014). The Strategic Advisory Group of Experts on Immunisation (SAGE) defines vaccine hesitancy as a behaviour that includes confidence, complacency, and convenience. According to SAGE, vaccine-hesitant people may accept all vaccines but with concerns, may accept only some vaccines or delay in taking up vaccines, or may totally reject all vaccines (Larson 2014).

There are varied reasons for failing to achieve universal coverage in different settings. Such reasons span from inaccessible services and poor logistic support, to political instability, including wars and public perceptions (Bloom 2005). Evidence is required to inform strategies to reach partially vaccinated and unvaccinated people in these countries. Such strategies also need to be tailored to local issues, needs, and conditions.

## Description of the intervention

Several experts have highlighted the wide range of issues affecting uptake of vaccines in various settings (Bloom 2005; Dubé 2013; Mills 2005; Munoz 2015). The issues vary between and within settings due to social, economic, cultural, geographical, political, and religious factors. Therefore, potential interventions are also likely to vary across different settings. Based on the findings from reviews on this, Table 1 presents a matrix of interventions to address the issues. Broadly, these strategies could include recipient-oriented interventions, for example, recipient recalls and reminders, health education of clients, teaching recipients skills; provider-oriented interventions, such as audit and feedback and chart-based or computerised provider reminders; and health system interventions, such as outreach programmes and improved quality of delivery of care (Lewin 2011). These could be delivered as single or multi-faceted interventions.

## How the intervention might work

The various interventions serve different purposes. Table 1 presents this matrix. Some interventions can be used for both recipients and providers, for example, remind/recall interventions could target both caregivers and healthcare providers.

## Why it is important to do this review

In many LMICs, immunisation coverage is low (WHO 2012b; UNICEF 2015b), routine immunisation systems are weak (Machingaidze 2013a), and community knowledge of immunisation is low (Zipursky 2010). The target of GVAP was to achieve DTP3 coverage of at least 90% in all countries by 2015. While 129 countries achieved the 90% coverage target by 2014, the 10 countries with the largest numbers of unimmunised children are all low-income or lower- to middle-income countries (SAGE 2015; WHO 2015).

Making well-informed decisions about how best to achieve and sustain high and equitable immunisation coverage in these countries will depend partly on decision makers accessing the best scientific evidence about what interventions work, and integrating this evidence into their national health systems (Lewin 2008). One previous Cochrane review assessed recipient-oriented reminders and recalls (Jacobson Vann 2005). The evidence indicated that

reminding people to receive vaccinations through postcards, letters, or telephone calls increased immunisation uptake. This strategy generally relies on setting up an efficient computerised vaccination registry or other practice-based information systems to track clients' vaccination status and eligibility for recommended vaccines, and also an efficient communication system to send reminders to clients. These technologies are lacking in many LMICs. This review examines the effects of strategies that utilise available resources in LMICs for improving vaccination coverage in the bid to provide evidence on appropriate strategies to improve and sustain immunisation coverage in these settings. In addition, it also explores provider-oriented interventions (Djibuti 2009), and health system interventions (Brugha 1996), towards improving immunisation coverage.

This is the first update of the Cochrane review published in 2011 (Oyo-Ita 2011), and complements two other Cochrane reviews conducted under the auspices of the 'Communicate to Vaccinate' project (Lewin 2011), which have a worldwide focus and assess the effects of face-to-face (Kaufman 2013) and community-directed interventions (Saeterdal 2014) to inform or educate about childhood vaccination. It also complements Jacobson Vann's review on participant reminder and recall systems to improve immunisation rates (Jacobson Vann 2005) by providing evidence on the wide range of interventions covering recipients, providers, and the health system that can be used to improve vaccination coverage.

## OBJECTIVES

To evaluate the effectiveness of intervention strategies to boost and sustain high childhood immunisation coverage in LMICs.

## METHODS

### Criteria for considering studies for this review

#### Types of studies

We included:

1. randomised controlled trials (RCTs), with randomisation at either individual or cluster level. For cluster RCTs, we only included those with at least two intervention and two control clusters.
2. non-randomised controlled trials (nRCTs), with allocation at either individual or cluster level. We included studies that allocated by alternation between groups, by the use of birth dates or weekdays, or by other non-random methods. For cluster trials, we only included those with at least two intervention and two control clusters.



3. interrupted time series studies (ITS) and repeated measures studies, with a clearly defined time point when the intervention occurred and at least three data points before and three after the intervention.

4. controlled before-after (CBA) studies with a minimum of two intervention and two control sites; comparable timing of the periods of study for the control and intervention groups; and comparability of the intervention and control groups on key characteristics.

We excluded:

CBA studies, cluster RCTs, and nRCTs that had only two study locations, in accordance with Effective Practice and Organisation of Care (EPOC) criteria for inclusion of studies (EPOC 2015a).

### Types of participants

Studies conducted in LMICs (World Bank 2016) that included:

1. children under five years of age receiving WHO-recommended vaccines through routine childhood immunisation services;
2. caregivers of children who were receiving vaccines through routine childhood immunisation services;
3. healthcare workers administering vaccines through routine childhood immunisation services;
4. or a combination of these.

For the purposes of this review, we defined routine childhood immunisation services as regularly scheduled immunisation services to children under five years of age, whether these services were offered at healthcare facilities, at fixed outreach sites, or by mobile health teams in communities (Machingaidze 2013b).

We limited the review to LMICs because of the continued failure to meet immunisation target and the weak routine immunisation system in this setting.

### Types of interventions

#### Interventions

1. Recipient-oriented interventions, for example:
  - i) interventions to improve communication about childhood immunisation, including to (Willis 2013):
    - a) inform or educate;
    - b) remind or recall;
    - c) teach skills;
    - d) provide support;
    - e) facilitate decision making;
    - f) enable communication;
    - g) enhance community ownership;
    - h) meet vaccination requirement for school entry;
    - i) use recipient incentives.
2. Provider-oriented interventions, for example:

i) any intervention to reduce missed opportunities for childhood vaccination (e.g. audit and feedback, provider reminders, supportive supervision);

ii) health education, training, and refresher courses for providers.

3. Health system interventions, for example:

i) interventions to improve the quality of services, such as provision of a reliable cold chain system, provision of transport for vaccination, vaccine stock management;

ii) outreach programmes (e.g. school immunisation outreach programmes, door-to-door canvassing (channeling);

iii) expanded services (e.g. extended hours for immunisation);

iv) increases in budgets for immunisation;

v) integration of immunisation services with other services;

vi) plans of action for immunisation coverage and disease reduction goals.

4. Multi-faceted (i.e. any combination of the above categories of) interventions.

5. Other interventions intended to improve immunisation coverage.

### Comparisons

1. Standard immunisation practices in the study setting.
2. Different interventions, or similar interventions implemented with different degrees of intensity.

### Types of outcome measures

#### Primary outcomes

1. Proportion of children who received DTP3 by one year of age.
2. Proportion of children who received all recommended vaccines by two years of age.

#### Secondary outcomes

1. Proportion of children who received the vaccine under study.
2. Number of children under five years of age fully immunised with all scheduled vaccines.
3. Occurrence of vaccine preventable diseases.
4. Costs of the intervention.
5. Attitudes of caregivers and clients towards immunisation.
6. Adverse events following immunisation (AEFI).

## Search methods for identification of studies

### Electronic searches

We placed no language or date restrictions on the search strategy. We translated the MEDLINE (Ovid) search strategy into the other databases using the appropriate controlled vocabulary. We searched the following electronic databases on the dates indicated:

1. Cochrane Central Register of Controlled Trials (CENTRAL), 2016, Issue 4, including the Cochrane EPOC Group Specialized Register (searched 12 May 2016)
2. MEDLINE In-Process and Other Non-Indexed Citations, MEDLINE Daily and MEDLINE 1946 to Present, OvidSP (searched 12 May 2016)
3. CINAHL 1981 to present, EbscoHost (searched 12 May 2016)
4. Embase 1980 to 2014 Week 34, OvidSP (searched 2 September 2014)
5. LILACS (VHL) (searched 2 September 2014)
6. Sociological Abstracts 1952 - current, ProQuest (searched 2 September 2014)

On 12 May 2016 we searched only CENTRAL, MEDLINE, and CINAHL. Embase, Sociological Abstracts, and LILACS were not searched for the following reasons. All 14 studies included in the review after the 2014 searches are indexed in CENTRAL, and 11 of the 14 studies are indexed in MEDLINE. The three studies not indexed in MEDLINE are not indexed in EMBASE. None of the 14 studies are indexed in Sociological Abstracts. The three studies not indexed in MEDLINE are not indexed in LILACS. All of the search strategies are in [Appendix 1](#).

### Searching other resources

We also searched the Cochrane Database of Systematic Reviews (CDSR) and the Database of Abstracts of Reviews of Effectiveness (DARE) for related reviews. We searched the reference lists of relevant reviews for potentially eligible studies ([Batt 2004](#); [Bordley 2000](#); [Glenton 2011](#); [Harvey 2015](#); [Jacobson Vann 2005](#); [Johri 2015b](#); [Kaufman 2013](#); [Kendrick 2000](#); [Lagarde 2009a](#); [Lagarde 2009b](#); [Pegurri 2005](#); [Ryman 2008](#); [Saeterdal 2014](#)). We also searched the reference lists of included studies for potentially eligible studies. We did a citation search for all included studies in Science Citation Index and Social Sciences Citation Index, 1975 to present; Emerging Sources Citation Index 2015 to present, ISI Web of Science (searched 2 July 2016)

We searched the following Trials Registries

- International Clinical Trials Registry Platform (ICTRP), World Health Organization (WHO) <http://www.who.int/ictpr/en/> (searched 5 July 2016)
- ClinicalTrials.gov, US National Institutes of Health (NIH) <http://clinicaltrials.gov/> (searched 5 July 2016)

## Data collection and analysis

### Selection of studies

At least two review authors independently screened the titles and abstracts of papers identified in the search output for potentially eligible studies. We retrieved full texts of potentially eligible studies for further assessment, and two review authors independently applied the inclusion criteria to these publications. We resolved disagreements about the inclusion of studies through discussion and consensus between the two review authors; and involved a third review author if the disagreement was not resolved. We obtained methodological advice from the EPOC editorial base for unresolved issues. The [Characteristics of excluded studies](#) presents reasons for excluding studies.

### Data extraction and management

All review authors developed and reviewed a data extraction form. Two review authors independently carried out data extraction and risk of bias assessment. We resolved disagreements in data extraction by consensus between the two review authors, with arbitration by a third author as required. The data extracted into an Excel spreadsheet included the following:

1. Setting of the study.
2. Type of study: distinguishing between individual RCTs, cluster RCTs, nRCTs, CBA studies, and ITS studies.
3. Type of participants: children, caregivers, and providers.
4. Type of interventions: categorised into participant and community, provider, health system, and multi-faceted.
5. Types of outcomes measured: data on outcome measures such as proportion of children immunised with different antigens based on the different interventions.

### Assessment of risk of bias in included studies

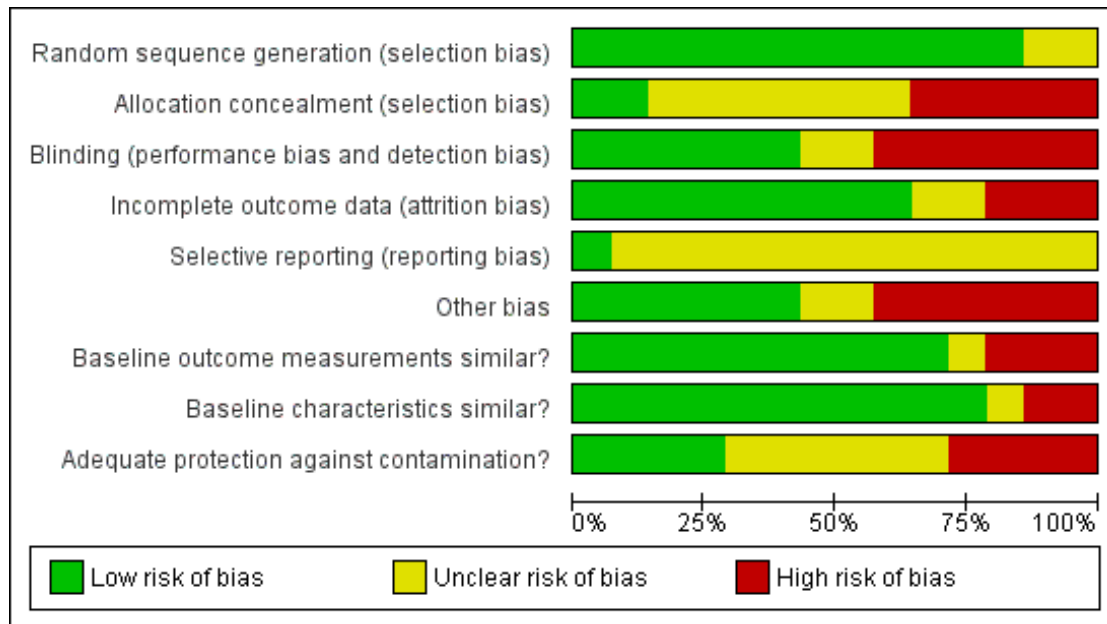
Two review authors applied the EPOC risk of bias criteria for RCTs, nRCTs, CBAs, and ITS studies to determine the risk of bias in included studies ([EPOC 2015b](#)). We resolved disagreements by discussion and consensus, with arbitration by a third review author as required.

Each criterion was scored as 'low risk', 'unclear risk', or 'high risk' ([Characteristics of included studies](#) table). [Figure 1](#) and [Figure 2](#) present the risk of bias for each included study. We considered a study as having a 'low risk of bias' if all criteria prescribed by EPOC were scored as 'Yes'; 'unclear risk of bias' if one or more criteria were scored as 'Unclear'; and 'high risk of bias' if one or more key criteria scored as 'No'. The key criteria included allocation concealment, completeness of outcome data, blinding of outcome assessors, and protection against contamination for RCTs and nRCTs; and independence of intervention from other changes, possibility of intervention affecting data collection, completeness of outcome data, and blinding of outcome assessors for ITS studies.

**Figure 1. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.**

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding (performance bias and detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias	Baseline outcome measurements similar?	Baseline characteristics similar?	Adequate protection against contamination?
Andersson 2009	+	+	+	+	?	-	+	+	?
Banerjee 2010	+	+	+	-	?	+	+	+	+
Barham 2005	?	-	-	?	?	?	-	+	?
Bolam 1998	+	?	+	-	?	+	+	+	+
Brugha 1996	?	?	-	?	?	-	+	+	?
Dicko 2011	+	-	-	+	+	+	-	+	-
Djibuti 2009	+	?	?	+	?	-	+	+	?
Maluccio 2004	+	-	-	-	?	-	?	?	-
Morris 2004	+	-	?	+	?	-	-	+	-
Owais 2011	+	?	+	+	?	+	+	+	+
Pandey 2007	+	?	+	+	?	-	+	+	?
Robertson 2013	+	-	+	+	?	?	+	-	-
Usman 2009	+	?	-	+	?	+	+	-	?
Usman 2011	+	?	-	+	?	+	+	+	+

**Figure 2. Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.**



### Measures of treatment effect

We used the risk ratio (RR) for dichotomous data. We planned to calculate the mean difference (MD) for costs and any other analysis of continuous data but none of the included studies reported these types of data. We reported 95% confidence intervals (CI) for all measures.

### Unit of analysis issues

We included cluster RCTs in the meta-analysis after making adjustments for design effect using standard procedures (Rao 1992), and the formula: design effect = 1 + (m - 1)r, where m was the mean cluster size and r was the intra-cluster correlation coefficient (ICC). Using data from Andersson 2009, we calculated the ICC for measles to be 0.25 and for DTP3 to be 0.14. We used this to estimate the adjusted standard error for the data of Andersson 2009; Banerjee 2010; Barham 2005; Brugha 1996; Dicko 2011; Maluccio 2004; and Robertson 2013 none of the data from the cluster RCTs were appropriately adjusted for clustering. We entered data from Dicko 2011 as absolute figures into Review Manager 5 (RevMan 2014) and calculated RRs; consequently, we applied the ICC to adjust for cluster effect.

### Dealing with missing data

We contacted the authors of two studies to obtain missing data (Djibuti 2009; Morris 2004). Morris 2004 responded, and we used the additional data to estimate the ICC for the study. Additional data received included the absolute number of events in each arm of the study for the Morris 2004 study; we estimated the ICC for mumps, measles, rubella (MMR) (0.013) and DTP1 (0.0377) for the post-intervention assessment only. We then used the ICC to adjust the standard error for the two outcomes from this study that we included in this review.

Five studies followed up the same set of participants post-intervention (Bolam 1998; Brugha 1996; Owais 2011; Usman 2009; Usman 2011). There were no missing data in three of these studies (Brugha 1996; Usman 2009; Usman 2011), and missing data were minimal (2%) in one study (Owais 2011) and high (greater than 20%) in Bolam 1998 study. Robertson 2013 accounted for missing data and applied intention-to-treat analysis. The remaining studies had independent sampling at pre- and post-intervention stages so missing data from loss to follow-up was not applicable in these studies (Andersson 2009; Banerjee 2010; Barham 2005; Dicko 2011; Djibuti 2009; Maluccio 2004; Morris 2004; Pandey 2007).

### Assessment of heterogeneity

We reviewed heterogeneity in the setting, interventions, and outcomes of included studies in order to make a qualitative assessment

of the extent to which the included studies were similar to each other. We examined the forest plots visually to assess the levels of heterogeneity. We considered meta-analyses with a  $P$  value for the  $\text{Chi}^2$  test of less than 0.1 to have considerable statistical heterogeneity. We used an  $I^2$  statistic of 50% or more to quantify the level of statistical heterogeneity. We planned to subject such meta-analyses to subgroup analyses for investigation of heterogeneity (see [Subgroup analysis and investigation of heterogeneity](#)). However, due to the paucity of data, such subgroup analysis was not feasible.

### Assessment of reporting biases

Test for asymmetry with a funnel plot was not feasible because the number of included studies for meta-analysis was too few.

### Data synthesis

We planned to pool data from studies with similar interventions (participant or community, provider, health system, multi-faceted), grouped by study design (RCTs, nRCTs, CBAs, ITS studies), in a meta-analysis using the random-effects model. For studies that reported only effect estimates with the measures of uncertainty, but without numbers of participants and numbers of events, we planned to analyse the effect estimate using the generic inverse variance approach. ITS studies were to be reported as changes in level and slope. We selected the random-effects model as the default procedure in the analysis due to heterogeneity, based on the assumption of random distribution of the variation in the effects of interventions in the different studies.

### Subgroup analysis and investigation of heterogeneity

We planned to explore anticipated differences in the impact of interventions across settings and mode of delivery of the interventions. We planned the following subgroup analyses:

1. Setting of the study (rural, urban).
2. Individual or group intervention.
3. Single or multi-faceted/integrated intervention.
4. Conditional or non-conditional incentive.
5. Facility- or community-based intervention.

Due to paucity of data subgroup analysis was only possible for facility- versus community-based health education.

### Sensitivity analysis

We planned to perform a sensitivity analysis based on risk of bias and missing data if we found sufficient data: however, available data were insufficient to perform this analysis. Due to diversity

in the reported outcomes across studies, we pooled data for only three interventions, namely health education for DTP3, health education plus redesigned cards for DTP3, and monetary incentive for full immunisation. There was heterogeneity in the pooled data on health education and health education plus redesigned card interventions. This could be attributed to the high risk of bias of included studies and the difference in the mode of delivery of the interventions.

### Assessment of certainty of evidence

We assessed certainty of the evidence using GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) (Guyatt 2008; Higgins 2011). We entered data for key interventions into the Grade Profiler and graded the certainty of evidence for the outcomes as 'high', 'moderate', 'low', and 'very low', defined as follows:

**High certainty:** this research provided a very good indication of the likely effect. The likelihood that the effect will be substantially different was low.

**Moderate certainty:** this research provided a good indication of the likely effect. The likelihood that the effect will be substantially different was moderate.

**Low certainty:** this research provided some indication of the likely effect. However, the likelihood that it will be substantially different was high.

**Very low certainty:** this research did not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different was very high.

'Substantially different' implies a large enough difference that it might affect a decision.

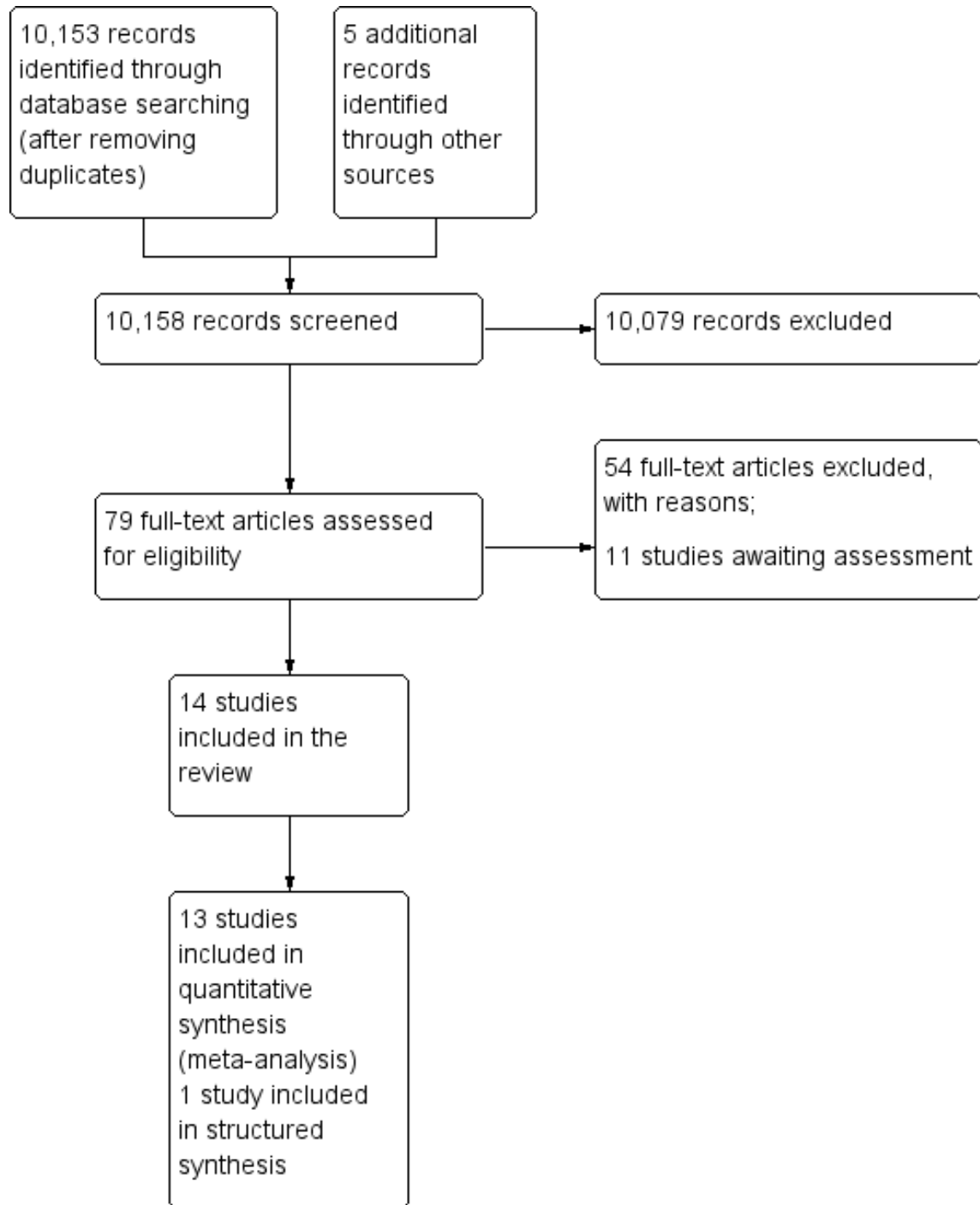
## RESULTS

### Description of studies

#### Results of the search

The electronic and supplementary searches yielded 10158 records, after removing duplicates. Following screening of titles and abstracts, we selected 79 studies for full text screening; 14 were eligible for inclusion in the review; we excluded 54, and 11 studies are awaiting assessment (Figure 3). In this update, we added an additional eight studies (Banerjee 2010; Barham 2005; Bolam 1998; Dicko 2011; Maluccio 2004; Owais 2011; Robertson 2013; Usman 2011) to the six studies included in the first version of the review (Oyo-Ita 2011).

**Figure 3. Study flow diagram.**



## Included studies

### Study design and setting

Fourteen studies met the inclusion criteria (Andersson 2009; Banerjee 2010; Barham 2005; Bolam 1998; Brugha 1996; Dicko 2011; Djibuti 2009; Maluccio 2004; Morris 2004; Owais 2011; Pandey 2007; Robertson 2013; Usman 2009; Usman 2011). Ten studies were cluster RCTs (Andersson 2009; Banerjee 2010; Barham 2005; Brugha 1996; Dicko 2011; Djibuti 2009; Maluccio 2004; Morris 2004; Pandey 2007; Robertson 2013). Of these, Brugha 1996 and Robertson 2013 were matched cluster RCTs and Djibuti 2009 used stratified cluster sampling. The remaining four studies were individually randomised controlled trials (Bolam 1998; Owais 2011; Usman 2009; Usman 2011). The unit of analysis was the participant in all the studies except Morris 2004 and Pandey 2007, in which household was the unit of analysis. There were no nRCTs, CBAs, or ITS studies among the included studies.

### Location of studies

The studies were conducted in Georgia (Djibuti 2009), Ghana (Brugha 1996), Honduras (Morris 2004), India (Banerjee 2010; Pandey 2007), Mali (Dicko 2011), Nepal (Bolam 1998), Pakistan (Andersson 2009; Owais 2011; Usman 2009; Usman 2011), Mexico (Barham 2005), Nicaragua (Maluccio 2004), and Zimbabwe (Robertson 2013).

### Participants

Owais 2011 recruited children aged less than six weeks; Usman 2009 and Usman 2011 included children registering for DTP1 (which the authors noted was given at six weeks of age in the country); Banerjee 2010 included children aged from birth to six months; Dicko 2011 recruited children aged from birth to 23 months; Andersson 2009 included children aged 12 to 23 months; and Brugha 1996 studied children who were aged 12 to 18 months. Barham 2005 studied children aged 12 to 18 months and Maluccio 2004 studied children aged from birth to 30 months. Robertson 2013 studied children under the age of five years. Participants in four studies were adults: primary healthcare workers (Djibuti 2009), the general population (Pandey 2007), pregnant women (Morris 2004), and postpartum women (Bolam 1998). The adults were targeted with a view to improving childhood immunisation coverage.

## Outcomes

Outcome measurements were similar at baseline between intervention and control groups except for Dicko 2011; the researchers did not adjust for this baseline difference.

### Sampling

Five studies carried out independent sampling in the pre- and post-intervention periods (Andersson 2009; Banerjee 2010; Dicko 2011; Djibuti 2009; Maluccio 2004). Morris 2004 and Barham 2005 had independent sampling for each outcome and for each arm of the intervention groups. Seven studies followed up the same participants at pre- and post-intervention (Bolam 1998; Brugha 1996; Owais 2011; Pandey 2007; Robertson 2013; Usman 2009; Usman 2011).

### Interventions

The individual studies evaluated interventions as follows:

1. Recipient-oriented interventions.
  - i) Health education on the importance of completion of the immunisation schedule, and on other immunisation-related issues.
  - ii) Health education plus 'reminder-type' immunisation cards to remind caregivers of their next immunisation appointment.
  - iii) Easy to understand pictorial card using simple language to explain how vaccines save children's lives, and where the vaccination centre was located.
  - iv) Monetary incentives to increase demand for preventive healthcare interventions.
    - a) Conditional and unconditional cash transfers to encourage clinic attendance for child development services.
2. Provider-oriented interventions.
  - i) Training of immunisation district managers, together with supportive supervision and audit and feedback regarding solving problems on immunisation services.
  - ii) Training of health providers on valid doses for vaccination.
3. Health system-oriented interventions.
  - i) Home visits to identify unimmunised children.
  - ii) Regular immunisation outreach sessions in the villages to ensure regular availability of immunisation services.
  - iii) Integration of immunisation with intermittent preventive treatment of malaria to support child health interventions.
4. Multi-faceted interventions.
  - i) Health system plus provider-oriented interventions.



ii) Health system plus provider-oriented plus recipient-oriented interventions.

iii) Reach every district approach: a combination of planning, outreach, community mobilisation, supportive supervision, and monitoring.

See below for more detail of these interventions.

## Recipient-oriented interventions

### *Health education*

Health education interventions included evidence-based discussions in the community on the prevalence of measles among children and the importance of childhood immunisation in Pakistan (Andersson 2009); an information campaign in India that involved presentation of audiotape messages, and distribution of posters and leaflets in the community (Pandey 2007); and three targeted pictorial messages regarding vaccines administered by trained lay/community health workers at the mothers' homes in Pakistan (Owais 2011). The first key pictorial message highlighted how vaccines save children's lives. The second message provided logistic information about the address and location of the local vaccination centres. The third key message emphasised the significance of retaining immunisation cards, and the role they could play at the time of the child's school admissions. A copy of these pictorial messages was left with the mother. Three studies in Nepal and Pakistan provided health education in the health facility on the importance of completion of the immunisation schedule (Bolam 1998; Usman 2009; Usman 2011). In the Bolam 1998 study in Nepal, one arm had only one-to-one facility-based education after delivery and before discharge from the hospital, the second arm had only a one-to-one education session in the mothers' homes three months after delivery, while the third arm included both one-to-one health education immediately after birth and three months later. The last arm was included in the study.

### *Monetary incentives*

Barham 2005 in Mexico combined conditional cash transfers with free provision of health and education services. The conditions for the cash transfer included receiving regular immunisation, growth monitoring, mother's attendance at health, hygiene, and nutrition education programs; and nutritional supplements for children aged from birth to two years and for pregnant and lactating mothers.

In Nicaragua, one of the interventions in Maluccio 2004 was a monthly "food security" cash transfer ("bono alimentario" = USD224 per year = 13% of total amount of household expenditures in beneficiary households before the programme), conditional on attendance at monthly health educational workshops,

on bringing their children aged under five for free scheduled preventive childcare appointments (which include the provision of anti-parasites drugs, and vitamins and iron supplements), on having up-to-date vaccination, and on adequate weight gain. Morris 2004 assessed the effect of withdrawing monetary vouchers if the mothers were not up-to-date with routine antenatal care and well-child preventive health care, and if the child did not attend school regularly.

Robertson 2013 in Zimbabwe compared two interventions. Both included a cash transfer of USD18 per household and USD4 per child every two months. In one of the arms, the transfer was on the condition that: those aged below 18 years with no birth certificate applied for one within three months; children aged under five years were up-to-date with immunisation, and attended growth monitoring clinics; children aged from six to 17 years had 90% monthly attendance at school; and a representative of every household attended two-thirds of local parenting skills classes. In the second arm there were no conditions attached to the cash transfer.

### *Health Education plus 'reminder-type' immunisation card*

Two studies evaluated an enlarged immunisation card, designed to remind mothers of immunisation appointments (Usman 2009; Usman 2011).

## Provider-oriented interventions

Interventions targeting providers in Georgia included training in continuous supportive supervision, development of supportive supervision guidelines, and tools for immunisation district managers (Djibuti 2009).

## Health system interventions

### *Home visits*

Brugha 1996 reported on the effects of home visits on childhood immunisation in Ghana: undergraduate students conducted the home visits, which aimed to identify non-immunised children and refer them for immunisation at the health centre. Another review considered these students to be lay/community health workers (Glenton 2011).

### *Integration of services*

The Dicko 2011 study assessed the effects of integrating immunisation service delivery with intermittent preventive treatment of malaria in infants.



### **Regular immunisation outreach sessions**

One study assessed the effects of regular monthly immunisation camps (Banerjee 2010). This intervention focused on ensuring the regular availability of immunisation services. It consisted of a mobile immunisation team, including a nurse and assistant, who conducted monthly immunisation camps in villages. The camp was held on a fixed date and time every month in each village.

### **Multi-faceted (health system plus provider interventions)**

One arm of the Morris 2004 study set up quality assurance (QA) teams in rural Honduras in health centres allocated to the intervention. The team, with wide representation from the local communities, was trained on QA methods. They produced work plans that could include minor structural repairs to health centres and the purchase of equipment, materials, and essential drugs. This arm of the study also included training of lay nutrition promoters who conducted monthly weighing of children aged less than two years and counselling of mothers. This intervention was not carried out as stipulated in the protocol, as only 17% of the total budget for the intervention was disbursed.

QA training was limited to only the introduction to the QA course. It was not clear what the composition of the QA course was. However, QA usually aims at ensuring that standards are met. This assures the service users of the quality of services and may encourage increased utilisation of services.

One arm of the study by Banerjee and colleagues assessed a regular once-monthly immunisation camp complemented with small material incentives in India (Banerjee 2010). The investigators offered parents 1 kg of raw lentils per immunisation administered and a set of “thalis” (metal plates used for meals) on completion of a child’s full immunisation. The value of the lentils was about USD1, equivalent to three-quarters of one day’s wage, and the value of the “thalis” was about USD2.00

### **Comparison**

The comparison groups received routine care in five studies (Andersson 2009; Brugha 1996; Dicko 2011; Morris 2004; Usman 2009). The study authors did not state what comprised routine care. The comparison group received no interventions in seven studies (Banerjee 2010; Barham 2005; Bolam 1998; Djibuti 2009; Maluccio 2004; Pandey 2007; Usman 2011). In the Owais 2011 study, the comparison group received verbal general messages (while the intervention group received three targeted pictorial messages). In the Robertson 2013 study, the comparison group received unconditional cash transfers.

### **Outcomes**

Eleven studies provided data on the proportion of the target population that was fully immunised (by age) by the recommended

vaccine (Andersson 2009; Banerjee 2010; Bolam 1998; Brugha 1996; Dicko 2011; Djibuti 2009; Maluccio 2004; Owais 2011; Robertson 2013; Usman 2009; Usman 2011). Other outcomes reported were: DTP3 coverage (Andersson 2009; Bolam 1998; Dicko 2011; Owais 2011; Usman 2009; Usman 2011); percentage change in immunisation coverage over time (Andersson 2009; Morris 2004); tetanus toxoid coverage in children (Pandey 2007); received at least one vaccine (Pandey 2007); oral polio coverage (Brugha 1996); completion of schedule (Brugha 1996); cost of the intervention (Andersson 2009); and coverage for tuberculosis and measles vaccines (Barham 2005).

Nine studies measured outcomes at the participant level (Andersson 2009; Banerjee 2010; Bolam 1998; Brugha 1996; Dicko 2011; Djibuti 2009; Owais 2011; Usman 2009; Usman 2011); while five studies measured the outcome at the household level (Barham 2005; Maluccio 2004; Morris 2004; Pandey 2007; Robertson 2013)..

### **Follow-up**

The period of follow-up varied between studies from three months to four years. Two studies had no loss to follow-up (Usman 2009; Usman 2011), three studies had 2% to 5% loss to follow-up (Morris 2004; Owais 2011; Pandey 2007), and two studies had loss to follow-up of 17% or more (Banerjee 2010; Bolam 1998). Five studies had two independent samples for pre- and post- follow-up (Andersson 2009; Barham 2005; Dicko 2011; Djibuti 2009; Maluccio 2004), while Brugha 1996 did not account for loss to follow-up. Robertson 2013 had less than 4% loss to follow-up.

### **Excluded studies**

We excluded 54 potentially studies for reasons provided in the [Characteristics of excluded studies](#) table.

Eleven studies are awaiting assessment of their eligibility (see [Characteristics of studies awaiting classification](#) table)

### **Risk of bias in included studies**

Based on our pre-defined criteria, we assessed no study as having a low risk of bias; one study had unclear risk of bias (Owais 2011), and the remaining 13 studies had high risk of bias.

### **Allocation**

The risk of selection bias (allocation concealment) was low for three studies (Andersson 2009; Banerjee 2010; Dicko 2011), unclear for seven studies (Bolam 1998; Brugha 1996; Djibuti 2009; Owais 2011; Pandey 2007; Usman 2009; Usman 2011), and high for four studies (Barham 2005; Maluccio 2004; Morris 2004; Robertson 2013).

## Blinding

Risk of bias in relation to blinding of participants, personnel, and outcome assessments was low for six studies (Andersson 2009; Banerjee 2010; Bolam 1998; Owais 2011; Pandey 2007; Robertson 2013), unclear for three studies (Dicko 2011; Djibuti 2009; Morris 2004), and high for five studies (Barham 2005; Brugha 1996; Maluccio 2004; Usman 2009; Usman 2011).

## Incomplete outcome data

The risk of attrition bias (completeness of outcome data) was low for nine studies (Andersson 2009; Dicko 2011; Djibuti 2009; Morris 2004; Owais 2011; Pandey 2007; Robertson 2013; Usman 2009; Usman 2011), unclear for two studies (Barham 2005; Brugha 1996), and high for three studies (Banerjee 2010; Bolam 1998; Maluccio 2004).

## Other potential sources of bias

The risk of contamination was low for four studies (Banerjee 2010; Bolam 1998; Owais 2011; Usman 2011), unclear for five studies (Andersson 2009; Brugha 1996; Djibuti 2009; Pandey 2007; Usman 2009), and high for five studies (Barham 2005; Dicko 2011; Maluccio 2004; Morris 2004; Robertson 2013).

## Effects of interventions

See: [Summary of findings for the main comparison](#)  
Community-based health education for improving childhood immunisation coverage; [Summary of findings 2](#) Facility-based health education plus redesigned reminder card for improving childhood immunisation coverage; [Summary of findings 3](#) Monetary incentives for improving childhood immunisation coverage; [Summary of findings 4](#) Home visits for improving childhood immunisation coverage; [Summary of findings 5](#) Immunisation outreach with and without incentives for improving childhood immunisation coverage; [Summary of findings 6](#) Integration of immunisation with other health services for improving childhood immunisation coverage in low- and middle-income countries

## Primary outcomes

### Proportion of children who received DTP3 by one year of age

### Recipient-oriented interventions versus standard care

These interventions included health education, use of a combination of redesigned cards and health education, and a monetary incentive.

### Health education

Included studies considered both community- and facility-based health education.

Andersson 2009 compared community-based health education with standard care; Owais 2011 compared community-based health education with general health promotion given verbally; and Pandey 2007 compared community-based health education with no intervention.

Community-based health education probably improved coverage of DTP3 (RR 1.68, 95% CI 1.09 to 2.59;  $I^2 = 68\%$ ; [Analysis 1.2](#)). Overall, there was high heterogeneity between the studies, probably due to the differing study methods. Certainty of evidence for community-based health education interventions was moderate ([Summary of findings for the main comparison](#)). Pandey 2007 did not report DTP3 coverage and was, therefore, not included in this pooled analysis.

Three studies assessed facility-based health education, and found substantial heterogeneity of effects (heterogeneity P value < 0.0001;  $I^2 = 91\%$ ; [Analysis 1.2](#)) (Bolam 1998; Usman 2009; Usman 2011). As we were unable to explain the heterogeneity, we did not report the pooled result. The findings from the three studies showed that the impacts of facility-based education on improving DTP3 uptake range from little to no effect (Bolam 1998: RR 1.01, 95% CI 0.95 to 1.08) to potentially important benefits (Usman 2009: RR 1.18, 95% CI 1.05 to 1.33; and Usman 2011: RR 1.50, 95% CI 1.27 to 1.77).

### Health education plus 'reminder-type' immunisation card

We found low-certainty evidence that combining facility-based health education with a redesigned 'reminder-type' immunisation card may improve DTP3 coverage (RR 1.50, 95% CI 1.21 to 1.87;  $I^2 = 77\%$ ; [Analysis 2.1](#); [Summary of findings 2](#)) (Usman 2009; Usman 2011).

### Provider-oriented interventions versus usual care

One study assessed the impact on immunisation coverage of training immunisation managers to provide supportive supervision for health providers (Djibuti 2009). This study provided low-certainty evidence that the intervention had little or no effect on coverage for DTP3. The difference in coverage between the intervention and control groups was 4.3% (P value = 0.285).

### **Integration of immunisation with other healthcare services versus standard care**

The [Dicko 2011](#) study provided low-certainty evidence that integrating immunisation services with intermittent prophylactic treatment of malaria in infants may improve DTP3 coverage (RR 1.92, 95% CI 1.42 to 2.59; [Analysis 6.2](#); [Summary of findings 6](#)).

### **Proportion of children who received all recommended vaccines by two years of age**

#### **Monetary incentives or disincentives versus no intervention**

One study in Nicaragua provided low-certainty evidence that monetary incentives may have little or no effect on coverage of all vaccines among children aged 12 to 23 months (RR 1.03, 95% CI 0.83 to 1.28; [Analysis 3.2](#)) ([Maluccio 2004](#)). One additional study from Zimbabwe provided low-certainty evidence on the effects of monetary incentives ([Robertson 2013](#)).

Pooled data from these two studies indicated that, overall, there was low-certainty evidence that monetary incentives may have little or no effect in improving vaccination coverage, although the CI included an important benefit (RR 1.05, 95% CI 0.90 to 1.23; [Analysis 3.2](#); [Summary of findings 3](#)) ([Maluccio 2004](#); [Robertson 2013](#)).

#### **Immunisation outreach sessions versus no intervention**

The [Banerjee 2010](#) study provided low-certainty evidence that regular once-monthly reliable immunisation outreach may increase the coverage for full immunisation (RR 3.09, 95% CI 1.69 to 5.67; [Analysis 5.1](#); [Summary of findings 5](#)).

### **Multi-faceted interventions**

#### ***Integration of immunisation to other healthcare services versus standard care***

There was low-certainty evidence that integrating immunisation services with intermittent prophylactic treatment of malaria in infants may improve DTP3 coverage (RR 1.92, 95% CI 1.42 to 2.59; [Analysis 6.2](#); [Summary of findings 6](#)) ([Dicko 2011](#)).

#### ***Health system plus recipient-oriented interventions versus no intervention***

The [Banerjee 2010](#) study provided low-certainty evidence that a multi-faceted intervention consisting of a health system (mobile immunisation camp) and recipient-oriented (non-monetary

incentive) intervention may improve coverage for full vaccination (RR 6.66, 95% CI 3.93 to 11.28; [Analysis 5.1](#); [Summary of findings 5](#)).

### **Secondary outcomes**

#### **Proportion of children who received the vaccine under study**

#### **Recipient-oriented interventions versus usual care**

##### ***Health education***

Evidence-based discussions probably improve coverage of measles vaccine (RR 1.63, 95% CI 1.03 to 2.58; [Analysis 1.1](#)) ([Andersson 2009](#)). We also found low-certainty evidence that information campaigns (presentation of audiotape messages, and distribution of posters and leaflets in the community) may increase the coverage of at least one dose of a vaccine (RR 1.43, 95% CI 0.72 to 2.86; [Analysis 1.3](#)) ([Pandey 2007](#)).

#### **Monetary incentives or disincentives versus no intervention**

One study conducted in Mexico provided low-certainty evidence that monetary incentives may have little or no effect on measles vaccination coverage (RR 1.00, 95% CI 0.69 to 1.45; [Analysis 3.1](#)) ([Barham 2005](#)), and coverage of BCG vaccination according to schedule (RR 0.98, 95% CI 0.47 to 2.05; [Analysis 3.3](#)) ([Barham 2005](#)). However, the CI for BCG uptake included an important benefit. [Morris 2004](#) reported data on the impact of withdrawing monetary vouchers (a household-level monetary incentive) on the coverage of MMR and DTP1 vaccines. The study provided low-certainty evidence that withdrawing monetary vouchers may have little or no effect on coverage of MMR (RR 0.95, 95% CI 0.83 to 1.07; [Analysis 3.4](#)) and DTP1 (RR 1.09, 95% CI 0.94 to 1.28; [Analysis 3.5](#)).

#### **Provider-oriented interventions versus usual care**

[Djibuti 2009](#) provided low-certainty evidence that training immunisation managers to provide supportive supervision for health providers may have little or no effect on coverage for three doses of oral polio vaccine (OPV3), and three doses of hepatitis B virus (HBV3). The differences in coverage between the intervention and control groups were 8.4% (P value = 0.173) for OPV3 and 13.4% (P value = 0.172) for HBV3.

## Health system interventions versus usual care

### *Home visits versus usual care*

Brugha 1996 assessed the effect of home visits on improving coverage for OPV3 and measles. This study provided low-certainty evidence that home visits may improve OPV3 (RR 1.22, 95% CI 1.07 to 1.39; Analysis 4.1; Summary of findings 4) and measles vaccine coverage (RR 1.26, 95% CI 1.08 to 1.46; Analysis 4.2).

## Multi-faceted interventions

### *Integration of immunisation to other healthcare services versus standard care*

There was low-certainty evidence that integrating immunisation services with intermittent prophylactic treatment of malaria in infants may improve measles vaccine coverage (RR 1.13, 95% CI 1.06 to 1.20; Analysis 6.3), but may have little or no effect on BCG coverage (RR 1.03, 95% CI 0.89 to 1.19; Analysis 6.1) (Dicko 2011).

### *Health system plus provider-oriented interventions versus standard care*

One arm of the study by Morris 2004 aimed to strengthen peripheral health services through training QA teams (provider package) and the provision of equipment, drugs, and materials (health system package) and also provided nutritional promotion. This arm of the intervention was not delivered as per protocol. There was low-certainty evidence that this intervention may lead to little or no difference in MMR coverage (RR 1.06, 95% CI 0.91 to 1.23; Analysis 3.4) and DTP1 coverage (RR 1.00, 95% CI 0.83 to 1.21; Analysis 3.5).

### *Health system plus provider-oriented plus participant-oriented interventions versus standard care*

Another arm of Morris 2004 evaluated a combination of monetary incentives (recipient-oriented); QA (provider-oriented); and provision of equipment, drugs, and materials (health system oriented interventions). The study provided low-certainty evidence that this intervention may lead to little or no difference in MMR coverage (RR 1.11, 95% CI 0.99 to 1.24; Analysis 3.4) and DTP1 coverage (RR 1.15, 95% CI 0.97 to 1.37; Analysis 3.5), though the CIs included important benefits.

## Number of children under five years of age fully immunised with all scheduled vaccines

### Monetary incentives

Robertson 2013 and Maluccio 2004 provide low-certainty evidence that monetary incentives may have little or no effect on coverage of all vaccines among children aged under five years (RR 1.05, 95% CI 0.90 to 1.23; Analysis 3.2; Summary of findings 3).

### Occurrence of vaccine preventable diseases

None of the included studies provided data on the occurrence of the targeted diseases.

### Costs of the intervention

Only one of the included studies estimated the costs of the intervention (Andersson 2009). This evaluation indicated that community-based health education cost USD9.00 per child.

### Attitudes of carers and clients towards immunisation

None of the included studies provided data on the attitudes of caregivers and clients towards immunisation.

### Adverse events following immunisation

None of the included studies reported data on AEFI.

## ADDITIONAL SUMMARY OF FINDINGS *[Explanation]*

<b>Population:</b> children aged 6 weeks <b>Setting:</b> Pakistan <b>Intervention:</b> facility-based health education + redesigned reminder vaccination card <b>Comparison:</b> standard care					
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Standard care	Health education plus re-designed card			
DTP3 (Follow-up: 90 days)	470 per 1000	705 per 1000 (569 to 879)	RR 1.50 (1.21 to 1.87)	1502 (2 studies) <sup>3</sup>	⊕⊕○○ <b>low</b> <sup>1,2</sup>

\*The effect in the 'health education + redesigned card' group (and its 95% CI) was based on the assumed risk in the 'standard care' group and the relative effect of the intervention (and its 95% CI).

CI: confidence interval; DTP3: 3 doses of diphtheria-tetanus-pertussis containing vaccines; RR: risk ratio.

### GRADE Working Group grades of evidence

**High certainty:** This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low

**Moderate certainty:** This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate

**Low certainty:** This research provides some indication of the likely effect. However, the likelihood that it will be substantially different is high

**Very low certainty:** This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different is very high

'Substantially different' implies a large enough difference that it might affect a decision

<sup>1</sup> We rated down by 1 level because of unexplained heterogeneity of effects across studies; P value = 0.04; I<sup>2</sup> = 77%.

<sup>2</sup> We rated down by 1 level because we judged the 2 included studies at unclear risk of selection bias and at high risk of performance and detection bias.

<sup>3</sup> Usman 2009; Usman 2011.

<b>Population:</b> children aged < 5 years <b>Setting:</b> Nicaragua (1 study) and Zimbabwe (1 study) <b>Intervention:</b> monetary incentives in the form of household cash transfers <b>Comparison:</b> standard care					
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Standard care	Monetary incentive			
Fully immunised children (Follow-up: 13 months to 5 years)	701 per 1000	736 per 1000 (631 to 862)	RR 1.05 (0.90 to 1.23)	1000 (2 studies) <sup>2</sup>	⊕⊕○○ <b>low</b> <sup>1</sup>
<p>*The effect in the 'monetary incentive' group (and its 95% CI) was based on the assumed risk in the 'standard care' group and the <b>relative effect</b> of the intervention (and its 95% CI).</p> <p>CI: confidence interval; <b>DTP3</b>: 3 doses of diphtheria-tetanus-pertussis containing vaccines; <b>RR</b>: risk ratio.</p>					
<p><b>GRADE Working Group grades of evidence</b></p> <p><b>High certainty:</b> This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low</p> <p><b>Moderate certainty:</b> This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate</p> <p><b>Low certainty:</b> This research provides some indication of the likely effect. However, the likelihood that it will be substantially different is high</p> <p><b>Very low certainty:</b> This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different is very high</p> <p>'Substantially different' implies a large enough difference that it might affect a decision</p>					

<sup>1</sup> We rated down by 2 levels because we judged the 2 included studies at high risk of bias.

<sup>2</sup> [Maluccio 2004](#); [Robertson 2013](#).

<b>Population:</b> children aged 12-18 months <b>Setting:</b> Ghana <b>Intervention:</b> home visits <b>Comparison:</b> standard care					
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Standard care	Home visits			
OPV3 (Follow-up: 6 months)	73 per 100	89 per 100 (76 to 100)	RR 1.22 (1.07 to 1.39)	419 (1 study) <sup>2</sup>	⊕⊕○○ low <sup>1</sup>
<p>* The effect in the 'home visits' group (and its 95% CI) was based on the assumed risk in the 'standard care' group and the <b>relative effect</b> of the intervention (and its 95% CI).          CI: confidence interval; <b>OPV3</b>: 3 doses of oral polio vaccine; <b>RR</b>: risk ratio.</p>					
<p>GRADE Working Group grades of evidence  <b>High certainty:</b> This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low  <b>Moderate certainty:</b> This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate  <b>Low certainty:</b> This research provides some indication of the likely effect. However, the likelihood that it will be substantially different is high  <b>Very low certainty:</b> This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different is very high</p>					

<sup>1</sup> We rated down by 2 levels because the 1 included study was judged to be at high risk of bias.

<sup>2</sup> [Brugha 1996](#).

<b>Population:</b> children aged 0-6 months <b>Setting:</b> India <b>Intervention:</b> regular immunisation outreach with or without household incentives <b>Comparison:</b> standard care					
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Standard care	Immunisation outreach			
Fully immunised - regular immunisation outreach only (Follow-up: 18 months)	58 per 1000	180 per 1000 (98 to 330)	RR 3.09 (1.69 to 5.67)	1239 (1 study) <sup>2</sup>	⊕⊕○○ <b>low</b> <sup>1</sup>
Fully immunised - regular immunisation outreach + non-monetary incentive (Follow-up: 18 months)	58 per 1000	387 per 1000 (228 to 656)	RR 6.66 (3.93 to 11.28)	1242 (1 study) <sup>2</sup>	⊕⊕○○ <b>low</b> <sup>1</sup>

\* **The effect in the 'immunisation outreach' group** (and its 95% CI) was based on the assumed risk in the 'standard care' group and the **relative effect** of the intervention (and its 95% CI).

CI: confidence interval; RR: risk ratio.

**GRADE Working Group grades of evidence**

**High certainty:** This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low

**Moderate certainty:** This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate

**Low certainty:** This research provides some indication of the likely effect. However, the likelihood that it will be substantially different is high

**Very low certainty:** This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different is very high

'Substantially different' implies a large enough difference that it might affect a decision

<sup>1</sup> We rated down by 2 levels because we judged the 1 included study at high risk of bias.

<sup>2</sup> [Banerjee 2010](#).



<b>Population:</b> children aged 0-23 months <b>Setting:</b> Mali <b>Intervention:</b> integration of immunisation services with intermittent preventive treatment of malaria <b>Comparison:</b> standard care					
Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	No of participants (studies)	Certainty of the evidence (GRADE)
	Standard care	Integration			
DTP3 (Follow-up: 12 months)	602 per 1000	1000 per 1000 (854 to 1000)	RR 1.92 (1.42 to 2.59)	1481 (1 study) <sup>2</sup>	⊕⊕○○ <b>low</b> <sup>1</sup>
<p>*The effect in the 'integration' group (and its 95% CI) was based on the assumed risk in the 'standard care' group and the <b>relative effect</b> of the intervention (and its 95% CI).  <b>CI:</b> confidence interval; <b>DTP3:</b> 3 doses of diphtheria-tetanus-pertussis containing vaccines; <b>RR:</b> risk ratio.</p>					
<p><b>GRADE Working Group grades of evidence</b></p> <p><b>High certainty:</b> This research provides a very good indication of the likely effect. The likelihood that the effect will be substantially different is low</p> <p><b>Moderate certainty:</b> This research provides a good indication of the likely effect. The likelihood that the effect will be substantially different is moderate</p> <p><b>Low certainty:</b> This research provides some indication of the likely effect. However, the likelihood that it will be substantially different is high</p> <p><b>Very low certainty:</b> This research does not provide a reliable indication of the likely effect. The likelihood that the effect will be substantially different is very high</p> <p>'Substantially different' implies a large enough difference that it might affect a decision</p>					

<sup>1</sup> We rated down by 2 levels because we judged the 1 included study at high risk of bias.

<sup>2</sup> [Dicko 2011](#).

## DISCUSSION

### Summary of main results

Ten cluster RCTs and four individually randomised controlled trials met our inclusion criteria. These were conducted in Georgia, Ghana, Honduras, India, Mali, Mexico, Nepal, Nicaragua, Pakistan, and Zimbabwe. The interventions evaluated in the studies included community-based health education, facility-based health education, home visits, household monetary incentives, and integration of immunisation services to intermittent preventive treatment of malaria. These were implemented either as single interventions or as multi-faceted interventions.

We found moderate-certainty evidence that giving information and discussing vaccination with parents and other community members at village meetings or at home probably improve immunisation coverage. We also found low-certainty evidence that giving information to parents about the importance of vaccinations during visits to health clinics combined with specially designed 'reminder-type' immunisation cards may improve immunisation coverage. There was low-certainty evidence that regular immunisation outreach, home visits, and integration of immunisation with other primary healthcare services (such as intermittent preventive treatment of malaria) may improve immunisation coverage. However, there was currently low-certainty evidence that household monetary incentives (in the form of conditional or unconditional cash transfers) may have little or no effect on immunisation coverage.

### Overall completeness and applicability of evidence

In the context of the GVAP, there is an urgent need for effective interventions that would ensure equitable uptake of existing vaccines by people in all communities around the world (WHO 2012a). However, immunisation coverage remains uneven between and within the world's regions and countries. For example, in 2014, DTP3 coverage was 96% in Europe and the Western Pacific and only 77% in sub-Saharan Africa (WHO 2015). The GVAP coverage target was to achieve DTP3 coverage of 90% in all countries by 2015; but only 129 (66%) countries have achieved this coverage target. The 10 countries with the largest numbers of unimmunised children are all low-income or lower- to middle-income countries (SAGE 2015).

Barriers to improving immunisation coverage could be broadly categorised into factors that affect the demand for vaccines, barriers to the supply of vaccines, or both (Lewin 2011). Around 2014, the concept of vaccine hesitancy emerged as a factor hindering the demand of vaccines (Larson 2014). The Strategic Advisory Group of Experts on immunisation identified factors that influence vaccine hesitancy. These were grouped into three major areas, namely

contextual influences, vaccine and vaccination specific issues, and individual and social group influences. The influences of these factors are said to be complex and context-specific, varying in time, place, and vaccine (Larson 2014). It is unclear if the interventions tested in the included studies were derived from identified barriers in the settings, though specific concepts were tested. In general, though, interventions to improve coverage should focus on identified barriers within settings.

The included studies evaluated interventions that varied enormously in content and in the intensity of delivery, raising questions regarding the likely impact of interventions in different settings and regarding how best to implement the interventions. For instance, how effective will a three-minute health education intervention (Usman 2009; Usman 2011; low-certainty evidence) be in a typical clinical setting in improving completion of the immunisation schedule? Will the same effect be obtained for more than one vaccine? How feasible is evidence-based discussion (Andersson 2009; moderate-certainty evidence) in a community with low literacy? How feasible is a monetary incentive intervention (Morris 2004; low-certainty evidence) in a resource-poor setting without donor support? The limited number of studies makes it difficult to explore these issues and restricts the wider applicability of the evidence.

Home visits to promote childhood vaccination uptake or to deliver vaccination are common in many settings. The applicability of the home visit intervention as implemented in Brugh 1996 may be affected by several factors. First, the use of first-degree university students as lay/community health workers to deliver this type of intervention may not be feasible in many resource-poor settings. Two reviews reported moderate-certainty evidence on the effectiveness of lay health workers in promoting the uptake of childhood immunisation services (Glenton 2011; Lewin 2010). In these reviews, the level of education of the lay health workers varied from primary school graduates to high school graduates, with some studies not reporting this information. Furthermore, the settings of the studies were middle- and high-income countries. Second, referring caregivers of children who need immunisation to a health facility requires that there be a facility within reasonable distance of the community. This type of intervention may not be useful in settings in which households do not have easy access to health facilities. Finally, administering injectable vaccines at home has implications for vaccine quality and injection safety; given the need to maintain the cold chain from manufacture to administration of vaccines as well as the need to dispose of injection material safely (preferably by incineration). This approach may not be cost effective or sustainable in a resource-constrained economy. The high diversity of the interventions and the contextual differences, therefore, make it difficult to draw conclusion on their effectiveness in improving vaccination coverage.

There is paucity of data on the sustainability of the interventions presented in this review, as none of the included studies reported long-term follow-up data. All had two data points that were at

baseline and post-intervention, making it impossible to ascertain the long-term effects of the interventions. However, two studies aimed to build the capacity of the providers (Djibuti 2009; Morris 2004), and to upgrade the physical structure (Morris 2004). These strategies can contribute to sustainability if other supporting resources are available. A sustainability framework for projects aimed at strengthening immunisation systems in LMICs should include maintenance or continuance of health benefits from projects, institutionalisation of projects within the system, and capacity development (Gruen 2008; Shediak-Rizkallah 1998). It has been observed that for a programme to be sustained, early and active planning is required (Shediak-Rizkallah 1998). Sustainability of quality improvement interventions has been particularly challenging in LMICs, especially when a programme is supported by external funds (Gruen 2008). Withdrawal of external funds may not only impact negatively on the gains of the programme but may jeopardise support for future programmes (Gruen 2008). This is particularly so when the intervention is cost intensive. Information on the resource implications of interventions may be helpful in determining their long-term sustainability and cost effectiveness. Only one study provided data on the cost of the intervention (Andersson 2009). This study reported that community-based health education in Pakistan costs USD9.00 per child. The cost of interventions would depend on the context of the intervention, as the cost to vaccinate a child fully has been reported to vary between USD1 and USD40 in LMICs (Shea 2009). Therefore, the cost of interventions should be reviewed within the context and settings of the studies. As part of their systematic review on the effects of lay or community health workers in primary health care (Glenton 2011; Lewin 2010), Glenton and colleagues reviewed the costs and cost-effectiveness of vaccination programme interventions involving lay health workers (Corluka 2009). The authors found that studies did not adequately address affordability and sustainability and were also highly heterogeneous in terms of settings and outcomes, limiting their comparability. In addition, they found insufficient data to allow any conclusions to be drawn regarding the cost-effectiveness of lay health worker interventions to promote vaccination uptake. Studies focused largely on health outcomes and did illustrate to some extent how the institutional characteristics of communities, such as governance and sources of financial support, influence sustainability (Corluka 2009). Considering that the interventions assessed in this review were set up as parallel programmes, rather than being integrated into routine services, it is unclear how effective they will be if integrated with other services within the system, with the typical levels of human and other resources available. This calls for cost-effectiveness evaluations of these interventions, particularly as integrated rather than stand-alone programmes (Dicko 2011; Okwo-Bele 2012). Such evaluations also have limitations as it can be difficult to translate these findings from one setting to another. Therefore, there is need for study authors to provide the details of the required resources to implement the intervention.

Many immunisation programmes in LMICs are delivered as mass immunisation on set 'immunisation days', following mass immunisation campaigns (Balraj 1986; Bandyopadhyay 1996; Berry 1991; Cutts 1990; Gomber 1996; Kumar 1990; Lin 1971; Linkins 1995; Shaikh 2003). None of the reports of this commonly used strategy met the criteria for inclusion in our review or for the Saeterdal 2014 Cochrane review on interventions aimed at communities to inform and/or educate on early childhood vaccination. Shea 2009 has noted that it may be difficult to randomise mass media interventions. However, ITS designs could be used to assess the effects of these mass immunisation campaigns on immunisation coverage (Nglazi 2014).

### Quality of the evidence

This review included 14 studies, three had unclear risk of bias (Andersson 2009; Owais 2011; Pandey 2007), while all the others had high risk of bias. The main study limitations were non-concealment of allocation, no blinding, lack of protection against contamination, and extraneous sources of bias. The cluster RCTs were adjusted for cluster effects. Overall, the certainty of the evidence for most interventions was low. This implies that the currently available research provides some indication of the likely effect of the interventions. However, the likelihood is high that the true effect of the interventions will be substantially different.

### Potential biases in the review process

We minimised bias in the process of conducting and reporting the current review by adhering to standard Cochrane guidelines (Higgins 2011). However, access to studies from LMICs is limited to those studies published in indexed journals. There may be a need to identify non-indexed local journals and the grey literature in low-income countries, and to conduct handsearching of these sources. In addition, as noted by Machingaidze and colleagues, due to the broad nature of childhood immunisation (encompassing many different components) identifying a search strategy that includes all aspects of childhood immunisations is challenging (Machingaidze 2014). However, in one 2014 Cochrane review on community-aimed interventions to inform and educate about childhood vaccination, the authors did not identify additional studies to those included in this review (Saeterdal 2014).

### Agreements and disagreements with other studies or reviews

Several previous systematic reviews assessed the effectiveness of interventions for improving childhood immunisation coverage (Batt 2004; Bordley 2000; Giles 2014; Glenton 2011; Jacobson Vann 2005; Johri 2015b; Kaufman 2013; Kendrick 2000; Pegurri 2005; Ryman 2008), although very few of them included studies

from LMICs (Batt 2004; Glenton 2011; Pegurri 2005; Ryman 2008), and many were already out-of-date as the dates of the most recent searches for the reviews were pre-2005 (Batt 2004; Bordley 2000; Jacobson Vann 2005; Kendrick 2000; Pegurri 2005).

Measures of effect for participant reminders in this review tend to agree with a now out-of-date systematic review of interventions aimed at reminding people of their immunisation schedules (Jacobson Vann 2005). Home visits, participant reminders through a redesigned immunisation card, and health education improved the uptake of immunisation in this review. Similarly, telephone calls, sending of letters and postcards, and speaking to clients in person improved the coverage of childhood vaccines in the participant-reminder review (Jacobson Vann 2005).

We found low-certainty evidence that monetary incentives (in the form of vouchers, conditional, and unconditional cash transfers) may have little or no effect on uptake of vaccines. This differs from the findings of several related systematic reviews: one systematic review on the effect of conditional cash transfers on health outcomes and the use of health services reported an improvement in the use of health services but, similar to this review, reported mixed results for uptake of immunisation in children (Lagarde 2009a). Two older (and now out of date) reviews also reported on the effects of this intervention (Giuffrida 1997; Kane 2004). One more recent review on the topic included 16 studies from high-income countries on smoking cessation (10 studies), attendance for vaccination or screening (five studies), and physical activity (one study) (Giles 2014). It reported an increase in vaccination and screening attendance with monetary incentives. However, subgroup analysis showed that cash plus other motivational components was more effective than cash or vouchers alone. The differences between our review findings and those of this review may reflect differences across settings (high-income compared to low- and middle-income countries) or limitations of the studies included in our review. In addition, the Morris 2004 study findings were of low certainty because of high risk of bias.

Ryman and colleagues conducted a comprehensive search in 2005 to identify peer-reviewed and grey literature on strategies for improving childhood immunisation coverage in LMICs (Ryman 2008). They identified 25 studies that included an appropriate control group, and grouped the papers into four strategic approaches: bringing immunisation closer to communities (11 studies), using information dissemination to increase demand for vaccination (three studies), changing practices in fixed sites (four studies), and using innovative management practices (seven studies). The studies included RCTs, nRCTs, CBAs, and observational studies, and reported improvements in immunisation coverage of varying degrees. Unlike Ryman and colleagues, we excluded observational studies. We included CBAs if they had more than two units in both the intervention and control groups, in accordance with EPOC guidance (EPOC 2015a). Though the Ryman review identified studies that reported improvements in immunisation coverage, they noted that the indicators of success varied widely

making it impossible for the data to be merged in a meta-analysis (Ryman 2008). We also found that studies reported immunisation outcomes in a variety of ways, for example, proportion of children aged 12 to 23 months who had received measles, proportion of children aged 12 to 23 month who had received full course of DTP (Andersson 2009); probability of receiving at least one immunisation (excluding OPV), the presence of the BCG scar, the number of immunisations received, the probability of being fully immunised (Banerjee 2010); immunisation full coverage of children aged 12 to 23 months with three doses of DTP, BCG, and measles vaccines (Barham 2005); DTP3 coverage at the end of day 90 post-enrolment (Usman 2011), etc. However, our foreknowledge of childhood immunisation programmes guided our decisions regarding which outcomes were synonymous (and thus can be combined in a meta-analysis) and which are not.

In a related systematic review, Glenton and colleagues assessed the effects of lay or community health worker interventions on childhood immunisation coverage (Glenton 2011). They conducted the last search in 2009, and identified 12 studies; including 10 RCTs. Five of the studies were carried out in LMICs. In 10 studies, community health workers promoted childhood immunisation and in the remaining two studies, community health workers vaccinated children themselves. Most of the studies showed that the use of lay or community health workers to promote immunisation uptake probably increased the number of children who were fully immunised. Our findings on the effect of community-based health education and home visits were consistent with these findings.

Johri and colleagues reported a systematic review of “strategies to increase demand for vaccination are effective in increasing child vaccine coverage in low- and middle-income countries”. The authors concluded that, “demand-side interventions are effective in improving the uptake of childhood vaccines delivered through routine immunization services in low- and middle-income countries” (Johri 2015b).

Finally, our review is related to two other Cochrane reviews (Kaufman 2013; Saeterdal 2014); conducted under the auspices of the ‘Communicate to Vaccinate’ project (Lewin 2011). Kaufman 2013 assessed the effects of face-to-face interventions for informing or educating parents about early childhood vaccination on immunisation uptake and parental knowledge and Saeterdal 2014 reviewed interventions aimed at communities to inform or educate (or both) about early childhood vaccination. The two reviews included studies from any setting while this review focused on low LMICs. We included three of the studies (Bolam 1998; Usman 2009; Usman 2011) included in the Kaufman 2013 review in our review and two studies (Andersson 2009; Pandey 2007) from our review were included in the Saeterdal 2014 review. While the findings of this review were similar to the findings of the Saeterdal 2014 review (i.e. that these interventions probably increase immunisation coverage), they differed from the findings of Kaufman 2013 that reported little or no improvement in immunisation cov-

erage. This may be because Kaufman included studies from high-, middle-, and low-income countries.

## AUTHORS' CONCLUSIONS

### Implications for practice

Barriers to immunisation uptake are context related. For any intervention to be adopted in a setting it must be designed to meet the peculiar needs of the setting and in the magnitude that best addresses the needs. Studies included in this review tested general concepts that were not linked with identified needs or barriers in the study settings. In addition, the certainty of evidence of the included studies was mostly low. This infers that even within the same setting, the likelihood of the observed effect being substantially different is high. In one systematic review to identify determinants of vaccine hesitancy in different settings, including their context-specific causes, expression, and impact, [Larson 2014](#) reported that these factors could not be considered in isolation as there were multiple influences at play. Further, individual factors may have conflicting effects even in the same setting. For instance, low-income status was both a promoter and a barrier to vaccination in Nigeria. As a barrier it was linked with access and low education. Adopting interventions without considering other confounding factors may produce little or no effect, as this review demonstrated.

This review showed that evidence-based discussion that aims at knowledge translation to community members may be more effective than conventional health education strategies. However, it has been observed that interventions such as community meetings may be cost intensive and so should be adopted with caution ([Saeterdal 2014](#)). Health system interventions such as home visits and regular immunisation outreach sessions are likely to be useful for difficult-to-reach communities though there were no data to assess the cost of their implementation. Overall, the magnitude of effect of these interventions is small and sustainability over long periods is uncertain. Participant reminder interventions have consistently shown improvement in vaccination in this review from studies in low- and middle-income countries and in another review from high-income countries ([Jacobson Vann 2005](#)). Therefore, it may be possible to adapt this intervention to suit different settings. There is low-certainty evidence that monetary incentives have little or no effect on immunisation uptake. Another review suggested that such incentives may fail to improve coverage when other barriers to immunisation exist ([Lagarde 2009a](#)). The affordability and sustainability of incentives is uncertain in low- and middle-income countries, particularly when supported by external funds. Implementation, particularly in low- and middle-income countries, may, therefore, need to be accompanied by rigorous evaluation.

### Implications for research

Despite the vast investment of resources in improving vaccination coverage in low- and middle-income countries few studies, and only low- to moderate-certainty findings, are available to inform policy and decision making on vaccination in these settings. The certainty of the existing evidence implies that the likelihood is high that the true effect of the interventions will be substantially different. Therefore, this review suggests that more rigorous studies are required to evaluate:

1. participant reminder and recall interventions that are adaptable to low- and middle-income countries as this approach has been shown to be effective in high-income countries;
2. community-based health education strategies, including mass campaigns, as these interventions may be more effective than facility-based health education;
3. provider-oriented and multi-faceted interventions (e.g. reaching every district strategy) for improving childhood immunisation coverage in low- and middle-income countries;
4. regulation to make vaccination a requirement for school entry, and, therefore, increase vaccination coverage;
5. incentives for vaccination providers;
6. plans of action for immunisation coverage and disease reduction.

These studies may also need to include:

1. measures of sustainability such as integration into routine immunisation services, long-term impact of the interventions, and incidence of targeted diseases;
2. Cost-effectiveness of various interventions and resource use and unit costs for vaccination for different strategies.

These studies should be based on factors influencing vaccination uptake within specified context, identified from qualitative studies, to aid translatability to similar contextual settings. [Larson 2014](#) has identified the paucity of qualitative data as a setback to identifying how factors associated with vaccine hesitancy interact with one another.

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\* Indicates the major publication for the study

## CHARACTERISTICS OF STUDIES

### Characteristics of included studies [ordered by study ID]

#### Andersson 2009

Methods	Cluster RCT in Pakistan	
Participants	<p>Setting: Lasbela, 1 of the poorest districts in Balochistan Province in Pakistan</p> <p>Aim: authors hypothesised that if the community accessed information on the cost-benefits of immunisation, the uptake of vaccines would improve without requiring improvement in service delivery</p> <p>Participants: 180 community groups with each group having 8-10 participants, both male and female. Outcome measured in children aged 12-23 months; 911 children at pre-intervention and 956 at post-intervention</p>	
Interventions	<p><b>Intervention:</b> <i>evidence-based discussion on immunisation in 18 clusters:</i> trusted members of the committee were selected for a 3-phased discussion. 9 field teams (facilitators) had discussion with 180 community groups of 8-10 members each in 94 villages for the intervention group. 3 phases of discussion were held with the community groups. First phase the community groups discussed the situation of child immunisation in the union council, the smallest unit of the local government system. Facilitators discussed the risk of non-vaccination for measles with the community groups. Second phase, discussed cost-benefits of vaccination and treatment of measles. Third stage featured discussion on challenges of immunisation and identification of barriers and plans of action to increase access for immunisation services and means of spreading the discussion on vaccination</p> <p><b>Control:</b> usual care in 14 clusters</p>	
Outcomes	<p>Proportion of 12-23 month olds who had received measles vaccination</p> <p>Proportion of 12-23 month olds who had received full course of DPT</p>	
Duration of intervention	August 2006 to May 2007 (9 months)	
Notes	Follow-up after 1 year (baseline conducted in spring 2005; follow-up spring 2007)	
<b>Risk of bias</b>		
<b>Bias</b>	<b>Authors' judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	Random number generator allocated baseline communities to 18 intervention enumeration areas and 14 control enumeration areas
Allocation concealment (selection bias)	Low risk	Sequence concealed and intervention assigned centrally
Blinding (performance bias and detection bias) All outcomes	Low risk	Interviewers did not know which clusters had received the intervention, only the field co-ordinator knew

Andersson 2009 (Continued)

Incomplete outcome data (attrition bias) All outcomes	Low risk	Not applicable. Samples taken pre- and post-intervention
Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in the protocol
Other bias	High risk	“Although the facilitators discussed with participants their plans for disseminating the discussions within their communities, the intervention did not make special provision for the participants to ‘take back’ the discussion to others in the community, relying rather on endogenous networks for the information spill over.” In addition, use of mothers’ recall for immunisation uptake may under estimate vaccine coverage Unit of study was enumeration area, analysis done at participant level; no adjustment for cluster effect
Baseline outcome measurements similar?	Low risk	Yes
Baseline characteristics similar?	Low risk	Baseline characteristics similar except, “mothers willing to travel to vaccinate”, which was higher in the intervention than the control group
Adequate protection against contamination?	Unclear risk	Measure to prevent contamination not stated

Banerjee 2010

Methods	Cluster RCT in India
Participants	Setting: disadvantaged rural community in Udiapur, India with 2% immunisation coverage Aim: to test the effect of reliable supply of free immunisation services and incentive to improve vaccine demand in a resource-poor setting Participants: 1640 children aged 0-6 months at baseline or 1-3 years at the endpoint survey
Interventions	<b>Intervention A:</b> once monthly reliable immunisation camp without incentive (379 children from 30 villages at endpoint). Intervention focused on establishing regular availability of immunisation services. Consisted of a mobile immunisation team, including a nurse and assistant, who conducted monthly immunisation camps in the villages. Camp held on a fixed date every month at a fixed time (11 am to 2 pm). Presence of nurse and assistant verified by requirement of timed and dated pictures of them in the villages and by regular monitoring <b>Intervention B:</b> once monthly reliable immunisation camp with small incentives consisting of raw lentils and metal plates for completion of schedule (382 children from 30 villages at endpoint). Intervention used the same infrastructure as intervention A but in addition offered parents 1 kg of raw lentils per immunisation administered and a set of “thalis” (metal plates used for meals) on completion of a child’s full immunisation. Value of the lentils about USD1, equivalent to three-quarters of 1 day’s wage, and the value of

	the “thalis” about USD2 <b>Control:</b> no intervention (860 children in 74 villages at endpoint)	
Outcomes	Probability of receiving at least 1 immunisation (excluding OPV, which almost all children received) Presence of the BCG scar Number of immunisations received Probability of being fully immunised. A fully immunised child received all the vaccines in the EPI schedule (1 dose of BCG, 3 doses of DTP, 3 doses of OPV, and 1 dose of measles vaccine) by the age of 1 year	
Duration of intervention	18 months	
Notes	Study conducted in rural state of Rajasthan, India	
<b>Risk of bias</b>		
<b>Bias</b>	<b>Authors’ judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	“Using the random number generator in the statistical package Stata (version 9), and after stratification by geographical block (the administrative unit above the village), one author (ED) randomly selected 30 of the 134 study villages to receive intervention A and 30 to receive intervention B. The 74 remaining villages were control villages and received no additional intervention”
Allocation concealment (selection bias)	Low risk	“Within each village, a household census was conducted, and 30 households containing children aged 0-5 years were randomly selected with a random number generator to be part of the sample. The same households were surveyed again at the end point. The criterion for inclusion of a child in this study was to belong to a sampled household and to be aged 1-3 at the end point of the study (main sample) or to have been aged 0-6 months at baseline (baseline cohort)”
Blinding (performance bias and detection bias) All outcomes	Low risk	“The allocation of villages to treatment or control was not blind. .. Surveys were undertaken in randomly selected households at baseline and about 18 months after the interventions started (end point)... Interviewers did not know which villages belonged to which intervention (or control) group”
Incomplete outcome data (attrition bias) All outcomes	High risk	Households lost between baseline and endpoint: 16% (71/453) in intervention A group, 17% (72/481) in intervention B group, and 17% (210/1224) in control group; 17% (363/2158) overall
Selective reporting (reporting bias)	Unclear risk	Protocol not available
Other bias	Low risk	None



**Banerjee 2010** (Continued)

Baseline outcome measurements similar?	Low risk	Yes
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Low risk	“Villages from all three treatment groups were sufficiently far from each other (over 20 km) so we expected no contamination between the villages”

**Barham 2005**

Methods	Cluster RCT in Mexico
Participants	Setting: Nicaragua, Mexico with immunisation rate > 90% Participants: 506/50,000 eligible villages randomly chosen Intervention groups: selected from 320 communities Control group: selected from 186 communities Value of the transfers: USD25, adding 20-30% to the household income
Interventions	Intervention: 2 cash transfers every 2 months; 1 general and 1 depending on school attendance 1. nutrition component: food supplements for children aged 4-23 months, underweight children aged 2-4 years, and pregnant and lactating women in beneficiary households 2. health component: regular healthcare appointments in health centres for the whole family 3. education component Control: Usual care
Outcomes	Immunisation full coverage of children aged 12-23 months with 3 doses of DPT, BCG, and measles vaccines
Duration of intervention	12-35 months
Notes	The controls should originally have acted as controls for 2 years, but for political reasons intervention in control communities occurred in late 1999 so only 18 months of comparison was possible and the control communities were, therefore, considered as cross-over intervention communities after 1 year of observation

***Risk of bias***

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not stated
Allocation concealment (selection bias)	High risk	Not stated

**Barham 2005** (Continued)

Blinding (performance bias and detection bias) All outcomes	High risk	Study was not blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Not applicable
Selective reporting (reporting bias)	Unclear risk	Study protocol not seen
Other bias	Unclear risk	Not stated
Baseline outcome measurements similar?	High risk	Baseline level of vaccination rate lower in treatment group
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Unclear risk	Protection against contamination not stated.

**Bolam 1998**

Methods	RCT in Nepal
Participants	Setting: main maternity hospital in Kathmandu, Nepal Aim: tested the effectiveness of 1-to-1 health education with perinatal mothers in a hospital setting in Nepal on infant care and family planning Participants: 540 post-partum women
Interventions	<b>Intervention A:</b> 20 minute, 1-to-1 health education immediately after birth and 3 months later <b>Intervention B:</b> 20 minute, 1-to-1 health education at birth only <b>Intervention C:</b> 20 minute, 1-to-1 health education at 3 months only <b>Intervention D:</b> control (no individual health education)
Outcomes	Duration of exclusive breastfeeding Appropriate immunisation of infant Knowledge of oral rehydration solution and need to continue breastfeeding in diarrhoea Knowledge of infant signs suggesting pneumonia Uptake of postnatal family planning
Duration of intervention	20-minute, individual health education at birth and 3 months later. Outcomes assessed at 3 and 6 months
Notes	First education session conducted in quiet room before discharge from hospital. Second education session conducted in the mothers' home 3 months after delivery. Although the health education given at birth and 3 months covered broadly the same areas, more emphasis was placed on the importance of exclusive breastfeeding in the first session and on the need for family planning in the second session. Topics covered were infant feeding, treatment of diarrhoea, recognition of and response to symptoms suggesting acute

	respiratory infection in young infants, importance of immunisation, and importance of contraception after the puerperium. At the end of each session, health educator repeated the key messages covered and asked mother if she had any other questions	
<b>Risk of bias</b>		
<b>Bias</b>	<b>Authors' judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	"Restricted randomisation was used in blocks of 20, each block consisting of a random ordering of the numbers 019. Numbers 04, 59, 1014, and 1519 were assigned to groups A to D respectively"
Allocation concealment (selection bias)	Unclear risk	"Timing of assignment was when a mother was identified by the research team either in labour or shortly after delivery. The details of allocation to groups for consecutively recruited mothers were in sealed envelopes... The generator of the assignment was not involved in the execution of the allocation"
Blinding (performance bias and detection bias) All outcomes	Low risk	"The mothers recruited and the health educators were not blind to the assignment of mothers to different groups. The outcome assessors were always blind to the assignment at both the 3 and 6 month follow up visits. Staff who were involved in data collection at the 3 month follow up were not involved in data collection at 6 months. The data analysts were not blind to the coding of the groups"
Incomplete outcome data (attrition bias) All outcomes	High risk	Each of the 4 groups (A-D) had 135 women. At 6 months, percentage of women lost-to-follow-up was 29% in group A, 21% in B, 26% in C, and 24% in D
Selective reporting (reporting bias)	Unclear risk	Protocol not available
Other bias	Low risk	None
Baseline outcome measurements similar?	Low risk	Not applicable
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Low risk	Yes

**Brugha 1996**

Methods	Matched and cluster RCT in Ghana	
Participants	<p>Setting: urban settings in Ghana with regular immunisation services</p> <p>Aim: addressing low immunisation coverage in spite of developed immunisation infrastructure</p> <p>Participants: children aged 12-18 months. Included 200 mother-and-child pairs in the intervention group and 219 in the control group</p>	
Interventions	<p><b>Intervention:</b> <i>home visits in 30 clusters.</i> During home visits, interviewers (university students) administered questionnaires to mothers or female caregivers and fathers or male caregivers of children aged 12-18 months. Immunisations recorded from road-to-health card or clinic record (if card was missing) in a register. All respondents advised to bring identified children who had not completed immunisation schedule to the clinic for immunisation. A referral note was given to each child to bring to the clinic. Children who failed to complete immunisation were identified from the register and a maximum of 3 home visits made to each child within 6 months</p> <p><b>Control:</b> standard care in 30 clusters</p>	
Outcomes	<p>Completion of polio1, OPV3, and measles</p> <p>Completion of schedule</p>	
Duration of intervention	6 months	
Notes	6 months of follow-up	
<b><i>Risk of bias</i></b>		
<b>Bias</b>	<b>Authors' judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Unclear risk	"Contiguous clusters were paired, as far as possible within enumeration areas, and one of each pair of clusters was randomly chosen for the survey..."
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	High risk	Neither the provider nor the child was blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Lost to follow-up not accounted for
Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in protocol
Other bias	High risk	Children in registered and unregistered houses included in intervention group but only children in registered houses included in control group Analysis done at cluster level; also took matching

Brugha 1996 (Continued)

		into account at analysis
Baseline outcome measurements similar?	Low risk	Baseline immunisation coverage in the 2 groups were not statistically significant
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Unclear risk	Though “contiguous clusters were paired as far as possible within the enumeration area”, it was unclear if they were protected from contamination

Dicko 2011

Methods	Cluster RCT in Mali
Participants	Setting: Kolokani, a district in Mali hyperendemic for malaria and with immunisation level < 50% Participants: children aged 0-23 months
Interventions	<b>Intervention:</b> intermittent preventive treatment of malaria in infants (in 11 clusters), i. e. administration to infants of ½ tablet of sulphadoxine-pyrimethamine along with EPI vaccines (DTP2, DTP3 and measles/yellow fever vaccine). Communities leaders were sensitised and health staff were trained. Supports for child health interventions were modified to allow the recording of the administration of the sulphadoxine-pyrimethamine along with EPI vaccines and the health interventions <b>Control:</b> standard care in 11 clusters
Outcomes	Proportion of 9-23 months old children completely immunised with BCG, 3 doses of DTP, 1 dose of measles, and yellow fever vaccines
Duration of intervention	12 months
Notes	Study conducted from December 2006 to December 2007. Sample size for the baseline survey estimated using the following assumptions. Based on a precision of 6% and alpha error of 5% and DTP3 coverage of two-thirds (67%), a sample of 472 children was selected using a cluster effect of 2. This sample size was doubled to take into account analysis for specific age categories and increased by 10% to take into account missing information, making a total sample size of 1050 children aged 0-23 months

*Risk of bias*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Simple balloting. “The health areas were numbered from 1 to 22 and each number was written on piece of paper that was folded. The 22 pieces of paper were then mixed and placed in box and 11 of them were randomly drawn to serve as intervention areas by one of the trainees in presence of the representatives of the

		22 communities' health centres"
Allocation concealment (selection bias)	High risk	"The study was an open cluster-randomised trial... The health areas were numbered from 1 to 22 and each number was written on piece of paper that was folded. The 22 pieces of paper were then mixed and placed in box and 11 of them were randomly drawn to serve as intervention areas by one of the trainees in presence of the representatives of the 22 communities' health centres"
Blinding (performance bias and detection bias) All outcomes	High risk	Study was open cluster-randomised trial. 2 cross-sectional surveys (using the WHO method of evaluation of vaccine coverage) performed, 1 at baseline and 1 after 1 year of the intervention. Did not state whether the people conducting the survey were aware of the treatment allocations or not
Incomplete outcome data (attrition bias) All outcomes	Low risk	Not applicable; 2 independent samples taken pre- and post-intervention
Selective reporting (reporting bias)	Low risk	No selective reporting
Other bias	Low risk	None
Baseline outcome measurements similar?	High risk	No. Difference was statistically significant
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	High risk	Training of staff was carried out in both control and intervention communities, followed by public randomisation

### Djibuti 2009

Methods	Cluster RCT in Georgia
Participants	Setting: low immunisation coverage despite healthcare reforms. Human resource management was weak with lack of knowledge and skills in management and supervision especially at the peripheral levels Participants: district immunisation managers, PHC providers. Number of health workers studied was 392 at pre-intervention and 521 at post-intervention. Apart from outcome measures from PHC workers, data were obtained on children's immunisation
Interventions	<b>Intervention:</b> <i>development of supportive supervision guidelines for district immunisation managers in 15 clusters:</i> intervention consisted of development of supportive supervision guidelines and tools for district managers, training in continuous supportive supervision, monitoring, and evaluation of performance. Each district manager visited subordinated health facility at least once a month. On-the-job training was provided for immunisation managers to improve on supervision practices to help providers solve problems encountered in immunisation <b>Control:</b> no intervention in 15 control clusters

Djibuti 2009 (Continued)

Outcomes	DTP3, polio 3, and HBV3 coverage Difference in proportion of coverage from baseline	
Duration of intervention	12 months	
Notes	Follow-up study conducted after 1 year of intervention	
<b><i>Risk of bias</i></b>		
<b>Bias</b>	<b>Authors' judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	"Stratified cluster randomisation was used to select the 30 cluster units out of the nation's 67 districts and allocate them into the two study groups (intervention and control), yielding two allocation sequences of 15 clusters each"
Allocation concealment (selection bias)	Unclear risk	"Given that immunization managers supervise health workers only within their districts, and similarly health workers provide immunization services to target population residing in communities within the same district, the risk of contamination of the control group with the intervention is negligible. Use of smaller units (e.g. village) would have posed a higher risk of contamination of intervention activities in control clusters"
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	Not applicable; 2 independent samples taken pre- and post-intervention
Selective reporting (reporting bias)	Unclear risk	Unclear if all the outcomes stated in the protocol were reported on
Other bias	High risk	During the course of intervention, the country improved healthcare financing for low-income people and there was also improved country level economic growth thus improving access to health care. "It is possible that improved access to health care may have contributed to improved immunization coverage in Georgia" Unit of study was district, but unit of analysis was participant. No adjustment for clustering effect
Baseline outcome measurements similar?	Low risk	Yes
Baseline characteristics similar?	Low risk	Demographic and employment characteristics were similar among Center of Public Health staff respondents in the intervention and control groups, both at baseline and follow-

Djibuti 2009 (Continued)

		up except mean years of experience, which was more among the control group
Adequate protection against contamination?	Unclear risk	Protection against contamination unclear

Maluccio 2004

Methods	Cluster RCT conducted in Nicaragua (Red de proteccion social)
Participants	<p>Setting: part of a social safety net programme targeted at poor households living in rural areas, but the pilot phase analysed in this study occurred in 2 departments (Madriz and Matagalpa) in the Northern part of the Central Region. This region is the only one in the country where poverty worsened during 1998 and 2001</p> <p>These pilot sites were not representative of the country situation: within the 2 chosen departments, 6 municipalities were chosen (out of 20) because they had benefited from a previous programme that developed the capacity of the governing bodies to implement and monitor social projects: "it is possible that the selected municipalities had atypical capacities to run RPS" in the chosen municipalities, 78-90% of the population was extremely poor/poor, compared to 21-45% at national level. 42 eligible areas (the neediest) were chosen for the pilot programme based on wealth index</p> <p>Private providers were specifically trained to deliver the specific healthcare services required by the programme. Incentives were also given to teachers to compensate for the larger classes they had after the implementation of the programme. 10% of beneficiaries were penalised at least once during the first 2 years of the programme; 5% were expelled or left the programme. Some conditions (adequate weight gain) were dropped at the end of the pilot phase and others were not properly enforced (up-to-date vaccination while there were delays in the delivery of vaccines)</p> <p>Delays occurred in the implementation of the health component, which finally started in June 2001. Therefore, when the first follow-up survey was realised in October 2001, the beneficiaries had been receiving the transfers for the education component for 13 months and those for the health and nutrition component for 5 months only</p> <p>Participants: All households except 169 (2.9% of households that lived in the intervention area) that owned either a vehicle (truck, pickup truck, or jeep) or land &gt;14.1 hectares or both</p>
Interventions	<p><b>INTERVENTION:</b> in 21 clusters</p> <p>Programme had 2 components:</p> <ol style="list-style-type: none"> <li>1. monthly "food security" cash transfer ("bono alimentario" = USD224 per year = 13% of total amount of household expenditures in beneficiary households before the programme) conditional on attendance at monthly health educational workshops, on bringing their children under age 5 years for free scheduled preventive childcare appointments (which included the provision of anti-parasitic medication, and vitamins and iron supplements), on having up-to-date vaccination, and on adequate weight gain.</li> <li>2. A "school attendance" cash transfer every 2 months (USD112 per year = 8% of total amount of household expenditures in beneficiary households), contingent on enrolment and regular school attendance of children aged 7-13 years. In addition, household received an annual cash transfer per eligible child for school supplies</li> </ol> <p>Beneficiaries did not receive the food or education cash transfers if they failed to comply</p>



**Maluccio 2004** (Continued)

	with any of the conditions <b>CONTROL:</b> no intervention in the 21 control clusters
Outcomes	Immunisation coverage: reported up-to-date vaccination schedule (children aged 12-23 months) Health services uptake: attendance of preventive care visits by children Anthropometric or nutritional outcomes: prevalence of stunting, wasting, and underweight (children aged < 5 years) Height for age Z-score (children aged < 5 years) Prevalence of anaemia
Duration of intervention	5 years
Notes	The “Red de Proteccion Social” project was financed by a loan from the Inter-American Development Bank. The impact analysis of the pilot phase was done by the International Food Policy Research Institute Possible detection of the “Hawthorne effect” since performance of the programme was slightly lower the second year Over the 2 years, the actual mean monetary transfer to households represented 18% of total household expenditure (similar to PROGRESA but 5 times larger than Programa de Asignación Familiar). The nominal transfers remained constant during the 2 years of the programme, thus the real value of the transfer declined by 8% due to inflation

**Risk of bias**

<b>Bias</b>	<b>Authors’ judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	“Random selection by balloting within each stratum, randomisation was achieved by blindly drawing one of six coloured balls (three blue for intervention, three white for control) from a box after the name of each comarca [region] was called out”
Allocation concealment (selection bias)	High risk	Randomisation not concealed
Blinding (performance bias and detection bias) All outcomes	High risk	Study not blinded
Incomplete outcome data (attrition bias) All outcomes	High risk	Reasons for attrition not given
Selective reporting (reporting bias)	Unclear risk	Unclear if all outcomes stated in the protocol were reported on
Other bias	High risk	“In October 2001, then, beneficiaries had been receiving transfers, and the educational components of the program had

**Maluccio 2004** (Continued)

		<p>been monitored for 13 months, but they had only received five months of the health and nutrition services, including the health education workshops”</p> <p>“It is important to emphasize that for most of the indicators considered, the control group also showed large improvements over the period, although on a much smaller scale. A possible explanation for this increase is that other providers are bringing health services into the areas not covered by the program (program providers do not offer or deliver any services to non-beneficiaries)”</p>
Baseline outcome measurements similar?	Unclear risk	Baseline number of children aged 12-23 months with updated immunisation similar between baseline and control
Baseline characteristics similar?	Unclear risk	Baseline characteristics on the intervention and control groups not stated. Author reported “few significant difference between households (or individuals) in intervention and control groups at baseline” but was unclear if the difference were related to outcomes of the review
Adequate protection against contamination?	High risk	“Control and intervention comarcas [regions] are at times adjacent to one another. A household may be a beneficiary while its neighbour is a nonbeneficiary, particularly in a few cases where boundaries such as roads divide two comarcas. Seeing the activity and the emphasis placed on the RPS objectives may lead non-beneficiaries to undertake behavior they would not have otherwise. Reasons for such actions could be many - including the possibility that the individuals thought this was a way to become eligible”

**Morris 2004**

Methods	Cluster RCT in Honduras
Participants	<p>Participants: households in 70 clusters including pregnant women, new mothers, and children aged &lt; 3 years. Outcome on immunisation was measured in 4359 children at pre-intervention and 3876 at post-intervention</p> <p>Aim: to drive demand, poor households benefited from cash transfer on the condition</p>

	that they keep up-to-date with preventive healthcare services	
Interventions	<p><b>Intervention A:</b> <i>household monetary incentive in 20 clusters:</i> consisted of distribution of vouchers worth GBP2.53 to mothers who were registered in 2000 census who were either pregnant or had a child &lt; 3 years of age to a maximum of 2 children. In addition, mothers with children aged 6-12 years enrolled in primary schools in grade 1-4 given vouchers worth GBP3.69 per month. Beneficiaries lost aid if they were not up-to-date with routine antenatal care, and well-child preventive health care and if child did not attend school regularly</p> <p><b>Intervention B:</b> <i>service-level monetary incentive in 10 clusters:</i> quality assurance teams set up at each health centre and trained on basic quality assurance methods. They developed work plans that included minor structural repairs; purchase of equipment, materials, and essential drugs; and money to pay lay assistants. Package included promotion of community-based nutrition programme for children aged &lt; 2 years</p> <p><b>Intervention C:</b> combination of household and service-level monetary incentives (i.e. Interventions A + B) in 20 clusters</p> <p><b>Control:</b> standard (routine) care in 20 clusters</p>	
Outcomes	<p>Proportion of pregnant women immunised against tetanus</p> <p>Proportion of children aged 93 days to 3 years who received first dose of DTP or pentavalent vaccine (diphtheria, tetanus, pertussis, Haemophilus influenzae type B, hepatitis B) at 42-92 days of age</p> <p>Proportion of children aged 1 year old immunised against measles</p>	
Duration of intervention	1 year	
Notes	2 years of follow up.	
<b>Risk of bias</b>		
<b>Bias</b>	<b>Authors' judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	Children made to pick coloured balls from a box where aperture would not allow the children to see the ballot balls
Allocation concealment (selection bias)	High risk	"From the day of the randomisation onwards, there was no attempt to conceal the allocation, but it was not possible for a household to become eligible for the vouchers by moving into a beneficiary municipality. On the other hand, it was not possible to restrict usage of 'improved' health services to residents of the appropriate municipality"
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Unclear
Incomplete outcome data (attrition bias) All outcomes	Low risk	"Loss to follow up did not exceed 5%"

**Morris 2004** (Continued)

Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in the protocol
Other bias	High risk	Service package could not be provided according to the protocol and training on quality assurance was limited to only the introduction. Disbursement of funds for this was only 17% of the budget Unit of randomisation was municipalities. Analysis not adjusted for cluster effect
Baseline outcome measurements similar?	High risk	The coverage of DTP1 vaccine in the group receiving intervention C (intervention A + B) was lower than the other 3 groups
Baseline characteristics similar?	Low risk	Demographic and socioeconomic data of the 4 groups similar
Adequate protection against contamination?	High risk	It was possible for participants from other arms of study to attend services at improved centres. 14% of children aged < 3 years attended clinics in municipalities other than their municipality of residence 1 month prior to post-intervention survey

**Owais 2011**

Methods	RCT in Pakistan
Participants	Setting: urban and semi-urban communities with low literacy and low immunisation coverage Participants: 364 mother-infant pairs, with infants aged ≤ 6 weeks. Excluded twin births, infants > 6 weeks of age, or infants born to mothers living outside the study surveillance areas. Cut-off of 6 weeks used to ensure that the intervention was implemented before the first dose of DTP/hepatitis B became due
Interventions	<b>Intervention:</b> 3 targeted pictorial messages regarding vaccines administered by trained CHWs. First key message highlighted how vaccines save children's lives. Second message provided logistic information about the address and location of the local vaccination centres. Third key message emphasised the significance of retaining immunisation cards, and role they could play at the time of the child's school admissions. Copy of these pictorial messages was left with the mother. Messages took about 5 minutes to impart <b>Control:</b> verbal general health promotion messages delivered by trained CHWs. Messages included information on hand washing, breastfeeding, clean water, benefits of using oral rehydration solutions during diarrhoea, bringing the infant to nearby health centre when there were symptoms of acute respiratory illnesses, importance of antenatal check-ups for mothers, and some general information on vaccines. Length of each educational session was approximately 10-15 minutes
Outcomes	DTP/hepatitis B vaccine completion (3 doses) at 4 months after enrolment (4-5 months of infant's age)

Duration of intervention	4 months
Notes	Community-based study conducted at 5 low-income sites in Karachi, Pakistan. Participants were enrolled from August 2008 to November 2008 and followed up for assessment of outcome from December 2008 to March 2009, with each individual mother-infant pair approached 4 months after the educational intervention session

**Risk of bias**

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"Randomization lists, stratified for each of the five enrolment sites were generated by a computer and provided to the CHWs. Upon consent, mother-infant pairs were assigned either to intervention or control arms through block randomisation (n = 4), according to the computer-generated list"
Allocation concealment (selection bias)	Unclear risk	Not described
Blinding (performance bias and detection bias) All outcomes	Low risk	"As the intervention was educational, blinding of study staff and participants was not possible... Outcome assessment was done by an investigator ... blinded to the exposure status of participants"
Incomplete outcome data (attrition bias) All outcomes	Low risk	Outcome data not available for 2% (4/183) in the intervention group (0 deaths) and 3% (5/183) in the control group (3 deaths)
Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in the protocol
Other bias	Low risk	None
Baseline outcome measurements similar?	Low risk	Yes
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Low risk	Yes

**Pandey 2007**

Methods	Cluster RCT in India
Participants	Setting: community-based trial Aim: tested the hypothesis that informing the community will enhance accountability of the health workers towards quantity and quality of services rendered. Resource poor rural populations were informed about entitled services Participants: households with at least 1 child going to public primary school in the village. Immunisation coverage targeted children aged 0-35 months. 1025 children included

Interventions	<b>Intervention:</b> <i>information campaign in 11 clusters</i> ; 2 rounds of information campaigns consisting of 2 or 3 meetings and distribution of posters and leaflets. 15-minute audiotaped message played twice at each meeting and 15 minutes given for questions. To ensure uniformity only questions for which answers were written in the leaflet were responded to <b>Control:</b> no intervention in 10 control clusters	
Outcomes	Received tetanus vaccination Received at least 1 vaccine	
Duration of intervention	Each of the 2 rounds of meetings lasted for 1 hour and each round was separated by 2 weeks	
Notes	Post-intervention data collected 12 months after	
<b>Risk of bias</b>		
<b>Bias</b>	<b>Authors' judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	Randomly generated numbers
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	Low risk	Research assistants at post-intervention had no knowledge of the intervention
Incomplete outcome data (attrition bias) All outcomes	Low risk	2.4% loss to follow-up
Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in the protocol
Other bias	High risk	Proportion at campaign meetings 11-14% and long recall period Unit of study was village; unit of analysis was household. No adjustment for clustering effect
Baseline outcome measurements similar?	Low risk	Difference between proportion of children immunised at baseline in the 2 groups was not statistically significant
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Unclear risk	"By randomly selecting only 5 village clusters of about 1000 in each district, we spread the selection of 105 village clusters over 21 districts to minimize any potential for contamination"

Methods	Matched, cluster RCT in 10 sites in Manicaland, Zimbabwe
Participants	<p>Aim: tested effect of conditional and unconditional cash transfer among poor and vulnerable populations in Zimbabwe</p> <p>Setting and participants: “We ranked households according to their index score and then divided them into quintiles in each study site, thus identifying the poorest 20% of households in each site... Eligible households contained children younger than 18 years and satisfied at least one other criteria: head of household was younger than 18 years; household cared for at least one orphan younger than 18 years, a disabled person, or an individual who was chronically ill; or household was in poorest wealth quintile</p> <p>Households within the clusters were eligible for inclusion in the trial when they contained children younger than 18 years and satisfied at least one other criteria at baseline: the head of the household was younger than 18 years; the household cared for at least one orphan (a child younger than 18 years with one or more deceased parents), disabled person, or an individual who was chronically ill; or the household was in the poorest wealth quintile. Households in the richest wealth quintile and those already receiving cash transfers for orphans and vulnerable children were not eligible</p> <p>We did a baseline survey of all households in the trial clusters between July, and September, 2009. We counted how many members made up each household and obtained information about trial endpoints and eligibility and exclusion criteria, including household asset data. We constructed a wealth index with a simple sum of reported household assets (appendix). We ranked households according to their index score and then divided them into quintiles in each study site, thus identifying the poorest 20% of households in each site. We obtained informed consent from the most senior member of the household available at time of interview”</p>
Interventions	<p><b>Intervention:</b> unconditional cash transfers in 1525 households, conditional cash transfers in 1319 households</p> <p>“Every household enrolled in the UCT [unconditional cash transfer] programme collected US\$ [USD] 18 plus \$4 per child in the household (up to a maximum of three children) from designated pay points every 2 months</p> <p>Households in the CCT [conditional cash transfer] group could receive the same amount, but were monitored for compliance with several conditions: an application for a birth certificate had to be made within 3 months for all children younger than 18 years (including newborn babies) whose births had not been registered; children younger than 5 years had to be up-to-date with vaccinations and attend growth monitoring clinics twice a year; children aged 6-17 years had to attend school at least 90% of the time per month; and a representative from every household had to attend two-thirds of local parenting skills classes. Compliance cards were issued to CCT households and were signed by service providers when beneficiaries accessed services. The signed cards were brought to the pay points every 2 months, along with other documents such as birth certificates, child health cards, and receipts for the payment of school fees. Community committees were familiar with most people living in the trial clusters. If a household provided a good reason for not meeting conditions (e.g. a child missing school because of illness), it was verified by the committee and judged on a case-by-case basis”</p> <p><b>Control:</b> no intervention in 1199 households</p>
Outcomes	<p>3 domains of child well-being (identity, health, and education)</p> <p>Proportion of children aged &lt; 5 years with a birth certificate</p> <p>Proportion of children aged &lt; 5 years with up-to-date vaccinations (measles, BCG, polio,</p>

	and DTP) Proportion of children aged 6-12 years attending school at least 80% of the time in the previous month	
Duration of intervention	13 months	
Notes	<p>“After the baseline survey, clusters were randomly assigned to UCT [unconditional cash transfer], CCT [conditional cash transfer], or control at public meetings that any community members could attend. In each site, one cluster was assigned to UCT, one to CCT, and one to control. Allocation was done by the drawing of lots from a hat. Participating households and individuals delivering the intervention were not masked to cluster assignment</p> <p>At follow-up, research assistants were not told the allocation of the household they were interviewing, but questions were included at the end of the questionnaire about whether households received transfers. LR was masked when doing the primary analysis”</p>	
<b><i>Risk of bias</i></b>		
<b>Bias</b>	<b>Authors’ judgement</b>	<b>Support for judgement</b>
Random sequence generation (selection bias)	Low risk	Randomisation through balloting
Allocation concealment (selection bias)	High risk	Randomisation not concealed
Blinding (performance bias and detection bias) All outcomes	Low risk	Study was single blinded. “LR was masked while doing the primary analysis”
Incomplete outcome data (attrition bias) All outcomes	Low risk	Lost to follow-up accounted for and analysis was by intention to treat
Selective reporting (reporting bias)	Unclear risk	Study protocol not available
Other bias	Unclear risk	2 villages randomised into the control group were mistakenly enrolled in the unconditional cash transfer group. Duration of study was shortened from 24 to 13 months due to lack of funds
Baseline outcome measurements similar?	Low risk	Yes
Baseline characteristics similar?	High risk	Some characteristics were dissimilar
Adequate protection against contamination?	High risk	Almost one-third of those for UCT reported having to comply with conditions



Usman 2009

Methods	RCT in Pakistan
Participants	Setting: reminder intervention in an urban setting in Pakistan to reduce drop-out rate in DTP3 Participants: 375 mothers visiting the EPI centre in each of 4 arms of study with 1125 children registering for DTP1 immunisation and residing in the study area for the past 6 months
Interventions	<b>Intervention A:</b> redesigned (“reminder-type”) immunisation card; a larger card (15.5 cm by 11.5 cm when folded) that had only the date and day of next immunisation on both sides of the outer card printed with Microsoft Word font size 42 was designed as a reminder for mothers/carers for immunisation. Inner side of the card contained information about the child’s complete immunization schedule dates and instructions for the mother/carer. For those in the arm for redesigned card, the date and day for each DTP vaccination was written on the outer side of the card; dates of previous vaccinations were crossed out to avoid confusion. Mother was advised to place the card at a frequently visible place at home and to bring it to the clinic during immunisation visits <b>Intervention B:</b> centre-base education; clinic-based education that lasted 2-3 minutes given to mothers at enrolment of their children in the EPI centre. The health education emphasised the importance of immunisation schedule completion <b>Intervention C:</b> intervention 1 + 2 <b>Control:</b> standard care
Outcomes	Number of enrolled children with DTP3 completed within 90 days of duration of study
Duration of intervention	2-3 minutes per session; follow-up for 90 days
Notes	Urban Pakistan

*Risk of bias*

Bias	Authors’ judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Allocation sequence was by computer-generated randomisation list
Allocation concealment (selection bias)	Unclear risk	Unclear whether allocation was concealed
Blinding (performance bias and detection bias) All outcomes	High risk	Neither the participant nor the assessor was blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss to follow-up
Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in the protocol
Other bias	Low risk	No other bias detected
Baseline outcome measurements similar?	Low risk	Not applicable

Usman 2009 (Continued)

Baseline characteristics similar?	High risk	Most of the socioeconomic variables were similar but ownership of a television was more among group receiving education and a higher proportion of those receiving standard care lived close to the facility than those in the redesigned card group
Adequate protection against contamination?	Unclear risk	Unclear

Usman 2011

Methods	RCT in Pakistan
Participants	<p>Setting: rural setting in Pakistan</p> <p>Aim: to test theory that reminder intervention can reduce drop-out rate for DTP3 vaccination</p> <p>Participants: 1508 mother-child pair visiting selected EPI centres for DTP1 who were resident in study area for at least 6 months. Criterion used to exclude 2 groups of temporary residents: women who temporarily relocated to their mothers' houses to deliver their children and internally displaced families who had migrated to the study area to avoid the aftermath of 2005 earthquake in the north of Pakistan</p>
Interventions	<p><b>Intervention A:</b> redesigned ("reminder-type") immunisation card; a larger card than the existing EPI card (15.5 cm by 11.5 cm when folded), placed in a plastic jacket and provided with a hanging string. A "trained interviewer pasted the upcoming date and day of DTP2 immunization on both outer sides of the card and showed it to the mother. Mother was asked to hang the card in her home at a frequently visible place and requested that she bring the card along on her next immunization visit to the EPI centre. At DTP2 visit, the interviewer crossed out the date and day for DTP2 visit to avoid any confusion to the mothers, pasted the date and day for the upcoming DTP3 immunization visit on both sides of the card and showed the information to the mother." The inner side of the card contained information about the child's complete immunisation schedule dates and instructions for the mother</p> <p><b>Intervention B:</b> centre-base education; 2- to 3-minute conversation between trained study interviewer and mother to convey the importance of completing the immunisation schedule and the potential adverse impact of incomplete immunisation on the child's health. Session was in simple vocabulary in the local language and deliberately kept short in prevision of potential large-scale use by EPI staff in the future</p> <p><b>Intervention C:</b> combination of redesigned card and centre-based education</p> <p><b>Control:</b> standard care i.e. routine EPI centre visit and neither intervention</p>
Outcomes	DTP3 coverage at the end of day 90 post-enrolment.
Duration of intervention	2-3 minutes per session; follow-up at 90 days
Notes	Rural areas around Karachi, Pakistan. Despite a small purchase volume, the cost of each card including the plastic jacket was USD0.05

*Risk of bias*

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	"The lead investigator provided a computer-generated randomisation list to each enrolment centre"
Allocation concealment (selection bias)	Unclear risk	"Each enrolled mother-child pair received an identification number (ID) from the randomisation list and was assigned to the study group corresponding to the ID on the list"
Blinding (performance bias and detection bias) All outcomes	High risk	"Because of the overt nature of interventions, neither the study participants nor the interviewers enrolling the study participants and recording the study outcome were blinded to the type of intervention received by the study participants"
Incomplete outcome data (attrition bias) All outcomes	Low risk	No loss to follow-up
Selective reporting (reporting bias)	Unclear risk	Unclear what outcomes were stated in the protocol
Other bias	Low risk	No other bias detected
Baseline outcome measurements similar?	Low risk	Not applicable
Baseline characteristics similar?	Low risk	Yes
Adequate protection against contamination?	Low risk	"Interventions were provided in a private space to prevent contamination between study groups"

BCG: Bacille Calmette-Guérin; CHW: community health worker; DTP: diphtheria-tetanus-pertussis; EPI: Expanded Programme on Immunization; HBV3: three doses of hepatitis B virus; OPV: oral polio vaccine; PHC: primary healthcare; RCT: randomised controlled trial; WHO: World Health Organization.

### Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
Abdul Rahman 2013	A controlled before-and-after study with single unit for intervention and control arms
al Teheavy 1992	Retrospective study
Alto 1989	Observational study
Aneni 2013	Observational study

(Continued)

Anjum 2004	A controlled before-and-after study with single unit for intervention and control arms
Attanasio 2005	No relevant data on outcome
Balraj 1986	Programme evaluation
Bandyopadhyay 1996	Observational study
Barham 2009	Programme evaluation
Bazos 2015	No relevant data on outcome
Berhane 1993	No relevant outcome. Reports on drop-out rate
Berman 1991	Observational study
Berry 1991	Observational study
Bishai 2002	No relevant data on outcome
Chandir 2010	Observational study
Chen 1976	Retrospective study
Chen 1989	Observational study
Cutts 1990	Observational study
Cutts 1994	Observational study
Dammann 1990	Observational study
Dini 1995	No relevant data on outcome
Dominguez Ugá 1988	Observational study
Ekunwe 1984	Observational study
Gomber 1996	Observational study
Hayford 2014	Observational study
Hong 2005	Observational study
Hu 2015	A controlled before-and-after study with single unit for intervention and control arms
Igarashi 2010	A controlled before-and-after study with single unit for intervention and control arms

(Continued)

Kaewkungwal 2015	Observational study
Kuhn 1990	Observational study
Kumar 1990	Observational study
Lechtig 1981	A controlled before-and-after study with single unit for intervention and control arms
Lin 1971	Observational study
Linkins 1995	Observational study
Maher 1993	Observational study
Main 2001	Observational study
Marshall 2007	Retrospective study
Ndiritu 2006	Observational study
Osinka 2000	Observational study
Pan 1999	Observational study
Pierce 1996	A controlled before-and-after study with single unit for intervention and control arms
Prinja 2010	A controlled before-and-after study with single unit for intervention and control arms
Przewlocka 2000	Observational study
Robinson 2001	Observational study
Ryman 2011	Data not summarised by the study groups
San Sebastian 2001	Observational study
Shaikh 2003	Observational study
Sutanto 1999	Observational study
Uddin 2010	A controlled before-and-after study with single unit for intervention and control arms
Uddin 2012	Study had no control arm
Uskun 2008	Observational study

(Continued)

van Zwanenberg 1988	Observational study
Wang 2007	No relevant outcome for the review
Zimicki 1994	Observational study

### Characteristics of studies awaiting assessment [ordered by study ID]

#### Ali 2015

Methods	A quasi-experimental study in rural Pakistan
Participants	Household heads
Interventions	Community service in intervention clusters (government Basic Health unit) versus standard care in control clusters
Outcomes	Knowledge and practices regarding routine immunisation, Fully vaccinated children, partially vaccinated children, un-vaccinated children
Notes	

#### Bangure 2015

Methods	Randomised controlled trial in Kadoma City, Zimbabwe
Participants	Women at delivery
Interventions	SMS reminders versus standard care
Outcomes	Immunisation coverage, timely vaccinations
Notes	

#### Basinga 2011

Methods	Cluster RCT in Rwanda
Participants	Healthcare providers
Interventions	Performance-based payment of healthcare providers (payment for performance; P4P) versus traditional input-based funding
Outcomes	Immunisation, prenatal care visits and institutional deliveries, quality of prenatal care, and child preventive care visits

**Basinga 2011** (Continued)

Notes	
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**Briere 2012**

Methods	controlled before-after study in rural Kenya
Participants	Caregivers of children aged 2-13 months
Interventions	Free hygiene kits and education about water treatment and hand hygiene
Outcomes	Fully vaccinated children
Notes	

**Brown 2016**

Methods	Cluster RCT in Ibadan, Nigeria
Participants	Children aged 0-12 weeks
Interventions	Mobile phone reminders and recall <i>versus</i> Primary Health Care immunisation providers' training <i>versus</i> combined Mobile phone reminders and recall <i>versus</i> Primary Health Care immunisation providers' training <i>versus</i> standard care
Outcomes	Children fully vaccinated at 12 months of age
Notes	

**Busso 2015**

Methods	A field experiment in rural Guatemala
Participants	Families whose children were due for a vaccine
Interventions	Personal reminders versus standard care
Outcomes	Fully vaccinated children
Notes	

**Domek 2016**

Methods	RCT in Guatemala City
Participants	Caregivers of infants aged 8-14 weeks presenting for first dose of primary immunisation series
Interventions	Mobile phone short message service versus standard care
Outcomes	Fully vaccinated infants
Notes	

**Gokcay 1993**

Methods	Random allocation of paraprofessionals and Midwives to “visiting area” in Istanbul, Turkey
Participants	Midwives and lady home visitors (paraprofessionals) and children aged < 5 years
Interventions	Use of lay home visitors vs. midwives for home visit
Outcomes	Infants fully vaccinated, children aged < 5 fully vaccinated
Notes	

**Haji 2016**

Methods	Random allocation of three facilities in three districts in Kenya to two interventions and control
Participants	children less than 12 months
Interventions	Reminder text message vs reminder sticker
Outcomes	Receipt of DTP 2 and DTP 3 at 10 and 14 weeks; dropout rate
Notes	

**Johri 2015a**

Methods	Cluster RCT in rural Uttar Pradesh, India
Participants	Mothers of children 0-23 months of age were eligible
Interventions	Home visits by volunteers plus community mobilisation to promote immunisation <i>versus</i> community mobilisation to promote nutrition
Outcomes	Primary outcomes were feasibility of recruitment, randomisation and retention of participants
Notes	



**Linkins 1994**

Methods	Randomised controlled trial
Participants	Children aged < 2 years, had telephone numbers listed in pre-existing computerised database, and were due or late for immunisation(s) during the 4-month enrolment period
Interventions	Household of children were randomised to receive or not receive a general or vaccine-specific computer generated telephone reminder message 1 day before the child was due, or immediately after randomisation if the child was late
Outcomes	The rate of immunisation visits in the 30-day follow-up period
Notes	

**Uddin 2016**

Methods	Non randomised trial in urban and rural Bangladesh
Participants	Families of children in need of vaccination
Interventions	Mobile phone short message service <i>versus</i> standard care
Outcomes	Fully vaccinated children
Notes	

## DATA AND ANALYSES

### Comparison 1. Health education

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Measles vaccine	1		Risk Ratio (Random, 95% CI)	Totals not selected
2 DTP3	5		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 Community-based education	2		Risk Ratio (Random, 95% CI)	1.68 [1.09, 2.59]
2.2 Facility-based education	3		Risk Ratio (Random, 95% CI)	1.20 [0.97, 1.48]
3 Received at least 1 vaccine	1		Risk Ratio (Random, 95% CI)	Totals not selected

### Comparison 2. Health education plus redesigned reminder card

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 DTP3	2		Risk Ratio (Random, 95% CI)	1.50 [1.21, 1.87]

### Comparison 3. Household monetary incentive

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Measles	1		Risk Ratio (Random, 95% CI)	Totals not selected
2 Fully immunised children	2		Risk Ratio (Random, 95% CI)	1.05 [0.90, 1.23]
3 BCG	1		Risk Ratio (Random, 95% CI)	Totals not selected
4 MMR	1		Risk Ratio (Random, 95% CI)	Totals not selected
4.1 Household monetary incentive	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
4.2 Service-level monetary incentive	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
4.3 Household + service-level monetary incentive	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
5 DTP1	1		Risk Ratio (Random, 95% CI)	Totals not selected
5.1 Household monetary incentive	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
5.2 Service-level monetary incentive	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]
5.3 Household + service-level monetary incentive	1		Risk Ratio (Random, 95% CI)	0.0 [0.0, 0.0]

#### Comparison 4. Home visit

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 OPV3	1		Risk Ratio (Random, 95% CI)	Totals not selected
2 Measles	1		Risk Ratio (Random, 95% CI)	Totals not selected

#### Comparison 5. Regular immunisation outreach

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Fully immunised children	1		Risk Ratio (Fixed, 95% CI)	Totals not selected
1.1 Regular immunisation outreach only	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]
1.2 Regular immunisation outreach + incentive	1		Risk Ratio (Fixed, 95% CI)	0.0 [0.0, 0.0]

#### Comparison 6. Integration of immunisation to other health services

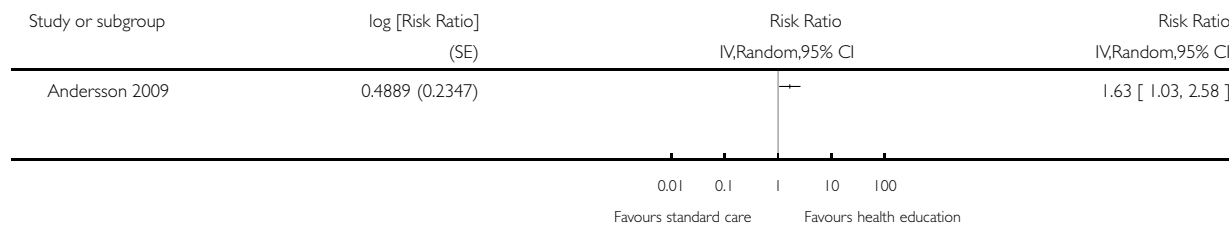
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 BCG	1		Risk Ratio (Random, 95% CI)	Totals not selected
2 DTP3	1		Risk Ratio (Random, 95% CI)	Totals not selected
3 Measles	1		Risk Ratio (Random, 95% CI)	Totals not selected

#### Analysis 1.1. Comparison 1 Health education, Outcome 1 Measles vaccine.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 1 Health education

Outcome: 1 Measles vaccine

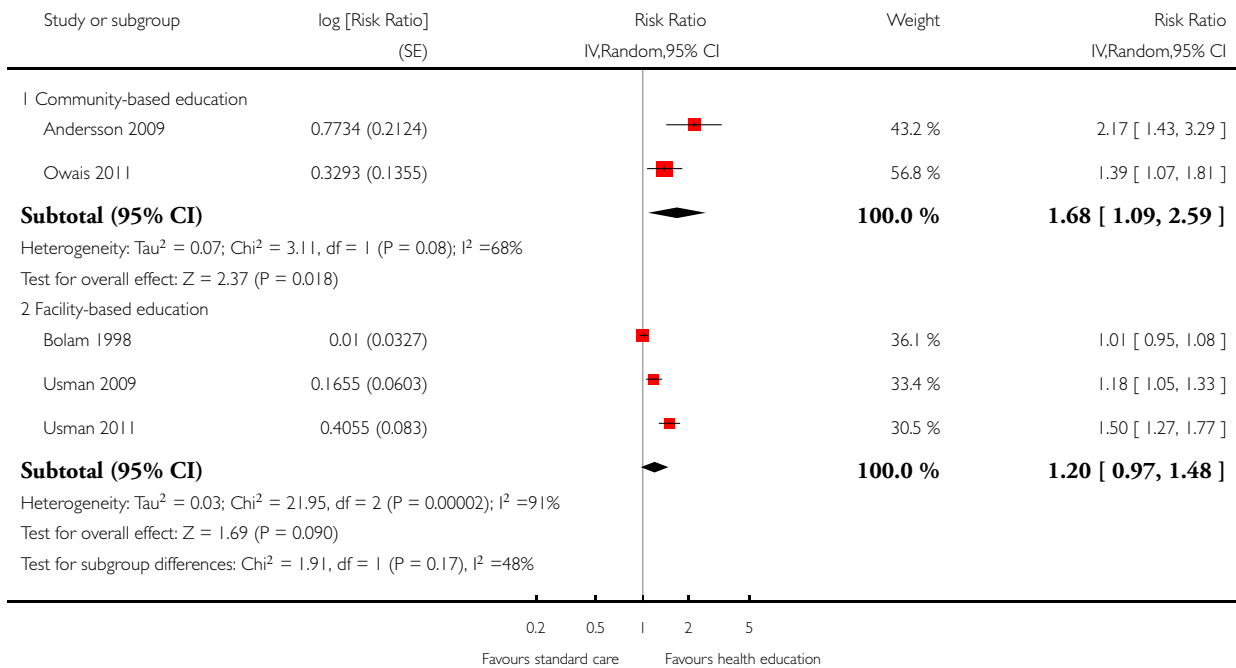


## Analysis 1.2. Comparison 1 Health education, Outcome 2 DTP3.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 1 Health education

Outcome: 2 DTP3

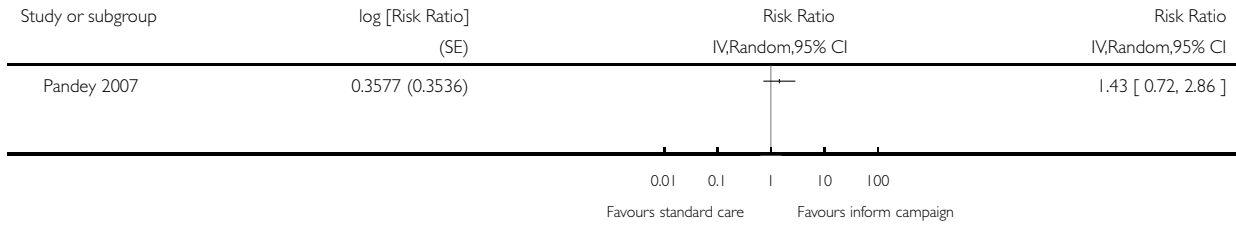


### Analysis 1.3. Comparison 1 Health education, Outcome 3 Received at least 1 vaccine.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 1 Health education

Outcome: 3 Received at least 1 vaccine

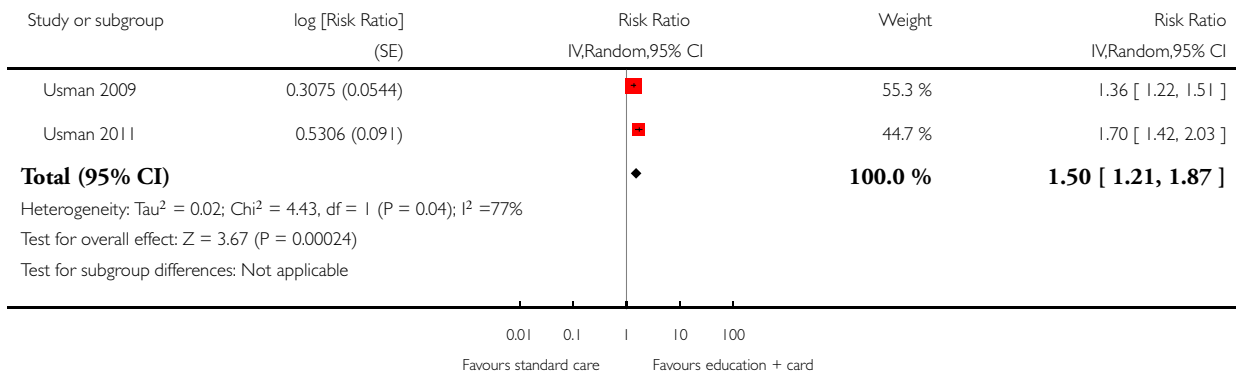


### Analysis 2.1. Comparison 2 Health education plus redesigned reminder card, Outcome 1 DTP3.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 2 Health education plus redesigned reminder card

Outcome: 1 DTP3

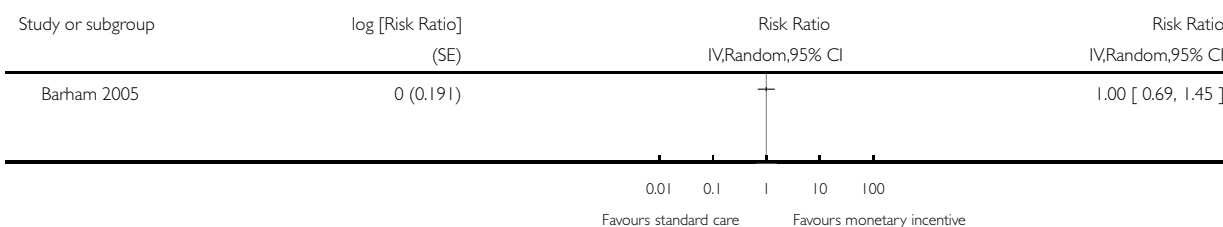


### Analysis 3.1. Comparison 3 Household monetary incentive, Outcome 1 Measles.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 3 Household monetary incentive

Outcome: 1 Measles

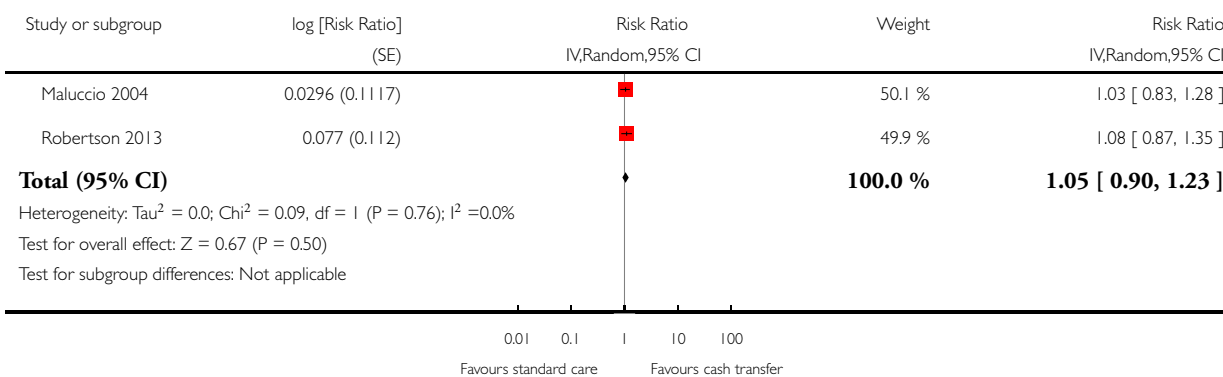


### Analysis 3.2. Comparison 3 Household monetary incentive, Outcome 2 Fully immunised children.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 3 Household monetary incentive

Outcome: 2 Fully immunised children

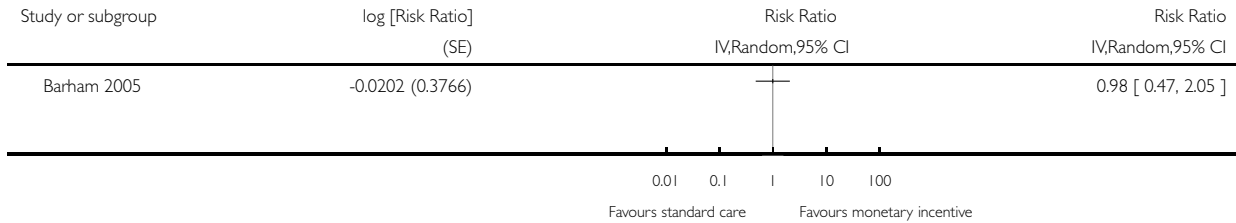


### Analysis 3.3. Comparison 3 Household monetary incentive, Outcome 3 BCG.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 3 Household monetary incentive

Outcome: 3 BCG

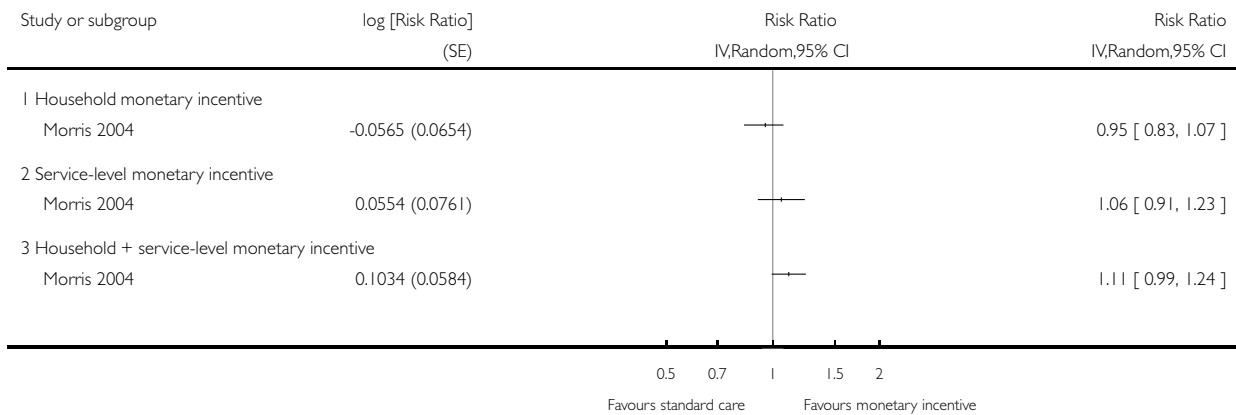


### Analysis 3.4. Comparison 3 Household monetary incentive, Outcome 4 MMR.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 3 Household monetary incentive

Outcome: 4 MMR

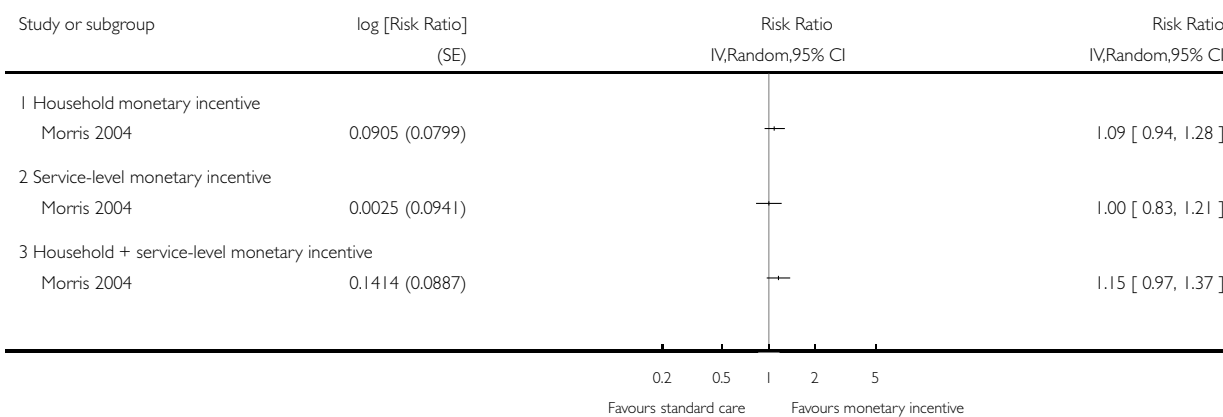


### Analysis 3.5. Comparison 3 Household monetary incentive, Outcome 5 DTPI.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 3 Household monetary incentive

Outcome: 5 DTPI

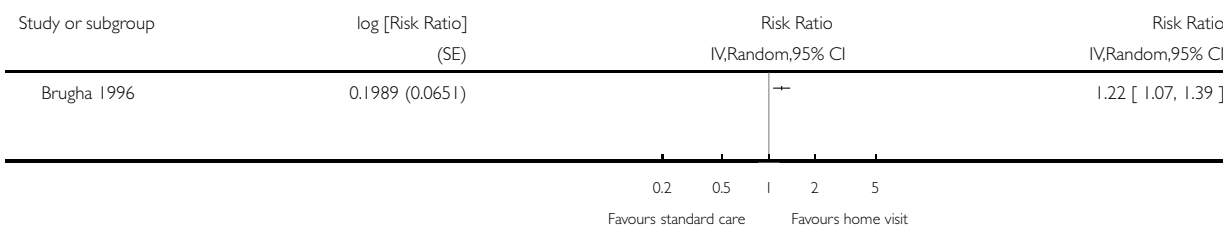


### Analysis 4.1. Comparison 4 Home visit, Outcome 1 OPV3.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 4 Home visit

Outcome: 1 OPV3



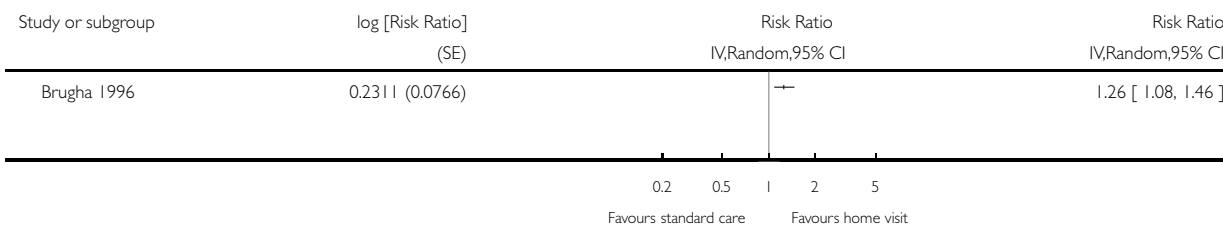


### Analysis 4.2. Comparison 4 Home visit, Outcome 2 Measles.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 4 Home visit

Outcome: 2 Measles

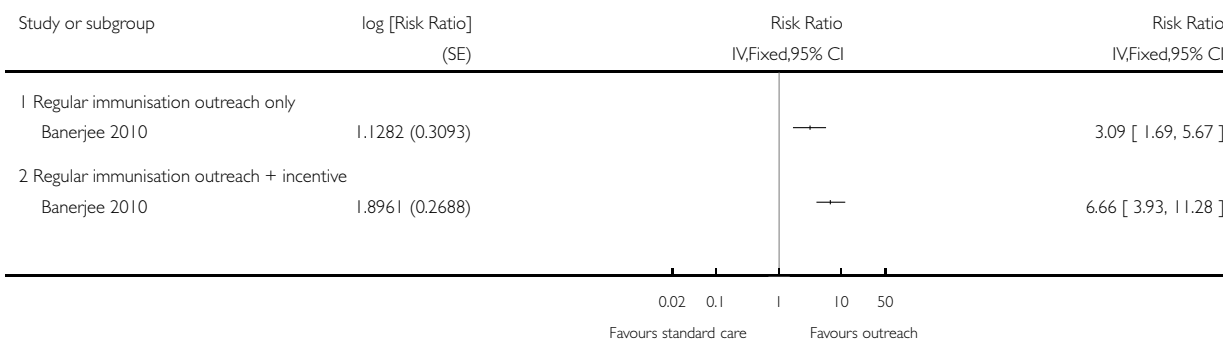


### Analysis 5.1. Comparison 5 Regular immunisation outreach, Outcome 1 Fully immunised children.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 5 Regular immunisation outreach

Outcome: 1 Fully immunised children

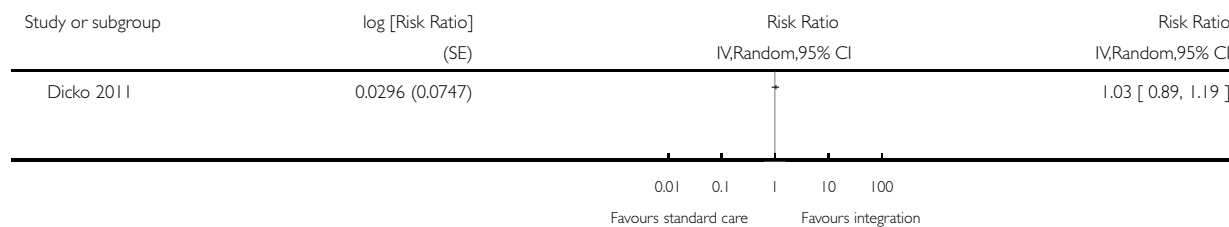


### Analysis 6.1. Comparison 6 Integration of immunisation to other health services, Outcome 1 BCG.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 6 Integration of immunisation to other health services

Outcome: 1 BCG

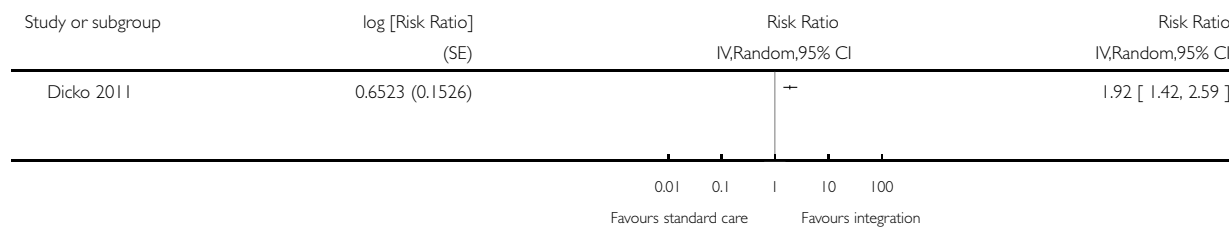


### Analysis 6.2. Comparison 6 Integration of immunisation to other health services, Outcome 2 DTP3.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 6 Integration of immunisation to other health services

Outcome: 2 DTP3

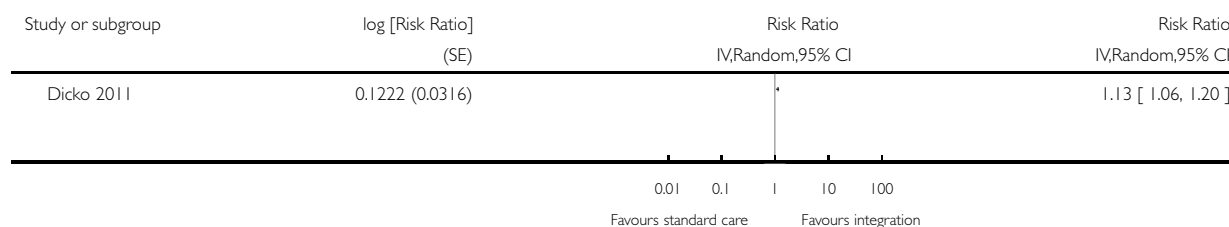


### Analysis 6.3. Comparison 6 Integration of immunisation to other health services, Outcome 3 Measles.

Review: Interventions for improving coverage of childhood immunisation in low- and middle-income countries

Comparison: 6 Integration of immunisation to other health services

Outcome: 3 Measles



## ADDITIONAL TABLES

Table 1. Interventions to improve vaccination uptake and how they work

Target	Interventions	Purpose of the interventions
Recipients	Communication interventions to inform and educate targeting individuals, groups, communities or providers, or a combination of these through face-to-face interaction, use of mass media, printed material, etc	To improve understanding on vaccination; its relevance; benefits and risks of vaccination; where, when, and how to receive vaccine services; and who should receive vaccine services (Willis 2013)
	Communication interventions to recall or remind using face-to-face interaction, telephone, mail, etc	To remind those who are overdue for vaccination in order to reduce drop-out rate (Willis 2013)
	Communication interventions to teach skills, e.g. parenting skills	To provide people with the ability to operationalise knowledge through the adoption of practical skills (Willis 2013)
	Communication interventions to provide support	To provide assistance or advice for consumers (Willis 2013)
	Interventions to facilitate decision-making, e.g. decision aids on vaccination for parents	To assist carers in participating in decision making (Dubé 2013)
	Interventions to enable communication through traditional media, internet, etc	To make communication possible (Dubé 2013)
	Interventions, including communication, to enhance community ownership, e.g. community dialogues involving traditional and religious rulers	To increase demand for vaccination To ensure sustainability To build trust in vaccination and vaccination services To drive demand for vaccination

**Table 1. Interventions to improve vaccination uptake and how they work** (Continued)

	Incentives	To reward service uptake; to cover out-of-pocket cost
Providers	Training	To improve knowledge on vaccination, to improve skills, to improve attitudes to clients, to reduce missed opportunities for vaccination
	Audit and feedback	To ensure quality and client satisfaction with services
	Supportive supervision	To ensure quality and maintain standards, to reduce missed opportunities for vaccination
	Incentives	To boost morale and enhance performance
Health system	Infrastructural development, e.g. provision of health facilities, provision of road to improve access to health facilities	To ensure access to services
	Logistic support	To improve service quality service and so improve utilisation to ensure availability of services
	Service delivery, e.g. outreach; home visits; integration of vaccination with other services; guidelines/protocol for vaccination; increased resources	Outreach to improve access to services Home visits to remind parents about vaccination and identify unimmunised children for immunisation Integration to encourage vaccine uptake Guidelines and protocols to ensure quality of services Improved resources to ensure availability of services
Policy makers	Advocacy for: development of supporting policies, increased funding of health services	To promote the development of policies to support vaccine uptake To increase funding to the health sector

## APPENDICES

### Appendix I. Search strategies

CENTRAL, Cochrane Library

ID	Search	Hits
#1	MeSH descriptor: [Immunization] this term only	636
#2	MeSH descriptor: [Immunization Schedule] this term only	931
#3	MeSH descriptor: [Immunization, Secondary] this term only	756
#4	MeSH descriptor: [Immunotherapy, Active] this term only	109
#5	MeSH descriptor: [Mass Vaccination] this term only	76
#6	MeSH descriptor: [Immunization Programs] this term only	377
#7	MeSH descriptor: [Vaccination] this term only	2330
#8	#1 or #2 or #3 or #4 or #5 or #6 or #7	4366
#9	MeSH descriptor: [Child] explode all trees	173
#10	MeSH descriptor: [Infant] explode all trees	14329
#11	MeSH descriptor: [Mothers] this term only	1195
#12	MeSH descriptor: [Women] this term only	253
#13	MeSH descriptor: [Pregnant Women] this term only	122
#14	#9 or #10 or #11 or #12 or #13	15639
#15	#8 and #14	369
#16	(immunization or immunisation or vaccination) next (program* or rate* or coverage or adher*):ti	309
#17	(vaccinat* or revaccinat* or immunization or immunisation) near/3 (child* or infant* or newborn* or neonat* or baby or babies or kid or kids or toddler* or woman or women or mother or mothers):ti,ab,kw	2183
#18	#15 or #16 or #17	2485
#19	(Africa or Asia or Caribbean or "West Indies" or "South America" or "Latin America" or "Central America"):ti,ab,kw	6277
#20	(Afghanistan or Albania or Algeria or Angola or Antigua or Barbuda or Argentina or Armenia or Armenian or Aruba or Azerbaijan or Bahrain or Bangladesh or Barbados or Benin or Byelorussian or Belarus or Belorussian or Belorus-	13336

(Continued)

	sia or Belize or Bhutan or Bolivia or Bosnia or Herzegovina or Hercegovina or Botswana or Brazil or Brasil or Bulgaria or “Burkina Faso” or “Burkina Fasso” or “Upper Volta” or Burundi or Urundi or Cambodia or “Khmer Republic” or Kampuchea or Cameroon or Cameroons or Cameron or Camerons or “Cape Verde” or “Central African Republic” or Chad or Chile or China or Colombia or Comoros or “Comoro Islands” or Comores or Mayotte or Congo or Zaire or “Costa Rica” or “Cote d’Ivoire” or “Ivory Coast” or Croatia or Cuba or Cyprus or Czechoslovakia or “Czech Republic” or Slovakia or “Slovak Republic”):ti,ab,kw	
#21	(Djibouti or “French Somaliland” or Dominica or “Dominican Republic” or “East Timor” or “East Timur” or “Timor Leste” or Ecuador or Egypt or “United Arab Republic” or “El Salvador” or Eritrea or Estonia or Ethiopia or Fiji or Gabon or “Gabonese Republic” or Gambia or Gaza or Georgia or Georgian or Ghana or “Gold Coast” or Greece or Grenada or Guatemala or Guinea or Guam or Guiana or Guyana or Haiti or Honduras or Hungary or India or Maldives or Indonesia or Iran or Iraq or “Isle of Man” or Jamaica or Jordan or Kazakhstan or Kazakh or Kenya or Kiribati or Korea or Kosovo or Kyrgyzstan or Kirghizia or “Kyrgyz Republic” or Kirghiz or Kirgizstan or “Lao PDR” or Laos or Latvia or Lebanon or Lesotho or Basutoland or Liberia or Libya or Lithuania):ti,ab,kw	14788
#22	(Macedonia or Madagascar or “Malagasy Republic” or Malaysia or Malaya or Malay or Sabah or Sarawak or Malawi or Nyasaland or Mali or Malta or “Marshall Islands” or Mauritania or Mauritius or “Agalega Islands” or Mexico or Micronesia or “Middle East” or Moldova or Moldovia or Moldovian or Mongolia or Montenegro or Morocco or Ifni or Mozambique or Myanmar or Myanma or Burma or Namibia or Nepal or “Netherlands Antilles” or “New Caledonia” or Nicaragua or Niger or Nigeria or “Northern Mariana Islands” or Oman or Muscat or Pakistan or Palau or Palestine or Panama or Paraguay or Peru or Philippines or Philipines or Phillipines or Phillippines or Poland or Portugal or “Puerto Rico”):ti,ab,kw	7142
#23	(Romania or Rumania or Roumania or Russia or Russian or Rwanda or Ruanda or “Saint Kitts” or “St Kitts” or Nevis or “Saint Lucia” or “St Lucia” or “Saint Vincent” or “St Vincent” or Grenadines or Samoa or “Samoan Islands” or “Navigator Island” or “Navigator Islands” or “Sao Tome” or “Saudi Arabia” or Senegal or Serbia or Montenegro or Seychelles or “Sierra Leone” or Slovenia or “Sri Lanka” or Ceylon or “Solomon Islands” or Somalia or Sudan or Suriname or Surinam or Swaziland or Syria or Tajikistan or Tadjhikistan or Tadjikistan or	8710

(Continued)

	Tadzhik or Tanzania or Thailand or Togo or “Togolese Republic” or Tonga or Trinidad or Tobago or Tunisia or Turkey or Turkmenistan or Turkmen or Uganda or Ukraine or Uruguay or USSR or “Soviet Union” or “Union of Soviet Socialist Republics” or Uzbekistan or Uzbek or Vanuatu or “New Hebrides” or Venezuela or Vietnam or “Viet Nam” or “West Bank” or Yemen or Yugoslavia or Zambia or Zimbabwe or Rhodesia) :ti,ab,kw	
#24	(developing or less* next developed or “under developed” or underdeveloped or “middle income” or low* next income or underserved or “under served” or deprived or poor*) next (countr* or nation* or population* or world):ti,ab,kw	3803
#25	(developing or less* next developed or “under developed” or underdeveloped or “middle income” or low* next income) next (economy or economies):ti,ab,kw	23
#26	low* next (gdp or gnp or “gross domestic” or “gross national”) :ti,ab,kw	33
#27	(low near/3 middle near/3 countr*):ti,ab,kw	391
#28	(lmic or lmics or “third world” or “lami country” or “lami countries”):ti,ab,kw	92
#29	(“transitional country” or “transitional countries”):ti,ab,kw	2
#30	(#19 or #20 or #21 or #22 or #23 or #24 or #25 or #26 or #27 or #28 or #29)	46313
#31	#18 and #30 in Trials	684

**MEDLINE In-Process & Other Non-Indexed Citations, MEDLINE Daily and MEDLINE 1946 to Present, Ovid**

#	Searches	Results
1	Immunization/	46749
2	Immunization Schedule/	9187
3	Immunization, Secondary/	7263
4	Immunotherapy, Active/	2360
5	Mass Immunization/	2518

(Continued)

6	Immunization Programs/	8340
7	Vaccination/	68480
8	or/1-7	130272
9	exp Child/	1663903
10	exp Infant/	1006268
11	Mothers/	32291
12	Women/	13948
13	Pregnant Women/	5684
14	or/9-13	2193372
15	8 and 14	31376
16	((vaccinat* or revaccinat* or immunization or immunisation) adj3 (child* or infant? or newborn? or neonat* or baby or babies or kid? or toddler? or woman or women or mother?)).ti,ab	16445
17	((immunization or immunisation or vaccination) adj (program* or rate* or coverage or adher*)).ti	3812
18	15 or 16 or 17	41477
19	Developing Countries.sh,kf.	76483
20	(Africa or Asia or Caribbean or West Indies or South America or Latin America or Central America).hw,kf,ti,ab,cp	207983
21	(Afghanistan or Albania or Algeria or Angola or Antigua or Barbuda or Argentina or Armenia or Armenian or Aruba or Azerbaijan or Bahrain or Bangladesh or Barbados or Benin or Byelarus or Byelorussian or Belarus or Belorussian or Belorussia or Belize or Bhutan or Bolivia or Bosnia or Herzegovina or Hercegovina or Botswana or Brazil or Brasil or Bulgaria or Burkina Faso or Burkina Fasso or Upper Volta or Burundi or Urundi or Cambodia or Khmer Republic or Kampuchea or Cameroon or Cameroons or Cameron or Camerons or Cape Verde or Central African Republic or Chad or Chile or China or Colombia or Comoros or Comoro Islands or Comores or Mayotte or Congo or Zaire or Costa Rica or Cote d'Ivoire or Ivory Coast or Croatia or Cuba or Cyprus or Czechoslovakia or Czech Republic or Slovakia or Slovak Republic or Djibouti	3140964



(Continued)

	<p>or French Somaliland or Dominica or Dominican Republic or East Timor or East Timor or Timor Leste or Ecuador or Egypt or United Arab Republic or El Salvador or Eritrea or Estonia or Ethiopia or Fiji or Gabon or Gabonese Republic or Gambia or Gaza or Georgia Republic or Georgian Republic or Ghana or Gold Coast or Greece or Grenada or Guatemala or Guinea or Guam or Guiana or Guyana or Haiti or Honduras or Hungary or India or Maldives or Indonesia or Iran or Iraq or Isle of Man or Jamaica or Jordan or Kazakhstan or Kazakh or Kenya or Kiribati or Korea or Kosovo or Kyrgyzstan or Kirghizia or Kyrgyz Republic or Kirghiz or Kirgizstan or Lao PDR or Laos or Latvia or Lebanon or Lesotho or Basutoland or Liberia or Libya or Lithuania or Macedonia or Madagascar or Malagasy Republic or Malaysia or Malaya or Malay or Sabah or Sarawak or Malawi or Nyasaland or Mali or Malta or Marshall Islands or Mauritania or Mauritius or Agalega Islands or Mexico or Micronesia or Middle East or Moldova or Moldavia or Moldovan or Mongolia or Montenegro or Morocco or Ifni or Mozambique or Myanmar or Myanma or Burma or Namibia or Nepal or Netherlands Antilles or New Caledonia or Nicaragua or Niger or Nigeria or Northern Mariana Islands or Oman or Muscat or Pakistan or Palau or Palestine or Panama or Paraguay or Peru or Philippines or Philipines or Phillipines or Phillippines or Poland or Portugal or Puerto Rico or Romania or Rumania or Roumania or Russia or Russian or Rwanda or Ruanda or Saint Kitts or St Kitts or Nevis or Saint Lucia or St Lucia or Saint Vincent or St Vincent or Grenadines or Samoa or Samoan Islands or Navigator Island or Navigator Islands or Sao Tome or Saudi Arabia or Senegal or Serbia or Montenegro or Seychelles or Sierra Leone or Slovenia or Sri Lanka or Ceylon or Solomon Islands or Somalia or Sudan or Suriname or Surinam or Swaziland or Syria or Tajikistan or Tadjhikistan or Tadjikistan or Tadjhik or Tanzania or Thailand or Togo or Togolese Republic or Tonga or Trinidad or Tobago or Tunisia or Turkey or Turkmenistan or Turkmen or Uganda or Ukraine or Uruguay or USSR or Soviet Union or Union of Soviet Socialist Republics or Uzbekistan or Uzbek or Vanuatu or New Hebrides or Venezuela or Vietnam or Viet Nam or West Bank or Yemen or Yugoslavia or Zambia or Zimbabwe or Rhodesia) .hw,kf,ti,ab,cp</p>	
22	<p>((developing or less* developed or under developed or underdeveloped or middle income or low* income or underserved or under served or deprived or poor*) adj (countr* or nation? or population? or world)).ti,ab</p>	68469
23	<p>((developing or less* developed or under developed or underdeveloped or middle income or low* income) adj (economy or economies)).ti,ab</p>	343

(Continued)

24	(low* adj (gdp or gnp or gross domestic or gross national)).ti,ab	181
25	(low adj3 middle adj3 countr*).ti,ab.	6060
26	(lmic or lmics or third world or lami countr*).ti,ab.	4111
27	transitional countr*.ti,ab.	125
28	or/19-27	3294625
29	18 and 28	13577
30	randomized controlled trial.pt.	416221
31	controlled clinical trial.pt.	90701
32	pragmatic clinical trial.pt.	314
33	multicenter study.pt.	201344
34	non-randomized controlled trials as topic/	57
35	interrupted time series analysis/	145
36	controlled before-after studies/	133
37	(randomis* or randomiz* or randomly allocat* or random allocat*).ti,ab	464168
38	groups.ab.	1550431
39	(trial or impact or effect or multicenter or multi center or multicentre or multi centre).ti	1074962
40	(intervention* or controlled or control group? or (before adj5 after) or (pre adj5 post) or pretest or pre test or posttest or post test or quasiexperiment* or quasi experiment* or evaluat* or time series or time point? or repeated measur*).ti,ab	3915143
41	or/30-40	5729695
42	exp Animals/	20169765
43	Humans/	15928724
44	42 not (42 and 43)	4241041

(Continued)

45	review.pt.	2110328
46	meta analysis.pt.	65647
47	news.pt.	176635
48	comment.pt.	663297
49	editorial.pt.	401580
50	cochrane database of systematic reviews.jn.	12225
51	comment on.cm.	663297
52	(systematic review or literature review).ti.	73686
53	or/44-52	7292678
54	41 not 53	4229940
55	29 and 54	4680

**CINAHL, EbscoHost**

#	Query	Results
S54	S16 AND S34 AND S52 [Exclude MEDLINE records]	119
S53	S16 AND S34 AND S52	780
S52	S35 OR S36 OR S37 OR S38 OR S39 OR S40 OR S41 OR S42 OR S43 OR S44 OR S45 OR S46 OR S47 OR S48 OR S49 OR S50 OR S51	940,212
S51	TI (randomis* or randomiz* or randomly or trial or effect* or impact* or intervention* or multicenter or “multi center” or multicentre or “multi centre” or controlled or groups or before N5 after or pre N5 post or ((pretest or “pre test”) and (posttest or “post test”)) or quasiexperiment* or quasi W0 experiment* or pseudo experiment* or pseudoexperiment* or evaluat* or “time series” or time W0 point* or repeated W0 measur*) OR AB (randomis* or randomiz* or randomly or trial or effect* or impact* or intervention* or multicenter or “multi center” or multicentre or “multi centre” or controlled or groups or before N5 after or pre N5 post or ((pretest or “pre test”) and (posttest or “post test”)) or quasiexperiment* or quasi W0 experiment* or evaluat* or “time series” or time W0 point* or repeated W0	877,979

(Continued)

	measur*)	
S50	(MH "Health Services Research")	7,382
S49	(MH "Experimental Studies+")	168,959
S48	(MH "Time Series")	1,612
S47	(MH "Multiple Time Series")	3
S46	(MH "Interrupted Time Series Analysis")	11
S45	(MH "Repeated Measures")	39,029
S44	(MH "Multicenter Studies")	11,769
S43	(MH "Quasi-Experimental Studies")	7,003
S42	(MH "Pretest-Posttest Design")	26,485
S41	(MH "Pretest-Posttest Control Group Design")	403
S40	(MH "Nonrandomized Trials")	170
S39	(MH "Intervention Trials")	5,990
S38	(MH "Clinical Trials")	84,421
S37	(MH "Randomized Controlled Trials")	26,420
S36	PT clinical trial	52,784
S35	PT randomized controlled trial	30,609
S34	S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33	213,994
S33	TI transitional W0 countr* OR AB transitional W0 countr*	34
S32	TI ( lmic or lmics or third W0 world or lami W0 countr* ) OR AB ( lmic or lmics or third W0 world or lami W0 countr* )	517
S31	TI low N3 middle N3 countr* OR AB low N3 middle N3 countr*	1,279

(Continued)

S30	TI ( low* W0 (gdp or gnp or gross W0 domestic or gross W0 national) ) OR AB ( low* W0 (gdp or gnp or gross W0 domestic or gross W0 national) )	16
S29	TI ((developing or less* W0 developed or under W0 developed or underdeveloped or middle W0 income or low* W0 income) W0 (economy or economies) ) OR AB ( (developing or less* W0 developed or under W0 developed or underdeveloped or middle W0 income or low* W0 income) W0 (economy or economies) )	46
S28	TI ( (developing or less* W0 developed or under W0 developed or underdeveloped or middle W0 income or low* W0 income or underserved or under W0 served or deprived or poor*) W0 (countr* or nation or nations or population* or world or area or areas) ) OR AB ( (developing or less* W0 developed or under W0 developed or underdeveloped or middle W0 income or low* W0 income or underserved or under W0 served or deprived or poor*) W0 (countr* or nation or nations or population* or world or area or areas) )	11,124
S27	MW ( Afghanistan or Bangladesh or Benin or “Burkina Faso” or Burundi or Cambodia or “Central African Republic” or Chad or Comoros or Congo or “Cote d’Ivoire” or Eritrea or Ethiopia or Gambia or Ghana or Guinea or Haiti or India or Kenya or Korea or Kyrgyz or Kyrgyzstan or Lao or Laos or Liberia or Madagascar or Malawi or Mali or Mauritania or Melanesia or Mongolia or Mozambique or Burma or Myanmar or Nepal or Niger or Nigeria or Pakistan or Rwanda or “Salomon Islands” or “Sao Tome” or Senegal or “Sierra Leone” or Somalia or Sudan or Tajikistan or Tanzania or Timor or Togo or Uganda or Uzbekistan or Vietnam or “Viet Nam” or Yemen or Zambia or Zimbabwe ) or TI ( Afghanistan or Bangladesh or Benin or “Burkina Faso” or Burundi or Cambodia or “Central African Republic” or Chad or Comoros or Congo or “Cote d’Ivoire” or Eritrea or Ethiopia or Gambia or Ghana or Guinea or Haiti or India or Kenya or Korea or Kyrgyz or Kyrgyzstan or Lao or Laos or Liberia or Madagascar or Malawi or Mali or Mauritania or Melanesia or Mongolia or Mozambique or Burma or Myanmar or Nepal or Niger or Nigeria or Pakistan or Rwanda or “Salomon Islands” or “Sao Tome” or Senegal or “Sierra Leone” or Somalia or Sudan or Tajikistan or Tanzania or Timor or Togo or Uganda or Uzbekistan or Vietnam or “Viet Nam” or Yemen or Zambia or Zimbabwe ) or AB ( Afghanistan or Bangladesh or Benin or “Burkina Faso” or Burundi or Cambodia or “Central African Republic” or Chad or Comoros or Congo or “Cote d’Ivoire” or Eritrea or Ethiopia or Gambia or Ghana or Guinea or Haiti or India or Kenya or	48,132

(Continued)

	Korea or Kyrgyz or Kyrgyzstan or Lao or Laos or Liberia or Madagascar or Malawi or Mali or Mauritania or Melanesia or Mongolia or Mozambique or Burma or Myanmar or Nepal or Niger or Nigeria or Pakistan or Rwanda or “Salomon Islands” or “Sao Tome” or Senegal or “Sierra Leone” or Somalia or Sudan or Tajikistan or Tanzania or Timor or Togo or Uganda or Uzbekistan or Vietnam or “Viet Nam” or Yemen or Zambia or Zimbabwe )	
S26	MW ( Albania or Algeria or Angola or Armenia or Azerbaijan or Belarus or Bhutan or Bolivia or Bosnia or Herzegovina or “Cape Verde” or Cameroon or China or Colombia or Congo or Cuba or Djibouti or “Dominican Republic” or Ecuador or Egypt or “El Salvador” or Fiji or Gaza or Georgia or Guam or Guatemala or Guyana or Honduras or “Indian Ocean Islands” or Indonesia or Iran or Iraq or Jamaica or Jordan or Kiribati or Lesotho or Macedonia or Maldives or “Marshall Islands” or Micronesia or “Middle East” or Moldova or Morocco or Namibia or Nicaragua or Palestin* or Paraguay or Peru or Philippines or Samoa or “Sri Lanka” or Suriname or Swaziland or Syria or “Syrian Arab Republic” or Thailand or Tonga or Tunisia or Turkmenistan or Ukraine or Vanuatu or “West Bank” ) or TI ( Albania or Algeria or Angola or Armenia or Azerbaijan or Belarus or Bhutan or Bolivia or Bosnia or Herzegovina or “Cape Verde” or Cameroon or China or Colombia or Congo or Cuba or Djibouti or “Dominican Republic” or Ecuador or Egypt or “El Salvador” or Fiji or Gaza or Georgia or Guam or Guatemala or Guyana or Honduras or “Indian Ocean Islands” or Indonesia or Iran or Iraq or Jamaica or Jordan or Kiribati or Lesotho or Macedonia or Maldives or “Marshall Islands” or Micronesia or “Middle East” or Moldova or Morocco or Namibia or Nicaragua or Palestin* or Paraguay or Peru or Philippines or Samoa or “Sri Lanka” or Suriname or Swaziland or Syria or “Syrian Arab Republic” or Thailand or Tonga or Tunisia or Turkmenistan or Ukraine or Vanuatu or “West Bank” ) or AB ( Albania or Algeria or Angola or Armenia or Azerbaijan or Belarus or Bhutan or Bolivia or Bosnia or Herzegovina or “Cape Verde” or Cameroon or China or Colombia or Congo or Cuba or Djibouti or “Dominican Republic” or Ecuador or Egypt or “El Salvador” or Fiji or Gaza or Georgia or Guam or Guatemala or Guyana or Honduras or “Indian Ocean Islands” or Indonesia or Iran or Iraq or Jamaica or Jordan or Kiribati or Lesotho or Macedonia or Maldives or “Marshall Islands” or Micronesia or “Middle East” or Moldova or Morocco or Namibia or Nicaragua or Palestin* or Paraguay or Peru or Philippines or Samoa or “Sri Lanka” or Suriname or Swaziland or Syria or “Syrian Arab Republic” or Thailand or Tonga or Tunisia or Turkmenistan or Ukraine or Vanuatu or “West Bank” )	52,828

(Continued)

S25	MW ( "American Samoa" or Argentina or Belize or Botswana or Brazil or Brasil or Bulgaria or Chile or Comoros or "Costa Rica" or Croatia or Dominica or Guinea or Gabon or Grenada or Grenadines or Hungary or Kazakhstan or Latvia or Lebanon or Libia or libyan or Libya or Lithuania or Malaysia or Mauritius or Mayotte or Mexico or Micronesia or Montenegro or Nevis or "Northern Mariana Islands" or Oman or Palau or Panama or Poland or Romania or Russia or "Russian Federation" or Samoa or "Saint Lucia" or "St Lucia" or "Saint Kitts" or "St Kitts" or "Saint Vincent" or "St Vincent" or Serbia or Seychelles or Slovakia or "Slovak Republic" or "South Africa" or Turkey or Uruguay or Venezuela or Yugoslavia ) or TI ( "American Samoa" or Argentina or Belize or Botswana or Brazil or Bulgaria or Chile or Comoros or "Costa Rica" or Croatia or Dominica or Guinea or Gabon or Grenada or Grenadines or Hungary or Kazakhstan or Latvia or Lebanon or Libia or libyan or Libya or Lithuania or Malaysia or Mauritius or Mayotte or Mexico or Micronesia or Montenegro or Nevis or "Northern Mariana Islands" or Oman or Palau or Panama or Poland or Romania or Russia or "Russian Federation" or Samoa or "Saint Lucia" or "St Lucia" or "Saint Kitts" or "St Kitts" or "Saint Vincent" or "St Vincent" or Serbia or Seychelles or Slovakia or "Slovak Republic" or "South Africa" or Turkey or Uruguay or Venezuela or Yugoslavia ) or AB ( "American Samoa" or Argentina or Belize or Botswana or Brazil or Bulgaria or Chile or Comoros or "Costa Rica" or Croatia or Dominica or Guinea or Gabon or Grenada or Grenadines or Hungary or Kazakhstan or Latvia or Lebanon or Libia or libyan or Libya or Lithuania or Malaysia or Mauritius or Mayotte or Mexico or Micronesia or Montenegro or Nevis or "Northern Mariana Islands" or Oman or Palau or Panama or Poland or Romania or Russia or "Russian Federation" or Samoa or "Saint Lucia" or "St Lucia" or "Saint Kitts" or "St Kitts" or "Saint Vincent" or "St Vincent" or Serbia or Seychelles or Slovakia or "Slovak Republic" or "South Africa" or Turkey or Uruguay or Venezuela or Yugoslavia )	62,809
S24	TI ( Africa or Asia or "South America" or "Latin America" or "Central America" ) or AB ( Africa or Asia or "South America" or "Latin America" or "Central America" )	14,134
S23	(MH "Asia+")	99,994
S22	(MH "West Indies+")	5,217
S21	(MH "South America+")	25,838
S20	(MH "Latin America")	1,323

(Continued)

S19	(MH "Central America+")	2,168
S18	(MH "Africa+")	32,362
S17	(MH "Developing Countries")	8,973
S16	S13 OR S14 OR S15	8,805
S15	TI (immunization or immunisation or vaccination) W0 (program* or rate* or coverage or adher*)	1,249
S14	TI ( (vaccinat* or revaccinat* or immunization or immunisation) N3 (child* or infant or infants or newborn or neonat* or baby or babies or kid or kids or toddler* or woman or women or mother*)) OR AB ( (vaccinat* or revaccinat* or immunization or immunisation) N3 (child* or infant or infants or newborn or neonat* or baby or babies or kid or kids or toddler* or woman or women or mother*))	3,345
S13	S5 AND S12	6,586
S12	S6 OR S7 OR S8 OR S9 OR S10 OR S11	320,243
S11	(MH "Expectant Mothers")	2,193
S10	(MH "Women")	11,013
S9	(MH "Mothers")	13,932
S8	(MH "Infant, Newborn")	65,336
S7	(MH "Infant")	83,244
S6	(MH "Child")	220,709
S5	S1 or S2 or S3 or S4	18,740
S4	(MH "Immunization Programs")	3,081
S3	(MH "Immunotherapy")	2,729
S2	(MH "Immunization Schedule")	1,940
S1	(MH "Immunization")	12,688

**EMBASE (Ovid)**



#	Searches	Results
1	Immunization/	75,652
2	Active Immunization/	6595
3	Mass Immunization/	2421
4	Vaccination/	96,045
5	Revaccination/	1059
6	(vaccinat\$ or revaccinat\$ or immunization or immunisation or immunotherapy).tw	226,888
7	or/1-6	289,620
8	Tetanus Prophylaxis/	1259
9	BCG Vaccination/	7072
10	Measles Vaccination/	2189
11	or/8-10	10,339
12	Tetanus Toxoid/	10,548
13	Diphtheria Toxoid/	2535
14	Diphtheria Toxoid crm197/	216
15	Diphtheria Tetanus Toxoid/	427
16	BCG Vaccine/	27,645
17	Diphtheria Pertussis Poliomyelitis Tetanus Haemophilus Influenzae Type B Hepatitis B Vaccine/	380
18	Diphtheria Pertussis Poliomyelitis Tetanus Vaccine/	393
19	Diphtheria Pertussis Tetanus Haemophilus Influenzae Type B Hepatitis B Vaccine/	158
20	Diphtheria Pertussis Tetanus Haemophilus Influenzae Type B Vaccine/	464
21	Diphtheria Pertussis Tetanus Vaccine/	6524
22	Diphtheria Poliomyelitis Tetanus Vaccine/	74

(Continued)

23	Diphtheria Tetanus Vaccine/	675
24	Diphtheria Vaccine/	1902
25	Haemophilus Influenzae Type B Hepatitis B Vaccine/	230
26	Haemophilus Influenzae Type B Vaccine/	4269
27	Haemophilus Influenzae Vaccine/	944
28	Haemophilus Vaccine/	764
29	Pertussis Vaccine/	6378
30	Triple Vaccine/	715
31	Hepatitis a Hepatitis B Vaccine/	502
32	Hepatitis B Vaccine/	15,773
33	Hepatitis Vaccine/	2126
34	Recombinant Hepatitis B Vaccine/	1776
35	Measles Mumps Rubella Vaccine/	5594
36	Measles Mumps Vaccine/	102
37	Measles Rubella Vaccine/	100
38	Measles Vaccine/	7860
39	Mumps Vaccine/	2031
40	Rubella Vaccine/	3477
41	Chickenpox Measles Mumps Rubella Vaccine/	219
42	Poliomyelitis Vaccine/	7207
43	Oral Poliomyelitis Vaccine/	4250
44	((tetanus or diphtheria) adj toxoid).tw.	5484
45	((tetanus or diphtheria? or pertussis or whooping cough or measles or mumps or rubella? or rubeola or mmr or polio\$ or tuberculosis or tuberculoses or bcg or calmette\$ or hepatitis b	17,760

(Continued)

	or haemophilus or triple) adj vaccine?).tw	
46	or/12-45	86,597
47	Tetanus/	12,351
48	Diphtheria/	9102
49	Measles/	15,582
50	Mumps/	5967
51	Rubella/	9019
52	Pertussis/	10,521
53	Poliomyelitis/	18,525
54	Tuberculosis/	89,886
55	Lung Tuberculosis/	63,542
56	Mycobacterium Tuberculosis/	48,597
57	Hepatitis B/	69,010
58	Chronic Hepatitis/	21,541
59	Haemophilus Influenzae/	18,964
60	Haemophilus Influenzae Type B/	3868
61	(tetanus or diphtheria? or measles or rubella? or rubeola or mumps or epidemic parotit\$ or pertussis or whooping cough or polio\$ or infantile paralysis or tuberculosis or tuberculoses or hepatitis b or haemophilus influenza?).tw	333,094
62	or/47-61	440,846
63	exp Child/	2,005,016
64	exp Newborn/	450,384
65	Child Care/	30,274
66	(child\$ or infant? or newborn? or neonat\$ or baby or babies or kid? or toddler?).tw	1,614,491

(Continued)

67	or/63-66	2,499,583
68	7 and (Tetanus/ or tetanus.tw.)	10,450
69	Tetanus Toxoid/ or Tetanus Prophylaxis/ or (tetanus toxoid or tetanus vaccin\$ or tetanus prophylaxis).tw	13,141
70	or/68-69	18,159
71	exp Mother/	86,127
72	Female/	5,983,316
73	(woman or women or mother? or female?).tw.	1,819,414
74	or/71-73	6,295,611
75	70 and 74	5326
76	Developing Country.sh.	75,918
77	(Africa or Asia or Caribbean or West Indies or South America or Latin America or Central America).hw,ti,ab,cp	227,844
78	(Afghanistan or Albania or Algeria or Angola or Antigua or Barbuda or Argentina or Armenia or Armenian or Aruba or Azerbaijan or Bahrain or Bangladesh or Barbados or Benin or Byelarus or Byelorussian or Belarus or Belorussian or Belorussia or Belize or Bhutan or Bolivia or Bosnia or Herzegovina or Hercegovina or Botswana or Brazil or Brasil or Bulgaria or Burkina Faso or Burkina Fasso or Upper Volta or Burundi or Urundi or Cambodia or Khmer Republic or Kampuchea or Cameroon or Cameroons or Cameron or Camerons or Cape Verde or Central African Republic or Chad or Chile or China or Colombia or Comoros or Comoro Islands or Comores or Mayotte or Congo or Zaire or Costa Rica or Cote d'Ivoire or Ivory Coast or Croatia or Cuba or Cyprus or Czechoslovakia or Czech Republic or Slovakia or Slovak Republic or Djibouti or French Somaliland or Dominica or Dominican Republic or East Timor or East Timur or Timor Leste or Ecuador or Egypt or United Arab Republic or El Salvador or Eritrea or Estonia or Ethiopia or Fiji or Gabon or Gabonese Republic or Gambia or Gaza or Georgia Republic or Georgian Republic or Ghana or Gold Coast or Greece or Grenada or Guatemala or Guinea or Guam or Guiana or Guyana or Haiti or Honduras or Hungary or India or Maldives or Indonesia or Iran or Iraq or Isle of Man or Jamaica or Jordan or Kazakhstan or Kazakh or Kenya or Kiribati or Korea or Kosovo or Kyrgyzs-	2,838,905

(Continued)

	tan or Kirghizia or Kyrgyz Republic or Kirghiz or Kirgistan or Lao PDR or Laos or Latvia or Lebanon or Lesotho or Basutoland or Liberia or Libya or Lithuania or Macedonia or Madagascar or Malagasy Republic or Malaysia or Malaya or Malay or Sabah or Sarawak or Malawi or Nyasaland or Mali or Malta or Marshall Islands or Mauritania or Mauritius or Agalega Islands or Mexico or Micronesia or Middle East or Moldova or Moldavia or Moldovan or Mongolia or Montenegro or Morocco or Ifni or Mozambique or Myanmar or Myanma or Burma or Namibia or Nepal or Netherlands Antilles or New Caledonia or Nicaragua or Niger or Nigeria or Northern Mariana Islands or Oman or Muscat or Pakistan or Palau or Palestine or Panama or Paraguay or Peru or Philippines or Philipines or Phillipines or Phillippines or Poland or Portugal or Puerto Rico or Romania or Rumania or Roumania or Russia or Russian or Rwanda or Ruanda or Saint Kitts or St Kitts or Nevis or Saint Lucia or St Lucia or Saint Vincent or St Vincent or Grenadines or Samoa or Samoan Islands or Navigator Island or Navigator Islands or Sao Tome or Saudi Arabia or Senegal or Serbia or Montenegro or Seychelles or Sierra Leone or Slovenia or Sri Lanka or Ceylon or Solomon Islands or Somalia or Sudan or Suriname or Surinam or Swaziland or Syria or Tajikistan or Tadjhikistan or Tadjikistan or Tadjhik or Tanzania or Thailand or Togo or Togolese Republic or Tonga or Trinidad or Tobago or Tunisia or Turkey or Turkmenistan or Turkmen or Uganda or Ukraine or Uruguay or USSR or Soviet Union or Union of Soviet Socialist Republics or Uzbekistan or Uzbek or Vanuatu or New Hebrides or Venezuela or Vietnam or Viet Nam or West Bank or Yemen or Yugoslavia or Zambia or Zimbabwe or Rhodesia).hw,ti,ab,cp	
79	((developing or less* developed or under developed or underdeveloped or middle income or low* income or underserved or under served or deprived or poor*) adj (countr* or nation? or population? or world)).ti,ab	68,123
80	((developing or less* developed or under developed or underdeveloped or middle income or low* income) adj (economy or economies)).ti,ab	351
81	(low* adj (gdp or gnp or gross domestic or gross national)).ti,ab	187
82	(low adj3 middle adj3 countr*).ti,ab.	4139
83	(lmic or lmics or third world or lami countr*).ti,ab.	3741
84	transitional countr*.ti,ab.	138

(Continued)

85	or/76-84	3,019,888
86	Randomized Controlled Trial/	348,266
87	Controlled Clinical Trial/	386,406
88	Quasi Experimental Study/	2013
89	Pretest Posttest Control Group Design/	206
90	Time Series Analysis/	14,239
91	Experimental Design/	10,019
92	Multicenter Study/	109,759
93	(randomis* or randomiz* or randomly or random allocat*).ti, ab	727,521
94	groups.ab.	1,698,086
95	(trial or multicentre or multicenter or multi centre or multi center).ti	192,503
96	(intervention* or controlled or control group or compare or compared or (before adj5 after) or (pre adj5 post) or pretest or pre test or posttest or post test or quasiexperiment* or quasi experiment* or evaluat* or effect or impact or time series or time point? or repeated measur*).ti,ab	8,028,793
97	or/86-96	8,766,538
98	(systematic review or literature review).ti.	62,313
99	“cochrane database of systematic reviews”.jn.	3777
100	Nonhuman/	4,359,920
101	or/98-100	4,424,301
102	97 not 101	6,927,465
103	7 and 62 and 67 and 85 and 102	4433
104	11 and 67 and 85 and 102	865
105	46 and 67 and 85 and 102	4231

(Continued)

106	103 or 104 or 105	5462
107	limit 106 to embase	4043

**Sociological Abstracts (ProQuest)**

ALL(vaccination or vaccine or vaccines or immunization)

AND

ALL(child\* or infant\* or newborn or neonat\* or baby or babies or kid or kids or toddler\* or mother\* or woman or women or female)

**LILACS (VHL)**

(immunization or inmunizacion or imunizacao or vaccination or vacunacion or vacinacao or vaccine or vaccines or vacuna or vacunas or vacina or vacinas) AND (tetanus or tetanico or diphtheria or difterico or pertussis or “whooping cough” or tosferina or “tos ferina” or “tos convulsa” or “tosse convulsa” or coqueluche or measles or sarampion or sarampo or mumps or paperas or caxumba or rubella or rubeola or mmr or polio\* or tubercul\* or “mycobacterium bovis” or bcg or calmette\* or hepatitis or hepatite or haemophilus) AND (child or children or infant or infants or newborn or neonat\* or baby or babies or kid or kids or toddler\* or nino or ninos or crianca or criancas or lactante\* or lactente\* or “recien nacido” or “recien nacidos” or “recem nascido” or “recem nascidos”) AND (randomi\* or randomly or azar or acaso or control\* or intervention\* or evaluar\* or effect\* or impact or impactos or intervencion\* or intervencao\* or evaluar or evaluacion or avaliacao or efecto or efectos or efeito or efeitos or impacto or impactos or “serie de tiempo” or “series de tiempo” or “serie de tempo” or “series de tempo” or “serie temporal” or “series temporal” or “serie temporales” or “series temporales” or “serie temporais” or “series temporais” or “puntos de tiempo” or “pontos de tiempo” or “puntos de tempo” or “pontos de tempo” or “puntos temporales” or “pontos temporales” or “punto temporais” or “ponto temporais” or “medida repetida” or “medida repetidas” or “medidas repetida” or “medidas repetidas” or “medicion repetida” or “medicion repetidas” or “mediciones repetida” or “mediciones repetidas”)

**WHAT'S NEW**

Last assessed as up-to-date: 5 July 2016.

Date	Event	Description
22 June 2016	New citation required and conclusions have changed	Eight new studies were added to this update and the conclusions have changed
22 June 2016	New search has been performed	This is the first update of the Cochrane review published in 2011. We conducted a new search and updated other content. New authors were also added

## CONTRIBUTIONS OF AUTHORS

AO: screening, data extraction, analysis, and write up.

CW: screening, data extraction, analysis, and write up.

CO: screening and data extraction.

CN: screening.

OO: screening.

MM: review of the update.

All authors read and approved the final version for submission.

## DECLARATIONS OF INTEREST

Angela Oyo-Ita: none known.

Charles S Wiysonge: none known.

Chioma Oringanje: none known.

Chukwuemeka E Nwachukwu: none known.

Olabisi Oduwole: none known.

Martin M Meremikwu: none known.

## SOURCES OF SUPPORT

### Internal sources

- Vaccines for Africa Initiative, University of Cape Town (CW), South Africa.

### External sources

- Norwegian Agency for Development Cooperation (Norad), Norway.
- Research Council of Norway, Norway.

## DIFFERENCES BETWEEN PROTOCOL AND REVIEW

We have changed the first primary outcome from 'Number of children aged two years fully immunised per vaccine' in the previous version of this review to the first primary outcome 'Proportion of children who received DTP3 by one year of age' in this present review. The latter is a widely accepted standard measure of a childhood immunisation programme's ability to reach the target population.



## **INDEX TERMS**

### **Medical Subject Headings (MeSH)**

\*Developing Countries; \*Health Education; Immunization [\*utilization]; Motivation; Randomized Controlled Trials as Topic; Reward

### **MeSH check words**

Humans; Infant; Infant, Newborn