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Interventions for improving coverage of child immunization in low- and middle-income countries (Review)

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[Intervention Review]

Interventions for improving coverage of child immunization in low- and middle-income countries

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ABSTRACT

Background

Immunization coverage remains low, particularly in low- and middle-income countries (LMIC), despite its proven effectiveness in reducing the burden of childhood infectious diseases. A Cochrane review has shown that patient reminder recall is effective in improving coverage of immunization but technologies to support this strategy are lacking in LMIC.

Objectives

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

Search methods

We searched the following databases for primary studies: Cochrane Central Register of Controlled Trials (CENTRAL) 2010, Issue 1, part of *The Cochrane Library*. www.thecochranelibrary.com, including the Cochrane Effective Practice and Organisation of Care (EPOC) Group Specialised Register (searched 8 July 2010); MEDLINE, Ovid (1948 to March Week 3 2011) (searched 30 March 2011); EMBASE, Ovid (1980 to 2010 Week 26) (searched 8 July 2010); CINAHL, EBSCO (1981 to present) (searched 8 July 2010); LILACS, VHL (1982 to present) (searched 8 July 2010); Sociological Abstracts, CSA Illumnia (1952 to current) (searched 8 July 2010). Reference lists of all papers and relevant reviews were identified and searched for additional studies.

Selection criteria

Included studies were randomized controlled trials (RCTs), non-randomized controlled trials (NRCTs), and interrupted-time-series (ITS) studies. Study participants were children aged 0 to 4 years, caregivers, and health providers. Interventions included patient and community-oriented interventions, provider-oriented interventions, health system interventions, multi-faceted (any combination of the above categories of interventions), and any other single or multifaceted intervention intended to improve childhood immunisation coverage The primary outcome was the proportion of the target population fully immunized with recommended vaccines by age.

Data collection and analysis

Two authors independently screened full articles of selected studies, extracted data, and assessed study quality.

Main results

Six studies were included in the review; four were at high risk of bias. There was low quality evidence that: facility based health education may improve the uptake of combined vaccine against diphtheria, pertussis, and tetanus (DPT3) coverage (risk ratio (RR) 1.18; 95% CI 1.05 to 1.33); and also that a combination of facility based health education and redesigned immunization cards may improve DPT3 coverage (RR 1.36; 95% CI 1.22 to 1.51). There was also moderate quality evidence that: evidence-based discussions probably improve DPT3 coverage (RR 2.17; 95% CI 1.80 to 2.61), and that information campaigns probably increase uptake of at least a dose of a vaccine (RR 1.43; 95% CI 1.01 to 2.02).

Authors' conclusions

Home visits and health education may improve immunization coverage but the quality of evidence is low.

PLAIN LANGUAGE SUMMARY

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

Millions of children in low- and middle-income countries still die from diseases that could have been prevented with vaccines. In order to reach these children, a variety of interventions have been developed and, in some cases, their effect has been evaluated. The studies in this review took place in both rural and urban areas in several countries, including Pakistan and Ghana. The interventions included organising village meetings where immunisation was discussed and promoted; giving information to mothers during their visits to clinics; and distributing specially designed immunisation cards to remind mothers of their children's immunisation appointments. The families receiving these interventions were compared to families who only received the usual health services.

The review showed that village meetings probably lead to an increase in the number of children who get vaccinated. The quality of this evidence is moderate. Giving information to mothers during visits to the clinic, or giving them specially designed immunisation cards may increase the number of children who get vaccinated, but the quality of this evidence is low.

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

Health education for improving coverage of child immunization in low- and middle-income countries

Patient or population: patients with improving coverage of child immunization in low- and middle-income countries
Settings: low- and middle- income countries
Intervention: health education

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Control	health education				
Uptake of at least one vaccine (information campaign) Follow-up: 12 months	**94 per 1000** [1]	**134 per 1000** (95 to 190)[1]	**RR 1.43** (1.01 to 2.02)	1025 (1 study[1,2])	Moderate	
DPT3 uptake (Facility Based Health Education) Follow-up: 90 days	**547 per 1000**	**645 per 1000** (574 to 728)	**RR 1.18** (1.05 to 1.33)	750 (1 study[3])	Low	
DPT3 uptake (Facility based Health Education + Redesigned card)	**547 per 1000**	**744 per 1000** (667 to 826)	**RR 1.36** (1.22 to 1.51)	750 (1 study[3])	Low	
DPT3 uptake (evidence based discussion) Follow-up: 12 months	**244 per 1000**	**529 per 1000** (349 to 803)	**RR 2.17** (1.43 to 3.29)	957 (1 study[4,5])	Moderate	
Measles uptake (evidence based discussion)	**324 per 1000**	**528 per 1000** (334 to 836)	**RR 1.63** (1.03 to 2.58)	956 (1 study[4,5])	Moderate	

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison 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 quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Household cluster randomisation
[2] Pandey 2007
[3] Usman 2009
[4] Andersson 2009
[5] Cluster randomisation of enumeration areas

BACKGROUND

Immunization is reported to be second to clean water in reducing the burden of infectious diseases (Andre 2008). Vaccines are available for tuberculosis, diphtheria, measles, tetanus, hepatitis B, poliomyelitis, Haemophilus Influenza, pertussis, yellow fever, mumps, rubella, pneumococcal infections, rotavirus, and cholera. Immunization is said to be the single most efficient and cost effective means of controlling these diseases (JAMA 2006; NSW 2003). This is evident in the drastic decline, and in some cases elimination, of certain infectious diseases since the introduction of vaccines in the 20th century (CDC 1999a; NSW 2003).

Vaccines are not only used in preventing disease, they are useful in the mitigation of the severity of disease, prevention of infections, prevention of cancers (for example cancer of the cervix, cancer of the liver), and reduction in the complications associated with the infections (Andre 2008). When a sufficient proportion of the population is immune there is an indirect effect on the whole population, called 'herd immunity' (Andre 2008). This causes a reduction in the spread of the infective agent by blocking its transmission from one person to another.

Description of the condition

There have been concerted efforts by the World Health Organization (WHO) to boost immunization coverage globally. One such effort was the launching of the Expanded Program on Immunization (EPI) in 1974. The target of the program was to achieve 80% coverage of children aged less than two years with vaccines against six childhood killer diseases, namely measles, diphtheria, tetanus, polio, tuberculosis (Bacille Calmette-Guérin (BCG), and pertussis, by 1990 (Piotrow 1992; Worldbank 2009). By 1980 the coverage of the combination vaccine against diphtheria, pertussis (whooping cough) and tetanus (DPT3) was estimated to be only 20%. By 2003, however, coverage had increased to 78% globally. The progress in low- and middle-income countries (LMIC) is slow nevertheless and DPT3 coverage in sub-Saharan Africa is estimated to be 60%. Of the estimated 27 million children that were yet to be reached with DPT3 vaccine, 9.9 million were in South Asia and 9.6 million in sub-Saharan Africa (WHO 2004). In 2002, WHO estimated that about 1.9 million of the 2.5 million (76%) vaccine preventable worldwide deaths among children aged less than five years occurred in Africa or South East Asia (JAMA 2006). Among these childhood deaths, over 500,000 were caused by measles; nearly 400,000 by Haemophilus influenza B; 300,000 by pertussis; and 180,000 by neonatal tetanus (WHO 2004).
This trend will leave the attainment of the Millennium Development Goal of reducing child mortality rate by two thirds by 2015 elusive, particularly in LMIC. So far, only 16% of LMIC countries are on track to achieve this goal, and none are on track in sub-Saharan Africa (GAVI 2005). Poor vaccination coverage has been attributed to poor access to vaccines and high dropout rates from vaccination programmes (Nath 2007). A strategy is needed for immunization that will achieve a high and sustainable coverage in LMIC countries.

Description of the intervention

Currently vaccines are made accessible through routine immunization provided in fixed facilities (such as health centres, outpatient clinics, and district hospitals) as well as through mobile strategies, immunization outreach programs, extended outreach programs, and immunization campaigns. In fixed-facility strategies, vaccines are provided on a routine basis in static health facilities at different levels of the health system. National or subnational immunization campaigns can be carried out for specific vaccines, and these are usually targeted at boosting ongoing immunization activities. For mobile immunization strategies, specialized vehicles are used to convey vaccines to remote areas. When health workers convey vaccines from the health facility to the homes of the people in the community this is termed an outreach programme. When the outreach is intensive (for example reaching out to target populations in their homes, markets, places of worship, and remote communities) it is known as 'extended outreach' (Brenzel 2006). All these strategies have been adopted in the LMIC to improve vaccine uptake.

How the intervention might work

Strategies for improving immunization coverage could be patient-oriented interventions, provider-oriented interventions, or system interventions (Jacobson Vann 2005). Patient-oriented interventions are aimed at increasing the demand for vaccination by the patient, for example patient recalls and reminders or health education of clients. Provider-oriented interventions are aimed at reducing missed opportunities, such as audit and feedback and chart-based or computerized provider reminders. System interventions improve access to the services through such methods as outreach programs and improve quality of delivery of care (CDC 1999b).

Why it is important to do this review

In a Cochrane systematic review a patient-oriented intervention, patient reminder and recall, was reviewed. The evidence indicated that reminding people to receive immunization through postcards, letters, or telephone calls increased immunization uptake (NSW 2003). This strategy generally relies on setting up an efficient computerized immunization registry or other practice based tickler systems to track clients' immunization status and eligibility for recommended vaccines, and also an efficient communication system to send reminders to clients. These technologies are lacking in LMIC. This review examines the effects of strategies that utilise

available resources in LMIC for improving immunization coverage in the bid to provide evidence on appropriate strategies to improve and sustain immunization coverage in this setting.

OBJECTIVES

To evaluate the effectiveness of intervention strategies to boost and sustain high childhood immunization coverage in low- and middle-income countries (LMIC).

METHODS

Criteria for considering studies for this review

Types of studies

1. Randomized controlled trials (RCT)
2. Non-randomized controlled trials (NRCT)
3. Interrupted-time-series studies (ITS) (with a clearly defined point at which the intervention occurred and at least three data points before and three after the intervention)

Types of participants

Community or institutional based studies in LMIC that include:

- children aged zero to four (under five) years who received globally recommended vaccines which include any of diphtheria, pertussis, tetanus, measles, mumps, rubella (as single or combined antigens), polio, BCG, Hepatitis B, Haemophilus Influenza;
- caregivers, to improve child vaccination;
- care providers, with the intent of improving child vaccination.

Types of interventions

Interventions

1. Patient- or community-oriented interventions, for example:
   - vaccination requirement for school entry;
   - client incentives;
   - health education.
2. Provider-oriented interventions, for example:
   - any intervention to reduce missed opportunity (e.g. audit and feedback, provider reminders, fact sheet provider reminders);
   - health education, training, and update courses for providers.
3. Health system interventions, for example:
   - interventions to improve the quality of services, such as provision of reliable cold chain system, provision of transport for vaccination, vaccine stock management;
   - outreach programmes e.g. school immunization outreach program, door-to-door canvassing (channeling), immunization campaigns (national and subnational);
   - expanded services e.g. extended hours for immunization;
   - budget for immunization;
   - integration of immunization services with other services;
   - plan of action for immunization coverage and disease reduction goals.
4. Multi-faceted (any combination of the above categories of interventions).
5. Single or multiple interventions, other than the above, intended to improve immunization coverage.

Exclusion

Patient reminder and recall as this is covered in an existing review (Jacobson Vann 2005).

Comparisons

1. Routine immunization 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 target population fully immunized with recommended vaccines, by age
2. Number of children aged two years fully immunized per vaccine

Secondary outcomes

1. Occurrence of vaccine preventable diseases
2. Number of under-fives fully immunized with all scheduled vaccines
3. Number of under-fives partially immunized for multi-dose vaccines
4. Costs of intervention
5. Attitudes of caregivers and clients towards immunization
6. Unintended adverse effects

Exclusion

Controlled before-and-after studies that had only two study locations were excluded from the review in accordance with Effective

Practice and Organization of Care criteria for inclusion of controlled before and after (CBA) studies.

Search methods for identification of studies

Electronic searches

We searched the Database of Abstracts of Reviews of Effectiveness (DARE) for related reviews. Selected reviews were searched for potentially eligible studies.

We searched the following electronic databases for primary studies:

- The Cochrane Central Register of Controlled Trials (CENTRAL) 2010, Issue 1, part of the *The Cochrane Library.* www.thecochranelibrary.com, including the Cochrane Effective Practice and Organisation of Care (EPOC) Group Specialised Register (searched 8 July 2010);
- MEDLINE, Ovid (1948 to March Week 3 2011) (searched 30 March 2011);
- EMBASE, Ovid (1980 to 2010 Week 26 2010) (searched 8 July 2010);
- CINAHL, EBSCO (1981 to March present) (searched 8 July 2010);
- LILACS, VHL (1982 to present) (searched 8 July 2010);
- Sociological Abstracts, CSA Illumnia (1952 to current) (searched 8 July 2010).

Strategies that incorporate the methodological component of the EPOC search strategy combined with selected index terms and free text terms were developed. The MEDLINE search strategy was translated for the other databases, using the appropriate controlled vocabulary, as applicable.
The full search strategies for all databases are included in Appendix 1.

Searching other resources

- Reference lists of all papers and relevant reviews were identified and searched.

Data collection and analysis

Selection of studies

Two review authors independently screened titles and abstracts of papers for potentially eligible studies. Full texts of selected studies were retrieved for screening and both authors independently applied the inclusion criteria to the publications. Disagreements about the inclusion of studies were resolved through a consensus between the two authors; a third author was involved if the disagreement was not resolved. Methodological advice was also obtained from the EPOC editorial base for unresolved issues. Reasons for excluding studies are presented in Characteristics of excluded studies.

Data extraction and management

A data extraction form was developed, which was reviewed by all of the review authors. Data extraction and risk of bias assessment were carried out independently by two review authors. Disagreements in data extraction were resolved by consensus between the two review authors. The data extracted into an Excel spreadsheet included the following.
1. Setting of the study.
2. Type of study: distinguishing between individual RCT, cluster RCT, and NRCT.
3. Type of participants: children, caregivers, providers.
4. Type of interventions: categorized into patient and community, provider, health system, and multi-faceted.
5 Types of outcomes measured: data on outcome measures like proportion of children immunized with different antigens based on the different interventions.

Assessment of risk of bias in included studies

The EPOC risk of bias criteria for randomised controlled trials (RCTs), non-randomised controlled trials (NRCT), and interrupted time series (ITS) studies were applied to determine the risk of bias of all eligible studies. Two review authors applied the criteria, which are given below. Disagreements were discussed with a third review author.

Criteria for randomised controlled and non-randomised controlled trials

1. Was the allocation sequence adequately generated?
2. Was the allocation adequately concealed?
3. Were baseline outcome measurements similar?
4. Were baseline characteristics similar?
5. Were incomplete outcome data adequately addressed?
6. Was knowledge of the allocated interventions adequately prevented during the study?
7. Was the study adequately protected against contamination?
8. Was the study free from selective outcome reporting?
9. Was the study free from other risks of bias?

Criteria for interrupted time series studies

1. Was the intervention independent of other changes?
2. Was the shape of the intervention effect pre-specified?
3. Was the intervention unlikely to affect data collection?
4. Was knowledge of the allocated interventions adequately prevented during the study?

5. Were incomplete outcome data adequately addressed?
6. Was the study free from selective outcome reporting?
7. Was the study free from other risks of bias?

Each criteria were scored as 'YES', 'NO', or 'UNCLEAR' (Figure 1). The methodological quality of each included study is presented in Figure 2.

Figure 1. Methodological quality graph: review authors' judgements about each methodological quality item presented as percentages across all included studies.

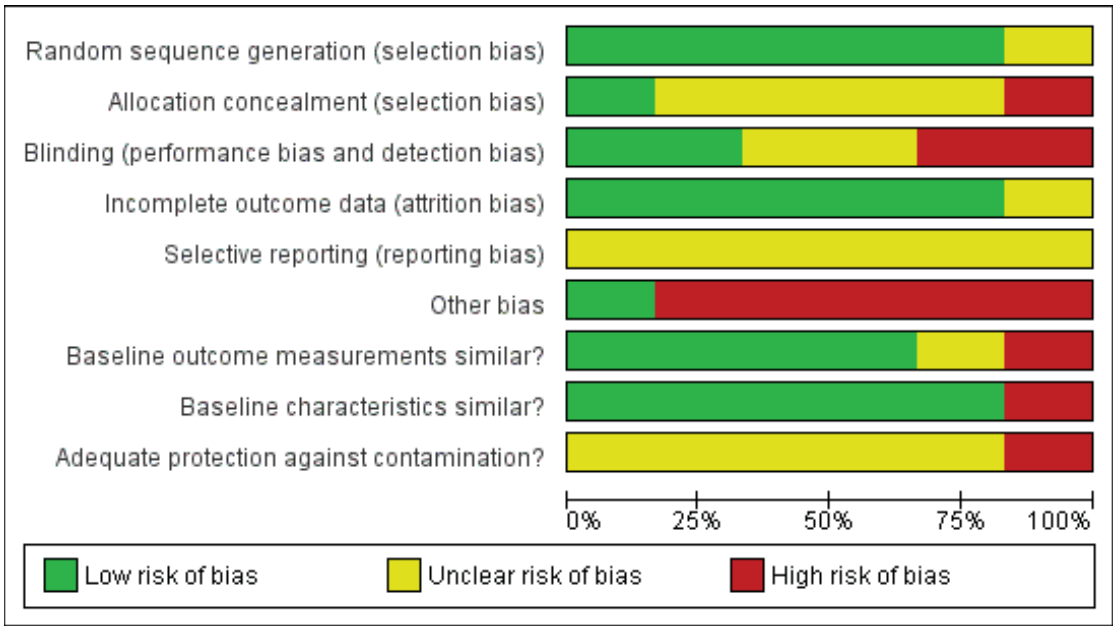
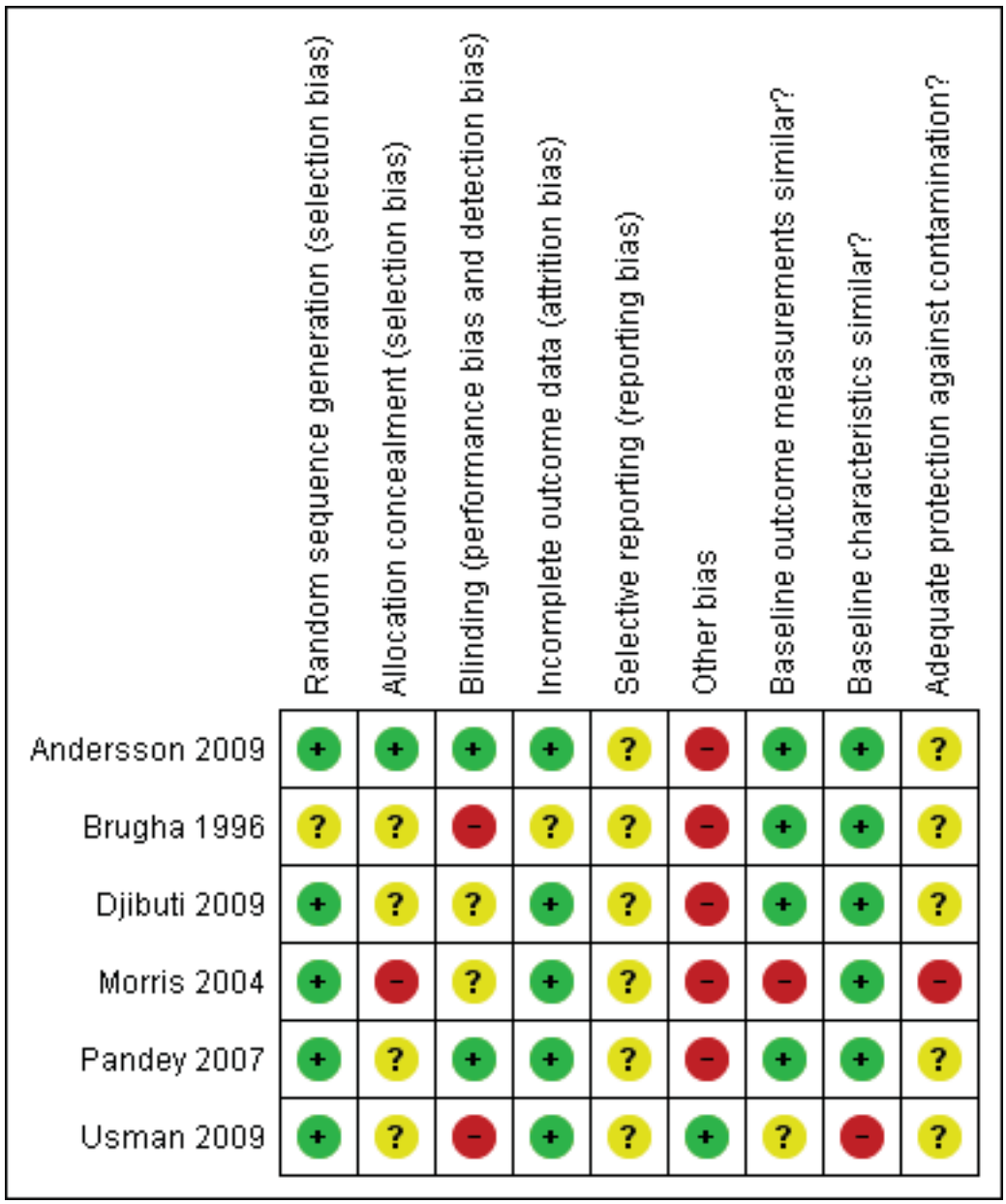


Figure 2. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.



Low risk of bias = all criteria prescribed by EPOC scored as 'done'
Moderate risk of bias = one or more criteria scored as 'not clear'
High risk of bias = one or more key criteria scored as 'not done'

Measures of treatment effect

Risk ratio was used in our analysis of dichotomous data. Outcomes reported varied between studies so the available data were entered into RevMan as individual studies. The risk ratio between intervention and control results for individual studies is discussed. The weighted mean difference was to be calculated for costs and any other analysis of continuous data but there were no data for this. The random-effects model was used as the default procedure in the analysis.

The results of analyses of the effects of interventions on immunization coverage were interpreted in the context of systematic reviews of the effects of an intervention across different outcomes. For example, the effects of client incentives on immunization coverage were interpreted in the context of systematic reviews of the effects of client incentives more broadly (Giuffrida 1997; Kane 2004; Lagarde 2007).

Unit of analysis issues

Cluster randomised trials were included in the meta-analysis only after adjustments were made for design effect. Design effects for cluster randomised studies were corrected by using standard procedures (Rao 1992), using the formula: design effect = 1 + (m - 1)r, where m is the average cluster size and r is the intra-cluster correlation coefficient. Using data from Andersson 2009, the intra-cluster correlation coefficient (ICC) was calculated to be 0.25 for measles and 0.14 for DPT3. This was used to estimate the adjusted standard error for the Andersson 2009, Brugha 1996, and Usman 2009 data.

Dealing with missing data

The authors of two studies (Djibuti 2009; Morris 2004) were contacted to obtain missing data. A response was received from Morris 2004, which was used in estimating the ICC for the study. Additional data received by communication with the primary author provided the absolute number of events in each arm of the study for the Morris 2004 study; the ICC for MMR (0.013) and DPT1 (0.0377) were estimated for the post-intervention only. The ICC was used to adjust the standard error for the two outcomes presented in the review from this study.

Two studies (Brugha 1996; Usman 2009) followed up the same set of participants post-intervention; there were no missing data in these studies. The remaining four studies had independent sampling at pre- and post-intervention stages.

Assessment of heterogeneity

We proposed to consider heterogeneity to be 'statistically significant' if the P value for the Chi^2 test was < 0.1, or the I^2 statistic was 50% or more. Such data were to be presented in additional tables and not pooled in a meta-analysis.

Due to paucity of data, differing methods of intervention, and variability in the outcome measures reported in the included studies, statistical pooling of outcome data was not possible. The data were therefore discussed by intervention for the individual studies.

Data synthesis

Data from studies of similar interventions (that is with similar participants, outcomes, and study designs) were to be pooled in a meta-analysis using the random-effects model if there was no significant statistical heterogeneity or methodological difference, or high risk of bias. ITS studies were to be reported as changes in level and slope.

ASSESSMENT OF DATA QUALITY

Quality of evidence was further assessed using GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) (Guyatt 2008; Higgins 2008). Data for key interventions were entered into the Grade Profiler and the quality of evidence for the outcomes was graded as 'high', 'moderate', 'low', and 'very low', defined as follows.

High quality: further research is very unlikely to change the confidence in the estimate of effect.

Moderate quality: further research is likely to have an important impact on the confidence in the estimate of effect and may change the estimate.

Low quality: further research is very likely to have an important impact on the confidence in the estimate of effect and is likely to change the estimate.

Very low quality: the estimate is uncertain.

Sensitivity analysis

Sensitivity analysis based on risk of bias and missing data was to be performed if there was sufficient data. There were insufficient data to perform a sensitivity analysis.

RESULTS

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of studies awaiting classification.

Results of the search

The initial search yielded 3678 records. Following screening of titles and abstracts, 46 studies were selected for full text screening; six of these were eligible for inclusion in the review. Reasons for exclusion are given in the table Characteristics of excluded studies.

Included studies

Six studies met the inclusion criteria. Five of the studies (Andersson 2009; Brugha 1996; Djibuti 2009; Morris 2004; Pandey 2007) were cluster RCTs. Of these, Brugha 1996 was a matched cluster randomised trial and Djibuti 2009 used stratified cluster sampling. Usman 2009 was an individually randomised controlled trial. The unit of analysis was individuals in all the studies except Morris 2004 and Pandey 2007, in which the unit of analysis was the household.

Location of study

Two of the studies (Andersson 2009; Usman 2009) were carried out in Pakistan; and one each in Georgia (Djibuti 2009), Ghana (Brugha 1996), Honduras (Morris 2004), and India (Pandey 2007).

Participants

Andersson 2009 included children aged between 12 and 23 months; Brugha 1996 studied children that were 12 to 18 months old; and Usman 2009 included all children (with no age specification). Participants in three studies were adults: primary healthcare workers (Djibuti 2009), in the general population (Pandey 2007), and pregnant women (Morris 2004). The adults were targeted with a view to improving childhood immunization.

Sampling

Two studies (Andersson 2009; Djibuti 2009) were population studies: independent sampling was carried out at pre- and post-intervention periods. Andersson 2009 sampled 32 enumeration areas (EAs) (18 EAs for intervention and 14 EAs for control); each enumeration area comprised four or five villages. Of the 3166 children aged less than 5 years in the intervention arm, 538 children aged 12 to 23 months were selected for the baseline study. The control arm had 2475 under 5 children, of which 373 aged 12 to 23 months were selected at baseline. The post-intervention period included 536 children in the intervention arm and 420 children in the control arm.

Djibuti 2009 included 197 and 195 primary healthcare providers in the intervention and control arms, respectively, at baseline; and 282 and 239 at post-intervention. Baseline evaluation also included 14 and 12 immunization managers in the intervention and control arms respectively. The number of children was not specified.

Two studies (Brugha 1996; Usman 2009) followed up the same participants at pre- and post-intervention. Brugha 1996 sampled clusters that consisted of 36 to 39 residences per cluster; 200 children were included in the intervention arm while the control arm had 219 participants. Usman 2009 had 375 children in each of the three intervention arms and 375 children in the control arm. The total number of children participating in the two studies was 1919 (1325 for the intervention groups and 594 for the control groups).

Morris 2004 had independent sampling for each outcome and for each arm of the four intervention groups. For tetanus toxoid (TT), 1150 mothers were included. DTP and measles had 3171 and 1188 children respectively at baseline. Post-intervention samples were 950, 2827, and 1049 children for TT, DTP, and measles respectively. This gave a total of 8235 children for this study.

Pandey 2007 included a total of 1045 households in the study.

Data Analysis

Meta-analysis was not feasible because of the variability in the outcomes reported in the included studies. Data from individual studies were presented based on the type of intervention used, as follows.

1. Patient and community oriented interventions
   - Health education
   - Redesigned immunization card plus health education
   - Monetary incentives

2. Provider intervention
   - Training of immunization district managers

3. Health system oriented
   - Home visits

4 Multi-faceted interventions
   - Health system plus provider oriented intervention
   - Health system plus provider oriented plus patient oriented intervention

Interventions

1. Patient and community 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 immunization (Andersson 2009); and an information campaign that involved presentation of audiotape messages, and distribution of posters and leaflets in the community (Pandey 2007). One of the four arms of the Usman 2009 study provided health education in the health centre on the importance of completion of the immunization schedule for those registered for immunization.

Monetary incentives

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.

Patient reminder

An enlarged immunization card for DPT vaccination, designed to remind mothers of immunization appointments, was evaluated in the Usman 2009 study. Patient reminders and recall have already been reviewed in another Cochrane Review (Jacobson Vann 2005) and they are not evaluated in this review.

2. Provider oriented interventions

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

3. Health system interventions

Home visits

Brugha 1996) reported on the effects of home visits on childhood immunization: undergraduate students conducted the home visits which aimed to identify non-immunized children and refer them for immunization at the health centre.

4. Multi-faceted (health system plus provider interventions)

An arm of the Morris 2004 study set up quality assurance teams at each health centre. The team was trained on quality assurance methods. They produced work plans which could include minor structural repairs 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 less than two years of age 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. Quality assurance (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 utilization of services.

Control

The control groups received routine care in four studies (Andersson 2009; Brugha 1996; Morris 2004; Usman 2009). The study authors did not state what the routine care comprised of. There were no interventions in two studies (Djibuti 2009; Pandey 2007).

Outcome

Three of the studies (Andersson 2009; Brugha 1996; Djibuti 2009) provided data on the proportion of the target population that was fully immunized (by age) by the recommended vaccine. Two studies (Andersson 2009; Morris 2004) reported the percentage change in immunization coverage over time. Other outcomes reported were: TT coverage in children (Pandey 2007), received at least one vaccine (Pandey 2007), oral polio I coverage (Brugha 1996), completion of schedule (Brugha 1996) (*schedule not specified in the Brugha study*), and cost of the intervention (Andersson 2009).

Outcomes were measured at an individual level by Andersson 2009 and Usman 2009; while Pandey 2007 measured the outcome at the household level.

Follow up

The period of follow up varied between studies from three months to four years. Only one study (Usman 2009) had no loss to follow up. Two studies (Morris 2004; Pandey 2007) had a 5% and 2.4% loss to follow, respectively. Two studies (Andersson 2009; Djibuti 2009) had two independent samples for pre- and post-follow up, while Brugha 1996 did not account for loss to follow up.

Excluded studies

Forty studies were excluded from the review. Reasons for exclusion were as follows: inappropriate study design (36 studies); one study reported on a patient reminder intervention, which is the subject of another Cochrane review (Linkins 1994); and Anjum 2004 and Pierce 1996 included only two study locations, which fails to meet the EPOC criteria for inclusion of controlled before and after (CBA) studies. The setting in Kerpelman 2000 was a high income country.

Risk of bias in included studies

For important outcomes, the risk of bias in relation to selection (allocation concealment) and attrition (incomplete outcome data) was generally assessed as low, apart from Brugha 1996 where the risk of bias was unclear. Risk of bias in relation to blinding of participants, personnel and outcome assessments was mixed, with two studies being assessed as being at high risk of performance and / or detection bias (Brugha 1996; Usman 2009). For all studies,

it was unclear if there was selective reporting of outcomes. Apart from Usman 2009, all studies were also at high risk of other forms of bias, largely due to a failure to adjust adequately for clustering.

Effects of interventions

See: **Summary of findings for the main comparison** health education for improving coverage of child immunization in low- and middle-income countries

1. Patient and community oriented interventions

These included health education, use of a combination of re-designed cards and health education, and a monetary incentive.

Impact of health education

There was moderate quality evidence that evidence based discussions probably improve vaccine coverage for: DPT3 (RR 2.17; 95% CI 1.43 to 3.29) and measles (RR 1.63; 95% CI 1.03 to 2.58) (Figure 3) (Andersson 2009).There was also low quality evidence that facility based health education may improve DPT3 coverage (RR 1.18; 95% CI 1.05 to 1.33) (Figure 4) (Usman 2009). Pandey 2007 provided moderate quality evidence that information campaigns probably increase uptake of at least one dose of a vaccine (RR 1.43; 95% CI: 1.01 to 2.02).

Figure 3. Forest plot of comparison: 1 Community based discussion for improving coverage of child immunization in low- and middle- income countries, outcome: 1.1 DPT3 and Measles (Adjusted)

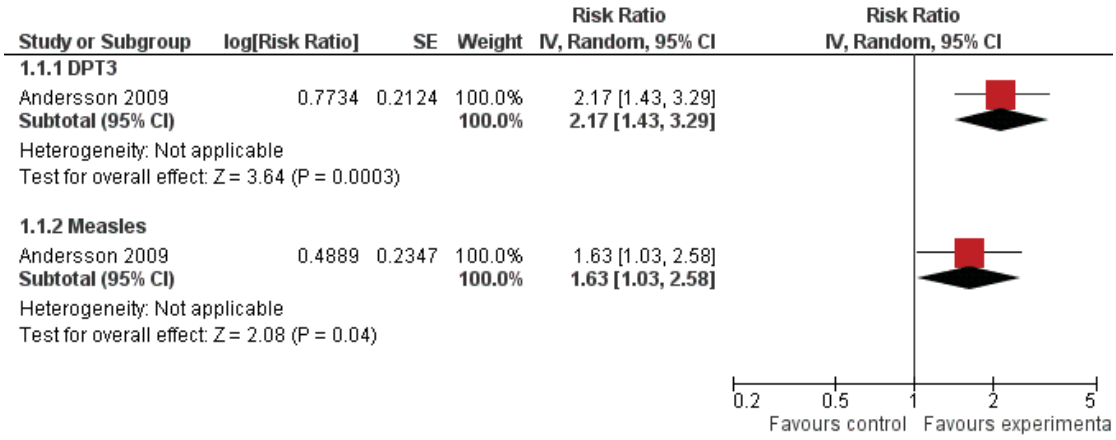
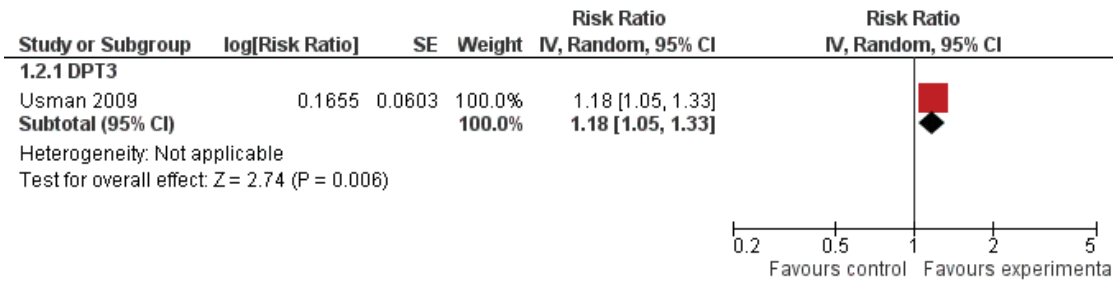


Figure 4. Forest plot of comparison: 1 Health Education for improving coverage of child immunization in low- and middle- income countries, outcome: 1.2 DPT3 coverage



Impact of health education plus redesigned card

One of the arms of the Usman 2009 study combined facility based health education with a redesigned immunization card. The findings suggest that this intervention may improve DPT3 coverage (RR 1.36; 95% CI 1.22 to 1.51). The evidence was of low quality.

Impact of monetary interventions

Morris 2004 provided data on the impact of withdrawing monetary vouchers (household package) on the uptake of mumps, measles, rubella (MMR) and DPT1 vaccines. The study suggests that this monetary incentive may lead to little or no difference in the uptake of MMR (RR 0.95; 95% CI 0.83 to 1.07) or DPT1 (RR 1.09; 95% CI 0.94 to 1.28). The quality of this evidence was low.

2. Provider oriented interventions

The impact on immunization coverage of training of immunization managers to provide supportive supervision for health providers was assessed by Djibuti 2009. Following the intervention, coverage for DPT3, OPV3, and hepatitis B3 was higher in the intervention than the control group. The differences were 4.3% (P = 0.285), 8.4% (P = 0.173), and 13.4% (P = 0.172) for DPT3, OPV3, and hepatitis B3 respectively. The quality of this evidence was low.

3. Health system interventions

Impact of home visits

Brugha 1996 assessed the effects of home visits on coverage for OPV3 and measles. These home visits may improve OPV3 (RR 1.22; 95% CI 1.05 to 1.42) (Figure 5) and measles coverage (RR 1.26; 95% CI 1.08 to 1.46) (Figure 6). The quality of the evidence was low.

Figure 5. Forest plot of comparison: 3 Home visits for improving coverage of child immunization in low- and middle income- countries, outcome: 3.1 OPV3 (Adjusted)

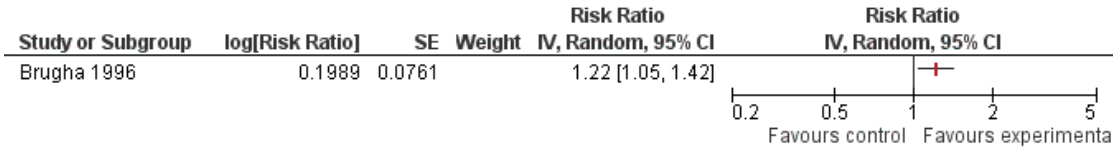
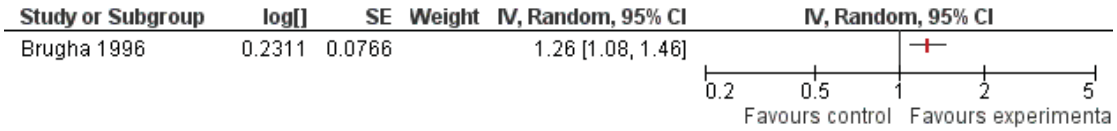


Figure 6. Forest plot of comparison: 3 Home visits for improving coverage of child immunization in low- and middle- income countries, outcome: 3.2 Measles coverage (Adjusted)



4 Multi-faceted interventions

i) Impact of health system plus provider oriented interventions

An arm of the study by Morris 2004 aimed to strengthen peripheral health services through training quality assurance teams (provider package) and the provision of equipment, drugs, and materials (health system package) as well as nutritional promotion.

As noted earlier, this arm of the intervention was not delivered as per protocol. There was low quality evidence that this intervention may lead to little or no difference in MMR (RR 1.06; 95% CI 0.91 to 1.23) or DPT1 (RR 1.00; 95% CI 0.83 to 1.21) coverage.

ii) Impact of health system plus provider oriented plus patient oriented interventions

A combination of monetary incentives (patient oriented); quality assurance (provider oriented); and provision of equipment, drugs and materials (health system oriented) interventions was evaluated in another arm of Morris 2004. The study suggests that this intervention may lead to little or no difference in MMR (RR 1.11; 95% CI 0.99 to 1.24) and DPT1 uptake (RR 1.15; 95% CI 0.97 to 1.37). The quality of this evidence was low.

Secondary outcomes

Costs of the intervention

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

DISCUSSION

Summary of main results

Six studies met the inclusion criteria; five were cluster randomised and one involved randomisation at an individual level. The studies were small and only two (Andersson 2009; Pandey 2007) were assessed as having moderate risk of bias; the others had a high risk of bias (Figure 2). The methods of delivering the interventions were very varied as were the outcomes reported, hence meta analysis was not feasible for any of the outcomes.

Data were summarised based on whether the interventions targeted patients (or caregivers), or the community health care providers, or the health system. Interventions focusing on the patient/community included health education, redesigned immunization cards, monetary aid and various combinations of these. The evidence on facility based health education was assessed as low quality and showed that it may lead to small increases in DPT3 uptake and that combination of health education with a redesigned card may result in a larger increase on coverage. Moderate quality of evidence indicated that evidence based discussions in the community may have an even larger impact on measles uptake and DPT3 than facility based health education; and information campaign in the community may increase the uptake of at least one vaccine.

Monetary incentives in the form of vouchers failed to impact on the uptake of vaccines (low quality evidence). This is contrary to reports from other systematic reviews. A Cochrane systematic review on the effect of conditional cash transfer on health outcomes and use of health services reported an improvement in the use of health services but a mixed result in uptake of immunization in children (Lagarde 2007). Another review demonstrated the effectiveness of financial incentives on patients' compliance to treatment (Giuffrida 1997). In another systematic review, Kane 2004 reports that economic incentives (for example cash, gifts, lotteries, free or reduced price for goods and services) are effective for short term impact on preventive care such as immunization but are not effective for sustained behaviour change in low- and middle-income countries. The Morris 2004 study may have failed to demonstrate an effect because only 79% of beneficiaries were reached and 86% of the entitlement was released, with the release of the last voucher partly coinciding with the post-intervention survey.

Only one study provided data on an intervention that targeted healthcare providers. It evaluated the impact of training of immunization managers to better supervise immunization providers. The intervention was of low quality and had no effect on the coverage of vaccines. Home visits were the only health system intervention studied. This intervention may lead to small increases in the uptake of OPV3 and measles vaccine when compared with routine immunization; the quality of the evidence is low. The low quality of evidence provided on multi-faceted interventions did not show an improvement in uptake of vaccines.

There is paucity of data on the sustainability of the interventions presented in this review. There were no indicators that the interventions were to be continued beyond the duration of the studies. One of the factors that may hinder sustainability is the cost of the intervention. This is particularly so when the intervention is cost intensive. Information on the cost implications for interventions may be helpful in determining their long term sustainability and cost effectiveness. Only one study provided data on the cost of intervention and this was estimated to be nine US dollars per child. Shea 2009 has observed that the cost of interventions depends on the context of the intervention, as cost effectiveness ratios have varied between one to forty dollars per child to be fully vaccinated. The cost of interventions should therefore be reviewed within the context and settings of the studies.

Overall completeness and applicability of evidence

Barriers to improving immunization coverage could be broadly categorised into factors that affect the demand for vaccines, barriers to the supply of vaccines, or both. Interventions to improve coverage should therefore target improving the demand or supply of vaccines, or both. For this, settings vary in their needs. While some will require an increased demand others may need to im-

prove supply. Adoption of any of the interventions therefore requires that the need be clearly identified and an appropriate intervention adopted as deemed fit for the setting.

Included studies presented interventions that varied enormously in content and in the intensity of delivery, raising questions on the replication of these interventions in non-experimental settings. For instance, how effective will a three minute health education (as presented in Usman 2009) be in a typical clinical setting in improving uptake and completion of immunization? Will the same effect be obtained for more than one vaccine? How feasible is an evidence based discussion in an illiterate setting? How feasible is a monetary incentive in a resource-poor setting without donor support? Limited numbers of studies make it difficult to explore these issues and restrict the wider applicability of the evidence.

The applicability of the home visit intervention that was included may be affected by the following:

- The use of first degree university students in delivering the intervention. This is not feasible in most settings and it is questionable if the use of community health workers will produce the same effect. A Cochrane systematic review has reported moderate quality evidence of effectiveness in the use of lay health workers in promoting the uptake of immunization in children (Lewin 2010). The lay health workers were primary school graduates or college educated and the setting of the studies was middle- and high- income countries. The use of first degree students may not be justified in a resource poor setting.
- Referring those who need immunization to the health facility requires that there is a facility within reasonable distance of the community. In settings in which households do not have easy access to health facilities this kind of intervention may not be useful.
- Choosing to give the vaccine at home raises questions on the cost effectiveness of such an approach in a resource-constrained economy, and also poses questions on sustainability. It has implications on vaccine quality and injection safety.

Though definitions of sustainability vary, some experts have identified a conceptual framework within which sustainability can be assessed. These are maintenance or continuance of health benefits from programs, institutionalisation of programs within the system, and capacity development (Gruen 2008; Shediac-Rizkallah 1998). None of the included studies discussed the possibility of maintaining the interventions beyond the study period, nor integrating them into existing programs. All had two data points which were at baseline and post-intervention, making it impossible to ascertain the long term effects of the interventions. Two studies, however, 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 the sustainability if the supporting resources are available. It has been observed that for a program to be sustained, early and active planning is required (Shediac-Rizkallah 1998). Sustainability has been particularly challenging in low- and middle-income countries (Gruen 2008). This is more so when the program is supported by external funds. Withdrawal of the external funds will not only impact negatively on the gains of the program but may jeopardize support for future programs (Gruen 2008).

Many immunization programs in LMIC are delivered as mass immunization on set immunization days following mass immunization campaigns (Balraj 1986, Bandyopadhyay 1996, Berry 1991, Cutts 1990, Dammanni 1990, Gomber 1996, Kumar 1990, Lin 1979, Linkins 1995, Shaikh 2003). No rigorous evaluations of this commonly used strategy were identified for inclusion in the review. 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 on immunisation coverage.

Considering that these interventions were set up as parallel programs, it is questionable how effective they will be if integrated with other services within the system, with the general level of manpower and other resources available. This calls for cost effectiveness evaluations of these interventions, particularly as integrated rather than stand-alone programs. The cost information provided in the studies was limited; more robust cost effectiveness studies are required for each intervention in order to estimate the unit cost of immunising one child when using different strategies.

Quality of the evidence

Six studies were included in the review. Studies could not be pooled for meta-analysis due to the small number of eligible studies, variations in study design and outcome measures, and unit of analysis errors.

Only two studies were of moderate risk of bias; the risk of bias was high in the other studies and this was mainly because of non-concealment of allocation, no blinding, lack of protection against contamination, and extraneous sources of bias. Only one of the five cluster randomised trials was adjusted for the cluster effect.

Potential biases in the review process

Access to studies from low- and middle-income countries is limited to those studies published in indexed journals. There may be a need for handsearching in non-indexed, local journals.

Agreements and disagreements with other studies or reviews

Measures of effect for patient reminders tend to agree with a similar review aimed at reminding patients of their immunization schedules (Jacobson Vann 2005). Home visits, patient reminders through a redesigned immunization card, and health education improved the uptake of immunization 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 patient reminder review.

AUTHORS' CONCLUSIONS

Implications for practice

Interventions targeting patients or communities and the health system (including with redesigned immunization cards, health education, and home visits) may increase the coverage of vaccines. The results of one study that combined redesigned cards with facility based health education suggest that the effect may be increased if the interventions are administered in combination rather than as single interventions. The magnitude of effect of these interventions is small and sustainability over long periods is uncertain. Evidence based discussion that aims at knowledge translation to the community members may be more effective than conventional health education strategies.

There is insufficient evidence on the effects of monetary incentives on immunization uptake. Monetary incentives may fail to improve coverage when other barriers to immunization exist. Issues to be considered by policy makers when planning incentive interventions are outlined in a Cochrane systematic review on conditional cash transfers (Lagarde 2007).

Provider oriented interventions appear to have a limited impact on increasing immunization coverage in LMIC, even when combined with patient and health system interventions.

There is, however, insufficient evidence of effectiveness of any of the interventions in improving immunization coverage in LMIC due to the paucity of rigorous studies and the low quality of available evidence.

Implications for research

Rigorous studies that measure outcomes that are important to policy makers are needed. The following outcomes should be included: the proportion of children that are fully immunized with all antigens, and the proportion of children with vaccine preventable diseases. Measures of sustainability, such as the extent to which these interventions are integrated into routine immunization services, should also be assessed in these studies. Economic studies should also accompany these studies to establish the cost effectiveness of different strategies.

Patient reminder and recall interventions that are adaptable to LMIC need to be developed and tested as this approach has been shown to be effective in high income countries. In addition, more head-to head evaluations of community based health education strategies are needed as these interventions may be more effective than a facility based approach.

The studies that assessed provider and multi-faceted interventions suggested that these did not improve immunization coverage in children. However, this evidence was of low quality and therefore needs to be viewed with caution as the true effect may be substantially different. Also, these studies did not include immunization coverage as their primary outcome, and so may have been underpowered to detect changes in this outcome. Rigorous trials are required to assess the effects of these interventions on immunization coverage.

Finally, the effects of mass immunization campaigns on vaccine coverage should be evaluated - interrupted time series studies may be an appropriate design for such evaluations.

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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 randomised controlled trial
Participants	180 community groups with each group having 8 to 10 participants, both male and female. Outome was measured in children aged 12 to 23 months; 911 at pre intervention and 956 at post intervention
Interventions	INTERVENTION: *Evidence based discussion on measles vaccination*. Trusted members of the committee were selected for a three-phased discussion. Nine field teams (facilitators) had discussion with 180 community groups of 8 to 10 members each in 94 villages for the intervention group. Three phases of discussion were held with the community groups. In the first phase the community groups discussed the situation of child immunization 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. At the second phase cost benefits of vaccination and treatment of measles were discussed. The third stage of discussion featured discussion on challenges of immunization and identification of barriers and plans of action to increase access for immunization services and means of spreading the discussion on vaccination CONTROL: Routine immunization
Outcomes	Proportion of 12 -23 month olds that had received measles; Proportion of 12 -23 month olds that had received full course of DPT
Notes	Follow up after one year (baseline conducted in spring 2005; follow up spring 2007)

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	A random number generator allocated baseline communities to 18 intervention EAs and 14 control EAs
Allocation concealment (selection bias)	Low risk	The sequence was 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 coordinator knew
Incomplete outcome data (attrition bias) All outcomes	Low risk	Not applicable. Samples taken pre- and post-intervention
Selective reporting (reporting bias)	Unclear risk	It is not clear what outcomes were stated in the protocol

Andersson 2009 (*Continued*)

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 immunization uptake may under estimate vaccine coverage Unit of study was enumeration area, analysis done at individual level; no adjustment for cluster effect
Baseline outcome measurements similar?	Low risk	Difference in baseline outcome measures were not statistically significant
Baseline characteristics similar?	Low risk	Baseline characteristics were 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 was not stated

Brugha 1996

Methods	Matched and clustered randomised clinical trial. "Contiguous clusters were paired, as far as possible within enumeration areas, and one of each pair of clusters was randomly chosen for the survey..."
Participants	All children aged 12 to 18 months within 30 selected clusters. This included 200 mother-and-child pair in the intervention arm and 219 in the control arm
Interventions	INTERVENTION : *Home visits*- During home visits, interviewers (O-level university students) administered questionnaires to mothers or female caretakers and fathers or male caretakers of 12 to 18 months old children. Immunizations of the children were recorded from road-to-health card or clinic record (if the card was missing) in a register. All respondents were advised to bring identified children who had not completed immunization schedule to the clinic for immunization. A referral note was given to each child to bring to the clinic. Children who failed to complete immunization were identified from the register and a maximum of three home visits made to such child within six months CONTROL: Routine immunization
Outcomes	Completion of polio1; OPV3; measles; and completion of schedule
Notes	6 months of follow up
Risk of bias	

Brugha 1996 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Method of randomisation not stated
Allocation concealment (selection bias)	Unclear risk	Unclear
Blinding (performance bias and detection bias) All outcomes	High risk	Neither the provider nor the patient was blinded
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Lost to follow up not accounted for
Selective reporting (reporting bias)	Unclear risk	It is not clear what outcomes were stated in the protocol
Other bias	High risk	Children in registered and unregistered houses included in the intervention but for control group only children in registered houses were included Analysis done at cluster level; also took matching into account at analysis
Baseline outcome measurements similar?	Low risk	Baseline immunization coverage in the two study groups were not statistically significant
Baseline characteristics similar?	Low risk	There was no difference in the baseline characteristics of intervention and control groups
Adequate protection against contamination?	Unclear risk	Though 'contiguous clusters were paired as far as possible within the enumeration area' it is not clear if they were protected from contamination

Djibuti 2009

Methods	Stratified cluster randomised study
Participants	District immunization managers, primary healthcare (PHC) providers. Number of health workers studies were 392 at pre intervention and 521 at post intervention. Apart from outcome measures from PHC workers, data was obtained on children's immunization
Interventions	INTERVENTION: *Development of supportive supervision guidelines for district immunization managers:* Intervention consisted of development of supportive supervision guidelines and tools for district managers, training in continuous supportive supervision,

Djibuti 2009 (*Continued*)

	monitoring and evaluation of performance. Each district manager visited subordinated health facility at least once a month. On-the-job training was provided for immunization managers to improve on supervision practices to help providers solve problems encountered in immunization CONTROL: No intervention
Outcomes	DPT 3, polio 3, and hep 3 coverage; difference in proportion of coverage from baseline
Notes	Follow-up study was conducted after one year of intervention

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Stratified randomisation of districts and use of table of random numbers to allocate to intervention and control groups
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; two independent samples taken pre- and post-intervention
Selective reporting (reporting bias)	Unclear risk	It is not clear 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 the poor 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 individual. No adjustment for clustering effect

Djibuti 2009 (*Continued*)

Baseline outcome measurements similar?	Low risk	Outcome measurements were similar in the two groups at baseline
Baseline characteristics similar?	Low risk	Demographic and employment characteristics were similar among CPH staff respondents in the intervention and control groups, both at baseline and follow up except mean years of experience which was more among the control group.
Adequate protection against contamination?	Unclear risk	Protection against contamination is unclear

Morris 2004

Methods	Cluster randomised controlled trial
Participants	Households in 70 clusters including pregnant women, new mothers, and children less than 3 years. Outcome on immunization was measured in 4359 children at pre intervention and 3876 at post intervention
Interventions	INTERVENTION 1: *Household package:* consisted of distribution of vouchers worth £2.53 to mothers who were registered in 2000 census who were either pregnant or had a child less than 3 years of age to a maximum of two children. In addition mothers with children aged 6 to 12 years enrolled in primary schools in grade 1 to 4 were given vouchers worth £3.69 per month. The beneficiaries were to lose the 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 INTERVENTION 2: *Service-level package:* quality assurance teams were set up at each health centre and were trained on basic quality assurance methods. They developed work plans which included minor structural repairs, purchase of equipments, materials, and essential drugs and money to pay lay assistants. The package also included promotion of community-based nutrition program for children below 2 years INTERVENTION 3: Intervention 1 and 2 CONTROL: Standard (routine) services
Outcomes	Proportion of pregnant women immunised against tetanus; proportion of children aged 93 days to 3 years who received their first dose of DTP (diphtheria, tetanus, pertussis) or pentavalent vaccine (diphtheria, tetanus, pertussis, Haemophilus influenzae type B, hepatitis B) between the ages of 42 and 92 days of age; proportion of 1 year olds immunized against measles
Notes	2 years

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

Morris 2004 (*Continued*)

Random sequence generation (selection bias)	Low risk	Children made to pick coloured balls from a box which 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%."
Selective reporting (reporting bias)	Unclear risk	It is not clear 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. Analaysis not adjusted for cluster effect
Baseline outcome measurements similar?	High risk	The coverage of DTP1 vaccine in the group receiving both intervention was lower than the other 3 groups.
Baseline characteristics similar?	Low risk	Demographic and socioeconomic data of the four groups were 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 less than 3 years attended clinics in municipalities other than their municipality of residence a month prior to post-intervention survey.

Pandey 2007

Methods	Cluster randomised controlled trial
Participants	Households with at least one child going to public primary school in the village. Immunization coverage targeted 0 to 35 months old children. Number of children included in the study was 1025
Interventions	INTERVENTION: *Information campaign.* Two rounds of immunization campaign consisting of two to three meetings and distribution of posters and leaflets. A 15 minutes audio taped message was 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 CONTROL: No intervention
Outcomes	Received TT; received at least one vaccine
Notes	Post-intervention data collected 12 months after

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Randomly generated number were used
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% LFU
Selective reporting (reporting bias)	Unclear risk	It is not clear what outcomes were stated in the protocol
Other bias	High risk	Proportion at campaign meetings ranged between 11% and 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	The difference between proportion of children immunized at baseline in the two groups was not statistically significant
Baseline characteristics similar?	Low risk	Baseline data were similar between the two groups.

Pandey 2007 (*Continued*)

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."

Usman 2009

Methods	Randomized controlled trial
Participants	375 mothers visiting the EPI centre in each of 4 arms of study with a total of 1125 children registering for DPT1 immunization and residing in the study area for the past 6 months
Interventions	INTERVENTION 1: *Redesigned immunization card*; A larger card (15.5cm by 11.5cm when folded) that had only the date and day of next immunization on both sides of the outer card printed with Microsoft Word font size 42 was designed as a reminder for mothers/caretakers for immunization. Inner side of the card contained information about the child's complete immunization schedule dates and instructions for the mother/caretaker For those in the arm for redesigned card the date and day for each DPT vaccination was written on the outer side of the card; dates of previous vaccinations are crossed out to avoid confusion. Mother is advised to place the card at a frequently visible place at home and to bring it to the clinic during immunization visits INTERVENTION 2 *Centre-base education*; Clinic-based education which lasted 2-3 minutes was given to mothers at enrolment of their children in the EPI centre. The health education emphasized the importance of immunization schedule completion INTERVENTION 3: Intervention 1 and 2. CONTROL: Routine immunization
Outcomes	Number of enrolled children with DPT3 completed within 90 days of duration of study
Notes	Follow up for 90 days

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Allocation sequence was by computer generated randomization list
Allocation concealment (selection bias)	Unclear risk	It is 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	There was no loss to follow up

Usman 2009 (*Continued*)

Selective reporting (reporting bias)	Unclear risk	It is not clear what outcomes were stated in the protocol
Other bias	Low risk	No other bias detected
Baseline outcome measurements similar?	Unclear risk	Baseline outcomes not measured
Baseline characteristics similar?	High risk	Most of the socioeconomic variables were similar but ownership of TV was more among group receiving education and a higher proportion of those receiving standard care live close to the facility than those in the redesigned card group
Adequate protection against contamination?	Unclear risk	Unclear

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

Study	Reason for exclusion
al Teheawy 1992	Retrospective study
Alto 1989	Observational study
Anjum 2004	A controlled before and after study with single site for intervention and control arms respectively
Balraj 1986	Program evaluation
Bandyopadhyay 1996	Observational study
Barham 2009	Randomized evaluation of a program, and no relevant data
Berhane 1993	No relevant outcome. Reports on dropout rate
Berman 1991	Observational study
Berry 1991	Observational study
Chen 1976	Retrospective study
Chen 1989	Observational studies - review of immunization records
Cutts 1990	Observational study
Cutts 1994	Observational study

(*Continued)*

Dammanni 1990	Observational study - Evaluation of immunization coverage
Deminguez Uka 1988	Observational study
Ekunwe 1984	Observational study: before and after, no control
Gomber 1996	Observational study
Hong 2005	Observational study
Kerpelman 2000	Setting of the study is Muscogee county, Georgia, a high income setting
Kuhn 1990	Observational study
Kumar 1990	Observational study
Lin 1979	Observational study
Linkins 1994	Patient reminder using computer generated telephone messages has been reviewed in a Cochrane systematic review
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	The two existing locations used for the study fails to meet EPOC criteria for inclusion
Przewlocka 2000	Observational study
Robinson 2001	Observational study
San Sebastin 2001	Study lacks control arm and is located at only one site
Shaikh 2003	Observational study
Sutanto 1999	Observational study

(*Continued*)

Uskun 2008	Observational study
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]*

Banerjee 2010

Methods	Clustered randomized controlled trial
Participants	1640 children aged 1 to 3 years at end point
Interventions	Intervention A: Once monthly reliable immunization camp without incentive Intervention B: Once monthly reliable immunization camp with small incentives consisting of raw lentils and metal plates for completion of schedule Control: No intervention
Outcomes	Proportion of children aged 1-3 years at the end point who were partially or fully immunized
Notes	Study setting: India

Chandir 2010

Methods	Cohort study
Participants	Parents or guardian of children aged 0 to 11 months receiving BCG or DPT1
Interventions	Food and medicine coupon incentives given to cohort families at each follow-up immunization visit till DPT3
Outcomes	DPT immunization coverage at 18 weeks of age
Notes	Study setting: Pakistan

Igarashi 2010

Methods	Time-lag study
Participants	Caretakers with children aged 11 to 59 months
Interventions	Monthly Growth Monitoring Programme Plus

Igarashi 2010 (*Continued*)

Outcomes	Improvement in the coverage of immunization and timeliness of immunization
Notes	Setting of study: Zambia

Prinjia 2010

Methods	Cohort study
Participants	Children less than 18 months of age
Interventions	An interventional package involving community volunteers and aimed at reducing operational barriers
Outcomes	Difference in DPT immunization coverage between pre and post intervention periods; mean age at immunization; and mean time differences in DPT between DPT doses in the pre and post cohorts
Notes	Study setting: India

Usman 2011

Methods	Randomized controlled trial
Participants	Mother and child pair visiting selected EPI centres for DPT1 who were resident in study area for at least 6 months prior to enrolment into study
Interventions	Redesigned immunization card, health education, combination of the two interventions, standard care
Outcomes	Immunization status (DPT2 and DPT3) of child 90 days post-enrolment
Notes	Study setting: Pakistan

DATA AND ANALYSES

Comparison 1. Health education

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Evidence based discussion	1		Risk Ratio (Random, 95% CI)	Subtotals only
1.1 DPT3	1		Risk Ratio (Random, 95% CI)	2.17 [1.43, 3.29]
1.2 Measles	1		Risk Ratio (Random, 95% CI)	1.63 [1.03, 2.58]
2 Facility Based Health Education	1		Risk Ratio (Random, 95% CI)	Subtotals only
2.1 DPT3	1		Risk Ratio (Random, 95% CI)	1.18 [1.05, 1.33]
3 Information campaign	1		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
3.1 Received at least one vaccine	1	1025	Risk Ratio (M-H, Random, 95% CI)	1.43 [1.01, 2.02]
4 Redesigned card + Health Education	1		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
4.1 DPT3	1	750	Risk Ratio (M-H, Random, 95% CI)	1.36 [1.22, 1.51]

Comparison 2. Monetary incentive

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 MMR	1		Risk Ratio (Random, 95% CI)	Subtotals only
1.1 Household Package	1		Risk Ratio (Random, 95% CI)	0.95 [0.83, 1.07]
1.2 Service Package	1		Risk Ratio (Random, 95% CI)	1.06 [0.91, 1.23]
1.3 Household + Service	1		Risk Ratio (Random, 95% CI)	1.11 [0.99, 1.24]

Comparison 3. Home visit

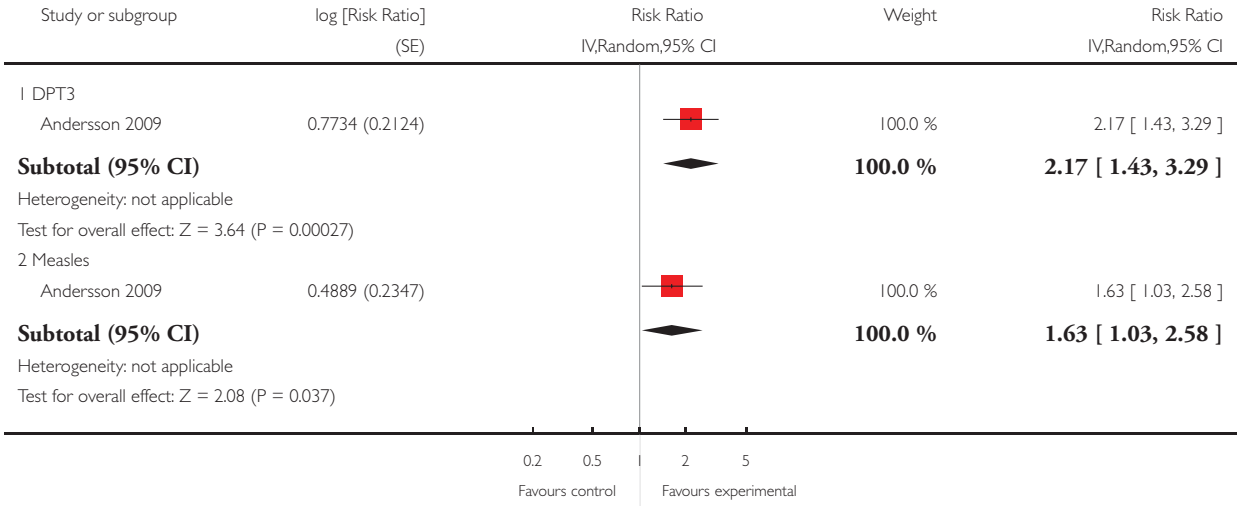
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 OPV3	1		Risk Ratio (Random, 95% CI)	Subtotals only
2 Measles	1		(Random, 95% CI)	Subtotals only
3 DPT1	1		Risk Ratio (Random, 95% CI)	Subtotals only
3.1 Household Package	1		Risk Ratio (Random, 95% CI)	1.09 [0.94, 1.28]
3.2 Service Package	1		Risk Ratio (Random, 95% CI)	1.00 [0.83, 1.21]
3.3 Household + Service	1		Risk Ratio (Random, 95% CI)	1.15 [0.97, 1.37]

Analysis 1.1. Comparison 1 Health education, Outcome 1 Evidence based discussion.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 1 Health education

Outcome: 1 Evidence based discussion



Analysis 1.2. Comparison 1 Health education, Outcome 2 Facility Based Health Education.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 1 Health education

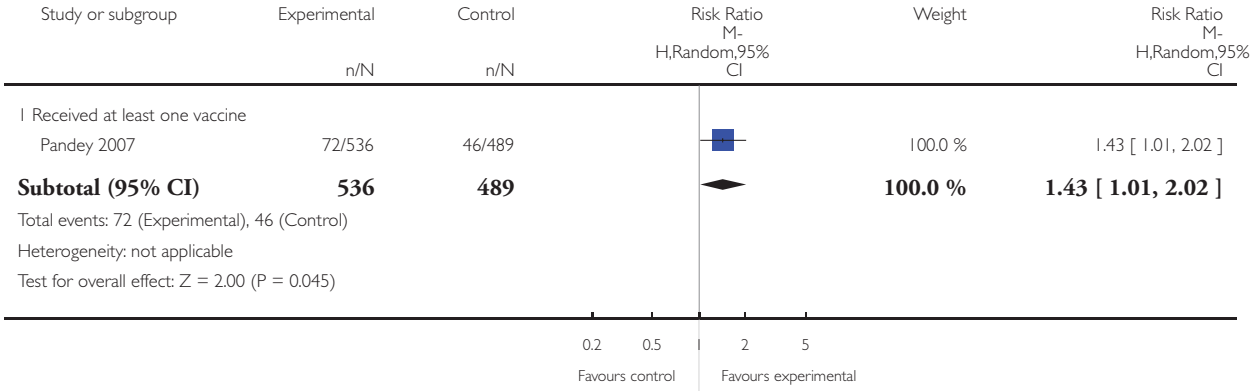
Outcome: 2 Facility Based Health Education

Analysis 1.3. Comparison 1 Health education, Outcome 3 Information campaign.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 1 Health education

Outcome: 3 Information campaign

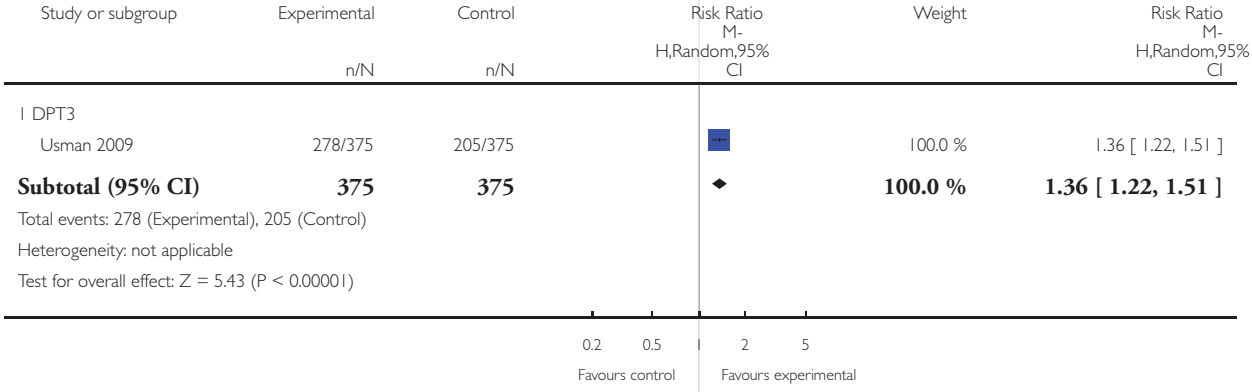


Analysis 1.4. Comparison 1 Health education, Outcome 4 Redesigned card + Health Education.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 1 Health education

Outcome: 4 Redesigned card + Health Education

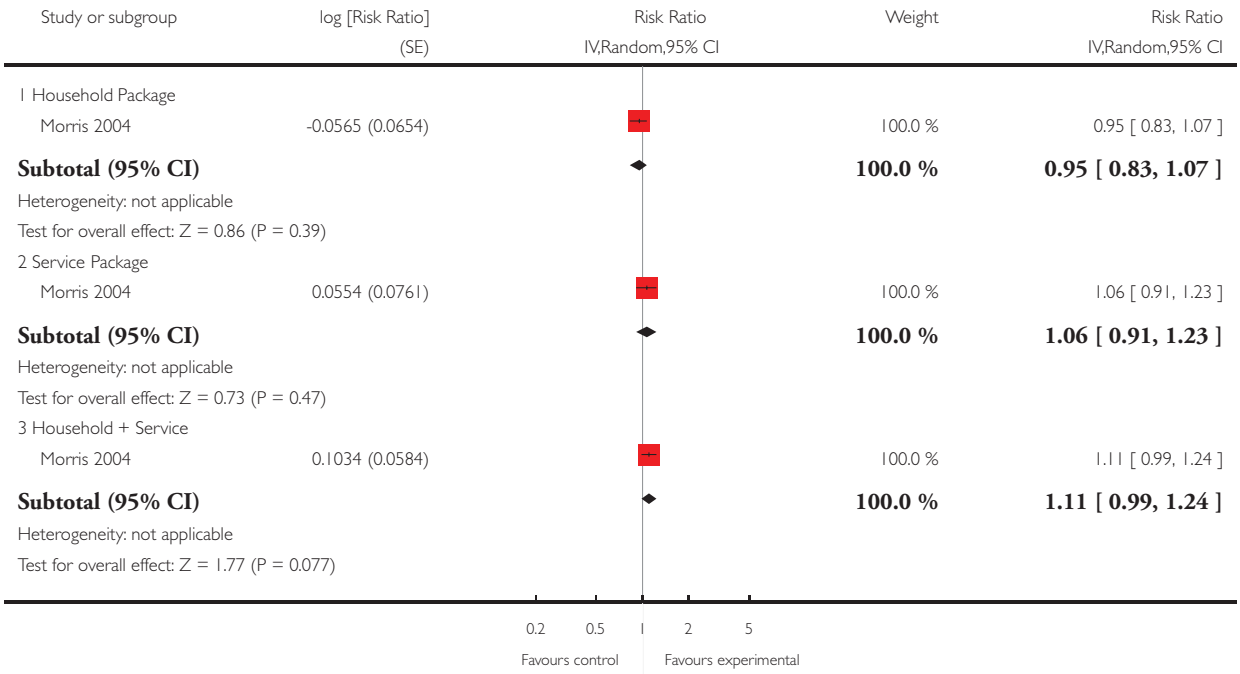


Analysis 2.1. Comparison 2 Monetary incentive, Outcome 1 MMR.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 2 Monetary incentive

Outcome: 1 MMR

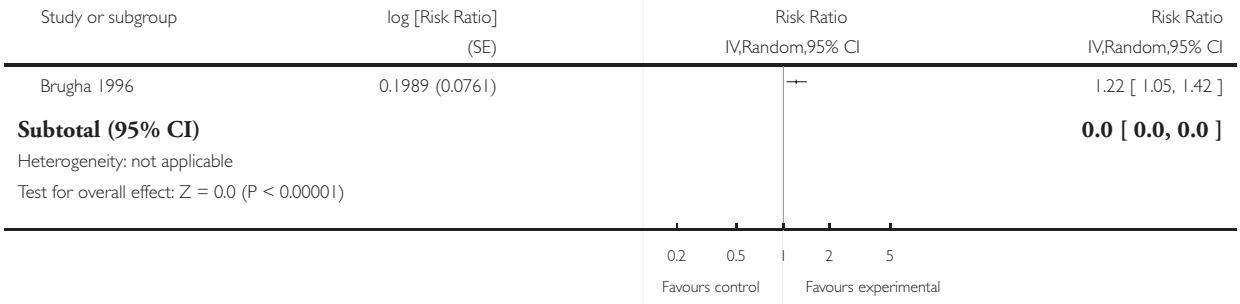


Analysis 3.1. Comparison 3 Home visit, Outcome 1 OPV3.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 3 Home visit

Outcome: 1 OPV3

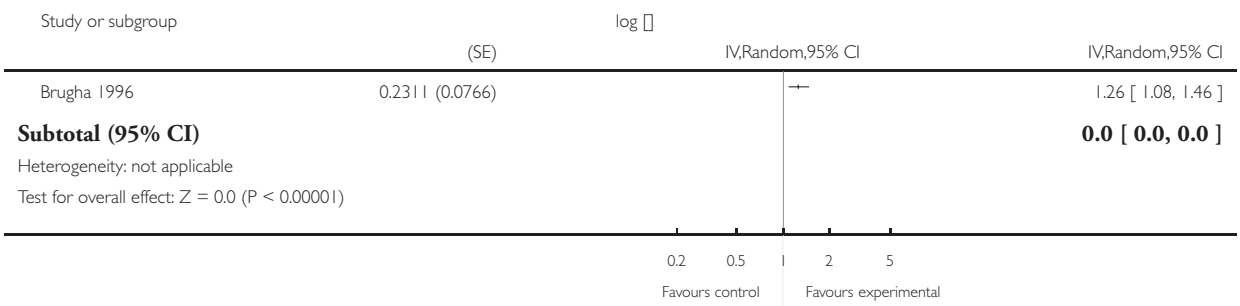


Analysis 3.2. Comparison 3 Home visit, Outcome 2 Measles.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 3 Home visit

Outcome: 2 Measles

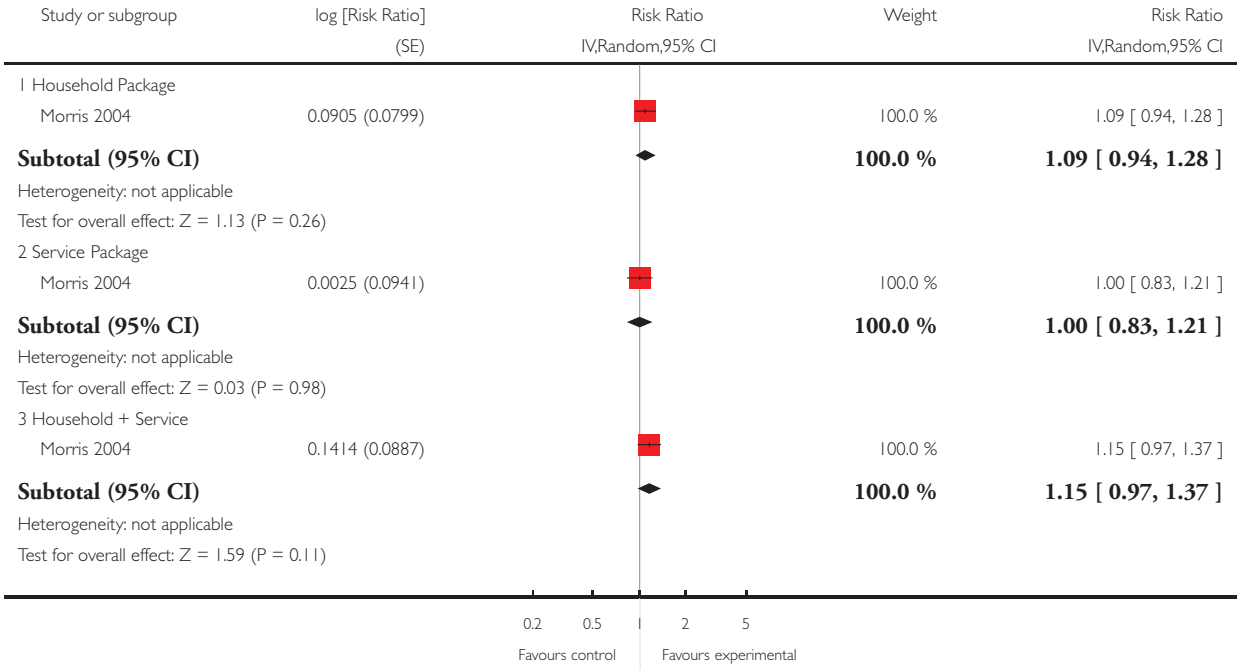


Analysis 3.3. Comparison 3 Home visit, Outcome 3 DPT1.

Review: Interventions for improving coverage of child immunization in low- and middle-income countries

Comparison: 3 Home visit

Outcome: 3 DPT1



APPENDICES

Appendix 1. Search strategies

MEDLINE, Ovid

1. Immunization/
2. Immunization Schedule/
3. Immunization, Secondary/
4. Immunotherapy, Active/
5. Mass Immunization/
6. Immunization Programs/
7. Vaccination/
8. (vaccinat$ or revaccinat$ or immunization or immunisation or immunotherapy).tw.
9. or/1-8
10. Tetanus Toxoid/
11. Diphtheria Toxoid/
12. Diphtheria-Tetanus-Acellular Pertussis Vaccines/

13. Diphtheria-Tetanus-Pertussis Vaccine/
14. Diphtheria-Tetanus Vaccine/
15. Pertussis Vaccine/
16. Measles-Mumps-Rubella Vaccine/
17. Measles Vaccine/
18. Mumps Vaccine/
19. Rubella Vaccine/
20. Poliovirus Vaccines/
21. Poliovirus Vaccine, Inactivated/
22. Poliovirus Vaccine, Oral/
23. Tuberculosis Vaccines/
24. BCG Vaccine/
25. Viral Hepatitis Vaccines/
26. Hepatitis B Vaccines/
27. Haemophilus Vaccines/
28. ((tetanus or diphtheria) adj toxoid).tw.
29. ((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 or haemophilus or triple) adj vaccine?).tw.
30. or/10-29
31. Tetanus/
32. Diphtheria/
33. Measles/
34. Mumps/
35. Rubella/
36. Whooping Cough/
37. Poliomyelitis/
38. Poliomyelitis, Bulbar/
39. Tuberculosis/
40. Tuberculosis, Pulmonary/
41. Mycobacterium Tuberculosis/
42. Hepatitis B/
43. Hepatitis B, Chronic/
44. Haemophilus Influenzae/
45. Haemophilus Influenzae Type B/
46. (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.
47. or/31-46
48. exp Child/
49. exp Infant/
50. exp Child Care/
51. (child$ or infant? or newborn? or neonat$ or baby or babies or kid? or toddler?).tw.
52. or/48-51
53. 9 and (Tetanus/ or tetanus.tw.)
54. Tetanus Toxoid/ or (tetanus toxoid or tetanus vaccine? or tetanus prophylaxis).tw.
55. 53 or 54
56. Mothers/
57. Women/
58. Pregnant Women/
59. Female/
60. (woman or women or mother? or female?).tw.
61. or/56-60
62. 55 and 61
63. Developing Countries/

64. Medically Underserved Area/
65. exp Africa/
66. exp Asia/
67. Americas/
68. exp Caribbean Region/
69. exp Central America/
70. Latin America/
71. exp South America/
72. (Africa or Asia or Americas or Central America or Latin America or South America).tw.
73. (American Samoa or Argentina or Belize or Botswana or Brazil or Bulgaria or Chile or Costa Rica or Croatia or Dominica or Equatorial Guinea or Gabon or Grenada or Hungary or Kazakhstan or Latvia or Lebanon or Libya or Lithuania or Malaysia or Mauritius or Mayotte or Mexico or Montenegro or Northern Mariana Islands or Oman or Palau or Panama or Poland or Romania or Russian Federation or Serbia or Seychelles or Slovak Republic or South Africa or "Saint Kitts and Nevis" or Saint Lucia or "Saint Vincent and the Grenadines" or Turkey or Uruguay or Venezuela or Yugoslavia).mp. or Guinea.tw. or Russia.tw. or Samoa.tw. or Slovakia.tw.
74. (Albania or Algeria or Angola or Armenia or Azerbaijan or Belarus or Bhutan or Bolivia or "Bosnia and Herzegovina" or Cameroon or Cape Verde or China or Colombia or Congo or Cuba or Djibouti or Dominican Republic or Ecuador or Egypt or El Salvador or Fiji or Georgia or Guatemala or Guyana or Honduras or Indonesia or Iran or Iraq or Jamaica or Jordan or Kiribati or Lesotho or Maldives or "Macedonia (Republic)" or Marshall Islands or Micronesia or Guam or Moldova or Morocco or Namibia or Nicaragua or Paraguay or Peru or Philippines or Samoa or Sri Lanka or Suriname or Swaziland or Syria or Thailand or Tonga or Tunisia or Turkmenistan or Ukraine or Vanuatu).mp. or Bosnia.tw. or Gaza.tw. or Macedonia.tw. or Palestin$.tw. or West Bank.tw.
75. (Afghanistan or Bangladesh or Benin or Burkina Faso or Burundi or Cambodia or Central African Republic or Chad or Comoros or "Democratic Republic of the Congo" or Cote d'Ivoire or Eritrea or Ethiopia or Gambia or Ghana or Guinea or Guinea-Bissau or Haiti or India or Kenya or North Korea or Kyrgyzstan or Laos or Liberia or Madagascar or Malawi or Mali or Mauritania or Mongolia or Mozambique or Myanmar or Nepal or Niger or Nigeria or Pakistan or Papua New Guinea or Rwanda or Senegal or Sierra Leone or Solomon Islands or Somalia or Sudan or Tajikistan or Tanzania or East Timor or Togo or Uganda or Uzbekistan or Vietnam or Yemen or Zambia or Zimbabwe).mp. or Burma.tw. or Lao.tw. or Sao Tome.tw. or Viet Nam.tw.
76. ((developing or less$ developed or third or under developed or middle income or low income or underserved or under served or deprived or poor$) adj (count$ or nation? or state? or world or population?)).tw.
77. (lmic or lmics).tw.
78. or/63-77
79. randomized controlled trial.pt.
80. random$.tw.
81. intervention$.tw.
82. control$.tw.
83. evaluat$.tw.
84. or/79-83
85. Animals/
86. Humans/
87. 85 not (85 and 86)
88. 84 not 87
89. 9 and 47 and 52 and 78 and 88
90. 30 and 52 and 78 and 88
91. 62 and 78 and 88
92. 89 or 90 or 91

CENTRAL

#1 MeSH descriptor Immunization, this term only
#2 MeSH descriptor Immunization Schedule, this term only
#3 MeSH descriptor Immunization, Secondary, this term only
#4 MeSH descriptor Immunotherapy, Active, this term only
#5 MeSH descriptor Mass Immunization, this term only
#6 MeSH descriptor Immunization Programs, this term only
#7 MeSH descriptor Vaccination, this term only
#8 (vaccinat* or revaccinat* or immunization or immunisation or immunotherapy):ti,ab

#9 (#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8)
#10 MeSH descriptor Tetanus Toxoid, this term only
#11 MeSH descriptor Diphtheria Toxoid, this term only
#12 MeSH descriptor Diphtheria-Tetanus-acellular Pertussis Vaccines, this term only
#13 MeSH descriptor Diphtheria-Tetanus-Pertussis Vaccine, this term only
#14 MeSH descriptor Diphtheria-Tetanus Vaccine, this term only
#15 MeSH descriptor Pertussis Vaccine, this term only
#16 MeSH descriptor Measles-Mumps-Rubella Vaccine, this term only
#17 MeSH descriptor Measles Vaccine, this term only
#18 MeSH descriptor Mumps Vaccine, this term only
#19 MeSH descriptor Rubella Vaccine, this term only
#20 MeSH descriptor Poliovirus Vaccines, this term only
#21 MeSH descriptor Poliovirus Vaccine, Inactivated, this term only
#22 MeSH descriptor Poliovirus Vaccine, Oral, this term only
#23 MeSH descriptor Tuberculosis Vaccines, this term only
#24 MeSH descriptor BCG Vaccine, this term only
#25 MeSH descriptor Viral Hepatitis Vaccines, this term only
#26 MeSH descriptor Hepatitis B Vaccines, this term only
#27 MeSH descriptor Haemophilus Vaccines, this term only
#28 (tetanus toxoid or diphtheria toxoid):ti,ab
#29 (tetanus NEXT vaccine* or diphtheria* NEXT vaccine* or pertussis NEXT vaccine* or whooping NEXT cough NEXT vaccine* or measles NEXT vaccine* or mumps NEXT vaccine* or rubella* NEXT vaccine* or rubeola NEXT vaccine* or mmr NEXT vaccine* or polio* NEXT vaccine* or tuberculosis NEXT vaccine* or tuberculoses NEXT vaccine* or bcg NEXT vaccine* or calmette* NEXT vaccine* or hepatitis NEXT b NEXT vaccine* or haemophilus NEXT vaccine* or triple NEXT vaccine*):ti,ab
#30 (#10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29)
#31 MeSH descriptor Tetanus, this term only
#32 MeSH descriptor Diphtheria, this term only
#33 MeSH descriptor Measles, this term only
#34 MeSH descriptor Mumps, this term only
#35 MeSH descriptor Rubella, this term only
#36 MeSH descriptor Whooping Cough, this term only
#37 MeSH descriptor Poliomyelitis, this term only
#38 MeSH descriptor Poliomyelitis, Bulbar, this term only
#39 MeSH descriptor Tuberculosis, this term only
#40 MeSH descriptor Tuberculosis, Pulmonary, this term only
#41 MeSH descriptor Mycobacterium tuberculosis, this term only
#42 MeSH descriptor Hepatitis B, this term only
#43 MeSH descriptor Hepatitis B, Chronic, this term only
#44 MeSH descriptor Haemophilus influenzae, this term only
#45 MeSH descriptor Haemophilus influenzae type b, this term only
#46 (tetanus or diphtheria* or measles or rubella* or rubeola or mumps or epidemic NEXT parotit* or pertussis or whooping NEXT cough or polio* or infantile NEXT paralysis or tuberculosis or tuberculoses or hepatitis NEXT b or haemophilus influenza*):ti,ab
#47 (#31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40 OR #41 OR #42 OR #43 OR #44 OR #45 OR #46)
#48 MeSH descriptor Child explode all trees
#49 MeSH descriptor Infant explode all trees
#50 MeSH descriptor Child Care explode all trees
#51 (child* or infant* or newborn* or neonat* or baby or babies or kid or kids or toddler*):ti,ab
#52 (#48 OR #49 OR #50 OR #51)
#53 MeSH descriptor Tetanus, this term only
#54 tetanus:ti,ab
#55 MeSH descriptor Tetanus Toxoid, this term only

#56 (tetanus NEXT toxoid or tetanus NEXT vaccine* or tetanus NEXT prophylaxis):ti,ab
#57 (#9 AND (#53 OR #54))
#58 (#55 OR #56)
#59 (#57 OR #58)
#60 MeSH descriptor Mothers, this term only
#61 MeSH descriptor Women, this term only
#62 MeSH descriptor Pregnant Women, this term only
#63 (woman or women or mother? or female?):ti,ab
#64 (#60 OR #61 OR #62 OR #63)
#65 (#59 AND #64)
#66 MeSH descriptor Developing Countries, this term only
#67 MeSH descriptor Medically Underserved Area, this term only
#68 MeSH descriptor Africaexplode all trees
#69 MeSH descriptor Americas, this term only
#70 MeSH descriptor Caribbean Region explode all trees
#71 MeSH descriptor Central America explode all trees
#72 MeSH descriptor Latin America, this term only
#73 MeSH descriptor South America explode all trees
#74 MeSH descriptor Asiaexplode all trees
#75 (Africa or Asia or Americas or South NEXT America or Latin NEXT America or Central NEXT America):ti,ab,kw
#76 ("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 Hungary or Kazakhstan or Latvia or Lebanon or Libya or Libia or Libyan or Lithuania or Malaysia or Mauritius or Mexico or Micronesia or Montenegro or Oman or Palau or Panama or Poland or Romania or Russia or "Russian Federation" or Seychelles or Slovakia or "Slovak Republic" or "South Africa" or "Saint Kitts and Nevis" or "Saint Lucia" or "Saint Vincent and the Grenadines" or Turkey or Uruguay or Venezuela or Yugoslavia or Mayotte or "Northern Mariana Islands" or Samoa or Serbia or "St Kitts and Nevis" or "St Lucia" or "St Vincent and the Grenadines"):ti,ab,kw
#77 (Albania or Algeria or Angola or Armenia or Azerbaijan or Belarus or Bhutan or Bolivia or Bosnia or Herzegovina 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 Georgia or Guam or Guatemala or Guyana or Honduras or "Indian Ocean Islands" or Indonesia or Iran or Iraq or Jamaica or Jordan or Lesotho or Macedonia or "Marshall Islands" or Micronesia or "Middle East" or Moldova or Morocco or Namibia or Nicaragua 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 "Cape Verde" or Gaza or Kiribati or Maldives or Palestine or "West Bank"):ti,ab,kw
#78 (Afghanistan or Bangladesh or Benin or "Burkina Faso" or Burundi or Cambodia or "Central African Republic" or Chad or Comoros or "Democratic Republic of the Congo" or "Cote d'Ivoire" or Eritrea or Ethiopia or Gambia or Ghana or Guinea or "Guinea Bissau" or Haiti or India or Kenya or Korea or Kyrgyzstan or Kyrgyz or Lao or Laos or Liberia or Madagascar or Malawi or Mali or Mauritania or Melanesia or Mongolia or Mozambique or Myanmar or Nepal or Niger or Nigeria or Pakistan or "Papua New Guinea" or Rwanda or Senegal or "Sierra Leone" or Somalia or Sudan or Tajikistan or Tanzania or "East Timor" or Togo or Uganda or Uzbekistan or Vietnam or "Viet Nam" or Yemen or Zambia or Zimbabwe or Burma or Congo or "North Korea" or "Salomon Islands" or "Sao Tome" or Timor):ti,ab,kw
#79 (developing or less* NEXT developed or third or under NEXT developed or middle NEXT income or low NEXT income or underserved or under NEXT served or deprived or poor*) NEXT (count* or nation* or state* or population* or world):ti,ab,kw
#80 (lmic or lmics):ti,ab,kw
#81 (#66 OR #67 OR #68 OR #69 OR #70 OR #71 OR #72 OR #73 OR #74 OR #75 OR #76 OR #77 OR #78 OR #79 OR #80)
#82 (#9 AND #47 AND #52 AND #81)
#83 (#30 AND #52 AND #81)
#84 (#65 AND #81)
#85 (#82 OR #83 OR #84)

EMBASE, Ovid

1. Immunization/
2. Active Immunization/
3. Mass Immunization/
4. Vaccination/

5. Revaccination/
6. (vaccinat$ or revaccinat$ or immunization or immunisation or immunotherapy).tw.
7. or/1-6
8. Tetanus Prophylaxis/
9. BCG Vaccination/
10. Measles Vaccination/
11. or/8-10
12. Tetanus Toxoid/
13. Diphtheria Toxoid/
14. Diphtheria Toxoid crm197/
15. Diphtheria Tetanus Toxoid/
16. BCG Vaccine/
17. Diphtheria Pertussis Poliomyelitis Tetanus Haemophilus Influenzae Type B Hepatitis B Vaccine/
18. Diphtheria Pertussis Poliomyelitis Tetanus Vaccine/
19. Diphtheria Pertussis Tetanus Haemophilus Influenzae Type B Hepatitis B Vaccine/
20. Diphtheria Pertussis Tetanus Haemophilus Influenzae Type B Vaccine/
21. Diphtheria Pertussis Tetanus Vaccine/
22. Diphtheria Poliomyelitis Tetanus Vaccine/
23. Diphtheria Tetanus Vaccine/
24. Diphtheria Vaccine/
25. Haemophilus Influenzae Type B Hepatitis B Vaccine/
26. Haemophilus Influenzae Type B Vaccine/
27. Haemophilus Influenzae Vaccine/
28. Haemophilus Vaccine/
29. Pertussis Vaccine/
30. Triple Vaccine/
31. Hepatitis a Hepatitis B Vaccine/
32. Hepatitis B Vaccine/
33. Hepatitis Vaccine/
34. Recombinant Hepatitis B Vaccine/
35. Measles Mumps Rubella Vaccine/
36. Measles Mumps Vaccine/
37. Measles Rubella Vaccine/
38. Measles Vaccine/
39. Mumps Vaccine/
40. Rubella Vaccine/
41. Chickenpox Measles Mumps Rubella Vaccine/
42. Poliomyelitis Vaccine/
43. Oral Poliomyelitis Vaccine/
44. ((tetanus or diphtheria) adj toxoid).tw.
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 or haemophilus or triple) adj vaccine?).tw.
46. or/12-45
47. Tetanus/
48. Diphtheria/
49. Measles/
50. Mumps/
51. Rubella/
52. Pertussis/
53. Poliomyelitis/
54. Tuberculosis/
55. Lung Tuberculosis/
56. Mycobacterium Tuberculosis/

57. Hepatitis B/
58. Chronic Hepatitis/
59. Haemophilus Influenzae/
60. Haemophilus Influenzae Type B/
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.
62. or/47-61
63. exp Child/
64. exp Newborn/
65. Child Care/
66. (child$ or infant? or newborn? or neonat$ or baby or babies or kid? or toddler?).tw.
67. or/63-66
68. 7 and (Tetanus/ or tetanus.tw.)
69. Tetanus Toxoid/ or Tetanus Prophylaxis/ or (tetanus toxoid or tetanus vaccin$ or tetanus prophylaxis).tw.
70. or/68-69
71. exp Mother/
72. Female/
73. (woman or women or mother? or female?).tw.
74. or/71-73
75. 70 and 74
76. Developing Country/
77. exp Africa/ or exp Asia/ or exp "South and Central America"/
78. (Africa or Asia or Americas or South America or Latin America or Central America).tw.
79. (American Samoa or Argentina or Belize or Botswana or Brazil or Bulgaria or Chile or Comoros or Costa Rica or Croatia or Dominica or Equatorial Guinea or Gabon or Grenada or Hungary or Kazakhstan or Latvia or Lebanon or Libya or Lithuania or Malaysia or Mauritius or Mexico or Micronesia or Montenegro or Oman or Palau or Panama or Poland or Romania or Russia or Seychelles or Slovakia or South Africa or "Saint Kitts and Nevis" or Saint Lucia or "Saint Vincent and the Grenadines" or Turkey or Uruguay or Venezuela or Yugoslavia or Guinea or Libia or libyan or Mayotte or Northern Mariana Islands or Russian Federation or Samoa or Serbia or Slovak Republic or "St Kitts and Nevis" or St Lucia or "St Vincent and the Grenadines").sh,tw.
80. (Albania or Algeria or Angola or Armenia or Azerbaijan or Belarus or Bhutan or Bolivia or "Bosnia and Herzegovina" 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 "Georgia (Republic)" or Guam or Guatemala or Guyana or Honduras or Indian Ocean Islands or Indonesia or Iran or Iraq or Jamaica or Jordan or Lesotho or "Macedonia (Republic)" or Marshall Islands or Micronesia or Middle East or Moldova or Morocco or Namibia or Nicaragua or Paraguay or Peru or Philippines or Samoa or Sri Lanka or Suriname or Swaziland or Syria or Thailand or Tonga or Tunisia or Turkmenistan or Ukraine or Vanuatu or Bosnia or Cape Verde or Gaza or Georgia or Kiribati or Macedonia or Maldives or Marshall Islands or Palestine or Syrian Arab Republic or West Bank).sh,tw.
81. (Afghanistan or Bangladesh or Benin or Burkina Faso or Burundi or Cambodia or Central African Republic or Chad or Comoros or "Democratic Republic of the Congo" or Cote d'Ivoire or Eritrea or Ethiopia or Gambia or Ghana or Guinea or Guinea-Bissau or Haiti or India or Kenya or Korea or Kyrgyzstan or Laos or Liberia or Madagascar or Malawi or Mali or Mauritania or Melanesia or Mongolia or Mozambique or Myanmar or Nepal or Niger or Nigeria or Pakistan or Papua New Guinea or Rwanda or Senegal or Sierra Leone or Somalia or Sudan or Tajikistan or Tanzania or East Timor or Togo or Uganda or Uzbekistan or Vietnam or Yemen or Zambia or Zimbabwe or Burma or Congo or Kyrgyz or Lao or North Korea or Salomon Islands or Sao Tome or Timor or Viet Nam).sh,tw.
82. ((developing or less$ developed or third or under developed or middle income or low income or underserved or under served or deprived or poor$) adj (count$ or nation? or state? or world or population?)).tw.
83. (lmic or lmics).tw.
84. or/76-83
85. randomized controlled trial/
86. controlled clinical trial/
87. Time Series Analysis/
88. random$.tw.
89. intervention$.tw.
90. control$.tw.
91. evaluat$.tw.

92. time series.tw.
93. or/85-92
94. Human/
95. Nonhuman/
96. Animal/
97. Animal Experiment/
98. or/95-97
99. 98 not (98 and 94)
100. 93 not 99
101. 7 and 62 and 67 and 84 and 100
102. 11 and 67 and 84 and 100
103. 46 and 67 and 84 and 100
104. 75 and 84 and 100
105. or/101-104

LILACS

(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 and cough) or (tos and ferina) 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 and bovis) or bcg or calmette$ or hepatitis or hepatite or haemophilus) [Words]
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 and nacido$) or (recem and nascido$) [Words]
AND
Pt RANDOMIZED CONTROLLED TRIAL or randomi$ or randomly or control$ or intervention$ or evaluat$ or effect$ or impact or impacts or (ensayo and azar) or (ensayo and acaso) or (ensaio and azar) or (ensaio and acaso) or intervencion$ or intervenção$ or evaluar or evaluacion or avaliação or efecto or efectos or efeito or efeitos or impacto or impactos [Words]

Sociological Abstracts

KW=(vaccination or vaccine or vaccines or immunization)
AND
KW=(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)

CINAHL (EBSCO)

#	Query
S82	S79 or S80 or S81
S81	S58 and S71 and S78
S80	S24 and S43 and S71 and S78
S79	S6 and S39 and S43 and S71 and S78
S78	S72 or S73 or S74 or S75 or S76 or S77
S77	TI (randomi* or randomly or control* or experiment* or impact or intervention* or evaluat* or effect* or "time series" or "pre test" or "post test" or pretest or posttest) or AB (randomi* or randomly or control* or experiment* or impact or intervention* or evaluat* or effect* or "time series" or "pre test" or "post test" or pretest or posttest)
S76	PT clinical trial

(*Continued*)

S75	(MH "Comparative Studies")
S74	(MH "Quasi-Experimental Studies+")
S73	(MH "Pretest-Posttest Design+")
S72	(MH "Clinical Trials")
S71	S59 or S60 or S61 or S62 or S63 or S64 or S65 or S66 or S67 or S68 or S69 or S70
S70	TI ("developing country" or "developing countries" or "developing nation" or "developing nations" or less* W1 "developed country" or less* W1 "developed countries" or less* W1 "developed nation" or less* W1 "developed nations" or "third world" or "under developed" or "middle income" or "low income" or "underserved country" or "underserved countries" or "underserved nation" or "underserved nations" or "under served country" or "under served countries" or "under served nation" or "under served nations" or "underserved population" or "underserved populations" or "under served population" or "under served populations" or "deprived country" or "deprived countries" or "deprived nation" or "deprived nations" or poor* W1 country or poor* W1 countries or poor* W1 nation* or poor* W1 population* or lmic or lmics) or AB ("developing country" or "developing countries" or "developing nation" or "developing nations" or less* W1 "developed country" or less* W1 "developed countries" or less* W1 "developed nation" or less* W1 "developed nations" or "third world" or "under developed" or "middle income" or "low income" or "underserved country" or "underserved countries" or "underserved nation" or "underserved nations" or "under served country" or "under served countries" or "under served nation" or "under served nations" or "underserved population" or "underserved populations" or "under served population" or "under served populations" or "deprived country" or "deprived countries" or "deprived nation" or "deprived nations" or poor* W1 country or poor* W1 countries or poor* W1 nation* or poor* W1 population* or lmic or lmics)
S69	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 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)
S68	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

(*Continued*)

	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")
S67	MW ("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 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)
S66	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")
S65	(MH "Asia+")
S64	(MH "West Indies+")
S63	(MH "South America+")
S62	(MH "Latin America")
S61	(MH "Central America+")
S60	(MH "Africa+")

(*Continued*)

S59	(MH "Developing Countries")
S58	S51 and S57
S57	S52 or S53 or S54 or S55 or S56
S56	TI (woman or women or mother* or female*) or AB (woman or women or mother* or female*)
S55	(MH "Female")
S54	(MH "Expectant Mothers")
S53	(MH "Women")
S52	(MH "Mothers")
S51	S47 or S50
S50	S48 or S49
S49	TI ("tetanus toxoid" or "tetanus vaccine" or "tetanus vaccines" or "tetanus prophylaxis") or AB ("tetanus toxoid" or "tetanus vaccine" or "tetanus vaccines" or "tetanus prophylaxis")
S48	(MH "Tetanus Toxoid")
S47	S6 and S46
S46	S44 or S45
S45	TI tetanus or AB tetanus
S44	(MH "Tetanus")
S43	S40 or S41 or S42
S42	TI (child* or infant* or newborn* or neonat* or baby or babies or kid or kids or toddler*) or AB (child* or infant* or newborn* or neonat* or baby or babies or kid or kids or toddler*)
S41	(MH "Child Care+")
S40	(MH "Child+")
S39	S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38
S38	TI (tetanus or diphtheria* or measles or rubella* or rubeola or mumps or epidemic W1 parotid* or pertussis or "whooping cough" or polio* or "infantile paralysis" or tuberculosis or tuberculoses or "hepatitis b"or "haemophilus influenza" or "haemophilus influenzae" or "haemophilus flue") or AB (tetanus or diphtheria* or measles or rubella* or rubeola or mumps or epidemic W1 parotid* or pertussis or "whooping cough" or polio* or "infantile paralysis" or tuberculosis or tuberculoses or "hepatitis b"or "haemophilus influenza" or "haemophilus influenzae" or "haemophilus flue")

(*Continued)*

S37	(MH "Haemophilus Influenzae")
S36	(MH "Hepatitis B, Chronic")
S35	(MH "Hepatitis B")
S34	(MH "Mycobacterium Tuberculosis")
S33	(MH "Tuberculosis, Pulmonary")
S32	(MH "Tuberculosis")
S31	(MH "Poliomyelitis")
S30	(MH "Whooping Cough")
S29	(MH "Rubella")
S28	(MH "Mumps")
S27	(MH "Measles")
S26	(MH "Diphtheria")
S25	(MH "Tetanus")
S24	S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or S17 or S18 or S19 or S20 or S21 or S22 or S23
S23	TI (tetanus W1 vaccine* or diphtheria* W1 vaccine* or pertussis W1 vaccine* or "whooping cough" W1 vaccine* or measles W1 vaccine* or mumps W1 vaccine* or rubella* W1 vaccine* or rubeola W1 vaccine* or mmr W1 vaccine* or polio* W1 vaccine* or tuberculosis W1 vaccine* or tuberculoses W1 vaccine* or bcg W1 vaccine* or calmette* W1 vaccine* or "hepatitis b" W1 vaccine* or haemophilus W1 vaccine* or hib W1 vaccine* or triple W1 vaccine*) or AB (tetanus W1 vaccine* or diphtheria* W1 vaccine* or pertussis W1 vaccine* or "whooping cough" W1 vaccine* or measles W1 vaccine* or mumps W1 vaccine* or rubella* W1 vaccine* or rubeola W1 vaccine* or mmr W1 vaccine* or polio* W1 vaccine* or tuberculosis W1 vaccine* or tuberculoses W1 vaccine* or bcg W1 vaccine* or calmette* W1 vaccine* or "hepatitis b" W1 vaccine* or haemophilus W1 vaccine* or hib W1 vaccine* or triple W1 vaccine*)
S22	TI ("tetanus toxoid" or "diphtheria toxoid") or AB ("tetanus toxoid" or "diphtheria toxoid")
S21	(MH "HIB Vaccine")
S20	(MH "Hepatitis B Vaccines")
S19	(MH "Viral Hepatitis Vaccines")
S18	(MH "BCG Vaccine")

(*Continued*)

S17	(MH "Poliovirus Vaccine")
S16	(MH "Rubella Vaccine")
S15	(MH "Mumps Vaccine")
S14	(MH "Measles Vaccine")
S13	(MH "Measles-Mumps-Rubella Vaccine")
S12	(MH "Pertussis Vaccine")
S11	(MH "Diphtheria-Tetanus Vaccine")
S10	(MH "Diphtheria-Tetanus-Pertussis Vaccine")
S9	(MH "Diphtheria-Tetanus-acellular Pertussis Vaccines")
S8	(MH "Diphtheria Toxoid")
S7	(MH "Tetanus Toxoid")
S6	S1 or S2 or S3 or S4 or S5
S5	TI ((vaccinat* or revaccinate* or immunization or immunisation or immunotherapy)) or AB ((vaccinat* or revaccinate* or immunization or immunisation or immunotherapy))
S4	(MH "Immunization Programs")
S3	(MH "Immunotherapy")
S2	(MH "Immunization Schedule")
S1	(MH "Immunization")

HISTORY

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CONTRIBUTIONS OF AUTHORS

The protocol was drafted by AO, CN, and MM. CO and AO independently screened titles and abstracts of papers for potentially eligible studies and applied the inclusion criteria to the publications. Data extraction and risk of bias (RoB) assessment were carried out independently by AO and CO. AO and CN applied the criteria for RoB. Analysis of data was carried out by AO who also wrote up all sections of the review with supports from MM. All authors commented on the draft of the review.

DECLARATIONS OF INTEREST

None

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INDEX TERMS

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

MeSH check words

Humans; Infant