Parental Financial Incentives for Increasing Preschool Vaccination Uptake: Systematic Review

abstract

BACKGROUND AND OBJECTIVE: Financial incentives have been used to promote vaccination uptake but are not always viewed as acceptable. Quasimandatory policies, such as requiring vaccinations for school enrollment, are widely implemented in some countries. A systematic review was conducted to determine the effectiveness, acceptability, and economic costs and consequences of parental financial incentives and quasimandatory schemes for increasing the uptake of preschool vaccinations in high-income countries.

METHODS: Electronic databases and gray literature were searched for randomized controlled trials, controlled before-and-after studies, and time series analyses examining the effectiveness of parental financial incentives and quasimandatory schemes, as well as any empirical studies exploring acceptability. All included studies were screened for information on economic costs and consequences. Two reviewers independently assessed studies for inclusion, extracted data, and assessed the quality of selected articles by using established instruments. Studies were synthesized in narrative reviews.

RESULTS: Four studies on the effectiveness and 6 on the acceptability of parental financial incentives and quasimandatory interventions met the inclusion criteria. Only 1 study reported on costs and consequences. Studies of effectiveness had low risk of bias but displayed substantial heterogeneity in terms of interventions and methods.

CONCLUSIONS: There was insufficient evidence to conclude whether these interventions were effective. Studies of acceptability suggested a preference, in settings where this already occurs, for incentives linking vaccinations to access to education. There was insufficient evidence to draw conclusions on economic costs and consequences.

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KEY WORDS
child, preschool, incentives, motivation, vaccination

ABBREVIATIONS
DTP—diphtheria-tetanus toxoids-pertussis
MMR—measles-mumps-rubella
NICE—National Institute for Health and Clinical Excellence
RCT—randomized controlled trial

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POTENTIAL CONFLICTS OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.
Childhood vaccination programs are a core component of public health strategies worldwide and have been highly effective in reducing the incidence of and morbidity and mortality from a range of infectious diseases.\(^1\)

The World Health Organization has a goal of 90% coverage for all vaccinations, with 95% coverage for measles and diphtheria. Coverage rates in the United Kingdom and United States approach or exceed the World Health Organization targets for most preschool vaccinations.\(^2\)

However, coverage rates also vary substantially within countries with high overall coverage. For example, diphtheria-tetanus toxoids-pertussis (DTP) coverage at 19 to 35 months in the United States varies from 77% in Idaho to 91% in Connecticut.\(^3\)

Factors identified as contributing to variation in vaccination coverage fall into the categories of sociodemographic, attitudinal, and health care factors. Parents living in less affluent circumstances, who lack trust of health care professionals, have limited access to healthcare, or believe the disease protected against is not serious, are less likely to have vaccinated children.\(^4\)–\(^6\)

Other factors related to uptake include concern over pain, safety, and side effects; access to transport and child care; and a lack of familiarity with vaccination schedules.\(^4\)–\(^5\)

Financial incentives have been successfully used to promote uptake of vaccinations in developing countries\(^7\)–\(^8\) but are not always viewed as acceptable. Criticisms include that they are socially divisive and coercive.\(^9\) However, recent work has found that financial incentives can be acceptable if the problems addressed are perceived to be serious, other interventions ineffective, and the necessary behaviors particularly difficult to achieve.\(^10\)–\(^12\)

Quasimandatory policies, such as requiring vaccinations for school enrollment (“quasi” because parents can exempt their child on philosophical or religious grounds) are widely implemented in some countries (eg, the United States) and can have large impacts on families and communities, both in terms of vaccination rates achieved and education lost. They have also been reported to be effective in some cases.\(^13\)

However, to date no existing systematic review has comprehensively explored the effectiveness of parental financial incentive and quasimandatory interventions in high-income countries. Similarly, there is a lack of review-level evidence on cost-effectiveness and acceptability of these interventions.

One systematic review explored the effectiveness of financial incentives for uptake of all healthy behaviors, including vaccinations, in low- and middle-income countries.\(^7\) Given the substantially different resource and health care settings between high- and middle- versus low-income countries, findings cannot be assumed to be generalizable. Two previous reviews on methods for increasing vaccination uptake have included sections on financial incentives, but neither focused on preschool-aged children in particular.\(^14\),\(^15\) There are many reasons why individuals may act differently for themselves than for their children, and findings on offering incentives to adults to vaccinate themselves are not necessarily generalizable to offering incentives to parents to vaccinate their children. Furthermore, only 1 of these previous reviews was systematic, and studies were dated only up to 1997, more than 15 years ago.\(^14\)

To fill this evidence gap, a systematic review of research evidence on the effectiveness, acceptability, and economic costs and consequences of parental incentive and quasimandatory schemes for increasing uptake of vaccinations in preschool-aged children in high-income countries, compared with usual care or no intervention, was conducted.

**METHODS**

The review was registered with PROSPERO before searches commenced (registration CRD42012003192). There were no substantive deviations from protocol. The review is presented in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidance.\(^16\)

**Inclusion Criteria**

We performed 1 systematic review with 3 parallel components: effectiveness, acceptability, and economics. Studies that met the criteria for either the effectiveness or acceptability components were screened for inclusion in the economic component. Throughout, parental incentive and quasimandatory schemes were defined as “interventions that increase demand for vaccinations by offering contingent rewards or penalties with real material value; or that restrict access to universal goods or services.”

The inclusion criteria for all 3 components are summarized in Table 1. No studies were excluded on the basis of language. Relevant articles were translated locally as needed.

**Information Sources**

The following databases were searched: Cumulative Index to Nursing and Allied Health Literature, Applied Social Science Index and Abstracts, International Bibliography for the Social Sciences, PsycInfo, Medline, Web of Science, Embase, Education Resources Information Center, Health Economic Evaluations Database, and the Cochrane Library (see Supplemental Information for example search strategy). The reference lists of studies meeting the inclusion criteria and relevant reviews\(^14\),\(^15\),\(^17\) were searched for additional publications, and citation searches of studies meeting the inclusion criteria were run in the Science and Social Science Citation Indices. Gray literature was searched via e-mails sent to relevant online discussion groups and entry of the formal search strategy
Study Selection

Initial screening of titles and abstracts was conducted by S.W. Full texts were screened independently by 2 researchers (S.W. and J.A.) against the inclusion criteria. Discrepancies were resolved by discussion. Where publications lacked details needed for a decision, authors were contacted to request additional details.

Data Collection and Data Items

A data extraction form was developed to record data on the nature and location of study participants, age and gender of children involved, time period, socioeconomic status of participants, type of intervention, study design, comparator, vaccination, and results. Data were extracted independently by 2 reviewers (S.W. and J.A.), with consensus reached by discussion. To allow comparisons, values of financial incentives were converted to their equivalent commodity real price value in US dollars in 2012, the latest date for which data were available when searches were conducted.18 Information on economic costs and consequences in all articles was assessed by a health economist (L.T.). This assessment focused on whether studies reported the cost of delivering the incentive and the consequences of undertaking, or not undertaking, the desired activity. Methods for reviewing the economic evidence followed those set out by the Cochrane and Campbell Collaborations.19

Risk of Bias

The quality and risk of bias of all studies meeting the inclusion criteria were independently assessed by 2 researchers (S.W. and J.A.). We assessed quantitative studies by using the Quality Assessment Tool for Quantitative Studies, which has acceptable test–retest and construct validity.20 We assessed the qualitative studies by using the Critical Appraisal Skills Program checklist.21 Methods derived from Campbell and Cochrane Economic Methods Group were used to assess quality of studies in the economic component.19 Quality ratings were used to inform the approach to synthesis.

Synthesis of Results

Narrative synthesis was performed throughout. Within the narrative synthesis, interventions were described by using an existing framework.22 Meta-analysis was considered for all 3 components. In the effectiveness component, 2 studies theoretically could have been meaningfully combined in a meta-analysis.23,24 However, 1 had high risk of bias,24 leaving any sensitivity analysis with only 1 included study. Therefore, meta-analysis was not considered appropriate for the effectiveness component.

Studies in the acceptability component were more heterogeneous in design, and meta-analysis was inappropriate. In accordance with recommendations of the Cochrane and Campbell collaborations, the economic data were not quantitatively synthesized; rather, a narrative synthesis was adopted.

RESULTS

Four studies were identified that met the criteria for inclusion in the effectiveness component.23–26 6 studies for inclusion in the acceptability component.27–32 and 1 for inclusion in the economic component (Fig 1).31

Studies included in the effectiveness component consisted of 1 cluster randomized controlled trial (RCT).26 2 non-clustered RCTs,23,24 and 1 time series analysis.25 Studies included in the

### TABLE 1 Inclusion Criteria for Effectiveness, Acceptability, and Economic Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Effectiveness</th>
<th>Acceptability</th>
<th>Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>Parents of preschool-aged children living in high-income countries19</td>
<td>Members of any relevant stakeholder group (eg, parents, health care providers, policymakers) living in high-income countries</td>
<td>Included in either the effectiveness or acceptability component</td>
</tr>
<tr>
<td>Intervention</td>
<td>Financial incentive interventions that increase demand for vaccinations by offering contingent rewards or penalties with real material value or quasimandatory schemes that restrict access to “universal” goods or services</td>
<td>Financial incentive interventions that increase demand for vaccinations by offering contingent rewards or penalties with real material value or quasimandatory schemes that restrict access to “universal” goods or services</td>
<td>Included in either the effectiveness or acceptability component</td>
</tr>
<tr>
<td>Comparator</td>
<td>Usual care or no intervention</td>
<td>Usual care or no intervention</td>
<td>Included in either the effectiveness or acceptability component</td>
</tr>
<tr>
<td>Outcome</td>
<td>Uptake of preschool vaccinations</td>
<td>Acceptability of the intervention</td>
<td>Economic costs and consequences of the intervention to parents or society</td>
</tr>
<tr>
<td>Study design</td>
<td>RCTs, cluster RCTs, controlled before-and-after studies, time series analyses19</td>
<td>Any study design</td>
<td>Included in either the effectiveness or acceptability component</td>
</tr>
</tbody>
</table>

19 As defined by the World Bank.41
20 As specified by the Cochrane Effective Practice and Organization of Care group.38

As defined by the World Bank.41
As specified by the Cochrane Effective Practice and Organization of Care group.38
acceptability component were primarily surveys, including 1 survey that made use of discrete choice modeling methods, with 1 qualitative study using semistructured interviews (Table 2). Interventions in included studies included proof of vaccination for school or day care entry, loss of welfare benefits, or imposition of criminal misdemeanor charges for nonvaccination and entry into a cash lottery for attending for vaccination (Table 3).

**Risk of Bias Within Studies**

Of the studies in the effectiveness component, 3 had low risk of bias, and the fourth had a strong risk of bias. All quantitative studies in the acceptability component had strong risk of bias, and in particular they were weak on study design and data collection methods (Fig 2). The qualitative study in the acceptability component lacked details of recruitment and assignment of patients to intervention groups, justification of data collection methods, and adequate discussion of reflexivity and how data saturation and contradictory data were dealt with.

**Effectiveness Component**

All studies in the effectiveness component were set in the United States. Individual- and state-level data from the US National Immunization Survey were used to conduct an interrupted time series study of the effects of school and day care entry mandates on uptake of varicella vaccination in preschool-aged children. Significant effects were seen in the year of mandate introduction at both the individual and the state level. At both the state and the individual level, mandates were associated with a 2.6% increase in vaccination uptake in the first year. Effects at state level peaked 2 years after introduction and were extinguished by 6 years. At the individual level, effects peaked at 2 years after the mandate and were extinguished by 5 years.

A cluster RCT of children who were not up to date with DTP, polio, or measles-mumps-rubella (MMR) vaccinations compared a cash lottery ticket incentive (combined with a vaccination prompt) with a no-intervention control. The cash lottery ticket incentive ($55.20–$221 in 2012 US$) and postal prompt advising that the lottery could be entered on attendance at the clinic were associated with a significant 21% increase in numbers of vaccinations received, compared with control. The effect persisted to at least 3 months after the incentive expired, with a 31.6% increase in number of vaccinations received compared with control.

In an RCT of families receiving welfare benefits, no effect was found from a penalty of $38.70 (in 2012 US$) for failing to have a child vaccinated for DTP, polio, and MMR. However, those who were penalized tended to have more children, qualifying them for extra welfare benefits, and this may have reduced the financial impact of the penalty.

An RCT found significant effects of cutting welfare benefits when children were not up to date for 5 preschool vaccinations. Significantly more of the intervention (72.4%) than the control (60.6%) group achieved vaccination series completion. The authors note that parents rarely lost benefits, and the threat rather than the imposition of the penalty appeared to be sufficiently incentivizing.

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**FIGURE 1**
Flow diagram showing identification, inclusion, and exclusion of studies.
<table>
<thead>
<tr>
<th>Author and Year</th>
<th>Country</th>
<th>Population</th>
<th>N</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Outcome(s)</th>
<th>Study Design</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yokley and Glenwick (1984)</td>
<td>USA</td>
<td>Preschoolers (aged &lt;5) registered at public health clinic not UTD with vaccinations (as defined by local health department). Mean (SD) age of children = 37.3 (18.2) months; 50% male.</td>
<td></td>
<td>Intervention, n = 183 children; control, n = 191 children</td>
<td>Parents sent tickets for cash lottery with prizes from $55.20 to $221 to be entered when attended clinic. Valid for 2 wk.</td>
<td>Usual care</td>
<td>N attending clinic for any reason, N attending for vaccination, N vaccinations given.</td>
<td>Cluster RCT clustered at family level with follow-up at 2 wk, 2 mo, and 3 mo. At each follow-up time point intervention associated with significantly more attendance for any reason, attendance for vaccination, and number of vaccinations.</td>
</tr>
<tr>
<td>Minkovitz et al (1999)</td>
<td>USA</td>
<td>Welfare claimants from Maryland. Children aged 3–24 mo; 51% male.</td>
<td></td>
<td>Intervention children, n = 911; control, n = 864</td>
<td>Penalty of loss of $38.70 from welfare benefits for failing to verify children's preventive health care, including vaccinations.</td>
<td>Usual care</td>
<td>UTD for DTP, polio, and MMR (as per American Academy of Pediatrics).</td>
<td>RCT with follow-up at 1 and 2 y. No difference in UTD rates for any vaccinations at 1 or 2 y follow-up.</td>
</tr>
<tr>
<td>Kerpelman et al (2000)</td>
<td>USA</td>
<td>Welfare claimants from Georgia. Mean age of intervention children = 3.22 y, 50% male. Mean age of control children = 3.34 y, 48.5% male.</td>
<td></td>
<td>Intervention children, n = 1725; control children, n = 1076</td>
<td>Penalty of loss of welfare benefit amount depending on family size and child age.</td>
<td>Usual care</td>
<td>UTD for DTP, MMR, polio, Hib, HBV (as per American Academy of Pediatrics). UTD for full series at age 2 y. At baseline no differences in uptake between intervention and control for any vaccination. At 1, 2, 3, and 4 y intervention associated with greater uptake of all vaccinations. This difference was significant except for HBV at 1 y and Hib at 1 and 2 y. At age 2, intervention associated with higher series completion.</td>
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<tr>
<td>Abrevaya and Mulligan (2011)</td>
<td>USA</td>
<td>State- and individual-level data on parents from National Immunization Surveys, 1996–2007. Children aged 19–35 mo, 51% male.</td>
<td></td>
<td>Day care or school entry restricted to those with varicella vaccination.</td>
<td>Usual care</td>
<td>Varicella vaccination. Time series analysis from 1 y before intervention to 7 y after intervention. At state level, mandate has effect from year of introduction to 6 y after introduction. Effect peaking at 2 y after introduction. At individual level (controlling for child gender, race, age, maternal age, education, and income) mandate has effect from introduction to 5 y after introduction. Effect peaking at 2 y after introduction.</td>
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</tbody>
</table>

**TABLE 2** Characteristics of Included Studies

<table>
<thead>
<tr>
<th>Author</th>
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<td>USA</td>
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</tr>
<tr>
<td>Schaefer</td>
<td>USA</td>
<td>Recipients and staff of incentive program.</td>
<td>1331</td>
<td>Penalty of loss of $38.70 from welfare benefits for failing to verify children's preventive health care including vaccinations.</td>
<td>Usual care</td>
<td>Views on interventions.</td>
<td>Survey</td>
<td>73% of recipients thought penalty for noncompliance with health requirements was fair. 66.7% of recipients thought penalty would motivate parents to meet health requirements. 73.5% of staff thought behavior could be changed by threat of penalties. 77.8% by imposing penalties. Most staff believed both the threat and imposition of penalty effective.</td>
</tr>
<tr>
<td>Freed et al</td>
<td>USA</td>
<td>District and county health department directors.</td>
<td>75</td>
<td>State laws allowing school or day care entry to be restricted, criminal misdemeanor charges to be brought, or injunctions to be filed against parents for not keeping children's vaccinations UTD.</td>
<td>No comparator</td>
<td>Experience of and views on intervention.</td>
<td>Survey</td>
<td>100% aware of authority to enforce school and day care restrictions, 83% of criminal misdemeanor charges, 69% of injunctions. 99% believed nonvaccinated children should be restricted from school or day care, 83% believed misdemeanor charges should be brought. 5% reported misdemeanor charges had been brought; 24% had threatened to do so. 83% believed injunctions should be filed, none had done so.</td>
</tr>
<tr>
<td>Bond et al</td>
<td>Australia</td>
<td>Parents of children regularly attending council-run day care in metropolitan area.</td>
<td>1722 families with 1779 eligible children</td>
<td>Additional welfare payments of $29.30–$175 per week for child care plus 1-time payment of $307 if UTD for all vaccinations.</td>
<td>No comparator</td>
<td>Views on intervention.</td>
<td>Survey</td>
<td>30% believed incentives should be given to parents for immunizing their child, though many believed the child's health, not monetary reasons, should be the motivator. ~30% believed the decision to immunize would not be affected by intervention.</td>
</tr>
</tbody>
</table>
Acceptability Component

Of the 6 studies included in the acceptability component, 3 were conducted in Australia, 2 in the United States, and 1 in Hong Kong. Two studies were based on the Australian government incentive schemes introduced in 1998 linking child care subsidies to vaccination, collecting data before and after introduction of the scheme. Before introduction of the scheme, only 30% of respondents said incentives should be given to parents for immunizing their children, with many saying health promotion rather than finance should be the motivation for vaccination and that education could encourage vaccination. In the follow-up study, only 4% of parents reported child care benefits as motivating them to keep their children's vaccinations up to date.

Hall et al (2002) used stated preference discrete choice modeling to predict the optimal characteristics of a preschool varicella vaccination program. Survey data collected from parents indicated that requiring vaccination for school entry was associated with a greater preference for vaccination uptake.

Freed et al (1998) described North Carolina's statute requiring age-appropriate vaccination for school and day care entry that allows criminal misdemeanor charges and injunctions to be brought against noncompliant parents. County health directors, whose decision it was to implement criminal statutes, were interviewed on their attitudes toward the statute. Most respondents (83%) believed criminal charges should be brought, but only 5% were aware of this ever being done, and none had filed an injunction themselves. Most respondents (99%) agreed that children should be excluded from school or day care if they were not up to date with vaccinations. There was some belief that using

<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Population</th>
<th>Intervention</th>
<th>Comparator</th>
<th>Study Design</th>
<th>Outcome</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hall et al (2002)</td>
<td>Australia</td>
<td>50</td>
<td>School entry restricted to those UTD for all vaccinations.</td>
<td>No comparator</td>
<td>Survey; discrete choice modeling</td>
<td>Semistructured person-centered interviews</td>
<td>Views on intervention.</td>
</tr>
<tr>
<td>Tarrant and Thomson (2008)</td>
<td>Hong Kong</td>
<td>15</td>
<td>Parents of children 6 mo–3 y receiving secondary health care.</td>
<td>No comparator</td>
<td>Survey</td>
<td>No comparator</td>
<td>No comparator</td>
</tr>
</tbody>
</table>

HBV, hepatitis B; Hib, Haemophilus influenzae B; UTD, up to date.

See Table 3 for additional details.
a criminal law in this context was too
due to its excessive punitive and po-
litically inadvisable nature, explaining
low enforcement rates. Some believed
clarification of the charges and process
of parent warnings would help en-
forcement.

Only 1 qualitative study was included in
the acceptability component.32 Parents
in Hong Kong, where vaccination up-
take is high, were interviewed to iden-
tify factors that encourage this high
uptake. Content analysis identi
fied mandatory vaccination for child care
and school entry as 1 important factor
in a system of other vaccine-related
services. Cultural and contextual fac-
tors found to be important included the
relative importance of society versus
individualism, trust in health pro-
fessionals, and the high population
density of Hong Kong, which increased
perceived susceptibility to infectious
diseases.

In a survey of administrators and staff
in the acceptability component, 70%
agreed that the penalty drove behav-
ior in delivery of a welfare benefit
involving non-compliance with health
intervention. Of these, 14% said that the
penalty was fair (73%) and 28%
said it was effective only when im-
posed rather than just threatened.

Recipients of the intervention reported
that the penalty was fair (73%) and
would motivate parents to meet health
requirements (67%). Only 1 qualitative study was included in
the acceptability component.32 Parents
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forcement. The lack of enforceability and high
parental acceptance in Hong Kong.excessive punitive and pol-
In Table 3, details of Parental Financial Incen-
tives and Quasi-mandatory Interventions in Included Studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Direction Form Magnitude ($US 2012)</th>
<th>Certainty</th>
<th>Target Frequency</th>
<th>Immediacy Schedule</th>
<th>Recipient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yokley and Glenwick (1984)</td>
<td>Positive reward Cash lottery</td>
<td>$55.20–$221</td>
<td>Uncertain chance</td>
<td>Clinic attendance and vaccination uptake</td>
<td>Once</td>
</tr>
<tr>
<td>Abrevaya and Mulligan (2011)</td>
<td>Avoidance of penalty Day care or school entry Loss of education</td>
<td>Certain</td>
<td>Unclear</td>
<td>Reassessed 6 monthly</td>
<td>Written warning before sanction</td>
</tr>
<tr>
<td>Schaefer (1997)</td>
<td>Avoidance of penalty Welfare benefits</td>
<td>$38.70</td>
<td>Certain</td>
<td>Vaccination uptake</td>
<td>Written warning before sanction</td>
</tr>
</tbody>
</table>

*Although many interventions are listed as “certain,” there was anecdotal evidence that penalties, in particular, were not always imposed in practice.
consequences in the format of a cost–benefit framework. Because no evidence of effectiveness of the program was found, the authors concluded that the costs of implementing the program outweighed the benefits.

DISCUSSION

Summary of Findings

To our knowledge, this is the first systematic review to explore the effectiveness, acceptability, and economic costs and consequences of parental incentive and quasimandatory schemes for increasing uptake of preschool vaccinations in high-income countries. Few studies were found that met the inclusion criteria. There was substantial heterogeneity across studies in terms of both interventions and methods.

There was insufficient evidence to conclude whether parental financial incentives and quasimandatory interventions are effective for encouraging uptake of preschool vaccinations. Interventions and evaluation were heterogeneous and results inconsistent. One study with low risk of bias did find short-term effects of quasimandatory interventions linking vaccinations to education, but effects were extinguished by 6 years after introduction of mandates. Studies also found that these mandates were particularly acceptable, although the risk of bias in relevant studies was high, and they were conducted in contexts where such interventions were the norm. There was insufficient evidence to draw generalized conclusions about the economic costs and consequences of these interventions.

Comparison of Results With Previous Reviews

Previous reviews that included work on these topics have had much wider scopes in terms of interventions, outcomes, and populations considered. A systematic review commissioned by the UK National Institute for Health and Clinical Excellence (NICE) explored the effectiveness and cost-effectiveness of all types of interventions for increasing uptake of preschool vaccinations. Only 2 studies included in the current review overlapped with studies in the NICE review. Other studies identified in the NICE review as “incentives” did not meet our definition because they either involved changing the frequency of attendance for welfare benefits but not the level of benefit itself or did not involve incentives with real material value. Similar to the current review, the NICE review concluded that incentives could be effective but that the strength and quality of the evidence varied, and cost-effectiveness data were insufficient.

Briss et al (2000) reviewed a range of interventions to improve vaccination coverage across all ages using non-systematic methods. Similar to the current work, they concluded that there was some evidence to support the effectiveness of day care and school entry mandates across all ages (not just preschool-aged children) but insufficient evidence for the effectiveness of family incentives. Economic evidence was also limited.

Kane et al (2004) conducted a structured but not systematic review of the effectiveness of financial incentive interventions for uptake of a range of preventive health behaviors. They reported that these were most effective for short-term goals such as vaccinations. However, this included vaccinations across all ages, not just preschool-aged children. It is possible that the effects of financial incentive interventions on uptake of vaccinations are different when incentives given directly to adults for receiving a vaccination themselves are considered.

FIGURE 2

Quality appraisal of quantitative studies included in systematic review.
compared with incentives given to parents for having their child vaccinated.

**Strengths and Limitations of Included Studies**

Studies included in the effectiveness component tended to have low risk of bias, whereas those in the acceptability component had higher risk of bias. This reflects the cross-sectional survey designs in the acceptability component.

There was a lack of reported theory underpinning the design of interventions in included studies. Given the complexity of financial incentive interventions, more consideration of behavior change theory may help guide the development of effective interventions.

There were a number of reports in included studies of threatened penalties not being imposed and belief that the threat of a penalty is sufficient for behavior change. This raises a number of important questions about intervention fidelity and the effective components of financial incentive interventions that should be explored further.

This is the first systematic review we are aware of that considered the acceptability of financial incentive and quasimandatory interventions. Only 1 of 6 included studies used qualitative methods. In-depth exploration of the acceptability of financial incentive and quasimandatory interventions to a range of stakeholders is needed.

The studies that found school entry mandates to be acceptable were conducted in settings where these are already common. The threat of withholding education from children may be less acceptable in other settings, and this possibility should be explored further.

**Strengths and Limitations of the Review**

Throughout the review, established criteria and protocols were used to inform methods and reporting. This led to exclusion of a number of studies that have been included in previous reviews. In particular, we excluded uncontrolled before-and-after studies that are straightforward to carry out using routine data. However, the lack of a control group makes it particularly difficult to infer causation from these studies.

A clear definition of parental incentive and quasimandatory interventions was also used, leading to the exclusion of interventions that have previously been considered incentives. In particular, we excluded studies related to the Supplemental Nutrition Program for Women, Infants, and Children in the United States, which offers low-income families vouchers that can be exchanged for nutritious food. Normally enough vouchers for 3 months are provided per attendance at the program. Under a vaccination initiative, families received only 1 month of vouchers at a time until their children’s vaccinations were up to date. Because the absolute number of vouchers families were eligible to receive did not change, we did not consider this a financial incentive. Although it is always possible that studies that met the inclusion criteria were not found, this is unlikely given the exhaustive searching process used.

There was heterogeneity across studies included in the effectiveness component in terms of intervention and method, such that a meta-analysis was not considered appropriate. This highlights the potential heterogeneity of financial incentive and quasimandatory interventions. A more considered approach to intervention design may be needed to begin to establish what configurations of financial incentive interventions are likely to be most effective in a range of different circumstances.

We attempted to describe the characteristics of interventions used in included studies. However, some details were missing and unobtainable from study authors. Such description of the complex components of incentives has been missing in previous research and limits meaningful comparisons across studies.

**Interpretation of Findings and Implications for Policy, Practice, and Research**

Any interventions to increase uptake of health promotion behaviors must be both effective and acceptable for widespread implementation. Consistent evidence that parental financial incentive and quasimandatory interventions are effective in encouraging uptake of preschool vaccinations was not found; the available evidence base was small, with substantial heterogeneity in both interventions and methods. Therefore, it is not clear whether these interventions are effective and, if so, in what circumstances.

Despite this absence of evidence, quasimandatory schemes limiting school entry to children who are up to date with required vaccinations are common in some countries, particularly the United States. Although such programs may be effective, without robust evaluation it is difficult to conclude this, justify any associated cost, or advocate for expansion of such programs to other vaccinations or countries.

Parental financial incentives and quasimandatory interventions for encouraging uptake of preschool vaccinations are likely to be implemented on a large scale, which can make evaluation difficult. Creative evaluation strategies such as natural experiments and stepped-wedge designs may be most useful in these contexts.

Intervention development work, taking account of existing behavior change theory, may also be useful to develop more effective incentive interventions. This should involve additional consideration of the effective component, or components, of financial incentive interventions. Strategies such as multiphase
optimization strategy may be particularly helpful in this context.  
All studies included in the review were conducted in countries that tend to achieve overall high coverage of preschool vaccinations. Although pockets of poor coverage exist in these countries, population-wide interventions such as parental incentives and quasimandatory interventions may not be adequately targeted to families that need the most assistance. Furthermore, these interventions may not adequately address the reasons for nonvaccination, including mistrust of health care professionals, limited access to health care, chaotic lifestyles, and low perceived susceptibility to and severity of vaccinated diseases.  
Additional consideration of reasons for nonvaccination should be considered in designing new interventions for promoting vaccination. Overall, these interventions were not considered to be clearly unacceptable by any stakeholders. However, parents did not report that financial incentives were particularly motivating in this context, and quasimandatory policies appeared to be considered more appropriate. However, only 1 study used an in-depth qualitative approach.  
Furthermore, few studies appeared to make specific attempts to capture the views of parents with unvaccinated children. In-depth, qualitative analysis is needed to explore what aspects of these interventions are and are not acceptable, to whom, and why. In addition, it is likely that acceptability is at least partly dependent on perceptions of effectiveness. This suggests that if high-quality evidence of effectiveness is generated and then effectively communicated to the public, higher levels of acceptability are likely to follow. Better understanding of how to effectively communicate research findings to the public would be valuable. Although acceptability of restricting day care or school entry to vaccinated children appeared to be high, all studies reporting such restrictions were conducted in settings where they are already the norm. Only 1 study of the effectiveness of such quasimandatory policies was included in the effectiveness component, finding that these policies were effective for up to 6 years after introduction. Such policies clearly have potential in countries where they do not currently exist. But effectiveness, cost-effectiveness, and acceptability in new contexts must be considered across a range of stakeholders, with the use of both qualitative and quantitative methods. Discrete choice experimental methods may be particularly useful.

CONCLUSIONS
This systematic review of the effectiveness, acceptability, and economic costs and consequences of parental financial incentives and quasimandatory interventions to increase uptake of preschool vaccinations identified a limited evidence base in all areas. There is not sufficient evidence to conclude whether these interventions are effective, although mandates limiting access to education to vaccinated children may be effective for up to 6 years after intervention. There was some evidence that quasimandatory interventions linking vaccinations to education were also the most acceptable interventions considered, although the risk of bias in these studies was high, and this finding may be specific to contexts where such interventions are widespread. There was insufficient evidence to draw conclusions on the economic costs and consequences of these interventions.

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Parental Financial Incentives for Increasing Preschool Vaccination Uptake: Systematic Review
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