

# Parental Financial Incentives for Increasing Preschool Vaccination Uptake: Systematic Review

**AUTHORS:** Sarah Wigham, PhD, Laura Ternent, PhD, Andrew Bryant, MSc, Shannon Robalino, MSc, Falko F. Sniehotta, PhD, and Jean Adams, PhD

*Institute of Health and Society, Newcastle University, Newcastle upon Tyne, United Kingdom*

## 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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Address correspondence to Jean Adams, PhD, Baddiley Clark Building, Richardson Rd, Newcastle University, Newcastle upon Tyne, United Kingdom, NE2 4AX UK. E-mail: [jean.adams@newcastle.ac.uk](mailto:jean.adams@newcastle.ac.uk)

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## 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. *Pediatrics* 2014;134:e1117–e1128

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.<sup>1</sup>

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.<sup>2</sup> 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.<sup>3</sup>

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.<sup>4-6</sup> 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.<sup>4,5</sup>

Financial incentives have been successfully used to promote uptake of vaccinations in developing countries<sup>7,8</sup> but are not always viewed as acceptable. Criticisms include that they are socially divisive and coercive.<sup>9</sup> 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.<sup>10-12</sup> 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.<sup>13</sup>

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.<sup>7</sup> 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.<sup>14,15</sup> 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.<sup>14</sup>

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 GRD42012003192). There were no substantive deviations from protocol. The review is presented in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidance.<sup>16</sup>

### 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<sup>14,15,17</sup> 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

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

	Effectiveness Component	Acceptability Component	Economic Component
Population	Parents of preschool-aged children living in high-income countries <sup>a</sup>	Members of any relevant stakeholder group (eg, parents, health care providers, and policymakers) living in high-income countries <sup>a</sup>	Included in either the effectiveness or acceptability component
Intervention	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	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	Included in either the effectiveness or acceptability component
Comparator	Usual care or no intervention	Usual care or no intervention	Included in either the effectiveness or acceptability component
Outcome	Uptake of preschool vaccinations	Acceptability of the intervention	Economic costs and consequences of the intervention to parents or society
Study design	RCTs, cluster RCTs, controlled before-and-after studies, time series analyses <sup>b</sup>	Any study design	Included in either the effectiveness or acceptability component

<sup>a</sup> As defined by the World Bank.<sup>41</sup>

<sup>b</sup> As specified by the Cochrane Effective Practice and Organization of Care group.<sup>58</sup>

terms into [www.google.com](http://www.google.com). When both an internal report and peer-reviewed article on the same study were retrieved, peer-reviewed findings were favored, but additional information from reports was used where relevant. Searches were carried out in February 2013.

### 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, socio-economic 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.<sup>18</sup>

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.<sup>19</sup>

### 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.<sup>20</sup> We assessed the qualitative studies by using the Critical Appraisal Skills Program checklist.<sup>21</sup> Methods derived from Campbell and Cochrane Economic Methods Group were used to assess quality of studies in the economic component.<sup>19</sup> Quality ratings were used to inform the approach to synthesis.

### Synthesis of Results

Narrative synthesis was performed throughout. Within the narrative syn-

thesis, interventions were described by using an existing framework.<sup>22</sup> Meta-analysis was considered for all 3 components. In the effectiveness component, 2 studies theoretically could have been meaningfully combined in a meta-analysis.<sup>23,24</sup> However, 1 had high risk of bias,<sup>24</sup> 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,<sup>23–26</sup> 6 studies for inclusion in the acceptability component,<sup>27–32</sup> and 1 for inclusion in the economic component (Fig 1).<sup>31</sup>

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

acceptability component were primarily surveys,<sup>27,31</sup> including 1 survey that made use of discrete choice modeling methods,<sup>30</sup> with 1 qualitative study using semistructured interviews<sup>32</sup> (Table 2).

Interventions in included studies included proof of vaccination for school or day care entry,<sup>25,30,32</sup> loss of welfare benefits,<sup>23,24,27,28,31</sup> or imposition of criminal misdemeanor charges<sup>29</sup> for nonvaccination and entry into a cash lottery for attending for vaccination (Table 3).<sup>26</sup>

### Risk of Bias Within Studies

Of the studies in the effectiveness component, 3 had low risk of bias,<sup>23,25,26</sup> and the fourth had a strong risk of bias.<sup>24</sup> 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<sup>32</sup> 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.

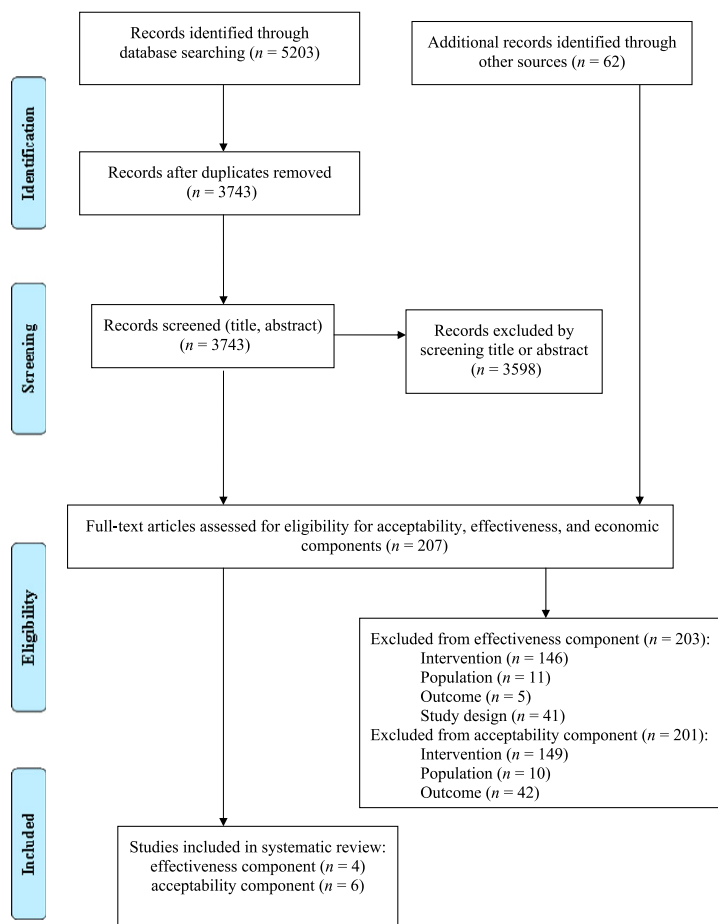
Individual- and state-level data from the US National Immunization Survey were used to conduct an interrupted time series study of the effects of school and day care entry mandates on uptake of varicella vaccination in preschool-aged

children.<sup>25</sup> 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.<sup>26</sup> 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.<sup>24</sup> 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.<sup>24,31</sup>

An RCT found significant effects of cutting welfare benefits when children were not up to date for 5 preschool vaccinations.<sup>23</sup> 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.



**FIGURE 1** Flow diagram showing identification, inclusion, and exclusion of studies.

TABLE 2 Characteristics of Included Studies

Author	Country	Population	N	Intervention <sup>a</sup>	Comparator	Outcome(s)	Study Design	Results
Effectiveness component								
Yokley and Glenwick (1984)	USA	Preschoolers (aged <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.	Intervention, n = 183 children; control, n = 191 children	Parents sent tickets for cash lottery with prizes from \$55.20 to \$221 to be entered when attended clinic. Valid for 2 wk.	Usual care	N attending clinic for any reason, N attending for vaccination, N vaccinations given.	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.
Minkovitz et al (1999)	USA	Welfare claimants from Maryland. Children aged 3–24 mo; 51% male.	Intervention children, n = 911; control, n = 864	Penalty of loss of \$38.70 from welfare benefits for failing to verify children's preventive health care, including vaccinations.	Usual care	UTD for DTP, polio, and MMR (as per American Academy of Pediatrics).	RCT with follow-up at 1 and 2 y.	No difference in UTD rates for any vaccinations at 1 or 2 y follow-up.
Kerpelman et al (2000)	USA	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.	Intervention children, n = 1725; control children, n = 1076	Penalty of loss of welfare benefit with amount depending on family size and child age.	Usual care	UTD for DTP, MMR, polio, Hib, HBV (as per American Academy of Pediatrics). UTD for full series at age 2 y.	RCT with follow-up at 1, 2, 3, and 4 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.
Abreyva and Mulligan (2011)	USA	State- and individual-level data on parents from National Immunization Surveys, 1996–2007.  Children aged 19–35 mo, 51% male.	324 553 children	Day care or school entry restricted to those with varicella vaccination.	Usual care	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.

TABLE 2 Continued

Author	Country	Population	N	Intervention <sup>a</sup>	Comparator	Outcome(s)	Study Design	Results
Acceptability component								
Schaefer 1997	USA	Recipients and staff of incentive program.	1331	Penalty of loss of \$28.70 from welfare benefits for failing to verify children's preventive health care including vaccinations.	Usual care	Views on interventions.	Survey	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. 100% aware of authority to enforce school and day care restrictions, 83% of criminal misdemeanor charges, 65% 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.
Freed et al (1998)	USA	District and county health department directors.	75	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.	No comparator	Experience of and views on intervention.	Survey	
Bond et al (1999)	Australia	Parents of children regularly attending council-run day care in metropolitan area.  Children <3 y (except 62 who were older), 50% male.	1722 families with 1779 eligible children	Additional welfare payments of \$29.30–\$175 per week for child care plus 1-time payment of \$507 if UTD for all vaccinations.	No comparator	Views on intervention.	Survey	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.

TABLE 2 Continued

Author	Country	Population	N	Intervention <sup>a</sup>	Comparator	Outcome(s)	Study Design	Results
Bond et al (2002)	Australia	Parents of children regularly attending council-run day care in metropolitan area. Children <3 y.	1706 families with 1793 eligible children	Additional welfare payments of \$29.30–\$175 per week for child care plus 1-time payment of \$307 if UTD for all vaccinations.	No comparator	Views on intervention.	Survey.	~30% believed intervention had not influenced decision to immunize. 4% reported they had kept their children's vaccinations UTD because they relied on related payments.
Hall et al (2002)	Australia	Parents of children <12 y	50	School entry restricted to those UTD for all vaccinations.	Range of other interventions to promote vaccination	Stated preference for vaccination uptake.	Survey; discrete choice modeling.	Most respondents preferred vaccination under most scenarios. 31% chose not to vaccinate in all scenarios. Requiring vaccination for school entry increased vaccination preference from 75% to 92%.
Tarrant and Thomson (2008)	Hong Kong	Parents of children 6 mo–3 y receiving secondary health care.	15	Day care and school entry restricted to those UTD for all vaccinations.	No comparator	Views on intervention.	Semistructured person-centered interviews.	Day care and school entry restriction identified as contributing to high vaccination rates within a system of other contributory factors.

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

<sup>a</sup> See Table 3 for additional details.

### Acceptability Component

Of the 6 studies included in the acceptability component, 3 were conducted in Australia,<sup>27,28,30</sup> 2 in the United States,<sup>29,31</sup> and 1 in Hong Kong.<sup>32</sup>

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.<sup>27,28</sup> 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.<sup>28</sup> 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.<sup>27</sup>

Hall et al (2002)<sup>30</sup> 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)<sup>29</sup> 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 3** Details of Parental Financial Incentives and Quasimandatory Interventions in Included Studies

Study	Direction	Form	Magnitude (\$US 2012)	Certainty <sup>a</sup>	Target	Frequency	Immediacy	Schedule	Recipient
<b>Effectiveness component</b>									
Yokley and Glenwick (1984)	Positive reward	Cash lottery	\$55.20–\$221	Uncertain chance	Clinic attendance and vaccination uptake	Once	No more than 2 mo	Fixed	Parent
Minkovitz et al (1999)	Avoidance of penalty	Welfare benefits	\$38.70	Certain	Vaccination uptake	Reassessed 6 months	Written warning before sanction	Fixed	Parent
Kerpelman et al (2000)	Avoidance of penalty	Welfare benefits	Variable	Certain	Vaccination uptake	Reassessed 6 months	Oral or written warning before sanction	Fixed	Parent
Abreyva and Mulligan (2011)	Avoidance of penalty	Day care or school entry	Loss of education	Certain	Vaccination uptake	Unclear	Unclear	Fixed	Parent and child
<b>Acceptability component</b>									
Schaefer (1997)	Avoidance of penalty	Welfare benefits	\$38.70	Certain	Vaccination uptake	Reassessed 6 months	Written warning before sanction	Fixed	Parent
Freed et al (1998)	Avoidance of penalty	Day care or school entry, criminal charges, parental injunctions	Loss of education, loss of parental freedom	Certain	Vaccination uptake	Unclear	Written warning before sanction	Fixed	Parent and child
Bond et al (1999)	Avoidance of penalty	Welfare benefits	\$29.30–\$175 plus 1-time payment of \$307	Certain	Vaccination uptake	Weekly	Unclear	Fixed	Parent
Bond et al (2002)	Avoidance of penalty	Welfare benefits	\$29.30–\$175 plus 1-time payment of \$307	Certain	Vaccination uptake	Weekly	Unclear	Fixed	Parent
Hall et al (2002)	Avoidance of penalty	School entry	Loss of education	Certain	Vaccination uptake	Unclear	Unclear	Fixed	Parent and child
Tarrant and Thomson (2008)	Avoidance of penalty	Day care or school entry	Loss of education	Certain	Vaccination uptake	Unclear	Unclear	Fixed	Parent and child

<sup>a</sup> Although many interventions are listed as “certain,” there was anecdotal evidence that penalties, in particular, were not always imposed in practice.

a criminal law in this context was too expensive, excessively punitive, and politically inadvisable, and this explained low enforcement rates. Some thought clarification of the charges and process of parent warnings would help enforcement.

Only 1 qualitative study was included in the acceptability component.<sup>32</sup> Parents in Hong Kong, where vaccination uptake is high, were interviewed to identify factors that encourage this high uptake. Content analysis identified mandatory vaccination for child care and school entry as 1 important factor in a system of other vaccine-related services. Cultural and contextual factors found to be important included the relative importance of society versus individualism, trust in health professionals, and the high population density of Hong Kong, which increased perceived susceptibility to infectious diseases.

In a survey of administrators and staff involved in delivery of a welfare benefit penalty for noncompliance with health behaviors, including vaccination of preschool-aged children,<sup>31</sup> 70% agreed that behavior could be changed by the intervention. Of these, 14% said that the penalties were very powerful, and 28% said they were effective only when imposed rather than just threatened. Recipients of the intervention reported that the penalty was fair (73%) and would motivate parents to meet health requirements (67%).

### Economic Component

Of the 4 studies included in the effectiveness component, none provided detailed information on the consequences of undertaking, or not undertaking, the desired activity. No study conducted a formal economic evaluation of the incentive scheme.

Only 1 of the studies included in the acceptability component included economic information on costs and



Author	Selection Bias	Study design	Confounders	Blinding	Data Collection	Withdrawals	Global Rating
<b>Effectiveness component</b>							
Yokley & Glenwick (1984)							
Minkovitz et al (1999)						N/A	
Kerpelman et al (2000)							
Abrevaya & Mulligan (2011)						N/A	
<b>Acceptability component</b>							
Freed et al (1998)			N/A			N/A	
Bond et al (1999)			N/A			N/A	
Bond et al (2002)						N/A	
Hall et al (2002)			N/A			N/A	
Schaefer (1997)							
Key	N/A: not applicable	Low risk of bias		Moderate risk of bias		Strong risk of bias	

**FIGURE 2**  
Quality appraisal of quantitative studies included in systematic review.

consequences in the format of a cost–benefit framework.<sup>31</sup> 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.<sup>15</sup> Only 2 studies included in the current review<sup>23,24</sup> 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<sup>33–35</sup> or did not involve incentives

with real material value.<sup>36</sup> 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)<sup>14</sup> 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)<sup>17</sup> 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 in 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,

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,<sup>22</sup> 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.<sup>31</sup> 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.<sup>37</sup>

### **Strengths and Limitations of the Review**

Throughout the review, established criteria and protocols were used to inform methods and reporting.<sup>16,38</sup> This led to exclusion of a number of studies

that have been included in previous reviews.<sup>14,15,17</sup> 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,<sup>22</sup> 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,<sup>33–35</sup> 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.<sup>23,24</sup> This highlights the potential heterogeneity of financial incentive and quasimandatory interventions.<sup>22</sup> 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.<sup>22</sup>

### **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 stepwedged designs may be most useful in these contexts.<sup>39</sup>

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.<sup>40</sup>

All studies included in the review were conducted in countries that tend to achieve overall high coverage of pre-school 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.<sup>4–6</sup> 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.<sup>32</sup>

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.<sup>25</sup> 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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