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Initiatives to increase childhood vaccination coverage: an international comparison

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A B S T R A C T

Background Childhood vaccination rates fluctuate over time and do not always meet the levels recommended by the WHO.

Objective This study aims to provide an overview of measures countries have introduced to increase vaccination rates.

Methods We developed a structured data collection template that was completed by country experts from Europe, Israel, the USA, and Canada. Experts were identified using the European Observatory on Health Systems and Policies' HSPM (Health Systems and Policy Monitor) network. We approached experts from 32 countries and received responses from 22 countries. In the template we asked for measures introduced between 2014 and 2019. The experts were asked to indicate the type of intervention, the target population, possible positive and negative effects, and evidence on effectiveness. The information was collected between September 2019 and January 2020.

Results We identified four main types of interventions: restrictive measures for the unvaccinated, financial incentives, measures supporting the logistics of vaccination, and vaccination promotion campaigns. Restrictive measures often involved expanding existing mandatory vaccination policies or limiting access to pre-school activities for unvaccinated children. Financial incentives for healthcare providers showed some positive effects. Regarding logistical support, several countries used schools as alternative vaccination sites, though this presented organisational challenges. Many countries invested in improving knowledge among both healthcare professionals and parents to encourage vaccine uptake.

Conclusions Most initiatives implemented in the countries covered focussed on communication and knowledge enhancement. However, there is limited evidence on the impact of these measures on vaccination coverage.

Background

Childhood vaccination rates are generally high across Europe, Canada, the United States and Israel, with approximately 95 % of children receiving the recommended diphtheria, tetanus, and pertussis (DTP) or measles vaccinations, and 91 % receiving hepatitis B vaccinations [1]. However, despite these overall high rates, nearly half of all countries do not meet the minimum immunisation levels recommended by the World Health Organization (WHO). Between 2000 and 2021, almost all countries in Europe, Canada, the United States and Israel experienced at least some years of decreasing vaccination rates for DTP and measles. Estonia, Lithuania, The Netherlands, Poland, and Sweden previously achieved the recommended 95 % coverage for measles but fell below this level in 2021 or 2022 [2]. The WHO recommends that children aged 9–14 years receive human papilloma virus (HPV) vaccination, with a target coverage of 90 %, prioritising girls [3,4]. In 2018, only Norway met the 90 % target for full immunisation, while Portugal reached 90 % for the first dose [5].

To achieve herd immunity, necessary to prevent an outbreak for some infectious diseases, vaccination coverage must be high enough to disrupt transmission chains and protect those who cannot be immunised [6]. Furthermore, governments prefer high uptake in less contagious diseases, since it diminishes the burden of disease [7].

Reasons to refrain from getting vaccinated are numerous. Amongst others, there may be fear of adverse effects, barriers for parents such as cost of transportation and competing priorities, inadequate knowledge among parents, religious beliefs and vaccine hesitancy [8–10]. Much of the literature on vaccine uptake takes an individual perspective, such as the 5As framework (Access, Affordability, Awareness, Acceptance, and Activation) by Thomson et al. [11], and the 5Cs framework (Confidence, Complacency, Constraints, Calculation, and Collective Responsibility) by Betsch et al. [12]. The focus of our study was on policies rather than individual-level factors, such as personal motivations for (not) vaccinating, the role of the anti-vaccine movement (i.e. individuals who believe that "vaccines do not work, are not safe, or refuse vaccines for themselves or their children" [13]), vaccine efficacy, potential side effects, prior negative experiences, or religious and philosophical objections [14]. In contrast, in this paper, we focus on the perspective of policy-makers and the options available to them to increase vaccination coverage in their countries.

Many countries have introduced a range of measures to increase immunisation coverage in recent years. This article aims to provide an overview of these initiatives. More specifically, we sought to answer the following two research questions:

- What measures were introduced in Europe, Israel, the United States, and Canada between 2014 and 2019 to increase childhood vaccination coverage?
- Have these measures been evaluated for their effectiveness in increasing childhood vaccination rates, and what were the results of these evaluations?

The study aimed to gather information on measures designed to increase vaccination coverage against childhood infectious diseases (excluding influenza and COVID-19 vaccines). Rather than providing an exhaustive list of measures for each country, we aimed to highlight the range of approaches used, the target populations addressed, and—where possible—evidence on the effectiveness of interventions. Furthermore, the focus was on policies newly introduced between 2014 and 2019. A measure newly introduced in one country may have been in place for a long time in another. In such cases, we discuss the policy only in the context of the country where it was newly introduced. Consequently, policies in countries with consistently high vaccination coverage, where no additional measures were considered necessary between 2014 and 2019, may be underrepresented in this research.

This study was initially conducted to inform the Dutch government on initiatives in other countries that could be considered for policy development to enhance vaccination coverage in The Netherlands. A report in Dutch was submitted to the Dutch Parliament in 2019 [15].

Methods

Template to collect information among countries

A standardised template was developed to take stock of recent measures introduced in the included countries. Country experts from the European Union, Israel, Canada, Norway, Switzerland, and the United States collaborated in collecting the relevant data. Although the sample was a convenience sample using the European Observatory on Health Systems and Policies' HSPM (Health Systems and Policy Monitor) expert network, all countries covered in this study are high-income Western economies, making them relatively comparable in terms of culture and financial resources.

The template contained questions about measures implemented over the previous five years (2014–2019), as data collection concluded in January 2020. It also addressed potential bottlenecks encountered during implementation. While we explicitly inquired about evaluations of these measures, unevaluated measures were also included to ensure a comprehensive overview of the most recent interventions that countries had introduced or were planning to introduce (See Table 1 for the template). The online template remained open from September 2019 to January 2020.

The template was distributed to members of the HSPM network, as well as to other relevant contacts within our international professional networks. The HSPM network comprises the countries of the European Union, Switzerland, Norway, Israel, the United Kingdom, Canada and

Table 1
Data collection template.

Question	Answering options
Which of the mentioned strategies did your country introduce in the last five years	○ Awareness campaigns ○ Reminder/ recall approach ○ Parent education ○ Provider education ○ Monitoring and feedback for providers ○ Offering alternative locations ○ Financial rewards for parents ○ Financial rewards for providers ○ Financial sanctions ○ Denying school or kindergarten entry for unvaccinated children ○ Other,…
For each strategy that was mentioned to be introduced in the past 5 years, the following questions were asked:	
Could you briefly describe the strategy	Open question
What is the target group of the strategy	Open question
To which types of vaccines does the strategy relate?	Open question
When did the strategy come into effect?	Open question
Where there any concerns when introducing the strategy? Which? And by whom?	Open question
How was the strategy expected to work (theory behind it)?	Open question
Were there any legal or ethical considerations that needed to be resolved before the strategy could be introduced?	Open question
How was the strategy expected to work (theory behind it)? E.g. because of increased knowledge, more people will opt for vaccination.	Open question
General questions:	
Have the introduced strategies been evaluated and, if so, what are the outcomes? Did the strategies live up to expectations? Could you send us any documentation?	Open question

A full version of the template is provided in the additional information, after the supplementary Tables 1–.4

the United States. Most of these contacts are affiliated to or in close collaboration with National Institutes of (Public) Health, health research institutes, or Ministries of Health. Respondents who did not feel confident completing the template themselves were encouraged to forward it to relevant national experts. In total, we contacted experts from 63 institutes across 32 countries of the HSPM network and received 31 responses from experts for 22 countries. The template was completed anonymously. The reporting countries are listed in Table 2. The template is provided in Annex 1.

A final review of the country information was conducted by HSPM members. They were asked to revise drafts of this article and add any relevant information that may have been overlooked. The HSPM members contributed as co-authors to this paper.

Table 2
Overview of countries for which information was collected in the template.

Country	
Austria	Israel
Bulgaria	Italy
Canada[a]	Latvia
Croatia	Lithuania
Cyprus	Norway
Czechia	Poland
Estonia	Portugal
Greece	Sweden
Germany[b]	Switzerland
Hungary	Massachusetts (United States)[c]
Ireland	

[a] For Canada, we received three answers, one for Ontario, one for Quebec and one that did not specify the province, but tried to provide an overview of the country as a whole.
[b] For Germany, we did not receive an answer via the template, but via an email exchange.
[c] For the United States, the results reported are only for the state of Massachusetts.

Analysis

We categorized the initiatives from the participating countries into four types of measures aimed at increasing vaccination coverage: restrictive measures for the unvaccinated, financial incentives, logistical support for vaccinations, and vaccination promotion programmes focused on knowledge. For each category, the countries that reported such measures are summarized in tables. A brief description of the measures, along with their effectiveness (where this information is available), is provided in Supplementary Tables 1–4.

Results

Broadly, policy measures can be classified into four main categories:

- Restrictive measures for the unvaccinated – When vaccines are considered mandatory, this may have different consequences. Vaccine mandates may lead to the criminalization of non-vaccinators, resulting in financial penalties or even imprisonment for non-compliance. Other restrictive measures resulting from vaccine mandates may be limiting the participation of unvaccinated individuals in certain activities, such as attending school or daycare. Furthermore, parents who do not let their children be vaccinated can be withheld financial support, such as daycare compensation or child benefits [7].
- Financial incentives – These may target different groups, such as direct payments to children, parents, or healthcare providers for receiving or administering vaccinations. Measures may also include making vaccinations free of charge for some or all of the population or providing (partial) reimbursement for associated costs (e.g. for transport).
- Measures supporting the logistics of vaccination – These address countering barriers within the health system, such as enabling catch-up vaccinations for those who miss scheduled doses or introducing alternative vaccine distribution models, such as school-based vaccination programmes.
- Vaccination promotion programmes – These focus on increasing knowledge among both the general public and healthcare professionals involved in child vaccination. Efforts may include information campaigns, the dissemination of research findings on vaccine safety and efficacy, and targeted outreach efforts.

Restrictive measures for the unvaccinated

In several countries and territories vaccination mandates exist for vaccinating children. In at least 14 countries—Bulgaria, Canada, Croatia, Cyprus, Czechia, France, Greece, Hungary, Italy, Latvia, certain regions in Poland, Slovakia, some cantons in Switzerland, and Massachusetts (United States)—parents are required to vaccinate their children against one or more childhood diseases. The implementation of these vaccine mandates varies widely, ranging from imposing fines to more indirect restrictions, such as vaccination being a prerequisite for school or child daycare admission.

Several countries recently introduced changes to their mandatory vaccination policies. In Germany, mandatory vaccinations were abolished in the latter half of the 20th century but were reintroduced in November 2019. A new law, which came into effect in March 2020, imposed a fine of up to €2500 on parents of children attending schools and daycare centres if they fail to vaccinate their children against

measles [16]. Currently, however, vaccination status is only verified for new school enrolments. Similarly, in 2020, Czechia expanded its vaccination requirement from childcare facilities receiving state subsidies to all childcare facilities. In Italy, the number of mandatory vaccines was increased from four to ten.

In Canada, Massachusetts (United States), and Switzerland, unvaccinated children may be required to stay home during outbreaks.

Several countries—Canada, Czechia, Bulgaria, and Poland—reported difficulties with enforcement. In Bulgaria, fines for non-compliance are relatively low, while in Czechia and Poland, they are rarely imposed. In Croatia, penalties apply not only to parents but also to healthcare providers who fail to administer vaccinations according to vaccine mandates.

Exemptions from mandatory vaccination exist in some countries, not only for medical reasons (as in Czechia) but also on religious or ideological grounds (as in Canada).

Some countries impose an indirect vaccination requirement by linking school or daycare admission to immunization status. For example, Italy, Hungary, Switzerland, parts of Canada (Ontario and New Brunswick), and Massachusetts (United States) enforce mandatory vaccination for children attending school and, in some cases, daycare. In Poland, public kindergarten admission may depend on vaccination status in certain regions. In Bulgaria, while vaccination is required for kindergarten admission, school attendance is not restricted based on vaccination status, though parents risk fines for non-compliance. Similarly, in Croatia and Czechia, vaccination is not mandatory for school attendance but is required for preschool and daycare. In Czechia, fines can also be imposed on daycare providers who accept unvaccinated children.

In some countries, vaccine mandates have led to litigation. In Poland, fines are rarely imposed due to concerns that parents may challenge them in court. In Hungary, multiple legal cases have been filed, but the Constitutional Court has upheld mandatory vaccination as legally permissible. In Croatia, a 2014 ruling by the Constitutional Court confirmed that mandatory vaccination is constitutional and serves a legitimate public interest, stating that such measures do not violate human rights and freedoms as they aim to protect the population. A similar ruling in Czechia validated mandatory preschool vaccination. In Switzerland, since 2012, unvaccinated children may be excluded from school for up to three weeks during a measles outbreak, which is seen as an incentive for parents to vaccinate.

Mandatory vaccination policies have sparked controversy in some countries, including Croatia, Hungary, Italy, and Switzerland. However, four countries—Croatia, Cyprus, Hungary, and Italy—reported increased or consistently high vaccination rates following the introduction or modification of mandatory vaccination policies (see Table 3 for a summary of measures and Supplementary Table 1 for more detail).

In this research, no measures that exclude parents from a form of financial support were reported. Also, imprisonment was not mentioned.

Financial incentives

Financial incentives can be directed at healthcare providers, parents, or school-aged children. However, we only identified incentives targeting providers or parents.

Incentives for healthcare providers were reported in Czechia, Estonia, Latvia, and Lithuania. In Estonia, general practitioners (GPs) participating in the Estonian Health Insurance Fund's pay-for-performance scheme receive additional financial compensation if they achieve a vaccination coverage rate of over 90 %. GPs not enrolled in this scheme tend to have vaccination rates that are approximately 5–15 % lower, depending on the type of vaccine [17]. In Latvia, since 2013 a set of quality criteria was introduced for GPs. Vaccination coverage is included as one of the achievements. The higher GPs score on the quality criteria, the higher the annual quality payment. There is no evaluation available on the effect on vaccination uptake.

In Czechia, GPs are reimbursed on a fee-for-service basis for administering a vaccination, whereas the vast majority of their other services are reimbursed by capitation payments. Prevention check-ups are also reimbursed on a fee-for-service basis and a pay-for-performance (P4P) scheme generally applies to achieving a certain level of prevention together with vaccination – however, these schemes may vary among health insurance funds. Health insurance funds are regularly assessing the effect of the P4P scheme on prevention levels, but data are generally not publicly available. This is also the case in Cyprus where, after the introduction of the New Health Care System in 2019, paediatricians are reimbursed on a fee-for-service basis by the health care organization for administering a vaccination. As a result, around 50–55 % of vaccinations are now taking place in the public sector (compared with 65–70 % in 2015) and 45–50 % are provided by private sector paediatricians (See Table 4 for a summary of measures per country).

Incentives targeting children were not reported.

In some countries with mandatory vaccination (e.g. Hungary, Italy, and Slovenia), compensation is available for individuals who experience side effects from vaccinations. In these countries, the government considers this its responsibility due to the vaccine mandate. By providing compensation, governments aim to build public trust [18]. In Czechia, this type of compensation was introduced recently, with the law coming into effect in April 2020.

Table 3
Overview of countries for which restrictive measures for the unvaccinated were mentioned.

Measure	Is there a fine in case of non-compliance?	Number of countries	Countries
Restricted access to school	Yes	3	CAN, ITA, GER
	No	4	CY, SWI[c], USA (Mass)
Restricted access to day care and pre-school facilities	Yes	4	CZE, ITA, POL, GER
	No	4	AUS, BUL, CRO, SWI
Other vaccination mandates[a]	Yes	6	CRO, CZE, FRA, HUN, POL[b], USA (Mass)
	No	0	
Total[d]		**13**	

USA(Mass) = Massachusetts.

[a] When vaccination is mandatory, this does not imply automatically that children do not have access to school or day-car/pre-school facilities, as a result countries may appear in multiple rows.

[b] Vaccine mandates exist in only some of the regions.

[c] In Switzerland, non-vaccinated children can be excluded from school attendance during (measles) outbreaks. Some cantons require vaccination against diphtheria.

[d] For additional information on measures per country, see supplementary Table 1. *Overview of countries with mandatory vaccination policies*.

Table 4
Overview of countries for which financial incentives were reported[a].

Measures targeted at	Number of countries	Countries
Parents	2	AUS, CYP
Providers	4	CZE, EST, LAT, LIT
Total	**6**	

[a] In many counties, (mandatory) vaccinations are free of charge. In the table here, we refer to other measures than free-of-charge vaccinations, unless introduced recently.

Measures supporting the logistics of vaccinations

Alternative locations

One way to reduce barriers for parents and children is to offer vaccinations at more convenient locations. Schools are one such option, with 10 countries reporting their use as an alternative vaccination site. A potential challenge, however, is obtaining parental consent. In Israel, mobile vaccination clinics are deployed in remote areas and, at times, in densely populated regions to increase vaccination coverage. In Portugal, children can be vaccinated at pharmacies and social sector health units, although these locations must receive authorisation before they are permitted to administer vaccinations (Table 5).

Reminders for parents

In some countries, parents of children eligible for vaccination (e.g. Croatia and Portugal) or parents of children who have not yet received a scheduled vaccination (e.g. Norway) are reminded by their primary care providers to have their children immunised. In Bulgaria, GPs are required to inform parents about upcoming vaccinations. They must notify all individuals subject to mandatory vaccination of the type and date of the next immunisation in a verifiable manner (e.g. by mail, phone, or email). In Czechia, GPs reach out to parents of unvaccinated children.

Monitoring and feedback for vaccination providers

Monitoring vaccination rates and providing feedback to individual healthcare providers by comparing their performance with peers is a practice implemented in several countries, including Bulgaria, Croatia, Czechia, Portugal, Poland, and the USA. However, the extent to which this contributes to increased vaccination coverage remains unclear. In Cyprus, vaccination uptake is monitored by primary schools.

Vaccination promotion programmes

Three target groups can be identified for communication and knowledge promotion measures: vaccination providers, parents, and children (Table 6).

Providers

Some countries place special emphasis on the education of vaccination providers, based on the idea that better knowledge of vaccines and infectious diseases will enable them to respond more effectively to parents' questions.

In Estonia, for example, vaccination providers must complete a compulsory 16-hour basic training course, followed by a five-hour refresher course each year. However, a significant challenge is the current shortage of trainers. In Lithuania, training is included in the five-year national action plan on vaccination, though no specific targets have been set, and no additional funding has been allocated. Similarly, Cyprus highlights the importance of educating providers to ensure they feel confident in answering parents' questions.

Overall, while training and education for providers are widely regarded as essential, financial and organisational barriers seem to hinder implementation in some countries.

Table 5
Overview of countries with recent measures supporting the logistics of vaccinations.

Measures targeted at	Number of countries	Countries
Alternative location		
• Schools	7	CAN(Ont, Que), CYP, EST, ISR, ITA, SWE, SWI
• Pharmacies	1	POR
• Other	2	ISR (Mobile clinics), POR (social sector health units)
Reminders for parents	10	AUT, BUL, CAN(Que), CRO, CZE, LAT, LIT, NOR, POR, SWI
Monitoring	9	BUL, CRO, CYP, CZE, EST, LAT, LIT, NOR, POR
Feedback to providers	2	POL
Total	**16**	

Ont= Ontario; Que=Quebec For additional information on measures per country, see supplementary Table 3, *Overview of countries with measures supporting the logistic system.*

Table 6
Overview of countries for which recent measures related to communication and knowledge improvement were reported.

Measures targeted at	Number of countries in our study	Countries
Providers	8	BUL, CAN, CRO, ISR, ITA, LAT, LIT, NOR
Parents	14	BUL, CAN, CRO, CYP, CZE, EST, GRE, IRE, ITA, LAT, LIT, NOR, POL, POR
Children	2	CYP, NOR
General public	11	AUT, BUL, CAN, EST, GRE, ISR, ITA, LIT, POR, POL, SWI
Total	**17**	

For additional information on measures per country, see supplementary Table 4, Overview of countries with measures related to communication and knowledge improvement.

Parents

Nearly all countries in our sample have introduced information campaigns aimed at parents. In Norway, these campaigns have been shaped by parent focus groups to ensure they address parents' specific information needs and utilise appropriate communication channels.

In some countries, such as Cyprus and Greece, information campaigns are held annually. In Portugal, campaigns are typically launched in response to an outbreak. In Poland, information campaigns serve as a countermeasure to the country's strong anti-vaccination movement. Conversely, in Estonia, an information campaign triggered a backlash from the anti-vaccination movement, which responded by sending letters to schools alleging serious side effects of the HPV vaccine. In Norway, all parents of newborns receive a letter from the health authorities directing them to a website for further information. In Israel, religious leaders collaborate with health authorities to promote vaccination coverage among specific target groups [19]. In Bulgaria, health mediators serve as a bridge between vulnerable groups, such as the Roma community, and the health system. These mediators speak Romani, understand the Roma culture, and live and work within the community.

Overall, it can be concluded that information campaigns are widely implemented, although their impact is rarely evaluated.

Children

In our sample, two countries reported communication efforts specifically targeting children. Norway introduced HPV vaccination for boys and developed information materials on the topic for children in the 7th grade. In Cyprus, vaccination campaigns directed at children are conducted during the annual Vaccination Week.

Discussion

Measures aimed at increasing childhood vaccination coverage were

implemented in all countries in our study. Measures addressing communication and promotion of knowledge were most often mentioned. Introduction of new financial measures were the least mentioned.

Restrictive measures for the unvaccinated

Most countries with vaccine mandates for childhood vaccinations have a long-standing tradition of these measures, often in place for a century or more [20–22]. New vaccine mandates mainly involve expanding the list of existing vaccine mandates rather than introducing entirely new ones. Germany is an exception, having first abolished mandatory vaccinations before recently reintroducing them. In Germany, before the reunification, vaccine mandates existed in Eastern Germany, but not in Western Germany. After the reunification in 1990, the vaccine mandates for Eastern Germany were abolished.

According to the literature, when exemptions (e.g. for religious or philosophical reasons) are widely available, mandatory vaccination policies appear to be less effective [20,23]. However, in cases where exemptions are granted only on medical grounds and enforcement is strict, high vaccination coverage can be achieved, as seen in Hungary and some states in the USA [24]. Countries with vaccine mandates often encounter challenges in enforcement, including legal action taken by parents against the state.

Some countries impose restrictions on access to schools or childcare facilities for unvaccinated children. However, in countries where school attendance is obligatory, denying access is not an option. In our study, some countries showed increases in vaccination rates linked to mandatory vaccination policies. However, in Italy, the literature reports that vaccination rates increased both after the partial abolition of mandatory vaccinations in 2007 in the Veneto region (in the first two years) [25] and after the expansion of mandatory vaccinations in 2017 [23,26]. This counterintuitive finding suggests that increased public debate and awareness surrounding policy changes may also play a role in increasing vaccination uptake.

Financial incentives

There is limited information on the effectiveness of financial incentives for parents. Systematic literature reviews have found little evidence that financial incentives increase vaccine uptake, and this approach is not recommended as a primary strategy to improve vaccination coverage [27–29]. However, it remains unclear whether this is due to a lack of studies on the topic or because financial incentives genuinely have little impact.

The effectiveness of financial incentives for providers is also uncertain. Most countries that have implemented such measures have not evaluated their impact, or the evaluations are not publicly available. Pay-for-performance schemes for providers, such as those in Estonia, can have an effect when additional compensation is awarded if vaccination coverage exceeds a certain threshold. The success of such schemes may depend on the size of the incentive relative to other income sources for providers. Estonia reported an increase in vaccination rates following the introduction of a pay-for-performance scheme.

Countries that offer financial compensation to those who suffer from the side effects of vaccination generally do so with the intent of supporting confidence-building in vaccination. However, this financial mechanism could unintentionally lead to doubts and fears around vaccination if it raises concerns that severe side effects could occur .

Measures supporting vaccination logistics

Regarding alternative vaccination locations—aside from standard healthcare settings, such as well-baby clinics, public health facilities, and GP practices—schools have been the most commonly used alternative site. School-based vaccination programmes, particularly for the HPV vaccine, have been associated with higher uptake. However, the literature notes logistical challenges with school vaccinations, including the need to ensure safety, provide trained healthcare workers, and access vaccination records [30]. Some countries have addressed workforce shortages by employing medical students or public health nurses to administer vaccines [31–33].

School-based vaccinations require significant organisational, administrative, and workforce capacity, as well as suitable facilities. Other alternative locations, such as pharmacies and dental clinics, are rarely used.

Focussing events, such as recent measles outbreaks in Europe or events like the European Vaccination Week, can raise public awareness and serve as opportunities for catch-up vaccination campaigns. Since missed vaccinations often result from forgetfulness or logistical barriers, reminders and publicising outbreak risks, along with catch-up vaccination opportunities, appear to be effective strategies [32,34–38] .

Some countries provide healthcare professionals administering vaccinations with data on their performance relative to national benchmarks. The idea is that low-performing providers may be motivated to improve their vaccination rates. According to a literature review by De Koning et al., feedback should be incorporated as part of a holistic package of measures to enhance motivation [39], which is in line with the findings of Fairbrother et al. that feedback as single measure seems to be not very effective [40]

Communication and promotion of knowledge

Most countries in our sample invested in improving the knowledge of healthcare professionals, parents, and the general public through information campaigns. In some cases, these campaigns were developed in collaboration with the target audience to ensure that they address specific information needs and use appropriate communication channels. Health mediators and influencers, such as religious leaders, are sometimes engaged to reach specific groups.

Many countries also invested in training healthcare professionals to improve their communication skills and enable them to answer parents' questions effectively. A combined approach targeting both parents (through reminders) and providers (by improving communication about the importance of vaccination), developed by the University of Pennsylvania, significantly increased HPV vaccination coverage [41].

Awareness campaigns were put in place in nearly all the countries covered by our study, with some specifically targeting minority groups through health mediators or partnerships with religious leaders. The literature debates the most effective ways to communicate with parents. An EU study found that an empathetic approach was effective for vaccine-hesitant parents [42]. However, in Ontario, a mandatory education session for vaccine-hesitant parents was largely unsuccessful, as 81 % of attendees still sought vaccination exemptions for their children after completing the sessions [43]. Similar results were found in Michigan, where those who had concerns on vaccine safety or religious beliefs were not likely to vaccinate their children. The vaccine-hesitant group that believed that there were too many doses was the most likely to have their child vaccinated after the educational event, with 4 out of 10 parents opting for vaccination [9].

Beyond technical challenges, the digital age has introduced new obstacles. The rapid evolution of information and mass communication technologies has been leveraged by anti-vaccination groups to undermine scientific knowledge and promote alternative narratives. Traditional public health campaigns may not be sufficient to counteract these efforts. However, at least prior to the COVID-19 pandemic, few governments had explored the potential of big data, network analysis, or artificial intelligence to disrupt anti-vaccination networks with targeted messaging. One example is a study by the Hungarian government that used network analysis to map the structure of social media activism among anti-vaccination groups [44], highlighting the potential for future efforts in this area.

Public trust in healthcare providers (e.g. GPs, paediatricians) is generally higher than trust in government or national health agencies [45], making physicians a valuable source of vaccine information. However, according to the Eurobarometer survey, not all healthcare providers in Europe are fully convinced of the safety (doubted by 30 % of respondents) or benefits (doubted by 20 %) of vaccines [45], highlighting the need for improved education and training.

The Norwegian Institute of Public Health has also identified a technical issue that may result in underestimations of vaccination coverage. "The most common reason why children appear to have incomplete vaccinations is due to technical problems with digital transmission of vaccine notifications from municipalities to the Norwegian Immunisation Registry (SYSVAK). Another reason may be that children have followed a non-standard vaccination schedule for their age group. This often explains slightly lower coverage rates for HPV." [46]. It is unclear whether similar technical issues affect other countries, but this should be considered when interpreting vaccination coverage data.

Challenges in evaluating measures

Most countries in our sample lacked data on the effectiveness of their vaccination measures. When measures are evaluated in the literature, they often focus on short-term effects, making it difficult to determine whether observed increases in vaccination rates result from the intervention itself or increased public attention. Many evaluations of information campaigns measure parents' intent to vaccinate, but it is unclear whether this intent translates into actual vaccinations [47–49].

Limitations

This study has several limitations. The selection of countries was based on responses from national experts and does not imply that other countries have not implemented similar measures. The selection of countries can be seen as a convenience sample, using the HSMP network. Additionally, some newly introduced measures in one country may have been in place for years elsewhere, meaning they would not be highlighted in our study. Furthermore, country experts provided descriptions of recent initiatives, but may not have been aware of all measures taken. We did not investigate the reasons why people forgo vaccinations, which fell outside the scope of our study, and we also did not assess the quality of the evidence for the reported measures' effectiveness.

Despite the data being collected before the COVID-19 pandemic, we believe our findings provide a useful addition to the literature, particularly given the continued challenges in ensuring high vaccination rates across Europe and beyond. There is a need for further research that investigates the impact of the COVID-19 pandemic on childhood vaccination rates and measures taken to maintain or improve them.

Conclusion

Our study shows that countries have implemented a broad range of measures to increase vaccination coverage. Most initiatives focus on communication and knowledge promotion, yet there is little research proving their effectiveness in improving vaccine uptake.

Cross-country learning from best practices can be valuable, but cultural, historical, organisational, and regulatory differences may affect the transferability of measures. For instance, introducing mandatory vaccination in a country without such a tradition may be particularly challenging. Any adaptation must consider the country's specific context, including logistical and cultural factors, as well as existing regulations.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the authors used ChatGPT 4o in order to improve the language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Conflict of interest

Nothing to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.healthpol.2025.105351.

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