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The Impact of Interventions Targeting Caregivers, Health Workers and the Community to Alter Vaccine Behaviours and Childhood Vaccination Uptake

A Rapid evidence assessment protocol

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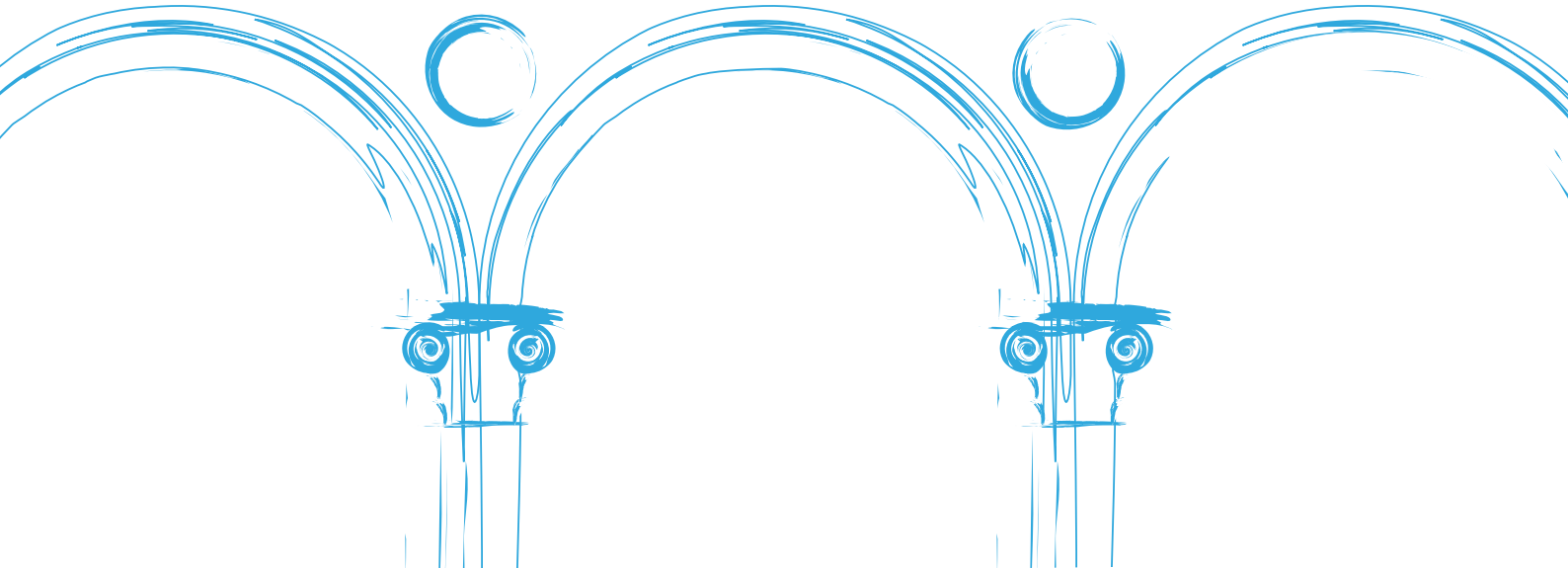

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THE IMPACT OF INTERVENTIONS TARGETING CAREGIVERS, HEALTH WORKERS AND THE COMMUNITY TO ALTER VACCINE BEHAVIOURS AND CHILDHOOD VACCINATION UPTAKE: A RAPID EVIDENCE ASSESSMENT PROTOCOL

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Abbreviations

Abbreviation	Definition
3ie	International Initiative for Impact Evaluation
BCG	Anti-tuberculosis vaccine (bacille Calmette-Guérin)
COM-B	Capability, Opportunity, Motivation and Behaviour
DT	Diphtheria, tetanus vaccine
DTP	Diphtheria, tetanus, and pertussis vaccine
ECARO	Europe and Central Asia Regional Office
EGM	Evidence gap map
FHW	Formal health worker
GRADE	Grading of Recommendations, Assessment, Development and Evaluations
Hep B	Hepatitis B
Hib	Haemophilus influenzae type b
HPV	Human papillomavirus
IPV	Inactivated polio vaccine
MCV	Measles containing vaccine
MMR	Measles, mumps, and rubella vaccine
MMRV	Measles, mumps, rubella, and varicella vaccine
MR	Measles and rubella vaccine
OPV	Oral polio vaccination
PCV	Pneumococcal conjugate vaccine
Pol3	Third dose against polio
PROSPERO	The international prospective register of systematic reviews
REA	Rapid evidence assessment
TT	Tetanus Toxoid
UNICEF	United Nations Children's Fund
WHO	World Health Organization

1. Introduction

1.1. Background and rationale

Vaccination is one of the most effective measures for preventing illness, disability and death among children. The vaccination schedule recommended by UNICEF for children ≤5 years is summarised in Appendix A and includes vaccines against diphtheria, pertussis, tetanus (DTP), hepatitis B (hep B), haemophilus influenzae type b (Hib), pneumococcal disease, polio, measles, mumps, rubella, varicella (chicken pox) and rotavirus.

In recent years (2015 to 2019), the global vaccination rates for childhood infections have plateaued; the proportion of children vaccinated against tuberculosis (bacille Calmette-Guérin [BCG] vaccine) was 87% in 2015 and 88% in 2019, against DTP (first dose) was 89% in 2015 and 90% in 2019, and against measles (first dose) was 85% in 2015 and 2019 (World Health Organization, 2020). However, vaccination coverage is insufficient for herd immunity benefits and therefore case numbers for several of these conditions are increasing, including diphtheria (4,535 cases in 2015; 22,986 cases in 2019), tetanus (10,338 in 2015; 14,745 in 2019), and measles (214,808 in 2015; 873,022 in 2019) (World Health Organization, 2020). In 2019, of the estimated 5.3 million deaths globally of children under 5 years old, approximately 21.7% (95% uncertainty range: 20.4, 25.6) were due to vaccine-preventable diseases (Perin et al., 2021).

In Europe and Central Asia, overall vaccination rates in the region are high, with greater than 90% of children receiving the third dose of DTP (DTP3), first dose of a measles-containing vaccine (MCV1) and third dose against polio (Pol3) in both 2015 and 2019 (Table 1) (UNICEF & WHO., 2021). However, the overall vaccination rates in the region mask the experience of individual countries (both at national and subnational levels), and an exploration of the vaccination rates in Bosnia and Herzegovina, Republic of Moldova, Romania and Ukraine highlight that the situation is changeable both between countries and over time (UNICEF & WHO., 2021). Between 2015 and 2019, DTP3 vaccination rates were decreasing in Bosnia and Herzegovina (82% to 73%), increasing in Republic of Moldova (87% to 91%), relatively stable in Romania (89% to 88%) and dramatically improving in Ukraine (23% to 80%) (Table 1).

Table 1: Proportion of children vaccinated against diphtheria, tetanus, pertussis (DTP3), measles (MCV1) and polio (Pol3) in selected countries in the Europe and Central Asia region, and in the region overall (data from UNICEF WUENIC analytics: (UNICEF & WHO., 2021))

Country	DTP3		Measles (MCV1)		Polio (Pol3)	
	2015	2019	2015	2019	2015	2019
Bosnia and Herzegovina	82%	73%	83%	68%	74%	73%
Republic of Moldova	87%	91%	89%	97%	88%	94%
Romania	89%	88%	86%	90%	89%	88%
Ukraine	23%	80%	56%	93%	51%	78%
Europe and Central Asia Region	91%	96%	94%	97%	93%	95%

Abbreviations: DTP3, third dose of diphtheria, pertussis, tetanus vaccine; MCV1, first dose of measles-containing vaccine; Pol3, third dose of polio vaccine

Barriers to vaccination uptake can be broadly categorised into two main groups: caregiver level barriers (Kaufman et al., 2021) and health system level barriers (Bangura et al., 2020). Obregon et al., 2021 explored the main determinants of vaccine hesitancy in Eastern Europe and Central Asia through a literature review, interviews with global immunisation experts, and interviews and focus group discussions with caregivers and health providers in Bosnia and Herzegovina, Republic of Moldova, Romania and Ukraine (Obregon et al., 2020). The main determinants of vaccine hesitancy identified in the region were mistrust between health institutions/staff and marginalised populations (including Roma populations); media (mass and social) amplifying fears of vaccine safety; lack of caregiver knowledge about vaccination and insufficient information provided by health professionals; health

professionals perceived as lacking counselling skills, and in some cases, they were perceived as disrespectful to caregivers; some health professionals were hesitant or negative about vaccination; and issues relating to procurement, supply, storage and cost of vaccines.

De Figueiredo et al., 2020 mapped global trends in vaccine confidence in a large retrospective modelling study (de Figueiredo et al., 2020). In Bosnia and Herzegovina, Republic of Moldova, Romania and Ukraine (the countries where interviews and focus groups were performed by Obregon et al., 2021), vaccine confidence varied over time and between countries. In line with declining vaccination rates in Bosnia and Herzegovina, the estimated proportion of people that strongly disagree that vaccination is important, safe, or effective increased between 2015 and 2019 (Table 2). In Ukraine, in parallel with increasing vaccination rates, there is also increasing confidence in vaccines with the proportion who strongly agree that vaccination is important (2015: 44%; 2019: 57%), safe (2015: 16%; 2019: 26%) and effective (2015: 25%; 2019: 34%) increasing over time. However, despite the increase in positive responses, the proportion of people surveyed who strongly agree that vaccines are safe (26%) and effective (34%) is still lower than other countries in the region (Table 2).

Table 2: Mean estimated proportion of survey respondents that strongly agree or disagree that vaccines are important, safe and effective in 2015 and 2019 in selected countries from Europe and Central Asia; data from (de Figueiredo et al., 2020)

Country	Strongly agree		Strongly disagree	
	2015	2019	2015	2019
IMPORTANT				
Bosnia and Herzegovina	60%	66%	5%	10%
Republic of Moldova	44%	55%	2%	2%
Romania	56%	81%	4%	2%
Ukraine	44%	57%	4%	2%
SAFE				
Bosnia and Herzegovina	23%	47%	16%	17%
Republic of Moldova	46%	43%	3%	3%
Romania	43%	61%	6%	4%
Ukraine	16%	26%	9%	8%
EFFECTIVE				
Bosnia and Herzegovina	32%	61%	11%	11%
Republic of Moldova	39%	37%	2%	4%
Romania	45%	69%	5%	3%
Ukraine	25%	34%	4%	4%

The UNICEF Office of Research – Innocenti (UNICEF Innocenti) has commissioned this rapid evidence assessment (REA) to summarise the impact of interventions designed to improve vaccination knowledge, awareness, and attitudes/beliefs of caregivers, healthcare workers, and the community; as well as interventions to improve healthcare workers' motivation to vaccinate. The review will assess the effect these interventions have on caregiver intention to vaccinate, and vaccination uptake. The REA will assess if the evidence-base can be used to address the barriers to vaccination uptake in Europe and Central Asia with the aim of informing future research priorities, policy, interventions and programming.

1.2. Why is it important to do this review and how does it differ from previous reviews?

Before undertaking the REA, we completed a scoping exercise to understand the breadth of the evidence base on vaccination uptake. Searches for evidence synthesis publications were conducted in

Medline, Social Systems Evidence, Health Systems Evidence and the International Initiative for Evaluation (3ie) database. During this process, we identified an evidence gap map (EGM) performed by Engelbert and colleagues at 3ie titled *'Interventions to improve childhood immunisation and related outcomes in low- and middle-income countries: an evidence gap map'* (Engelbert et al., 2021). The EGM focussed on low- and middle-income countries and reported that the majority of publications on childhood vaccination assessed outcomes relating to vaccine coverage, but data on vaccine behaviours were reported less frequently.

There are many systematic reviews assessing childhood vaccination uptake; the EGM by Engelbert et al., 2021 identified 60 systematic reviews and was restricted to low- and middle-income countries. The Centre for Disease Control's Community Guide to Preventative Services has undertaken many systematic reviews that assesses interventions to increase vaccination uptake (Centers for Disease Control and Prevention). These reviews include studies regardless of the age of the population or disease being vaccinated against. The most recent update of their vaccination reviews was in 2016. Our independent advisor on the REA, Prof Julie Leask, also highlighted an ongoing scoping review of interventions to increase vaccination uptake (Heneghan et al., 2021). The scoping review includes systematic reviews regardless of the age of the population or disease being vaccinated against, only includes studies published from 2010 onwards, with vaccination uptake as the primary outcome. We did not find any overview of systematic reviews that was specific to vaccination uptake in children with an emphasis on both behavioural outcomes and vaccination uptake outcomes.

Therefore, we will undertake an REA of systematic reviews that will leverage the body of evidence synthesis publications and build on the work already done in the EGM by Engelbert et al., 2021. This will allow the REA to have a broad remit, while undertaking a deep dive of several interventions and outcomes identified by the EGM by Engelbert et al., 2021, and will synthesise the results to provide policy recommendations. Barriers to vaccination in Europe and Central Asia are varied, and although we recognise that there are practical barriers to vaccination in Europe and Central Asia (including, but not limited to, procurement issues, cold chain shortcomings and costs) we will focus on vaccine acceptance and demand-based barriers, specifically on behavioural interventions that target individuals (caregivers, health workers, and the community).

We also recognise that there may not be a systematic review undertaken on every behavioural intervention designed to increase vaccination uptake. For example, the EGM by Engelbert et al., 2021 identified an evidence synthesis gap relating to healthcare worker incentives (material and non-material incentives). To fill this synthesis gap, we will also include evaluation studies assessing healthcare worker incentives.

The scoping exercise identified a wealth of literature assessing human papilloma virus (HPV) vaccine uptake in adolescents (Abdullahi et al., 2020; Acampora et al., 2020; Ferrer et al., 2014; Fu et al., 2014; Ortiz et al., 2019). Searches of PROSPERO (the international prospective register of systematic reviews) also identified a planned '*Umbrella review of interventions used to improve HPV vaccine uptake in children, adolescents and young adults'*, (Edwards et al., 2021) therefore, to avoid research waste, we will not include vaccination against HPV in our REA.

1.3. Research questions and aims

The REA will utilise primary and secondary research studies to answer the following research questions:

- How effective are interventions targeting caregivers, healthcare workers and the community to increase the intention and motivation to vaccinate and vaccination rates of children ≤5 years old?

- What evidence is available on the link between intention and motivation to vaccinate and vaccination uptake?

By answering these research questions, the REA aims to:

1) Develop a conceptual framework linking intention and motivation to vaccinate with vaccination uptake
2) Identify evidence gaps in the literature taking a global perspective
3) Provide an evidence-base to inform and support policy decisions on interventions that increase vaccination uptake

2. The scope of this review

Section 2 details the scope of this REA and includes a summary of the eligibility criteria (Section 2.1), details of the relevant population (Section 2.2), and definitions and rationale for the interventions (Section 2.3) and outcomes (Section 2.4). Section 2 concludes with an initial conceptual framework that summarises how the interventions may lead to behavioural change and ultimately vaccination uptake (Section 2.5). This framework will be refined and further developed using the results of the REA.

2.1. Eligibility criteria

The inclusion and exclusion criteria for the REA are presented in Table 3. The REA will focus on routine vaccination of children ≤5 years old (vaccination schedule included in Appendix A). Studies will only be included if there is a comparative component, be it another intervention, a before-and-after comparison, or compared to no additional intervention (i.e., standard of care). Included studies will be limited to those published in the English language. The REA will take a global perspective and will not include limitations on publication date or duration of follow-up post-intervention.

Table 3: Eligibility criteria of the REA

	Inclusion criteria	Exclusion criteria
Population	Children aged ≤5 years old eligible for vaccination against routinely targeted diseases: tuberculosis, diphtheria, pertussis, tetanus, haemophilus influenzae type B, hepatitis B, pneumococcal disease, polio, measles, mumps, rubella, varicella (chicken pox), and rotavirus	• Vaccination against other vaccine targeted diseases including HPV, influenza or COVID-19. • Vaccination of a population in close contact with children (e.g., caregivers)
Interventions	**Caregiver focused** • Sustained sensitisation campaigns • Non-material incentives • Home visits **Health worker focused** • Training and education • Material incentives • Non-material incentives **Community focused** • Collaborating with selected community groups and networks • Faith-based outreach • Promoting outreach to vaccine-hesitant groups, refugees and migrants Interventions combining a relevant intervention with another intervention will also be included	**Caregiver focused** • One-time sensitisation and education campaigns • Material/monetary incentives for caregivers **Health worker focused** • Pay-for-performance schemes—incentives should target health workers rather than the health institution. If the incentive is non-monetary (e.g., sense of team achievement) it will be included • Interventions should be targeting health care professionals, interventions for lay community health workers will be excluded • Interventions targeting the health system
Comparators	All studies must include a comparison group for example another behavioural intervention, before and after comparison, or standard of care (where no intervention is delivered)	Studies without a comparison group

	Inclusion criteria	Exclusion criteria
Outcomes	Studies that report any of the following outcomes will be included: • Caregiver knowledge and awareness about immunisation or immunisation services • Caregiver readiness (intention) to vaccinate • Caregiver attitudes and beliefs about vaccination including perception of side effects • Community norms • Caregiver health service experience • Health worker motivation and capacity • Health worker attitudes and beliefs • Vaccine uptake	Studies not reporting on outcomes relating to vaccine uptake, or behaviour, intention, or motivation of caregivers, health workers or the community
Context	Global	N/A
Study design	For all interventions we will include systematic reviews, rapid evidence assessments, evidence gap maps, scoping reviews, and realist reviews For material and non-material incentives for health workers, scoping suggests there will be few or no systematic reviews. Therefore, for these interventions we will also include evaluation studies (experimental, quasi-experimental, observational).	If a systematic review is superseded by a more recent systematic review (i.e., all the included studies are included in another systematic review) the outdated review will be excluded.

Abbreviations: HPV, human papilloma virus; N/A, not applicable

2.2. Population

There are three populations of interest in this REA: the population receiving the vaccine, the population delivering the intervention and the population receiving the intervention.

1. **Population receiving the vaccine:** children ≤5 years for vaccinations recommended by UNICEF against routinely targeted diseases: tuberculosis, diphtheria, pertussis, tetanus, haemophilus influenzae type B, hepatitis B, pneumococcal disease, polio, measles, mumps, rubella, varicella (chicken pox), and rotavirus
2. **Population implementing the intervention:** healthcare workers, peers and community members
3. **Population receiving the intervention:** parents, caregivers, expectant parents or caregivers (referred to collectively as caregivers for the remainder of the document), healthcare workers, and community members.

2.3. Interventions

Vaccine hesitancy is defined as the delay in acceptance, or the refusal of vaccination, despite the availability of vaccination services (MacDonald, 2015). Hesitancy is a multidimensional phenomenon, recognised to occur along a continuum, between complete refusal with doubts, to acceptance, without doubts. The factors that drive an individual to accept or refuse a vaccine are complex and context specific (Larson et al., 2014). Childhood vaccine hesitancy is similarly complicated, influenced by a combination of individual and environmental factors.

2.3.1. Targeting caregivers

Recent evidence suggests that caregiver hesitancy relates to risk perception; mistrust of vaccine-related institutions, including health professionals; alternative beliefs about immunity, scheduling or harmfulness of vaccines; parenting views; and the caregiver's information needs (Díaz Crescitelli et al., 2020). These issues have also been identified as barriers to uptake in the Europe and Central Asia region. In a study conducted in 2017, caregivers reported their knowledge on vaccination as insufficient, and attributed this to a lack of information provided by the health provider. This information asymmetry eroded trust between the caregiver and the health worker, and fuelled perceptions of corruption and lack of transparency in the vaccine procurement process (Obregon et al., 2020). In Europe and Central Asia, attitudes towards childhood vaccination were also related to negative experiences with vaccination services. Caregivers complained about waiting times, and having to mingle with other children and clients who were sick, when accessing their appointments (Obregon et al., 2020). Selecting interventions that inform, educate and motivate caregivers to accept routine immunisation may have promise. However, in situations where there is high mistrust of government institutions, material incentives may be seen as coercive, and could be counterproductive. We have therefore included the following three caregiver focussed interventions in this REA: i) sustained sensitisation and education campaigns; ii) home visits; and iii) interventions that seek to motivate caregivers to vaccinate through use of non-material incentives.

2.3.2. Targeting health care workers

Research in Europe and Central Asia has linked childhood vaccination hesitancy with lack of knowledge and skills of health professionals and failure of health workers to communicate with caregivers to allay their concerns (Obregon et al., 2020). Strategies that seek to build health workers' interpersonal communication and counselling skills, and to strengthen their capability to provide accurate informational support to clients could be a valuable approach (Rodrigues et al., 2022). Another issue is health workers' attitudes towards immunisation. For example, some parents in the Ukraine, were of the perception that health providers did not vaccinate their own children, and were responsible for disseminating anti-vaccination propaganda (Obregon et al., 2020). The health professional's predisposition towards vaccination, and their confidence, or lack of confidence in the national immunisation program, may be an important predictor of caregiver's vaccine behaviour. According to MacDonald (2015), the strength of the health professional's recommendation, is a key motivating factor in vaccine uptake (MacDonald, 2015). Health workers may respond positively to incentives to promote immunisation, but it is important to go beyond general performance-based incentives, and identify strategies that can alter the health worker's attitudes and beliefs, and motivate them to recommend vaccination (Herzog et al., 2013). We have therefore chosen to include three interventions targeting the health care worker: i) training and education; ii) material or monetary incentives; and iii) non-material incentives.

The taxonomy provided by (Engelbert et al., 2021), includes additional interventions for health workers, such as the use of vaccination guidelines and involvement of health workers in vaccine planning and monitoring. These interventions, and others such as audit and feedback, can bring about behaviour change. However, we view them as strategies that are more closely aligned to quality improvement measures for the health system as a whole and have omitted them from this REA. We also recognize that all front-line health workers, including community health workers, social workers, paraprofessionals, volunteers, and lay individuals, play roles in childhood immunisation programs, however, we opted to limit the scope of the REA to formal health workers (FHWs) who will be administering the vaccines.

2.3.3. Targeting the community

Following Saeterdal et al. (2014), we define the community as a geographic areas, or a group of people sharing at least one common social or cultural characteristic (Saeterdal et al., 2014). Vulnerable and marginalized communities in Europe and Central Asia face specific issues with respect to vaccination. Roma communities may have negative attitudes and mistrust of health institutions leading to lower immunization coverage compared with non-Roma populations (Obregon et al., 2020). Even when aware of available immunisation services, they tend to feel stigmatised, or discriminated, and base their immunisation decisions on past experience with the health system. Children of refugees tend to have limited access to vaccination services because of lack of documentation or registration. Migrant populations are often under-vaccinated with higher drop-out rates, and there is some evidence that Orthodox populations in the region hold beliefs which do not support vaccination (Wilder-Smith & Qureshi, 2020). Interventions are therefore needed to reduce the inequities that may exist among these groups. The REA includes five such interventions: i) collaborating with selected community groups and networks; ii) outreach to vaccine-hesitant groups; iii) faith-based outreach/outreach using local leaders; iv) outreach to migrant populations; and v) campaigns to vaccinate refugee populations.

Definitions and examples of all interventions covered in the REA are provided in Table 4.

2.4. Outcomes

2.4.1. Behaviour

The Capability, Opportunity, Motivation and Behaviour (COM-B) framework is a well-known and accepted behaviour change model (Michie et al., 2011). This theoretical framework posits that desired behaviour change occurs when there is interaction between three necessary conditions—capability, opportunity, and motivation. Our REA incorporates these three aspects with respect to childhood vaccine decision-making. The caregiver must have the psychological capability (knowledge, awareness, and accurate information); social opportunity (supportive cultural and social norms and recommendations from health care providers); automatic motivation (correct emotional states); and reflective motivation (correct beliefs) to make the decision to vaccinate their child. Reflective and automatic motivation are inter-related but may also be inconsistent. For example, a caregiver may have strong beliefs about the importance of childhood vaccination but may harbour equally strong fears of side effects. Similarly, fear of side-effects may influence beliefs about vaccine efficacy and necessity. Given that it may be difficult to distinguish the type of motivation (reflective or automatic) influencing vaccine behaviour, we treat motivation as a single outcome driven by both reflective and automatic mechanisms, which we identify broadly as attitudes and beliefs. This is in line with scholars such as Habersaat & Jackson, 2020 (Habersaat & Jackson, 2020). Using this perspective, the following behavioural outcomes, in each of the COM-B domains, are included in our REA:

- Capability: (Knowledge and awareness) applicable to caregivers, health care workers, and community members; and technical skills applicable to health workers.
- Motivation: (attitudes, beliefs) applicable to caregivers, health care workers, and community members.
- Opportunity (health provider vaccination recommendations; social and community norms).

Definitions and examples of the outcomes for each of these domains are presented in Table 5.

2.4.2. Vaccine uptake

The desired result from activities to counteract childhood vaccine hesitancy is vaccination uptake. There is no consistent definition of vaccination uptake in the literature. Table 6 provides a list of outcomes relating to vaccine uptake that are relevant to our REA.

Table 4: Caregiver, health care worker and community focused interventions and definitions. Definitions were taken from the EGM by Engelbert et al., 2021 (Engelbert et al., 2021).

	Intervention	Definition from the EGM by Engelbert et al., 2021	Example interventions
Caregiver focused	Sustained sensitisation and education campaigns	Sustained interventions (i.e., those that are not designed with a fixed end date in mind) that provide targeted caregivers with information about immunisation and its importance, the vaccination schedule, or where and how to access immunisation services. For example, village health and nutrition days in India in which health education and counselling services are provided to pregnant women and mothers of young children on a regular basis.	**Interventions should be given more than once or in combination with other interventions** **Style of communication:** • Face-to-face discussions • Presentations • Individual or group classes • Information sessions • Telephone contact • Mass media • Pamphlets • Postal information • Short Message Service • Automated voice messages delivered to mobile phones • New media
	Home visits	Use of visits to caregivers' homes by health workers.	• Home visits to encourage caregivers to vaccinate their children • Home visits to deliver vaccines (targeted to specific households for routine immunisation)
	Non-material incentives for caregivers	Interventions that seek to motivate caregivers to vaccinate through non-material incentives like social recognition. Unlike reminder messages, interventions in this category should seek to create or strengthen a desire to vaccinate, rather than activating a standing intention to vaccinate.	• Social recognition
Health Care worker focused	Training and education	Programmes that train or educate formal health workers (FHWs). FHWs are typically vaccinators (and they tend to provide/prescribe medication or administer tests such as recording blood glucose level, etc.). (The only likely exception to this would be oral polio vaccination, especially supplementary polio campaigns, where community health workers or community volunteers may be enlisted to administer the vaccination.)	• Professional education • Supportive supervision • Communication tool-based training for health care workers • Self-efficacy training • Cultural competency training • Implicit-bias training • Health worker training focussed on improving service quality

	Intervention	Definition from the EGM by Engelbert et al., 2021	Example interventions
	Material/monetary incentives for health workers	Interventions that incentivise formal health workers to deliver vaccination services through items with monetary value.	• Cash transfers; material goods like food or home goods.
	Non-material incentives	Interventions that use non-material incentives like social recognition to incentivise formal health workers to deliver vaccination services.	• Social visibility: Featuring FHWs in interviews, newsletters, posters, or other printed material. • Career incentives: Providing incentives at recruitment (e.g., prospects for promotion and career advancement) that may attract high-performing FHW to a job. • Intrinsic incentives: Incentives such as apps and technology that can make the FHWs' job more rewarding. • Employer recognition: Top performing workers receive congratulatory letters or other forms of recognition from employers. • Social comparison: Employer recognition and social visibility interventions that also discloses comparable employee rankings.
Community focused	Collaborating with selected community groups and networks	Interventions that involve selected groups or networks of community members beyond health workers (other than the traditional or religious leaders) in developing plans and solutions to improve immunisation outcomes in the community. This includes interventions focusing on mother's groups, father clubs, self-help groups, etc.	• Structured discussions with parents, or trusted members of the community, that conclude with development of community-based action plans. • Door-to-door canvassing by trained community volunteers from grassroot organizations. • Development of social mobilisation networks. • Using local community members to provide health information and to track immunisations. • Using low-literacy urban volunteers to follow up immunisation defaulters.
	Promoting outreach to vaccine-hesitant groups	Outreach to groups that, because of religious, cultural, or other reasons, are suspicious of vaccination or have specific fears about it (e.g., that vaccinations cause infertility or spread disease).	• School immunisation outreach programmes • Door-to-door canvassing (channelling)
	Faith-based outreach/outreach using local leaders	Interventions that enlist influential community members (often religious or other traditional leaders) to promote vaccination in the community.	• Training, educating and engaging traditional and religious leaders as advocates for immunisation. • Involving community leaders, including religious leaders, in planning and delivering outreach to immunisation defaulters.

	Intervention	Definition from the EGM by Engelbert et al., 2021	Example interventions
	Outreach to migrant populations	Outreach to populations who have migrated temporarily or seasonally because of cultural or employment reasons.	• Education campaigns • Workshops • Tailoring educational and communication material to include linguistically and culturally relevant material. • Engaging with community members and community-based organizations to design and deliver programmes. • Delivering outreach programmes in non-traditional venues that community members regularly frequented (e.g., schools, places of worship, public parks, hotels, business centres, and train stations).
	Campaigns to vaccinate refugee populations	Interventions that make a special effort to vaccinate populations which have been displaced temporarily or permanently because of conflict, war or famine.	

Abbreviations: EGM, evidence gap map; FHW, formal health worker.

Table 5: Outcomes relating to vaccine knowledge, skills, attitudes, beliefs, norms, motivation, intention and experience.

	Outcome	Definition	Example outcome measures
Caregivers	Knowledge and awareness about immunisation	**Caregivers' knowledge and awareness about immunisation in general** (i.e., knowledge about vaccine preventable diseases; purpose and role of vaccines in preventing diseases; how to recognise and treat normal side effects).*	• Survey or questionnaire assessing knowledge • Focus group results • Interview results • Knowledge scores • Continuous outcome scales
	Knowledge and awareness about immunisation service delivery	**Caregivers' knowledge of where to go, when or which vaccines are due, how to access services**.	• Survey or questionnaire assessing knowledge • Knowledge scores • Interview results
	Attitudes about immunisation	**Caregivers' attitudes towards immunisation in general** (i.e., whether they view it favourably or unfavourably; have high or low confidence in its efficacy; have concerns about the likelihood and severity of side effects from vaccination.)*	• Surveys • Focus group results • Interview results
	Beliefs about immunisation	**Caregivers' core beliefs about vaccines** (i.e., beliefs about the severity of vaccine-preventable diseases, and necessity of vaccines; risks of vaccines; the benefits of alternative medicines versus immunisation; conspiracy theories; and influence of pharmaceutical industry on policy makers).	• Survey or questionnaire • Focus group result • Interview results
	Health service experience	**The actual experience of health services in the last visit such as duration of waiting time, availability of vaccine or vaccinator, and behaviour of the health staff** (respect, rudeness). This also includes level of satisfaction with the health services, professionals, and facilities.*	• Survey or questionnaire • Continuous outcome scales
	Intention to vaccinate	**Any measure of caregivers' intention, decision or choice to vaccinate their children.**	• Survey or questionnaires • Interview results • Intention scores • Intended choice measure, using Likert scales • Binary measure of whether or not caregiver intends or do not intend to vaccinate child.
Formal health	Formal health worker knowledge	**Any measure of formal health workers' (FHWs) knowledge of vaccine preventable diseases, the immunisation schedule, vaccine contraindications or similar technical characteristics related to childhood immunisation programs.**	• Survey or questionnaires assessing knowledge • Interview results • Questionnaires

	Outcome	Definition	Example outcome measures
	Formal health worker skills	**Any measure of FHWs' capacity to deliver quality and timely vaccination services, or of their performance in doing so.** This includes their interpersonal communication and counselling skills, and cultural competencies (ability to integrate knowledge about individuals and groups in delivering vaccine services).*	• Survey or questionnaires • Interview results
	Formal health worker attitudes about vaccine and immunisation services	**FHWs' general predisposition towards vaccines and immunisation services** (i.e., whether they view it favourably or unfavourably; have high or low confidence in its efficacy; have concerns about side effects, concerns about FHW's role in vaccination; concerns about the immunisation program's vaccine recommendations).	• Survey or questionnaire • Focus group results • Interview results
	Formal health worker beliefs about immunisation and vaccines	**FHWs' core beliefs about vaccines** (i.e., beliefs about: the necessity for vaccines given severity/susceptibility of children to diseases; vaccines benefit versus risk; benefits of alternative medicines versus immunisation; conspiracy theories; and influence of pharmaceutical industry on policy makers; caregivers' need for information about vaccines).	• Survey or questionnaire • Focus group results • Interview results
	Formal health worker motivation to vaccinate	**Any measure of FHWs' reported habit of recommending a specific vaccine or full vaccination; or FHWs' intention to vaccinate or recommend vaccination to the populations they serve.**	• Survey or questionnaire • Intention to recommend vaccination, using Likert scale
Community	Community norms	Community-level attitudes and beliefs about immunisation, including whether there is social pressure to vaccinate or not vaccinate. This can be measured either objectively through aggregating community-level responses or subjectively by soliciting individual community members' beliefs about the norms in their community. This includes attitudes and beliefs about immunisation of key influencers in the community like traditional or religious leaders.*	• Survey or questionnaire • Focus group results • Interview results

* Definitions from the EGM by Engelbert et al., 2021 (Engelbert et al., 2021)

Abbreviations: EGM, evidence gap map; FHW, formal health worker.

Table 6: Outcomes relating to vaccine uptake

Outcome	Definition
Full routine immunisation	Binary measure of whether or not children have received all routine vaccinations for the relevant country or region.
Immunisation status for specific antigens:	
BCG	Binary measure of whether or not children have received the BCG vaccine. This may be measured by checking whether children have a BCG vaccination scar.*
Pentavalent 1	Binary measure of whether or not children have received the first dose of the DTP or pentavalent vaccine.*
Pentavalent 2	Binary measure of whether or not children have received the second dose of the DTP or pentavalent vaccine.*
Pentavalent 3	Binary measure of whether or not children have received the third dose of the DTP or pentavalent vaccine.*
OPV0	Binary measure of whether children have received 1st dose of oral polio vaccine (recommended for administration at birth).*
OPV1	Binary measure of whether children have received 2nd dose of the oral polio vaccine (recommended for administration at 6 weeks).*
OPV2	Binary measure of whether children have received the 3rd dose of the oral polio vaccine (recommended for administration at 10 weeks).*
OPV3	Binary measure of whether children have received the 4th and final dose of the oral polio vaccine (recommended for administration at 14 weeks).*
IPV	Binary measure of whether children have received inactivated polio vaccine, given as injection. Countries differ in their guidelines/practices regarding IPV.*
Measles	Binary measure of whether or not children have received the measles vaccine.
Mumps	Binary measure of whether or not children have received the mumps vaccine.
Rubella	Binary measure of whether or not children have received the rubella vaccine.
Hepatitis B	Binary measure of whether or not children have received the hepatitis B vaccine.
Pneumococcal disease	Binary measure of whether or not children have received the pneumococcal disease vaccine.
Varicella	Binary measure of whether or not children have received the varicella (chicken pox) vaccine.
Rotavirus	Binary measure of whether or not children have received the rotavirus vaccine.
No/partial immunisation	Proportion of children who receive at least one vaccination versus those who are completely unvaccinated.*

Outcome	Definition
Vaccination timeliness	Proportion of vaccinations delivered on time according to the recommended schedule, versus those that are delivered late.*
Drop out (multi-dose vaccine)	Proportion of children who fail to receive the complete course of a multi-dose vaccine (DTP/pentavalent, OPV, or in some cases measles) after receiving the first dose.*
Unspecified coverage	If an evaluation or systematic review refers to impacts on routine vaccination coverage for children, but without specifying which vaccines.*
Initiation of vaccination course	If an evaluation or systematic review refers to the proportion of children commencing vaccination.
Up-to-date for age	If an evaluation or systematic review refers to the proportion of children immunised according to the schedule appropriate for their age.
Vaccination uptake	If an evaluation or systematic review refers to the proportion of the eligible children who received a vaccine during a specific time.
Un-vaccinated	Evaluation studies or systematic reviews that refers to infants that do not receive any vaccine.
Under-vaccinated	If an evaluation or systematic review refers to an infant that received some but not all the recommended vaccine-doses on the immunization schedule. (Related to drop-out rate and up-to-date for age).
Immunization coverage	If an evaluation or systematic review refers to the proportion of eligible children that is vaccinated (regardless of when they received the vaccine).

Abbreviations: BCG, Bacillus Calmette–Guérin; DPT, diphtheria, pertussis, and tetanus; EGM, evidence gap map; IPV, inactivated polio vaccine; OPV, oral polio vaccine.

* Definitions from the EGM by Engelbert et al., 2021 (Engelbert et al., 2021)

2.5. How interventions might work to change behaviour and increase vaccine uptake

Our conceptual diagram illustrates the main pathways through which interventions can potentially impact childhood vaccination uptake (Figure 1). The model distinguishes between 'vaccination uptake' as the **final outcome**, or ultimate objective of the individual or combined interventions, and **intermediate outcomes**, which are the links in the causal chain. To increase acceptance and uptake of childhood vaccinations, we hypothesize that behaviour change must occur at three levels—the caregivers of children, health care workers, and the community—and within the three COM-B domains.

Vaccine acceptance begins with knowledge and awareness about vaccines and vaccination services, and positive attitudes toward vaccination, which could then lead to the intention to vaccinate, and finally the infant's receipt of immunisation. In our model, 'intention to vaccinate' is an expression of vaccine acceptance. Similarly to Kaufman et al. (2018), we treat 'intention' as a separate outcome, more directly preceding the change in behaviour (uptake of the vaccine) (Kaufman et al., 2018). We therefore differ from scholars such as Saeterdal et al. (2014) who treat 'intention to vaccinate' as part of the caregivers' 'attitudes' or beliefs about vaccination (Saeterdal et al., 2014).

The framework depicts the important role health professionals and the community play in influencing vaccine decision-making at the individual level. Recommendations from health providers are known to be a strong predictor of acceptance (Brewer & Fazekas, 2007; Radisic et al., 2017), and community-based strategies can directly target defaulting or hesitant caregivers (Kaufman et al., 2018; Ryman et al., 2008; Saeterdal et al., 2014; Shea et al., 2009). Combined or multi-faceted interventions are likely to be more effective in moving the caregiver along the continuum from hesitant to accepting.

We recognise that the pathway from improved knowledge to changes in attitudes to acceptance and eventual receipt or uptake of vaccination, is not linear. Caregivers may vacillate along the vaccine hesitancy continuum. In addition, behaviour change interventions by themselves, will be insufficient to increase vaccination uptake if there are supply-side issues such as financing, data availability, or vaccine procurement and delivery. Our model is not attempting to overcome issues of vaccine supply, instead it addresses the question of how to increase vaccine acceptance and demand when supply is readily available. In addition, this is an initial conceptual framework that is subject to refinement and further development as the evidence is assessed.

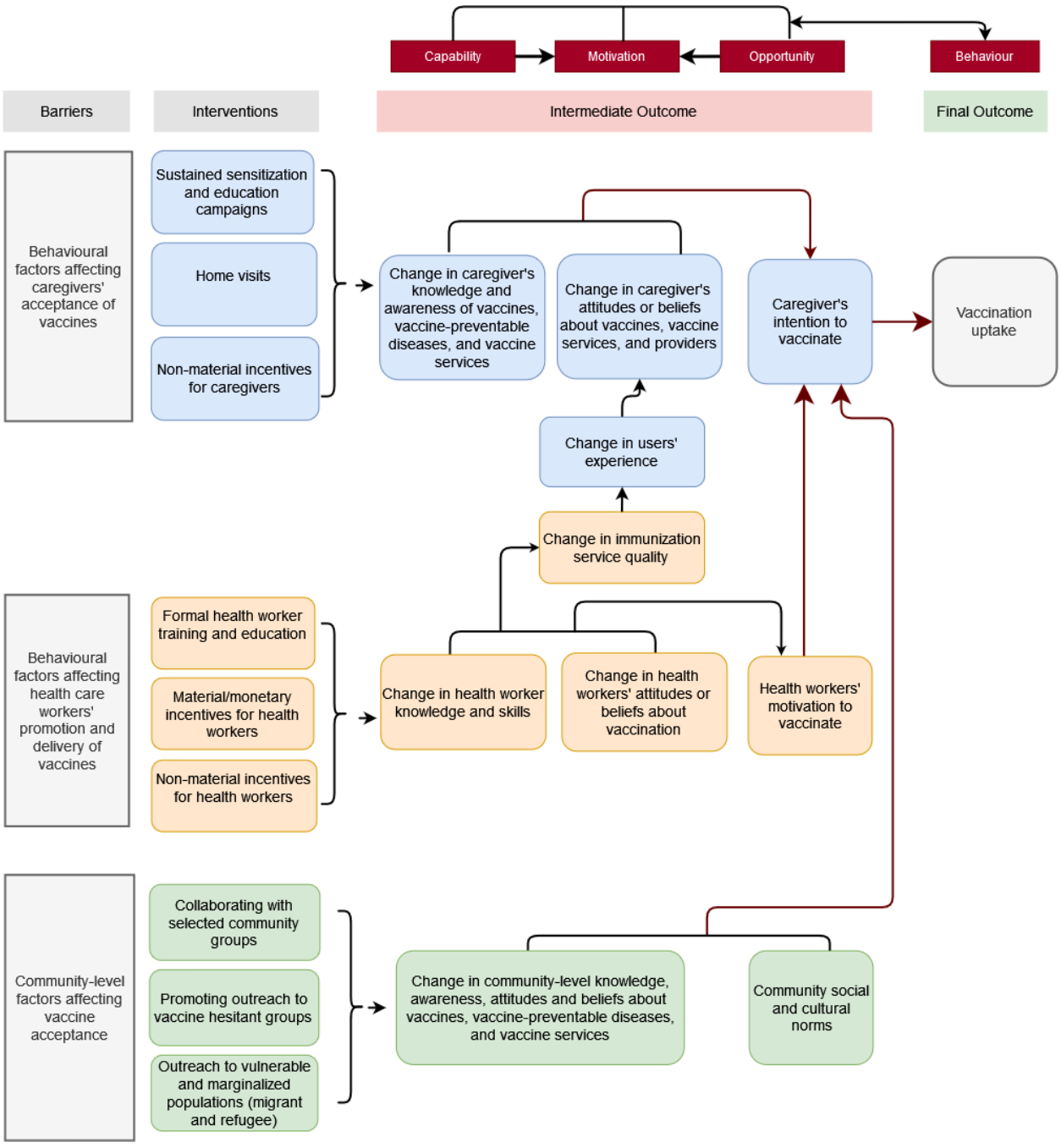

Figure 1: Conceptual framework of interventions for improving childhood vaccination uptake. Note: definitions and examples of interventions are provided in Table 4. Definitions and examples of outcomes are provided in Table 5 and Table 6.

3. Methods

This section outlines the methods that will be used to undertake this REA and includes the search strategy, approach to screening and data extraction, quality appraisal, evidence synthesis, and potential limitations. The methods for this REA will follow the guidelines included in the UNICEF Innocenti Methodological Briefs on Evidence Synthesis (Bakrania, 2020).

3.1. Search strategy

The searches will be run in the following databases: Medline (EBSCO), Web of Science (Clarivate), PsycINFO (EBSCO), CINAHL (EBSCO), Embase, Epistemonikos, Social Systems Evidence, the Campbell Collaboration and the Cochrane Database of Systematic reviews. Institutional databases and evidence platforms will also be searched: 3ie database, European Centre for Disease Prevention and Control, World Health Organization, UNICEF, and the Community Guide. In addition, we will screen the shortlisted studies from the scoping review being undertaken by Heneghan et al. 2021 (Heneghan et al., 2021).

Searches were designed by an information specialist (GS) and include free-text terms for children, vaccination, caregivers/healthcare workers/community, the interventions of interest and relevant study designs. Where index terms were available in a database, these were used in addition to free-text terms. The searches will be stratified by study design, with one search aiming to capture systematic reviews for all interventions and a second search aiming to capture evaluation studies for healthcare worker incentives. Search strategies are presented in Appendix B.

3.2. Screening and data extraction

Abstracts will be de-duplicated and screened using the EPPI-Reviewer platform (Thomas, 2020). Five percent of abstracts will be screened in duplicate by JOR and AY using the inclusion criteria in Table 3 and the screening checklist in Appendix C. After 5% of the abstracts are screened, consensus between the two reviewers will be assessed to ensure that inter-rater reliability is ≥80%. Disagreements will be resolved by discussion, and if needed another member of the team will be consulted. The remaining 95% of abstracts will be screened in single. The same screening process will be used for full-paper review.

The EPPI-Reviewer platform will also be used for data extraction and quality appraisal. Extraction will be performed by one member of the review team, and the extracted data from 10% of the included studies will be checked by a second reviewer. Disagreements will be resolved by discussion or if needed, another member of the team will assist in decision making. The remaining studies will be extracted in single.

The data extraction endpoints relating to vaccine uptake are listed in Table 6 while outcomes relating to behaviour are listed in Table 5. Quality appraisal is discussed in detail in Section 4.5. The variables that will be extracted are tabulated in Appendix D.

3.3. Data analysis and synthesis

Data synthesis will be narrative and will not include statistical analyses. We will generate tables and figures to summarise the included studies. Data from systematic reviews will be categorised by the target of the intervention (i.e., caregiver, health care worker and community), and by the type of intervention (e.g., education, outreach, home visits). For each of the systematic reviews, we will extract the key messages and where possible we will extract quantitative estimates of effect size (e.g., odds ratios, risk ratios). For evaluation studies, quantitative estimates will be extracted for both vaccine uptake, and intermediate behavioural outcomes. We anticipate that many different surveys and

questionnaires will be used to assess vaccine knowledge, attitudes/beliefs, motivation and intention, therefore we will extract the results as presented in the included studies. Quantitative results will be tabulated to allow comparison across studies.

No statistical analyses will be conducted; however, the evidence will be used to further develop our conceptual framework (Figure 1) and evaluate if intermediate behavioural outcomes (e.g., motivation and intention), and improved knowledge lead to improved vaccination rates. Where possible, the data will be presented in tables and figures to allow easier interpretation of the data. Figures will include an overview of quality appraisal and a flow diagram illustrating the number of studies included at each stage of the review.

Narrative syntheses will be used to frame the evidence around themes that are relevant to Eastern Europe and Asia and where possible we will relate the evidence back to the most common barriers to vaccination in the region. A report will be developed summarising the findings of the REA and an EGM will be developed using EPPI-Reviewer as a visual representation of the evidence base.

3.4. Quality appraisal

All study designs are associated with biases that may impact the design, conduct or analysis. To assess study quality, we will use quality appraisal tools designed by the Joanna Briggs Institute. The Joanna Briggs Institute has developed critical appraisal tools for a number of study designs including randomised controlled trials, quasi-experimental studies and systematic reviews. The checklists used for each of the study designs are included in Appendix E.

Quality appraisal will be conducted in single by JOR and AY. Ten percent of the quality appraisals (across different study designs) will be reviewed by a second reviewer to ensure consistency. Agreement will be reached on classification of risk across each study type. The Joanna Briggs Institute coding format of Yes/No/Unclear/Not applicable will be used for all studies. By selecting critical appraisal tools developed by one organization, it will allow more uniform assessment of bias across study designs. For each question that a study is coded as 'Yes', the review will be awarded 1 point. Reviews will be categorised as low (total score 0-3), moderate (score 4-7) or high (score 8-11) quality based on the results of the quality appraisal checklists. A similar approach will be taken for randomised controlled trials (0-4=low quality, 5-9=moderate quality, 10-13=high quality) and quasi-experimental studies (0-3=low quality, 4-6=moderate quality, 7-9=high quality).

3.5. Potential limitations of this REA

There are several limitations inherent to the design of REAs (Bakrania, 2020). REAs are not as comprehensive as systematic reviews. The underlying search strategy is not as exhaustive, therefore, REAs may not to capture all relevant studies. They are more prone to bias due to utilising less rigorous methods (for example single screening and extraction), and are usually not suitable for broad topics. To overcome the limitation of REAs not being suitable for broader research questions, our REA will include systematic reviews rather than primary studies. This approach will allow us to leverage the many systematic reviews already undertaken in the area, however, we will miss primary studies that have not been captured in previous systematic reviews. To address this, we will include evaluation studies for incentives for health workers as this was identified as an evidence synthesis gap in the EGM by Engelbert et al., 2021.

The review is not assessing systems level interventions such as changes to vaccination tracking systems, cold chain infrastructure, vaccination guidelines, or health system financing. We recognise

that these factors can impact vaccine behaviour and uptake, however, we are focussing on interventions that directly target people (caregivers, health workers and the community).

4. Proposed timeline

The estimated timeline for the REA is provided in Table 7. The protocol will be finalised at the end of March 2022, screening and data extraction will be completed by mid-May 2022 and reporting will be finalised in July 2022.

Table 7: Estimated timelines for the REA and summary reports and presentations

Date	Task
18th March 2022	Finalisation of the study protocol
13th May 2022	Screening, data extraction and narrative synthesis
3rd June 2022	Draft report providing an overview of the findings
06th July 2022	Final report

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Appendix A – Definitions

The vaccine schedule recommended by UNICEF is presented in Table 8.

Table 8: Vaccine schedule for common vaccine-preventable diseases (table adapted from "Protecting young children from vaccine-preventable diseases" by Schwethelm et al)

Disease	Vaccine	Timing of doses
Tuberculosis	– Bacille Calmette Guérin (BCG)	As soon after birth as possible
Diphtheria	– Diphtheria, pertussis, and tetanus (DTP) Tetanus and diphtheria – Pentavalent [DTP + hepatitis B (hepB) + Haemophilus influenzae type B (Hib)]	DTP containing vaccine, 3 doses: First dose at 6 weeks, intervals 4-8 weeks
Pertussis (whooping cough)	– DTP for infants and children – Pentavalent (DTP+HepB+Hib)	DTP containing vaccine, 3 doses. First dose at 6 weeks, intervals 4-8 weeks
Tetanus	– Tetanus Toxoid (TT) – DTP – Diphtheria, tetanus (DT) – Td Pentavalent (DTP+HepB+Hib)	DTP containing vaccine, 3 doses: First dose at 6 weeks, intervals 4-8 weeks
Hepatitis B (hepB)	– HepB – Pentavalent (DPT+HepB+Hib)	3-4 doses, 1st as soon as possible after birth, with 4-week intervals between doses
Haemophilus influenzae Type b (Hib)	– Hib – Pentavalent (DPT+HepB+Hib)	3 doses, first dose at 6 weeks, intervals 4 weeks
Pneumococcal disease	– Pneumococcal conjugate vaccine (PCV)10 – PVC13	3 doses, first does at 6 weeks, intervals 4 weeks
Polio	– Oral polio vaccine (OPV) – Inactivated polio vaccine (IPV)	3-4 doses, first dose at 6-8 weeks, intervals 4-8 weeks
Measles	– Measles – Measles, mumps, rubella (MMR) – Measles, rubella (MR)	2 doses, first does at 9-12 months
Mumps	– MMR Measles, mumps, rubella, varicella (MMRV)	2 doses, at 9-12 months, interval 4 weeks to school entry
Rubella (German measles)	– MMR – MR	1 dose at 9-12 months
Varicella (chickenpox)	– Varicella vaccine – MMRV	1-2 doses, first dose at 12-18 months, interval of 4-12 weeks
Rotavirus	– Rotavirus vaccine	2-3 doses, 1st dose at 6 weeks, interval of 4 weeks

Community-level interventions are defined as those developed for defined geographic areas, or interventions targeting groups of people who share at least one common social or cultural characteristics. (Saeterdal et al., 2014)

Europe and Central Asia has been defined as the 22 countries and territories that **the UNICEF Europe and Central Asia Regional Office (ECARO)** works in: Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Georgia, Greece, Kazakhstan, Kosovo (in line with UN Security Council Resolution [UNSCR 1244]), Kyrgyzstan, Moldova, Montenegro, North Macedonia, Romania, Serbia, Tajikistan, Turkey, Turkmenistan, Ukraine, Uzbekistan

Vaccine hesitancy is defined as the delay in acceptance, or the refusal of vaccination, despite the availability of vaccination services (MacDonald, 2015).

Appendix B – Search strategies

Two searches will be run, the first to identify systematic reviews and evidence synthesis publications for all interventions, and a second to identify evaluation studies for incentives (material and non-material) for healthcare workers.

B.1.Web of Science search strategy for systematic reviews

Database:	Web of Science (Core Collection)
Search fields:	All searches run in Topic field except conditions to exclude
Language restrictions:	Limit to English
Publication type:	Articles and Review Articles only
Estimated number of hits:	564 hits (search run on 24 January 2022)

Terms for children

baby OR babies OR boy* OR child OR children* OR childhood OR girl* OR infant* OR juvenile* OR minor* OR neonat* OR newborn* OR "new born*" OR pediatric* OR paediatric* OR schoolboy* OR schoolgirl* OR toddler* OR young*

Terms for family/community/healthcare workers

aunt* OR brother* OR caregiver* OR "care giver*" OR cousin* OR father* OR grandfather OR grandmother* OR guardian* OR mother* OR parent* OR sister* OR stepmother* OR stepfather* OR uncle* OR communit* OR district* OR faith* OR families OR family OR household* OR "house hold*" OR neighbo* OR province* OR religious OR school* OR town* OR village* OR work OR workplace* OR clinician* OR counsellor* OR counselor* OR dentist* OR dietitian* OR doctor* OR "general practitioner*" OR gynaecologist* OR gynecologist* OR hospitalist* OR midwife OR midwives OR nurse* OR nutritionist* OR obstetrician* OR paediatrician* and pediatrician* OR pharmacist* OR physician* OR physiotherapist* OR psychiatrist* OR psychologist* OR psychotherapist* OR "social worker*" OR therapist* OR "welfare worker*" OR ((health* OR hospital OR medical OR nurs* OR "operating room" OR paramedical OR pharmac* OR psychiatric) NEAR/2 (aide* OR assistant* OR consultant* OR officer* OR personnel OR practitioner* OR professional* OR provider* OR specialist* OR staff OR worker*))

Intervention terms

appreciat* OR award* OR bonus* OR cash OR communic* OR educat* OR engag* OR gift* OR "health promotion" OR "household item*" OR incentiv* OR intervention* OR marketing OR monetary OR money OR nonmonetary OR outreach OR pay OR payment OR "professional development" OR recogni* OR reward* OR "social mobilisation" OR "social mobilization" OR train* OR ((home OR house) NEAR/2 (call* OR care OR visit*)) OR (("mobile health") NEAR/2 (unit* OR team*))

Vaccination terms

immunis* OR immuniz* OR vaccin*

Systematic review and evidence synthesis terms

((evidence OR gap) NEAR/2 map*) OR EGM OR "meta analy*" OR metaanaly* OR "research synthes*" OR ((systematic OR rapid OR realist OR impact) NEAR/2 (review* OR assessment* OR stud*))

Remove non-relevant conditions

NOT (HPV OR papilloma* OR COVID* OR coronavirus OR influenza OR cancer*) in Title

B.2.Web of Science search strategy for evaluation studies

Database: Web of Science (Core Collection)

Search fields: All searches run in Topic field except conditions to exclude

Language restrictions: Limit to English

Publication type: Articles and Review Articles only

Estimated number of hits: 379 hits (search run on 24 January 2022)

Terms for children

baby OR babies OR boy* OR child OR children* OR childhood OR girl* OR infant* OR juvenile* OR minor* OR neonat* OR newborn* OR "new born*" OR pediatric* OR paediatric* OR schoolboy* OR schoolgirl* OR toddler* OR young*

Terms for healthcare workers (professional)

clinician* OR counsellor* OR counselor* OR dentist* OR dietitian* OR doctor* OR "general practitioner*" OR gynaecologist* OR gynecologist* OR hospitalist* OR midwife OR midwives OR nurse* OR nutritionist* OR obstetrician* OR paediatrician* and pediatrician* OR pharmacist* OR physician* OR physiotherapist* OR psychiatrist* OR psychologist* OR psychotherapist* OR "social worker*" OR therapist* OR "welfare worker*" OR ((health* OR hospital OR medical OR nurs* OR "operating room" OR paramedical OR pharmac* OR psychiatric) NEAR/2 (aide* OR assistant* OR consultant* OR officer* OR personnel OR practitioner* OR professional* OR provider* OR specialist* OR staff OR worker*))

Intervention terms

appreciat* OR award* OR bonus* OR cash OR gift* OR "household item*" OR incentiv* OR monetary OR money OR nonmonetary OR pay OR payment OR "professional development" OR recogni*

Vaccination terms

immunis* OR immuniz* OR vaccin*

Impact assessments terms

CCT OR RCT OR RDD OR PSM OR "propensity score matching" OR "regression discontinuity design" OR "difference* in difference*" OR "time series" OR "instrumental variable*" OR cohort* OR experiment* OR quasiexperiment* OR "case control" OR matching OR "between groups design" OR "time series" OR counterfactual OR "counter factual" OR evaluat* OR "before after" OR "pre post" OR ((random* OR nonrandom* OR control* OR clinical OR comparison) NEAR/2 (trial* OR allocat* OR sampl* OR group*)) OR effect*

Remove non-relevant conditions

NOT (HPV OR papilloma* OR COVID* OR coronavirus OR influenza OR cancer*) in Title

Appendix C – Screening checklist

Table 9 summarises the screening tool for assessing inclusion of abstracts and full-papers. For abstracts, if the question is answered as "unclear" then it will be forwarded to full-paper screening. If a full-paper is classified as unclear, it will be discussed with a second reviewer and a consensus reached.

Table 9: Screening tool for assessing abstracts and full-papers for inclusion in the REA

Question	Yes (include)	No (exclude)	Unclear
For systematic reviews: Does at least one study included in the review assess children aged ≤5 years old?			
For evaluation studies: Are the study participants children aged ≤5 years old?			
Are the children being vaccinated against tuberculosis, diphtheria, pertussis, tetanus, haemophilus influenzae type B, hepatitis B, pneumococcal disease, polio, measles, mumps, rubella, varicella (chicken pox), and rotavirus?			
Does the intervention target caregivers, health workers or the community?			
Does the study assess an intervention of interest? **Caregiver focused** • Sustained sensitization campaigns • Non-material incentives • Home visits **Health worker focused** • Training and education • Material incentives • Non-material incentives **Community focused** • Collaborating with selected community groups and networks • Faith-based outreach • Promoting outreach to vaccine-hesitant groups, refugees and migrants Interventions combining a relevant intervention with another intervention will also be included			
Study design is a systematic review, experimental, quasi-experimental, or observational (with comparator)?			
Study reports one or more of the outcomes included in the REA? • Caregiver knowledge and awareness about immunization and immunisation service delivery • Caregiver readiness (intention) to vaccinate • Caregiver attitudes and beliefs about vaccination including perception of side effects • Caregiver health service experience • Community norms • Health worker knowledge and capacity (skills) • Health worker attitudes and beliefs • Health worker motivation (to vaccinate) • Vaccine uptake			
Is the article published in English?			

Appendix D – Data extraction protocol

Table 10 summarises the data that will be extracted from the included studies. For additional information on outcome variables (including definitions) refer to Table 5 and Table 6.

Table 10: Variables that will be extracted

Coding category	Data
Bibliographic data	Lead author Publication year Study name (if available) Title Abstract (if available)
Study characteristics	Study design • Systematic reviews (with or without meta-analysis or meta-regressions) • Randomised controlled trial • Quasi-experimental (including those that use regression discontinuity design, propensity score or other matching techniques to create a comparison group or difference in difference and instrumental variables techniques to estimate relationships and impact) • Quantitative observational studies, including Before-after studies and Time-series For systematic reviews, what study designs were eligible for inclusion? Income level of countries included in the studies • Low income • Lower middle income • Upper middle income • Low and middle income • High income • Global Countries (if available) Duration of follow-up
Population characteristics	N Target population • Caregiver • Health care workers • Community Residence (urban/rural) Race/ethnicity/culture/language Religion Socioeconomic status Other relevant characteristics of the included population (free-text) For systematic reviews, what was the number of studies with high, unclear and low risk of bias?
Intervention characteristics	**Intervention category:** **Caregiver focused** • Sustained sensitization campaigns • Non-material incentives • Home visits **Health worker focused** • Training and education • Material incentives • Non-material incentives **Community focused** • Collaborating with selected community groups and networks • Faith-based outreach

Coding category	Data
	• Promoting outreach to vaccine-hesitant groups, refugees and migrants **Combination intervention** (provide details) Brief summary of intervention (free-text) Brief description of control group (free-text)
Outcomes assessed and measurement of effect	**Vaccine uptake outcomes** • Type of vaccine being assessed • Outcome being assessed (uptake, timeliness, drop-out) • For systematic reviews: number of studies assessing the outcome • Binary outcomes: n, percent, relative effect estimate (e.g., odds ratio, risk ratios), p-value • If quantitative estimate not provided, include brief free-text summary • Direction of effect (positive, neutral, or negative effect of intervention) • If GRADE assessment was performed, what was the certainty of the evidence? **Behaviour outcomes** • Type of vaccine is being assessed • Name of scale or survey used (if applicable) • Outcome being assessed (and definition if available) • For systematic reviews: number of studies assessing the outcome • Mean effect, or mean change, relative effect estimate (e.g., odds ratio, risk ratios), p-value • If quantitative estimate not provided, include brief free-text summary • Direction of effect (positive, neutral, or negative effect of intervention) • If GRADE assessment was performed, what was the certainty of the evidence?
Quality appraisal and risk of bias measures	Assessed using the appropriate Joanna Briggs Institute checklist

Abbreviation: GRADE, Grading of Recommendations, Assessment, Development and Evaluations

Appendix E – Quality appraisal checklists

All checklists were developed by the Joanna Briggs Institute. Checklists will be selected depending on the design of the study. For all checklists, possible answers are Yes, No, Unclear or Not Applicable.

E.1. Critical appraisal checklist – systematic reviews

1. Is the review question clearly and explicitly stated?
2. Were the inclusion criteria appropriate for the review question?
3. Was the search strategy appropriate?
4. Were the sources and resources used to search for studies adequate?
5. Were the criteria for appraising studies appropriate?
6. Was critical appraisal conducted by two or more reviewers independently?
7. Were there methods to minimize errors in data extraction?
8. Were the methods used to combine studies appropriate?
9. Was the likelihood of publication bias assessed?
10. Were recommendations for policy and/or practice supported by the reported data?
11. Were the specific directives for new research appropriate?

E.2. Critical appraisal checklist – randomised controlled trials

1. Was true randomisation used for assignment of participants to treatment groups?
2. Was allocation to treatment groups concealed?
3. Were treatment groups similar at the baseline?
4. Were participants blind to treatment assignment?
5. Were those delivering treatment blind to treatment assignment?
6. Were outcomes assessors blind to treatment assignment?
7. Were treatment groups treated identically other than the intervention of interest?
8. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?
9. Were participants analysed in the groups to which they were randomised?
10. Were outcomes measured in the same way for treatment groups?
11. Were outcomes measured in a reliable way?
12. Was appropriate statistical analysis used?
13. Was the trial design appropriate, and any deviations from the standard RCT design (individual randomisation, parallel groups) accounted for in the conduct and analysis of the trial?

E.3. Critical appraisal checklist – quasi-experimental studies

1. Is it clear in the study what is the 'cause' and what is the 'effect' (i.e., there is no confusion about which variable comes first)?
2. Were the participants included in any comparisons similar?
3. Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?
4. Was there a control group?
5. Were there multiple measurements of the outcome both pre and post the intervention/exposure?
6. Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analysed?
7. Were the outcomes of participants included in any comparisons measured in the same way?
8. Were outcomes measured in a reliable way?
9. Was appropriate statistical analysis used?