Background Paper on

Behavioural and Social Drivers of Vaccine Uptake

Prepared for Strategic Advisory Group of Experts on Immunization (SAGE)

For the meeting on 4-7 October 2021

15 September 2021

World Health Organization

Contents

Session summary

Purpose of session

This session on '*Behavioural and social drivers (BeSD) of vaccine uptake'* aims to put forward new evidence, tools and guidance to support programmes to address under-vaccination. It is the second of two sessions on the topic. The first session in March 2021 provided an update to SAGE on work underway to develop an evidence-based approach to measuring and addressing behavioural and social drivers[1] of uptake to inform programme planning and evaluation. SAGE provided feedback on the approach.

The objectives of the October 2021 session are to present the outputs of work to establish tools for assessing the behavioural and social drivers of vaccination uptake:

- Present findings of tool field-testing and validation, with final **measures and proposed core indicators;**
- Present a guidebook to support local use of the tools and resulting data, including initial directions on **interventions to improve uptake;**
- Propose **implementation considerations** for programmes to routinely gather and use behavioural sciences data to guide planning and evaluation;
- Invite SAGE to consider **draft recommendations** to Member States on standardised methods to measure behavioural and social drivers.

Questions posed to SAGE**:**

- What is SAGE's feedback on the work to date?
- What next steps should be incorporated?
- What recommendations can be put forward to Member States?

Background description

In the years since the SAGE sessions on vaccine hesitancy in 2014, vaccination programmes have benefitted from substantial advances in the behavioural and social science of vaccination. Evaluation and intervention efforts have increasingly addressed a wider range of barriers to vaccine uptake.[2] A complex web of interconnected actors; systems; social, cultural and religious influences; resources, and behaviours come together to support vaccination programmes and people getting vaccinated. To maintain and enhance resilience of vaccination programmes and the global success story they represent, it is essential to support the quality assessment of factors that affect vaccine uptake. Giving renewed momentum to this area, the *Immunization Agenda 2030* (IA2030) has put an emphasis on Commitment and Demand (strategic objective 2) and Coverage and Equity (strategic objective 3).

Assessing the barriers to and drivers of vaccine uptake requires programmes to develop an understanding of the determinants of under-vaccination, implement tailored evidence-based strategies to improve uptake, and monitor and evaluate these efforts to determine their impact and sustainability.

To support programmes and partners' systematic assessment of behavioural and social factors affecting uptake, WHO and partners have been developing tools that will support countries to gather quality and

actionable data to best target the reasons for under-vaccination. Use of globally consistent tools enables countries to track trends over time and between settings. In October 2018, following discussions with core global partners, WHO established a global working group called 'Measuring Behavioural and Social Drivers of Vaccination' (BeSD) involving a diverse range of global, regional, and country-level partners and experts. The BeSD working group is also connected to the global partner Demand Hub, facilitating regular exchanges with a wider network. Specifically, these tools include **in-depth interview guides and surveys for both childhood immunization and for COVID-19 vaccination and a user-friendly guidebook (box)**.

What tools and guidance were developed?

BeSD tools for childhood vaccination:
- Survey
- Interview guides

BeSD tools for COVID-19 vaccination:
- Survey for adults
- Survey for health workers
- Interview guides

Data for action guidebook:
A guide to gathering and using data from the behavioural and social drivers of vaccination tools

We conceptualize behavioural and social drivers as influences on vaccination uptake that are: 1) measurable, 2) specific to vaccination, and 3) potentially changeable by vaccination programmes. We focus on a range of constructs outlined in this document, but we do not focus on broader contextual issues that were well described by the SAGE Vaccine Hesitancy Working group in 2014 and its subsequent outputs.[3]

This session – with details in this supporting background paper – will outline key steps in the process of testing and validating the BeSD tools, including evidence reviews, expert input, partner consultations, field testing, cognitive interviewing, and psychometric validation. In the development of the tools, WHO and the BeSD working group have partnered with immunization stakeholders around the world to gather insights and learn from early testing. Thus, the BeSD tools for childhood immunization and COVID-19 vaccination are designed with the end-user in mind. A *'Data for Action Guidebook'* has also been developed to support implementation. End-users inputs have been sought throughout the process,[4] and in recent months actively informed iterative improvements to the guidebook.

To complement the work on measurement of BeSD and to identify interventions to improve vaccination uptake, WHO initiated a scoping review that examines the systematic reviews and meta-analyses of strategies to increase vaccine uptake. Initial findings of this review will also be presented to SAGE. The reviews were categorized according to different vaccines, populations (e.g., children aged under 5 years, aged 5-10 years, adolescents, adults, health workers), countries, and outcomes (e.g., uptake, confidence, norms, knowledge, etc). Outcomes were prioritised as high, moderate and low, according to the WHO Handbook for Guideline Development. Certainty in the evidence or quality of evidence was assessed using GRADE (Grading of Recommendations Assessment, Development and Evaluation).

In addition to the measures and interventions, this session brings to SAGE an outline of the guidance and supporting activities that will be established in the upcoming year to support Member States to gather and use data for the design and evaluation of interventions. These activities will occur at a global, regional, and country-level, and WHO and partners will help to ensure that the necessary facilitators are in place, including adequate funding, technical support, operational structures, and integration into NITAG and RITAG processes to guide decision-making and planning. Mechanisms will

also be established – integrated with existing immunization programme information management systems – to track data on core indicators.

The final element of the session will include draft recommendations for SAGE to consider. The draft conclusions and recommendations are available in Section 10 of this document.

Outline of session – *(90 minutes)*

- Introduction and framing (5 mins) – SAGE member
- Overview of objectives and process to gather and translate evidence (10 mins) – Dr Julie Leask
- **Measures**: development and validation of tools and identification of core indicators (10 mins) – Dr Noel Brewer
- **Interventions**: scoping review to identify interventions to increase uptake (5 mins) – Dr Carl Heneghan
- **Implementation considerations**: guidance and support to Member States to use BeSD tool data to inform the evidence-based implementation of interventions (5 mins) – Lisa Menning
- Draft recommendations for consideration by SAGE (5 mins) – SAGE member
- Q&A and discussion (40 mins)

Key messages:

- **While immunization is a global success story, coverage for children varies widely** within and among countries, and in recent years progress has stagnated or even declined in some countries. New strategies are now needed to identify and address immunity gaps, as per the *Immunization Agenda 2030*[1], which sets out the objective to achieve and sustain high and equitable coverage nationally and in every district (strategic objective 3).
- **Public support for child vaccination is strong globally**. Most infants receive their recommended vaccines in most countries. However, in 2020, 23 million children missed out on vaccinations, and global coverage for DTP3 was at 83%.[5] There is **limited systematic understanding of the causes** of these gaps in coverage from a behavioural perspective.
- **A range of factors contribute to low uptake.** Availability, accessibility, quality and experience of services, overall trust in health systems, services and service providers, socio-cultural and gender norms influence vaccine uptake. Hesitancy – a state of being conflicted about whether to get immunisation[6] – can also be a major cause of declines in coverage or persistent low vaccination. Hesitancy is often context-specific and is affected by local influences, individual and social group influences, and vaccine and vaccination-specific issues.[7] Programme managers and health workers can find hesitancy and refusal difficult to address. Evidence on how to address hesitancy specifically is limited.[8] In some settings, hesitancy is thought to be the only cause of poor uptake, but closer study reveals the greater prominence of other challenges such as access and availability of vaccines-related factors.
- **The causes of low vaccination are often not measured**. Where they are, the focus is often more on attitudes and less on practical issues such as ease of access to services. Many measures are not validated, and standardisation is lacking between and within countries, resulting in a lack of time trends and inability to make comparisons across settings. Data on barriers, community perceptions, and concerns are rarely used for the design or evaluation of interventions.

[1] Immunization Agenda 2030: A Global Strategy to Leave No One Behind. https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/ia2030

- **Better data needs to be gathered and used to sustainably address under-vaccination.** Evidence-informed and validated BeSD tools have been developed for childhood and COVID-19 vaccination to support the gathering and use of local data. Evidence on what works to increase vaccination uptake has identified a range of promising interventions. However, important gaps remain in the evidence base for supporting vaccination programmes.

Abbreviations

BeSD	Behavioural and social drivers
BMGF	Bill & Melinda Gates Foundation
CDC	US Centers for Disease Control and Prevention
DHS	Demographic and Health Surveys
DRC	Democratic Republic of Congo
DTP3	Three doses of diphtheria-tetanus-pertussis containing vaccine
eJRF	Electronic Joint Reporting Form
EPI	Expanded Programme on Immunization
Gavi	Gavi, the Vaccine Alliance
GRADE	Grading of Recommendations Assessment, Development and Evaluation
GVAP	Global Vaccine Action Plan
HIC	High-income country
HW	Health care worker
IA2030	Immunization Agenda 2030
IVIR-AC	Immunization and Vaccine-related Implementation Research and Advisory Committee
IVM	Increasing Vaccination Model
KAP	Knowledge, attitudes, and practices
LMIC	Low- or middle-income country
MCV1	First dose of measles-containing vaccine
MICS	Multiple Indicator Cluster Surveys
MOV	Missed opportunity for vaccination
M&E	Monitoring and evaluation
ODK	Open Data Kit
SAGE	Strategic Advisory Group of Experts on Immunization
UNICEF	United Nations Children's Fund
WHO	World Health Organization

Section 1. An introduction to assessing behavioural and social drivers

Summary: Countries and regions would benefit from standardized tools and guidance for assessing the behavioural and social underpinnings of vaccination. From 2018-2021, the Behavioural and Social Drivers of Vaccination' (BeSD) working group developed tools and guidance that are evidence-informed and globally standardized to support programmes and partners. **The tools include quantitative surveys, qualitative in-depth interview guides, and a guidebook to assist programmes and partners to gather and use data.**

The tools are available for routine childhood and COVID-19 vaccination and can be used to assess and address different needs in different settings. For example, the tools promote an understanding of the reasons for low uptake at a national level, or for a more detailed examination of drivers and barriers in a specific population. **These tools have been extensively field-tested and validated in a range of low- and middle-income countries.**

From the outset, **end-user needs and perspectives have contributed to each phase** of work and each output, informing the design of the tools and the supporting guidebook.

Context and evolution of the field

High coverage is vital to achieving the full benefit of vaccines. However, countries have reported persistent challenges of inadequate, delayed and unstable vaccination uptake.[9] Some vaccine preventable diseases have surged in geographically concentrated areas. Globally, immunization coverage for MCV1 has plateaued at 85% since 2010, leaving almost 20 million children unprotected.[10] As a result, several countries recently lost their measles elimination status. Many children missed vaccination during the COVID-19 pandemic,[11,12] and there is the new challenge of how to achieve high uptake of COVID-19 vaccines. The Global Vaccine Action Plan (GVAP) in its 2017 report outlined goals for the 'decade of vaccines' (2011-2020), emphasizing the need for all countries to develop comprehensive national vaccine confidence management strategies, encompassing regular assessment of local hesitancy, trust building, and emergency response planning.[13] The Immunization Agenda 2030 (IA2030) then expanded upon these objectives.[14] Strategic objective 2 of IA2030 – commitment and demand, and with important linkages to objective 3 on coverage and equity – have also recognised the need for evidence-informed, globally standardized tools to support programmes and partners in measuring, tracking and addressing reasons for under-vaccination over time.

Recent research has measured aspects of vaccine confidence (e.g., perceived importance, confidence in vaccine safety and effectiveness) and demonstrated the value of standardizing measures between countries and over time.[15] However, this research also finds that effect sizes for vaccine confidence constructs alone are small.[15] In studies seeking to identify why parents/caregivers don't vaccinate children at all, or on time, they report a range of practical and logistical barriers in addition to issues of confidence.[16,17] Therefore, to increase coverage, the full range of causes of under-vaccination and their relative contributions to low coverage must be better understood. **By pinpointing the social and behavioural factors that influence vaccine uptake, immunization programmes can prioritise which evidence-based interventions are needed to improve uptake. They can also monitor and evaluate interventions over time.**

Launch of the BeSD working group of experts

Resulting from discussions with key vaccination partners – including UNICEF; the US Centers for Disease Control and Prevention; Gavi, the Vaccine Alliance; and the Bill and Melinda Gates Foundation –WHO established the 'Measuring Behavioural and Social Drivers of Vaccination'[6] working group of experts in November 2018.[18] The aim of the BeSD group is to support the systematic assessment of behavioural and social factors affecting vaccination uptake and oversee the development of tools and related implementation guidance.[19] The BeSD approach also emphasized development of tools for in-country implementation and ease of translatability between different cultures and languages, particularly to enable the collection of quality, comparable and actionable data.

Members of the BeSD working group include representatives of global agencies and experts from multiple geographical regions, covering a range of social and behavioural science disciplines with practical and programmatic experience in high-, middle-, and low-income settings (Annex I). The BeSD working group is also linked to the larger multi-partner Demand Hub to facilitate alignment and coordination with partner efforts in other technical areas, and BeSD has given regular updates to, and had consultations with, the Hub. Working under terms of reference (Annex I), BeSD working group members have participated in regular teleconferences to support information sharing, contribute expert inputs, and create new insights from a range of relevant projects on immunization.

What are "behavioural and social drivers" (BeSD)?

BeSD are proximal influences:

- Measurable in individuals
- Specific to vaccination
- Potentially changeable by vaccination programmes

BeSD are not distal influences:

Politics, literacy, education, social inequity, rurality, age, employment, insurance, etc., many of which will operate through BeSD. Exploring distal influences is possible using BeSD tools including in-depth interviews and incorporating survey items on demographics.

Incorporating end-user perspectives throughout the process

The end-users of the BeSD tools (primarily programmes, partners, civil society organizations, and researchers) have been central to the development of the tools from the outset. As a first step, we sought input from the envisaged end-users on the need and capacity for utilising the tools and their needed characteristics. In 2019, our team conducted 20 qualitative key informant interviews which purposively recruited individuals with regional and country-level roles responsible for immunization activities in Gavi-eligible and middle-income countries, as well as input from individuals with globally-focused roles within other health organizations.[4] Throughout the process, we have returned to the interview findings and sought ongoing feedback from end-users as we continued to develop and refine the tools (Figure 1.1). A summary of findings from the interviews is available in Annex B.

These interviews reinforced the need for the proposed tools. Participants described a wide variation in current measurements and systems in use, and an equally wide variation in resources and technical capabilities.[4] They affirmed a need for globally standardized tools for measuring the social and behavioural drivers of immunization. In describing the necessary attributes of the proposed tools, the stakeholders identified flexible standardization: They would like globally validated tools that can be adapted for cultural and contextual nuances. Furthermore, the BeSD tools would need to address three key areas for support: 1) Integration of the tools into existing systems and processes, 2) Easy or automated analyses of raw data and presentation of data for greatest impact, and 3) Clarity regarding

how to operationalise the data to inform decision-making and the design of interventions. Importantly, the interviews highlighted that to support these three key areas and for the tools to be widely embraced and adopted, user-friendly 'how-to' guidance should be developed (a summary of the development process and output is provided in Section 8). These end-user insights, coupled with continued discussions with countries and regional stakeholders have informed BeSD's aims, process, and outcomes.

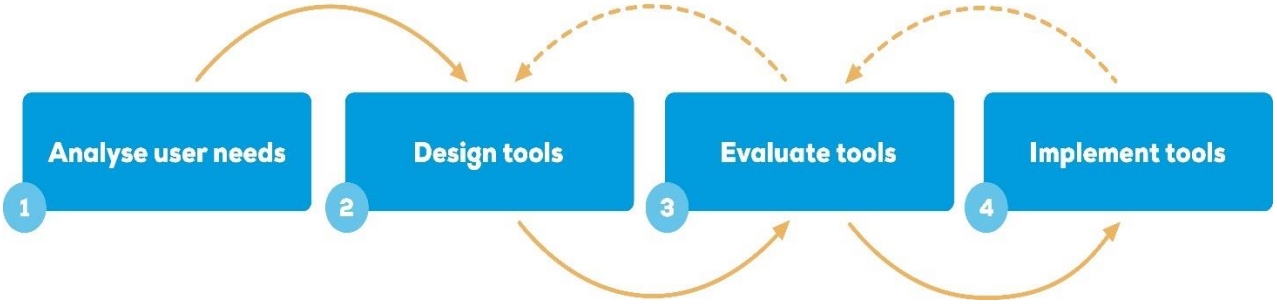

Figure 1.1. *A consultative process: End-users were engaged at every stage of tool development and feedback will continue to be gathered and used at key milestones in future.*

Adaptations for COVID-19 vaccine uptake

With the arrival of the COVID-19 pandemic in 2020 and the resulting development of COVID-19 vaccines, it became clear that immunization programmes and partners would need to be able to measure the behavioural and social drivers of COVID-19 vaccination to support and inform rapid vaccine deployment. In response, WHO established a new time-limited working group, the BeSD COVID-19 Working Group or "BeSD COVID-19", using the groundwork already completed for the BeSD childhood vaccination tools to underpin rapid development of COVID-19 vaccine-specific tools (Section 5 for more detail).

Process summary and outputs of the BeSD work

There were three iterative phases to develop the BeSD childhood and COVID-19 tools (summarised in Table 1.1). Note that many of the activities fed back to previous steps, e.g. insights from field testing helped to inform revisions to tools. These phases represent a methodological and data-driven process for tool development, informed by end-users, theoretically and pragmatically driven, and extensively field tested and validated.

Phase 1: Tool development

From the start of 2019, the BeSD group reviewed the literature, developed a **conceptual framework** informed by evidence and experience, and carried out **end-user interviews**.

First drafts of the childhood tools were developed in 2019: the survey and in-depth interview guides (Sections 3 and 4). In 2020, the COVID-19 vaccination tools were also developed: the survey and in-depth interview guides (Section 5). Initial work was completed in 2021 to explore the linkage of tool results to steps for intervening effectively to promote uptake.

Development of the **'Data for action' guidebook** was initiated in mid-2019 and continued to evolve iteratively throughout 2020, launching in February 2021 as a guidebook specific to COVID-19 vaccination. In mid-2021 the guidebook was broadened to represent all BeSD tools for childhood and COVID-19 vaccination (and to accommodate future vaccine-specific tools). This is detailed in Section 8.

Phase 2: Field testing in countries

The initial testing, translation and local adaptation of the tools includes related guides for recruitment, sampling, and translation, as well as training in research methods. The testing included cognitive interviewing for the surveys and user testing for in-depth interviews with further tool modification in iterative stages. This is detailed in Sections 3-5.

Phase 3: Psychometric validation and indicator selection

This involves the validation of the tools themselves and separate activities to gather feedback on the guidebook. A complete analysis was carried out to determine which combination of items best predict vaccine uptake. This has informed selection of a long- and short-subset of items measuring the behavioural and social drivers (Section 6).

Summary of outputs

Accordingly, the outputs of the BeSD working group detailed in this Background Paper are:

- **BeSD tools for childhood vaccination**
    - Childhood vaccination interview guides, for parents and caregivers, health workers, community stakeholders, and authorities across the health and immunization system (refer to Section 3 for more detail)
    - Childhood vaccination survey, for parents and caregivers of children under 5 years of age (refer to Section 4 for more detail)
- **BeSD tools for COVID-19 vaccination** (refer to Section 5 for more detail)
    - COVID-19 vaccination survey for adults
    - COVID-19 vaccination survey for health workers
    - COVID-19 vaccination interview guides for adults and health workers
- **Indicators for childhood and COVID-19 vaccination** to facilitate tracking of standardized trends and to contribute to the IA2030 and Gavi 5.0 strategy and updated WHO/UNICEF electronic Joint Reporting Form (eJRF) questions. (Refer to Section 6 for more details).
- **A list of interventions to consider for increasing uptake**, linked to the measurement domains. A scoping review provides a repository of interventions that have been systematically reviewed and assessed for quality. This is a first step towards further work (refer to Section 7 for details).
- **A 'data for action' guidebook**, to inform the local gathering, analysis and use of data, including integration of tools with existing data-collection processes, to guide planning (refer to Section 8 for details).
- **Planned support for implementation**, outlining a range of activities to support the use of the tools and guidance, e.g. modules for capacity-building, a community of practice, digital tools and templates to facilitate data-collection, a global BeSD dashboard, case examples, and coordinated technical assistance (refer to Section 9 for details).

Building on the tools for childhood and COVID-19 vaccination, plans have been made for development of BeSD tools for HPV and seasonal influenza vaccination in 2022.

Table 1.1. *BeSD tool development phases and corresponding outputs*

	Phase	Inputs and activities	Outputs
P1	Tool development	☑ Conceptual framework ☑ Constructs from the literature ☑ Key informant insights ☑ Qualitative interview questions ☑ Survey items from the literature ☑ Prioritized short list of survey items ☑ Socio-demographic survey items ☑ Survey intro and transition language ☑ Plan for translation	**Draft surveys** **Draft in-depth interview guides** **Outline of guidebook**
P2	Field testing	☑ Countries and languages selected ☑ Study protocol ☑ Participant recruitment in English ☑ Consent scripts in English **Cognitive interviewing for survey** ☑ Guide for cognitive interviews ☑ All data collection materials translated ☑ Spreadsheet with each item, results of cognitive interviews and proposed changes **Qualitative interview guide testing** ☑ Draft qualitative guides in English ☑ Interviewer debrief form	**Draft surveys updated, translated and back-translated** **Final qualitative interview guides** **First draft of guidebook**
P3	Survey psychometric validation and indicator selection	☑ Validation study protocol ☑ Survey with translations ☑ Data analysis plan	**Final survey** long form (14 items) short form (5 items) **Final draft guidebook**
P4	Finalisation of all tools and guidance	☑ **BeSD tools for childhood vaccination** (survey and interview guides) ☑ **BeSD tools for COVID-19 vaccination** (surveys and interview guides for adults and health workers) ☑ **Data for Action Guidebook**	**Final version of Data for Action Guidebook with all tools in annexes**

Consultations with IVIR-AC

At both the March and September 2019 meetings of the Immunization and Vaccine-related Implementation Research and Advisory Committee (IVIR-AC), the Committee was updated and consulted on the planned work. In March 2019, IVIR-AC were consulted on the terms of reference and plan of work. The committee provided inputs on the tool development process and lessons from other efforts to standardize global data collection.[20] Conclusions and recommendations were particularly useful for shaping how the tools and their delivery could account for global diversity, complexity and variability on reasons for under-vaccination by vaccine, location and time.

In September 2019, IVIR-AC was presented with an update on work in progress, the draft conceptual framework, findings from key informant interviews, and plans for testing and validation of the draft tools, including the criteria for selection of countries. IVIR-AC supported the approach and recommended testing of the tool in English-speaking countries first, to stabilise the questions before adaptation to other languages.[21] The committee recommended testing the tools both in countries with large numbers or large proportions of unvaccinated or under-vaccinated children, but also in countries with high coverage where vaccine hesitancy exists in sub-groups. The need for routine and periodic data collection with the eventual tools was also emphasized.

Section 2. Developing the BeSD framework

Summary: We developed a framework to identify critical behavioural and social drivers that influences uptake to support development of the BeSD tools. We reviewed existing theoretical models, published reviews of qualitative studies with caregivers on factors affecting uptake, and survey measures that could inform the development of new tools. The full working group built primarily on the Increasing Vaccination Model to create the BeSD framework, which includes four domains: 'thinking and feeling', 'social processes', 'motivation', and 'practical issues.' For each of these domains, we specified constructs and indicators that would provide countries with actionable information to inform their immunization programmes. We also standardized the definitions of key terms.

What are behavioural and social drivers?

Behavioural and social sciences have a rich tradition of theoretical models and frameworks and empirical work to understand health behaviours, including vaccination. A main focus of the BeSD group was to leverage these sciences to develop standard tools usable by vaccination programmes. **We conceptualize behavioural and social drivers as aspects about people and their circumstances that affect their vaccination behaviour – being vaccinated or taking one's child to be vaccinated.**

Development of the BeSD framework

From April to June 2019, the BeSD working group sought to develop a conceptual framework that would ground the structure of the BeSD tools. We considered available behavioural models and frameworks that have been applied to vaccination to identify reasons for under-vaccination. The main theoretical models examined were the COM-B model;[22] the 5 A's model;[23] 5 C's model;[24] the Gates/UNICEF's Caregiver Journey framework,[25] the Social Ecological Model,[26] and Brewer and colleagues' Increasing Vaccination Model (IVM).[9]

Most of the models and frameworks are not specific to vaccination behaviour or focused on confidence. We sought to identify relevant constructs from the ground-up. Therefore, we reviewed published qualitative and quantitative reviews of studies that identified barriers and facilitators to childhood vaccination. We grouped each barrier and facilitator under the six COM-B domains and then identified domains from each of the above frameworks and models (Annex A). In reviewing the existing surveys, we also identified a lack of conceptual clarity.[6]

During an in-person meeting at the WHO in Geneva in May 2019, the working group met to agree on the overall structure of the BeSD tools, the target audience for these tools, refine a conceptual framework with key constructs that should be included in the tools, and to guide tool development. The working group adapted a conceptual framework specific to vaccination that would set out the domains and eventual constructs for the measures to be developed (Figure 2.1). The framework was broadly informed by Brewer and colleagues' IVM.[9] This identifies "thoughts and feelings" and "social processes" as influencing behaviour directly. However, as a framework for measuring the drivers of vaccination, it needed to more fully incorporate the access, convenience, and physical opportunity barriers to vaccination. To do this, we renamed the IVM's "Direct behaviour change" to be "practical issues" and brought steps from the Journey to Vaccination model to inform the constructs therein.

The final framework has four domains: 1) Thinking and feeling, 2) Social processes, 3) Motivation, and 4) Practical issues. These largely follow the domains of the Increasing Vaccination Model. While motivation is part of the thinking and feeling domain of the IVM, we separated motivation to emphasise its importance as a facilitator or barrier to uptake and to locate where hesitancy is and is not. Namely, hesitancy is an intentional construct of being conflicted or opposed to getting vaccinated.

Each domain is conceptualized as follows:

- ***Thinking and feeling:*** Includes people's cognitive and emotional responses to the vaccine-preventable diseases and vaccine.
- ***Social processes:*** Includes people's experiences related to vaccination when interacting with others, including family friends, and their broader social network.
- ***Motivation***: Includes people's wanting the vaccine or willingness to get it (as well as hesitancy to get vaccinated).
- ***Practical issues*****:** Includes the experiences people have when trying to get vaccinated, e.g. related to accessing vaccination services.

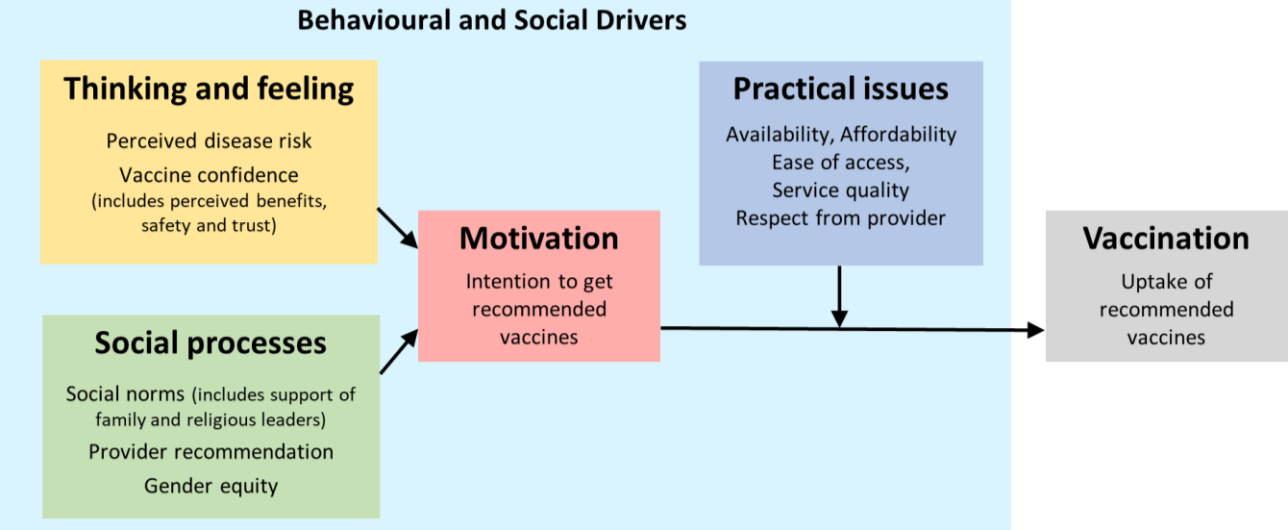

Figure 2.1. *The BeSD Framework: changeable influences on vaccination uptake*

Source: The BeSD expert working group. Based on: Brewer NT, Chapman GB, Rothman AJ, Leask J, and Kempe A (2017). Increasing vaccination: Putting psychological science into action. *Psychological Science for the Public Interest.* 18: 149-207.[9]

We acknowledge that these domains, while conceptually meaningful, do not offer a perfect place for some variables. For example, provider recommendation may operate through all of these domains, but we located it in the social processes domain given the large role of the interpersonal communication during vaccination visits. Examples of constructs that don't perfectly sit in a specific domain will be offered in the guidebook to improve clarity for end-users.

For each of the above four domains, we specified constructs from the literature and experience. Then for each construct, we specified indicators that would provide countries with actionable information (e.g., percentage of caregivers who do not have easy access to vaccination). We also prioritized constructs that would be meaningful across diverse contexts, consideration of issues that will become

important in the future, affordability and practical aspects for country use, ease of translation, among other considerations. We subsequently refined and modified the list of constructs iteratively based on continued expert discussion and input, including adding several new constructs.

The structure of the tools was also explored in relation to the BeSD framework, including how the qualitative and quantitative aspects of the tools might be deployed in given scenarios. We agreed that the mixed-methods approach enabled flexibility to do scoping or deep-dive investigations, in addition to routine data collection activities. This was also in-line with end-user's recommendations.

Throughout 2020 and 2021, the framework was further refined and discussed at length with global and regional programme partners (i.e., UNICEF, CDC, Gavi, BMGF), as well as WHO colleagues across relevant HQ departments and in Regional Offices. Feedback has helped to clarify that the framework is not an overarching theory of the broader complexity of systems and policy level influences. Rather, it represents the factors identified through a comprehensive process as being measurable in individuals, specific to vaccination, and changeable by vaccination programmes. While broader contextual or sociocultural and demographic factors are not directly measured in the surveys, the in-depth interview guides provide capacity to explore the interaction between these context and the specific vaccination factors represented in the Framework with caregivers, community representatives, health workers, and programme managers. This mixed-methods approach thus provides complementary insights.

Review of previous measures of vaccine confidence

We reviewed measures of childhood vaccination and their psychometric properties to identify constructs and potential items from previous scales to measure under-vaccination.[6] Many of the available measures focus on vaccine confidence. We conducted a critical literature review aimed at identifying a comprehensive set of key measures of childhood vaccine confidence.

The review[6] identified 14 confidence measures applicable to childhood vaccination in general, all published between 2010 and 2019. The measures were predominantly developed in high-income countries. We examined 1-5 constructs and included a mean of 12 items. Validation studies commonly examined factor structure, internal consistency reliability, and criterion-related validity. Fewer studies examined convergent and discriminant validity, test-retest reliability, or used cognitive interviewing. Most measures were developed and validated only in high-income countries. These findings highlight the need for a more expansive childhood vaccine measure validated for use in diverse global contexts that can provide comparable data over time.

Key definitions

The BeSD working group adapted and proposed definitions of key terms (shown in Table 2.1), also published in Shapiro *et al*.[6] Developers of previous vaccine measures have used conceptually overlapping terms such as attitudes, beliefs, confidence, hesitancy, and acceptance in ways that were often inconsistent and unclear. Clear conceptualization is critical to achieve meaningful measures.

Table 2.1. *Definitions of key terms used in vaccine confidence measures*

Term	Definition
Thinking and Feeling	
Disease risk appraisal	Thoughts and feelings about potential health problems caused by infectious agents. Includes perceived risk, worry, fear, and anticipated regret.
Confidence	Attitudes and beliefs that vaccines work, are safe, and are part of a trustworthy medical system[9]. Includes perceived importance and effectiveness of vaccines and concerns about vaccines being unsafe.
Motivation	
Hesitancy	Motivational state of being conflicted about, or opposed to, getting vaccinated; includes intentions and willingness.
Intention	Aim or plan to get vaccinated.
Behaviour	
Coverage	Estimated percentage of individuals who received specific vaccines. Low coverage reflects both individuals who will never be vaccinated and those for whom vaccination is delayed but eventually occurs.
Delay	Receiving a vaccination after the recommended age. Delay can be the result of a deliberate choice, passive inaction, or forces external to the individual, such as a vaccine shortage.
Refusal	Declining to receive a vaccine when offered.
Un-vaccinated	Has not received any of the recommended vaccines for their age. (For childhood vaccination, a common measure is "has not received a single dose of diphtheria, tetanus and pertussis-containing vaccine.")
Under-vaccinated	Has received some, but not all, of the recommended vaccines.
Uptake	Receipt of a vaccine.

Source: Shapiro et al. 2021.[6] Adapted from [9,27-29]

Section 3. Childhood vaccination interview guides

Summary: The BeSD childhood vaccination interview guides were developed by experienced qualitative and mixed methods researchers to understand the experience, perspective, and attitudes of four groups: a) caregivers of vaccine-eligible children, b) frontline health workers, c) community health advocates, and d) vaccination programme managers. The interview guides were field tested in nine LMICs and one high income country with the intended target participants. Testing examined the flow of questions, understandability, ease of delivery, and quality of produced data. The interview guides were reviewed and refined based on findings.

Development of the BeSD vaccination interview guides

Whether a child is vaccinated or not relies on a complex interaction of factors occurring at individual, interpersonal, community, institutional, and policy levels.[30] By using open-ended questions, qualitative methods account for this complexity, as well as the relationships between these levels. End-users had also recommended the use of such methods to allow for deep-dive investigations, in addition to routine data collection activities. Thus, to complement the survey tool, in-depth interview guides were developed for data collection.

Nine members of the working group with combined expertise in qualitative and mixed methods research and practical and programmatic experience developed the BeSD childhood vaccination interview guides. Guides were intended for use with: a) parents and caregivers of vaccine-eligible children; b) front line health workers; c) community health advocates; and, d) immunization programme managers at a national or sub-national level (summarised in Table 3.1). The BeSD group also had members with strong in-country experience, whose inputs as practitioners helped to guide development of the tools.

The childhood vaccination interview guides are generally incorporate the four domains of the BeSD Framework: Thinking and feeling, social processes, motivation, and practical issues. We drafted open-ended questions that would enhance flow (for the interviewee and the investigator) and could be easily adjusted to enable exploration of topics of interest in specific settings. In developing the interview guides, the group considered inputs from key informants (Annex B) on how such tools would be used and who would use them.

As a flexible method, the guides were developed for use either before the childhood vaccination survey as an exploratory approach to help identify areas of focus for the survey, or in parallel with / afterwards to enrich and contextualise survey findings.

***Table 3.1**. Elements covered in interview guides across groups**

Interview guide	Elements covered by the guide
Caregiver	• Background information on participant • Social processes and intention / readiness to vaccinate • Practical factors experienced by participant when accessing vaccination • Thinking and feelings about vaccination

Health Worker	• Details about the health worker's role and how it involves vaccination • Processes followed by health worker when vaccinating children • In their experience, what works and what is difficult in keeping families up to date with vaccines? • Thoughts on how vaccination services could be improved in their setting
Community Influencer	• Details of influencer's role and level of involvement in vaccination • Processes followed by influencer when working with families • In their experience, what works and what is difficult in keeping families up to date with vaccines in their area? • Thoughts on how vaccination services could be improved in their setting
Immunization Programme Manager	• Details about the manager's role and how much of their role involves vaccination-related work • *What do they find works well, and what doesn't work well in immunization provision in their area / jurisdiction?* • What they feel could improve the situation

** Note that these are suggested guides. As per accepted qualitative research practice, guides may be adapted to answer specific research questions or adapted to other groups of participants, e.g., teachers or adolescents.*

Field testing of the childhood vaccination interview guides

The interview guides were tested in several settings in 2021 (Table 3.2). The aim was to assess the guides with their intended target participants for flow, understandability, ease of delivery, and quality of data produced. Testing involved completion of a small number of interviews per guide in six countries with the target populations in each setting (approximately 160 interviews total) undertaken by local researchers. Interviewer feedback on the ease of use of the guide was captured via a standardised report form. The interview data and the interviewer report forms were analysed to assess the interview guides and subsequently adjust the guides as required.

Additionally, the pilot testing offered insight into how these guides will be adapted to suit the local needs, to contribute to shaping the 'Data for action guidebook'. This, along with findings from the needs assessment[4] and ongoing end-user feedback will inform technical support and associated qualitative research capacity-building in countries in future.

Table 3.2. *Pilot testing activities for the childhood vaccination interview guides*

Country	Guide tested (total interviews)	Work led by	Comments
Indonesia	Caregivers HW EPI manager Indonesia (n=57)	Universitas Indonesia	Lessons from use of tools noted and incorporated into development process
Sierra Leone	Caregiver (n=1)	BeSD team and Statistics SL	Lessons from use of tools noted and incorporated into development process. (Work in-country ended early due to COVID-19.)
Guatemala	Caregivers HW EPI manager Influencer (n=10)	Universidad del Valle de Guatemala and WHO Guatemala	Data analyses in progress, with learnings to inform future guidance for the subnational audience on adaption and translation of tools.

Angola DRC* Ethiopia India Nigeria Pakistan	Caregivers HW EPI manager Influencer (n=96)	Kantar Public**	Data incorporated into development process
Australia	Caregivers (n=7)	BeSD team	Data incorporated into development process

*DRC: Democratic Republic of Congo

** Kantar Public: A division of Kantar, a global market research company, specialised in public policy.

Section 4. Childhood vaccination survey

Summary: We developed survey items about the behavioural and social drivers of vaccination for parents of children under age 5. We then conducted cognitive interviews in 2 HICs and 8 LMICs to ensure that participants had the same understanding of the items as we intended. The final version of the survey is in Annex C.

Item development and refinement

Surveys enable quantitative measurement of the behavioural and social drivers of childhood vaccination and complement data from qualitative insights. Such data enable countries to identify the most prominent barriers to vaccination and prioritise actions to address them. The working group sought to develop and validate a single survey that could be used across multiple settings that measured the major drivers located within the framework. Figure 4.1 illustrates the different steps of item development, testing and validation, and the number of items at the end of each phase.

As a first step, we created potential survey items (i.e., questions and response options) in English linked to each of the proposed constructs. We included items from surveys on childhood vaccination in general from the published and grey literature (searched July-August 2019). We also reviewed the published literature for quantitative scales assessing relevant constructs, identified items from existing relevant survey instruments, and reviewed the grey literature including:

- Expanded Programme on Immunization (EPI) reviews – a systematic investigation of programme strengths and weaknesses
- Multiple Indicator Cluster Surveys (MICS)
- Demographic and Health Surveys (DHS)
- UNICEF/Gates Vaccine Caregiver Journey
- Missed Opportunities for Vaccination Strategy
- UNICEF/Harvard Opinion Research Program
- WHO/UNICEF electronic Joint Reporting Form (eJRF)

The search yielded about 259 items.

Next, we established criteria to guide item selection (Table 4.1). This included length, simplicity, readability, translatability, existing use, psychometrics, validity, and ceiling effects. Two members of the core BeSD group examined all potential items, and recommended prioritization of items for each construct based on these criteria (August 2019).

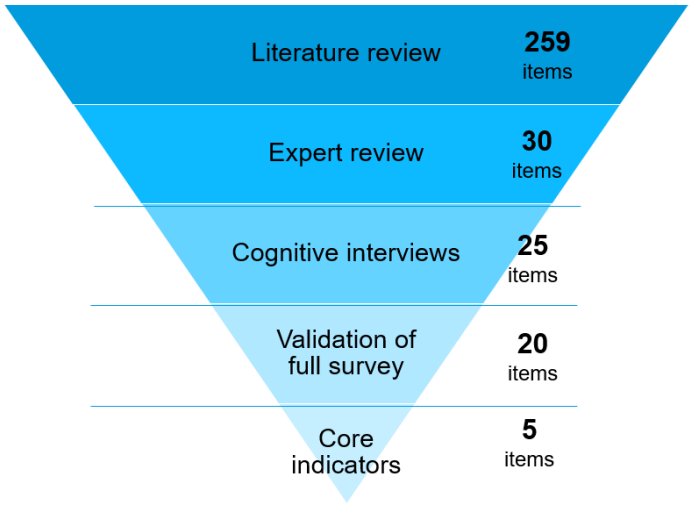

Figure 4.1. *Key stages in the childhood vaccination survey development and corresponding number of items.*

Input from the working group informed the selection and refinement of indicators, survey questions, and response scales through an iterative process of consensus. Four to six experts participated in three sub-groups (20 experts in total), with two members participating across all groups to ensure consistency in the process. Each of the sub-groups met on 3-4 occasions for 1.5 hours during August-October 2019.

The groups selected, adapted, or developed about 75 candidate items, which the full group then refined down to 40 items.

Table 4.1. *Criteria to guide item selection*

Consideration	Notes
Short length	Shorter items are easier to understand and less prone to variations in meaning
Tried and tested	If it has been used/validated in more than one LMIC and has undergone cognitive interviewing by a lead agency
Evaluative	More focused on evaluation of service, not reason for vaccination
Predictive validity	Known to be associated with coverage
Capacity to serve as key indicators for global strategies	For example, *Immunization Agenda 2030*, and Gavi 5.0 Strategy.
Applicable to multiple contexts	Not specific to a certain delivery setting – must be adaptable to multiple countries, cultures and contexts
Avoid hypothetical questions	More prone to social desirability and misunderstanding (abstract)
Avoid relying on subgroups to deliver	Questions based on actual service experience or reasons for under-vaccination need to be filtered
Simplicity of response options	Response options are easy to understand
Ease of translation	Can be easily translated to different languages
Low reading age	Short and simple sentences, use of active voice, words with the least number of syllables possible, etc. Question should not be cognitively demanding to read and understand.
Usability of insights/ programmatic perspective	Use for improving programming is important, with the caveat of making sure the questionnaire does not only function as a tool for program evaluation
Future perspective	To consider ongoing issues as well as anticipate future issues
Reduce ceiling effect and questions with psychometric flaws	Questions should be sensitive to the full range of opinions (from weak to strong endorsement)
Survey consistency	E.g., coding of all 'don't know/refused to answer' will be modified to be consistent in this survey

To further reduce the number of survey items, we invited working group members and regional UNICEF and WHO colleagues to complete an online survey to convey their feedback. These colleagues also forwarded the survey to colleagues and partners in priority countries. The survey sought feedback on the specific wording of items and to rank the items in terms of their prioritization on a 5-point response scale from 'Not at all' (coded as 1) to 'Extremely important' (coded as 5) for this item to be included in the childhood vaccination survey. We retained the most highly rated items (mean scores > 3.8), and four additional items with slightly lower scores (mean = 3.6 to 3.8) were also retained for further evaluation given WHO and partner priorities (see Supplementary Material). Using feedback on items gathered through the survey, the core group refined items to be included. For two survey items with equivocal feedback, we agreed to move alternative wordings forward for the next stage of cognitive interviewing.

We also selected demographic items, predominantly from the Multiple Indicator Cluster Surveys (MICS) and the WHO Missed Opportunities for Vaccination [31] Exit Survey,[32] to support our evaluation. These

demographic items will be available but not part of the official childhood vaccination survey. A draft-zero survey was developed for cognitive interviewing, the first stage of testing for the BeSD tools.

To illustrate the process, a sample of items, their mean expert priority rating and the proposed action is shown in Table 4.2. Note the items included are in the original form, prior to any refinement following cognitive interviews.

Table 4.2. *Example of item reduction resulting from the feedback survey*

Construct	Mean rating*	Proposed action	Original item
ITEMS RETAINED			
Knowledge	4.5	Retain.	Do you know where to go to get vaccines for your child?
Household decision making	4.4	Retain.	In your family, who has the final say about vaccinating your child?
Confidence - benefits	4.0	Retain.	How important are vaccines for your child's health?
Vaccination availability	3.8	Retain: Lower score but important implications for missed opportunities to vaccinate.	Have you ever been turned away by the vaccination clinic?
ITEMS REMOVED			
Time required for Vaccination	3.6	Remove: Low score, redundant	Does waiting at the vaccination clinic take too long?
Perceived risk	3.1	Remove: Low score, duplicative	How likely is it that unvaccinated children can get diseases that vaccines can prevent?

* Based on rankings from working group members; regional UNICEF and WHO staff; and colleagues and partners in priority countries.

The initial drafts of the survey were in English, as recommended by IVIR-AC during a session on acceptance and uptake in September 2019.[21] We then adapted the survey and tested it in other languages to de-centre the survey from English.

Cognitive interviews

Cognitive interviews are verbal probing techniques to identify the meaning that participants bring to survey items.[33] The interviews ensure that an item achieves its measurement purpose and elicits the meaning a respondent gives to an item and its response options. Cognitive interviews of the draft survey sought to determine comprehension of each question, retrieval from memory of relevant information; decision processes in answering the question; and response processes.[34] For cross-cultural surveys, cognitive interviews are a powerful tool for revealing how social, cultural and political contexts differentially affect responses to survey questions and how this can be minimised.[31]

An interviewer undertakes the cognitive interviews with a small sub-sample of participants using standardized questions for each survey question such as, "Could you tell me in your own words what this question was asking?"; "What were you thinking about when deciding your answer"; "What do the words [insert] mean to you?"; and, "Do the response options make sense?"

Cognitive interviews in the United States and Australia. To refine and stabilize an English version of the survey as recommended by IVIR-AC, we completed cognitive interviews with the draft-zero version in

Chapel Hill, North Carolina, USA (*n*=14, November 17-20, 2019) and in Sydney, Australia (*n*=9, December 12-18, 2019). In the USA, we used convenience sampling to identify parents with a child under 18 including a sub-sample of fathers (n=4) aiming for diversity in level of education. In Australia a market research agency recruited parents with a child under 5 including a sub-sample of fathers. Recruitment also sought diversity in education and cultural and linguistic group. All interviews were in English.

We made minor modifications to the survey to address any misinterpretations, verify that response options were clear and comprehensive, simplify or clarify language, and improve the flow of items. Further cognitive interviewing confirmed the utility of these changes.

Cognitive interviews in Sierra Leone. In an effort led by the Sierra Leone Ministry of Health and Sanitation (MoHS), we partnered with Statistics Sierra Leone (Stats SL), UNICEF and WHO country offices, to test the BeSD childhood vaccination tools in Sierra Leone (February 2020). English is the official language, but Krio (a derivative of English) is more commonly spoken. To support testing of the childhood vaccination survey and interview guides, Dr Kerrie Wiley and Francine Ganter-Restrepo undertook a field visit. They carried out briefings, trainings in conducting interviews, and developed adapted materials to enable country staff from Stats SL to carry out the cognitive interviews for testing of the survey, and to conduct qualitative interviews that would inform improvements of the interview guides.

The Ministry of Health selected clinics and pre-recruited parents for interviews based on the inclusion criteria (parents over the age of 18, with a child younger than age 5). Enumerators from Stats SL conducted interviews across two days, sampling from urban and rural areas was conducted opportunistically using the interview guides for parents and caregivers. At the start of day two partners and enumerators met to discuss cognitive interview insights from day one and recommend changes to be applied to the survey and tested on day two.

Cognitive interviews in Indonesia. Testing of the BeSD childhood vaccination tools in Indonesia was a stand-alone activity owned by the Ministry of Health in Indonesia and supported by WHO. Researchers from Universitas Indonesia tested the BeSD childhood vaccination tools in West Java, Indonesia, having translated them into Bahasa. The researchers translated the childhood vaccination survey and proposed adjustments to better match the local language. The cognitive interviews were completed in September 2020, with recruitment of parents to children under five years old taking place at two integrated health clinics in Depok City. The 28 cognitive interviews in Indonesia resulted in greater standardization of response options and some other small changes. These insights also helped Universitas Indonesia in their refinement of translations. Furthermore, the process of translation and local adaption offered important learnings to the BeSD group for how to support these processes and address them in the eventual BeSD 'Data for action guidebook'.

Refinement of tools based on cognitive interviews. Based on insights from cognitive interviews in the USA, Australia, Indonesia, and Sierra Leone, version 1.0 of the survey was completed.

Pandemic pivot. In November 2019, WHO HQ had approached WHO Regional Offices with details of the proposed activities and potential suggestions to guide the selection of countries, based on the pre-set criteria. Regional Office selected a country and facilitated introductions with the appropriate in-country WHO colleagues/partners. These activities were due to take place across Q1-Q3 of 2020. However, due to the COVID-19 pandemic, the process for testing of the tools in these countries was put on hold and the approach to in-country testing from March 2020 reconsidered to accommodate safe-guarding measures related to COVID-19.

Feedback on the translatability of concepts in the survey. The WHO and UNICEF Regional Offices and some Country Offices were re-engaged for feedback on the refined survey items (January - February 2020). Feedback was collected using a short online survey that was sent to colleagues based in Regional Offices, with a request to send onward to key Country Offices (surveys were anonymous unless the respondent provided details). Colleagues were invited to review each survey item to assess whether the item would translate adequately to the main language(s) in their country. Colleagues were also asked to indicate whether they would prioritise inclusion of items (response options: 'yes' or 'no') if conducting a survey to inform immunization programmes in their country or region. The rate of inclusion allowed the BeSD group to prioritise items and remove alternate versions of items that had been A/B tested (to compare two versions of a single item to determine which is more effective). This feedback was collated and addressed alongside insights and modifications resulting from cognitive interviews in Sierra Leone.

The working group also undertook a process of parallel translation using current recommended best practice.[35] The childhood vaccination survey was translated into all the UN languages (Arabic, Basic Chinese, English, French, Russian, Spanish) by two separate translators and any differences in the resulting translations were resolved via a discussion and process of agreement with the two translators and a BeSD core group member. To support this process the BeSD group drafted a set of item descriptions and rationales to briefly describe the meaning and purpose of each survey item and describing any more complex or critical concepts in an item (e.g., community, religious leader, decision-maker). All item-specific feedback was addressed by language and then across languages. A meeting with all translators across all languages was also held to inform broader revisions. The feedback included recommendations for revisions to the response options and simplification of terms. More broadly, the translators also suggested that the descriptions were very helpful and should be offered with the tools to support further localisation of the tools for other languages and dialects.

Refinement of the childhood vaccination survey following cognitive interviewing. To enable in-country field testing to proceed during the pandemic, Gavi engaged Kantar Public on the working group's behalf to evaluate the BeSD tools in Q1 of 2021. This included cognitive interviews in Angola, Democratic Republic of Congo (DRC), Ethiopia, India, Nigeria, and Pakistan. Kantar conducted cognitive interviews; two rounds of interviews with the target populations and using the templates offered by the working group for probing and reporting on cognitive interview results. The aggregate summary of results and recommendations for changes to the survey were shared with WHO and when considered along the other cognitive interview data (described above) informed key decisions for updates to the global survey. Section 6 reports on validation of the survey items for childhood vaccination and Covid-19 vaccination.

Learning from the testing process

To help illustrate the field-testing and validation process, Table 4.3 was developed to offer a snapshot of how a single question evolved through the testing process. It outlines each stage, the insights generated and corresponding revisions to the item.

Table 4.3. *Evolution of an item through the testing and validation process.*

Stage	Insights and changes	Item as it evolved
Item generation	This item was developed by the working group in an iterative process **to measure awareness of clinic place or time**. This was noted in previous work as being linked to Practical Knowledge and was important in other surveys.	**Do you feel you know where to go for vaccination?** Yes / No / Not sure

Expert review and ranking	The item was revised for shorter length and to clarify vaccination of the *child*. Response options were selected for simplicity. When experts were surveyed on the item, it tied for first place as a necessary item.	**Do you know where to go <u>to get vaccines</u> <u>for your child</u>?** Yes / No / Not sure
Cognitive interviews in English	Cognitive interviews were conducted in English in North Carolina (USA), Sydney (Australia), and Freetown (Sierra Leone). No changes were made to the question wording as the item was well understood and response options worked well. The "not sure" response option was dropped as this was deemed to be a "no".	**Do you feel you know where to go to get <u>your child vaccinated</u>?** Yes / No
Parallel translations	The item was translated into UN languages (Arabic, basic Chinese, French, Russian, Spanish, Russian) and Portuguese through a process of parallel translation. In this process we learned the item translated well into other languages and no revisions were made.	**Do you feel you know where to go to get your child vaccinated?** Yes / No
Cognitive interviews in multiple languages	In testing, the 'your child' wording did not work well throughout the survey, but otherwise the item was clear. Testing revealed that that interviewers should be trained to code 'No' for equivocal response answers such as "don't know" and "unsure". The order of "yes" and "no" response options were flipped to match the direction of other survey items and reduce social desirability bias when answering this question.	**Do you feel you know where to go to get your child vaccinated?** No / Yes
Psychometric validation	The item performed well in the validation. It was closely related to other items that measure "Familiarity with vaccination services" and remained stable across setting and demographics It also predicted uptake. The item was included in the final BeSD survey for childhood vaccination.	

Section 5. COVID-19 vaccination surveys and in-depth interview guide development

Summary: With the advent of the COVID-19 pandemic, the BeSD COVID-19 Working Group (BeSD COVID) adapted the BeSD tools in late 2020 to respond to countries' requests for tools to understand the drivers of COVID-19 vaccination. We reviewed available literature, identified new constructs for inclusion, drafted and refined survey items, and developed qualitative interview guides. The survey and interview guides were tested and validated in conjunction with the childhood vaccination tools through 2021. The final version of the COVID-19 vaccination survey is in Annex D.

Adaptation and development

The development, licensing and procurement of vaccines to prevent COVID-19 led countries to request tools to understand the drivers of COVID-19 immunization. Therefore, in July 2020, a new time-limited BeSD sub-group was established, the BeSD COVID-19 Working Group or "BeSD COVID-19". This group served a dual role as a sub-group of the demand workstream of the ACT-Accelerator's Country Readiness and Delivery group. It included members of the existing working group together with new members who brought relevant expertise in adult vaccination and LMICs. Members included representatives from vaccination programmes, implementing partners, and social and behavioural science, also covering a diverse range of geographies.

This new working group was tasked with adapting the existing BeSD tools for national immunization programmes and partners to measure and understand the behavioural and social drivers of COVID-19 vaccination, with a focus on LMICs. The overall aim of this group was similar to the original BeSD group focused on childhood vaccination. This intensive effort is coordinated with other activities stemming ACT-Accelerator groups focused on country readiness and delivery of COVID-19 vaccines.

The quantitative surveys and qualitative interview guides developed as part of the BeSD COVID-19 vaccination tools were targeted at populations most likely to be prioritized for vaccination, based on the SAGE roadmap; 1) Adults with chronic illness or aged 65+, and 2) Health workers closely involved in the pandemic response.

In developing the BeSD COVID-19 tools, the working group drew from existing BeSD childhood vaccination tools with respect to the framework and types of tools (survey and interview guides) and many of the domains with additional ones pertinent to adult and health worker vaccination.

Literature review

To inform the expansion of the existing tools to adults and health workers, we reviewed the literature to identify available measures of COVID-19 and COVID-19 vaccine attitudes and behaviours. Our search included both published and pre-print literature sought through the working group network. Many constructs identified overlapped with existing constructs in the BeSD framework. However, new constructs were identified such as "trust in a new vaccine". We also reviewed the Ebola vaccination literature to identify drivers of novel vaccine uptake during an outbreak, and existing measures. The Ebola vaccination literature was helpful to identify drivers for novel vaccine uptake among health workers and frontline responders such as "perceived risk [of infection] to patients" and "perceived risk [of infection] to family and close friends". The group returned to the literature throughout the item

refinement process and drew on expert consultation within and outside the group iteratively to ensure adequate expansion of the existing BeSD tools.

Working group contributions and outputs

Consultation within the BeSD COVID-19 working group was achieved in 6 group teleconferences of 8 hours total. During these group calls, members reviewed the existing BeSD CI tools to identify the concepts and constructs from the BeSD Framework that could be extended to the BeSD COVID-19 tools and identify any gaps. Specifically, the group considered the constructs that were relevant to adult and health worker vaccination and highly correlated with vaccine behaviour based on the existing literature. A key consideration was for the dual role of health workers as both likely priority recipients of COVID-19 vaccines and in providing information and recommendations for COVID-19 vaccination to other adults. In addition to the teleconferences, two group voting exercises were also carried out to secure inputs, and experts and the secretariat closely involved also carried out extensive preparation throughout the process.

The working group was divided into three smaller groups of five participants each, where each subgroup was responsible reviewing and refining items under a domain, with one group responsible for items under both social processes and motivation. Items were reviewed and iteratively refined over a succession of two 90-minute teleconferences, and subgroups rotated domains to ensure alignment and a range of expertise was applied across the entire surveys. An additional 90-minute teleconference was scheduled with one subgroup to address unresolved items (where questions about the item wording were outstanding).

The group determined that the existing four BeSD domains (1. Thinking and Feeling, 2. Social Processes, 3. Motivation, 4. Practical Issues) should be maintained for adult and health worker vaccination and expanded the framework by introducing several new constructs based on the findings of the literature review and expert consultation (Figure 5.1).

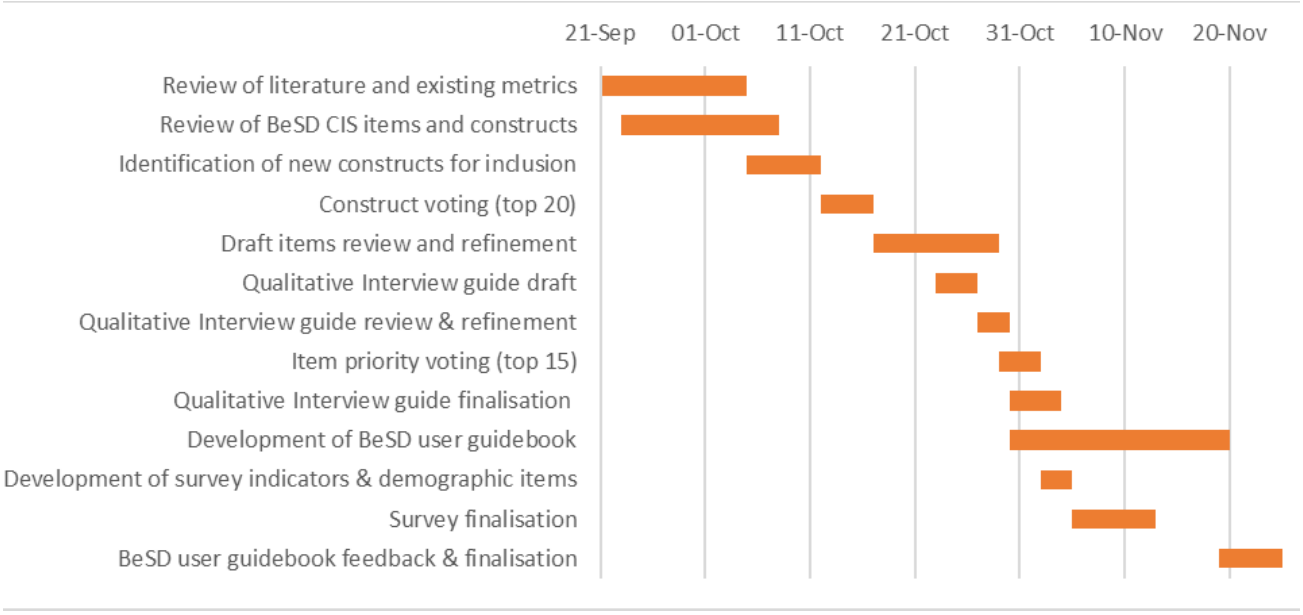

Figure 5.1. *Overview of BeSD COVID-19 activities and progress*

Development of the BeSD COVID-19 vaccination in-depth interview guides

The COVID-specific qualitative interview guides were drafted by two members of the working group with expertise in qualitative research methods and reviewed by the remaining seven members of the working group who had developed the childhood vaccination interview guides. The same process was employed, whereby open-ended questions covering the same subject matter as the domains of the BeSD COVID-19 vaccination surveys were crafted in a way to facilitate easily gathered, good quality data from vaccine-eligible adults and health workers.

Given the limited time available and that the COVID-19 interview guides were very similar in structure and function to the childhood immunization interview guides for which field testing was already underway, insights from the field testing of the childhood interview guides would be applied to the COVID-19 interview guides, as required. In the development of the COVID-19 interview guides we applied lessons from early testing of the childhood vaccination interview guides and developed a "menu" of interview question options for researchers to choose from depending on their needs. While the COVID-19 interview guides cover the broad spectrum of constructs to explore, the guidance offered with the tool makes clear that in designing the research protocol, users should selectively choose questions based on the context and research needs.

COVID-19 vaccination surveys

A subset of the BeSD COVID-19 sub-group that had been closely involved in the BeSD childhood vaccination tools reviewed the childhood vaccination survey and drafted revised items based on the survey for the COVID-19 vaccination survey target respondents' groups: 1) adults with chronic illness or aged 65+, and 2) health workers. These draft items facilitated the working groups review of the BeSD Framework and constructs for the COVID-19 vaccination surveys, resulting in the identification of new constructs to adequately assess the drivers of vaccination for the target populations, particularly in the "thinking and feeling" domain. To prioritise which constructs to take forward for the next stage of work, item development and refinement, members of the working group were asked to examine the twenty-three potential "thinking and feeling" constructs and select just eight for prioritization. This prioritization exercise resulted in a total of twelve "thinking and feeling" constructs that the group took forward for item development and refinement.

With a selection of 38 priority constructs across the four domains, the BeSD COVID-19 vaccination working group proceeded to review and refine the corresponding items. The working group was divided into three smaller groups of five participants each, where each subgroup was responsible for reviewing and refining items under a domain, with one group responsible for items under both social processes and motivation. Items were reviewed and iteratively refined over a succession of two 90-minute teleconferences, and subgroups rotated domains to ensure alignment and a range of expertise was applied across the entire surveys. An additional 90-minute teleconference was scheduled with one subgroup to address unresolved items (where questions about the item wording were outstanding). Throughout the process of item refinement, the working group was able to determine additional eight items for removal where concepts overlapped across constructs, resulting in a total of 30 constructs and corresponding items to be considered for final inclusion.

The working group was asked to review the 30 constructs and corresponding items and consider just 15 items for adults, and 15 items for health workers that should be prioritised for the final surveys. This final prioritization exercise resulted in a total of survey length of 21 constructs/items that apply to adults, and up to 28 BeSD items can apply for respondents who are health workers. In addition to these items, two three members of the BeSD COVID-19 vaccination sub-group that had been closely involved in the BeSD childhood vaccination tools also selected demographic items, predominantly from the MICS

and the survey tool for behavioural insights on COVID-19 from the WHO Regional Office for Europe, [14] to support minimum demographic requirements for using the BeSD COVID-19 surveys. These demographic items will be available but are not considered to be official BeSD items.

Applying learnings from early implementation of the childhood vaccination survey across different countries, the COVID-19 vaccination tools also offer a rationale and brief item descriptions to support translations and local adaption of the items. These recommendations include guidance on how to adapt specific items, which are currently focussed on a future COVID-19 vaccine, once a COVID-19 vaccine becomes available in the country.

Publication and subsequent updates

Given the urgent needs associated with the rollout of COVID-19 vaccines, the first version of the COVID-19 survey and interview guides was published in January 2021 under the title '*Data for action: achieving high uptake of COVID-19 vaccines*' (Figure 5.2)[36] publication made available untested versions of the tools, however as described above, were aligned with the evidence and expertise that contributed to the development of the childhood immunization tools.

Then in early April 2021, an updated version was published, reflecting the evolving context and new availability and approval of COVID-19 vaccines globally. Further guidance was included on how to adapt the tools if no COVID-19 vaccines were yet available in country, or where more than one COVID-19 vaccine might be available. These revisions were reviewed alongside recommendations from Kantar Public for adaptation of the surveys based on the summary cognitive interviewing results of the original draft.

Figure 5.2. *Data for action – achieving high uptake of COVID-19 vaccines*

New items were also added to probe for COVID-19 vaccination status, reminders and completion. All changes were discussed with the expert group and final wordings were reached on group consensus drawing on expert input and feedback from members who had experiences of implementing the tools and guidance. Section 6 reports on validation of the survey items for childhood vaccination and COVID-19 vaccination.

Section 6. Survey validation and item selection

Summary: This section presents the validation of the BeSD vaccination surveys. Conducted in six LMICs, this research established the psychometric properties of candidate survey items and led to the selection of the final versions of the surveys. Finally, this section presents the proposed core indicators to be used for countries to report findings from the BeSD surveys, together with the associated analysis.

We sought to validate the BeSD surveys[37] that cover three areas: Childhood vaccination, COVID-19 vaccine for adults, and COVID-19 vaccine for health workers. We used the previously developed banks of items (See Sections 4 and 5) in online surveys in six LMICs. Gavi supported the surveys in partnership with local immunization programmes and Kantar Public. Survey validation aims to identify strong survey items usable with diverse populations. Our validation approach was to identify items that scored well on three quality indicators in psychometric analyses: 1) predicts past vaccination, 2) low overlap with other items, and 3) item stability across subgroups.

Psychometric validation of childhood vaccination survey

For the childhood vaccination survey validation, Kantar recruited a representative sample of 1,819 parents or caregivers for children ages 0-4 from Angola (*n*=300), DRC (*n* =309), Ethiopia (*n* =301), India (*n* =305), Nigeria (*n*=300), and Pakistan (*n* =304). Overall, 22% of respondents had attained lower secondary school education or less, 35% upper secondary school education, 42% more than upper secondary education. The majority were female (56%). Most respondents (71%) indicated that their children had all recommended immunizations; 26% said some, and 3% said none.

Methods. The survey had 20 items. Annex F reports more of the methodological details. We used the following three quality criteria for selecting survey items:

Overlap and information. We examined which items were more informative. One part was identifying item overlap using exploratory factor analyses that found 6 meaningful factors (A through F, see Table 1 note). We preferred items with highest loading on a factor, but not other items loading on the same factor. Another part examined the information curves for each item to avoid floor and ceiling effects. These curves tell how much information items give, with higher curves across the full range of responding being more desirable.

Stable. Second, we examined which items had stable functioning across different countries, education levels, and respondent gender.

Predicts vaccination. Third, we examined whether the items were associated with receipt of childhood vaccines, defined as receipt of all recommended vaccines.

We used a stratified random sampling approach to randomly select two thirds of participants within each country to serve as the data exploration sample for these quality analyses. Using these criteria, we chose core items, the main survey, and some optional items. We then used the remaining third of the sample to characterize whether each of the three sets of survey items added predictive value.

Findings.
The psychometric validation findings are summarized in Table 6.1.

Most of the Thinking and Feeling items loaded onto a vaccine confidence factor (Factor A). All but the trust item were stable across subgroups, and all predicted vaccine uptake. We prioritized Item 1, on vaccine importance, as core because it had strong metrics and it is widely used globally. While we preferred to drop Item 3, on trust, because it did poorly on all metrics, many partners ask for such an item; thus, we made it an optional supplementary item. We opted to drop Item 2, on vaccination protecting others, because of the overlap with the other items.

Table 6.1. *Validation of the childhood vaccination survey*

Construct	Information	Stable	Predicts uptake (*r*)	Use in survey	Notes
Thinking and Feeling					
1. Vaccines are important	A		.27	✪	
2. Vaccination protects others	A		.24		Overlap
3. Vaccines are safe	A		.16	●	
4. Trust providers who give vacc	A C		.11	○	Low quality
Motivations					
5. Wants child to get vaccines	A F		.52	✪	
6. Willing for child to get vaccines	A F		.21		Overlap
Social Processes					
7. Other parents get children vacc	F		.22	●	
8. Family and friends want vacc	E F		.24	✪	
9. Religious leaders want vacc	E		-.05	○	Low quality
10. Community leaders want vacc	E		-.01	●	
11. Provider recommendation	-		.12	●	
12. Mother decides about vacc	B D		.08		Low quality
13. Mother needs permission	-		.18	○	Limited use
Practical Issues					
14. Know where to get child vacc	B		.32	✪	
15. Took child to get vacc	B		.21	●	
16. Easy to get child vacc	C		.18	●	
17. Easy to pay for child vacc	C		.30	✪	
18. Vaccine concerns not addressed	D		.12	●	
19. Turned away for vacc	D		.22	●	
20. Heard anything bad about vacc	D		.06		Low quality

Note. Darker green shading shows higher quality.

● Main survey item. ✪ = Core item in main survey. ○ = Optional item.

"Information" column shows factors (A-F) that the items loaded on, with darker shading for items with higher information curves. Factor A = Confidence, B = Familiarity with vaccination services, C = Access, D = Negativity, E = Community norms, F = Family norms.

"Stable" column shows whether participants' use of item was stable across subgroups (respondent country, education, and gender), based on differential item functioning.

"Predicts uptake" column shows correlation of item with uptake of all childhood vaccines.

"Notes" column reports reasons for items being optional or dropped. We designated Item 13 as "limited use" because it is usable in a relatively small number of countries.

The Motivation items had low loadings that were split across two factors, confidence and family norms (Factors A and F). Item 5, on wanting the child to get vaccinated, was the strongest correlate of uptake, and did adequately on other metrics; thus, we prioritized it as core. We dropped Item 6, on willingness based on overlap.

Many of the Social Processes items loaded onto two factors about family and community norms (Factors E and F). We prioritized Item 8, on family and friend norms, as core because it performed well on all metrics. We prioritized Item 11, on provider recommendation, as core because it performed well on the metrics and is a strong correlate of vaccination in many previous studies. While we preferred to drop two other items (Item 9, on injunctive norms from religious leaders, and Item 12, on gender equity/needing permission to leave the house) that they did poorly on the metrics, some partners ask for such items; thus, we made them optional supplementary items. We opted to drop the gender equity item on mothers deciding about vaccination because it performed poorly on all metrics.

Practical Issues items loaded onto factors related to familiarity with vaccination services, ease of accessing, and negative experiences (Factors B, C, and D). We prioritized Items 14 and 17 (on knowing whether to get a child vaccinated and ease of paying for vaccination) as core because they had the second strongest correlations with uptake and performed adequately on other metrics. We dropped Item 20 on misinformation as it performed poorly on the metrics.

Discussion. **The psychometric analyses yielded a 13-item survey** that efficiently assesses all BeSD domains. The items emphasize the practical issues that families and immunization programmes face. They also address the social experiences that shape vaccination behaviour. The 5 core items serve as a minimum that countries should assess – they efficiently address all BeSD domains.

The final core items appear in Table 6.2 along with indicators countries can use to report their findings. For the other survey items, indicators for reporting are available and will be indicated when all final tools are published. Future work on the childhood vaccination survey should consider whether to develop more effective items for gender equity, altruism, and misinformation. Recent studies show differences in vaccination coverage between men and women (few data are available on non-binary people). Gender equity is an important topic in Gavi 5.0 and IA2030. Thus, country surveys should assess gender and may wish to develop ad hoc items on gender equity that are relevant to the local context.

Table 6.2. *Childhood vaccination survey core items and indicators*

Domain	Construct	Question and response options	Indicator for reporting findings
Thinking and feeling	Confidence in vaccine benefits	How important do you think vaccines are for your child's health? Would you say… - Not at all important - A little important - Moderately important - Very important	% of parents who think that vaccines are "moderately" or "very" important for their child's health
Motivation	Intention to get child vaccinated	[COUNTRY NAME] has a schedule of recommended vaccines for children. Do you want your child to get none of these vaccines, some of these vaccines, or all of these vaccines?	% of parents who want their child to get "all" of the recommended vaccines

		- None - Some - All	
Social processes	Family norms	Do you think most of your close family and friends want you to get your child vaccinated? - No - Yes	% of parents who think most of their close family and friends want their child to be vaccinated
Practical issues	Know where to get child vaccination	Do you know where to go to get your child vaccinated? - No - Yes	% of parents who know where to get their child vaccinated
Practical issues	Affordability	How easy is it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, plus the cost of taking time away from work. Would you say… - Not at all easy - A little easy - Moderately easy - Very easy	% of parents who say vaccination is "moderately" or "very" easy to pay for

Validation of COVID-19 vaccination survey for adults and health workers

We started with the childhood vaccination survey structure and examined whether it also worked for the COVID-19 vaccination survey for adults and health workers. The general sampling approach was the same as for the childhood vaccination survey. In the same six LMICs, we surveyed 1,875 adults who did not work in healthcare and 1,817 health workers. Male respondents made up 61% of the adult sample and 55% of the health worker sample. Among health workers, 69% had received at least one dose of COVID-19 vaccine, 20% were unvaccinated and intended to be vaccinated, and 11% were unvaccinated with no intentions to be vaccinated. Among other adults, 35% were vaccinated, 43% were unvaccinated and intended to be vaccinated, and 22% were unvaccinated with no intentions to be vaccinated.

Methods and findings. The adult survey had 31 items, and the health worker survey had 34 items. The detailed validation methods and findings appear in Annex G. We used the same analytic procedure, replacing the exploratory factor analysis with a confirmatory analysis and using the full sample in all analyses. The main target for predictive validity was vaccination intentions because some respondents may not have had full access to COVID-19 vaccination. Generally, the same items that performed well in the childhood surveys performed will in the COVID-19 surveys as shown in Table 6.3. Thus, we prioritized item selection to align with the childhood vaccination survey. We present the current form of the COVID-19 surveys in Table 6.4, however there may be final refinements in coming months.

The core items represent the same constructs as in the childhood survey. The main survey items are somewhat fewer in number. Users of the COVID-19 surveys should consider whether to add adapted versions of items from the childhood survey: provider recommendation, vaccine concerns not addressed, and being turned away for vaccination. These items were not included in this study because COVID-19 vaccine introduction in these countries at the time of our planning meant that the items were not yet fully relevant given the context.

We shifted Item 9, on religious leaders supporting the vaccine, from optional in childhood survey to being in the main survey here because the item performed much better. We included as optional Item 21, concern about getting COVID-19, because we expect substantial demand for a survey item on this construct. The two gender equity items again performed poorly (e.g., no association with intentions), so we did not include them in our summary here. The survey also included several items particular to healthcare providers that users may wish to consider adopting (e.g., vaccine is available at work).

Table 6.3. *Validation of the COVID-19 vaccination survey for adults and health workers*

Construct	Information	Stable	Predicts intentions (*r*)	Use in survey	Notes
Thoughts and feelings, Motivation					
21. Concerned about getting COVID-19			.10	○	
1. Vaccines are important	A		.62	✪	
22. Vacc will allow you to see people	A		.70	●	
2. Vaccination protects others	A		.50		Overlap
3. Vaccines are safe	A		.65	●	
23. Vaccines cause serious reactions	A		.27		Low quality
4. Trust providers who give vacc	A		.60	○	
24. Trust authorities who give info	A		.62		Overlap
20. Heard anything bad about vacc	A		.43		Low quality
5. Wants to get vaccine	A		[1.00]	✪	
6. Willing to get vaccine	A		.92		Overlap
Social Processes					
7. Other people will get the vacc	B		.60	●	
8. Family and friends want vacc	A B		.72	✪	
9. Religious leaders want vacc	B		.43	●	
10. Community leaders want vacc	B		.38	●	
Practical Issues					
14. Know where to get vacc	C		.38	✪	
16. Easy to get vacc	C		.21	●	
17. Easy to pay for vacc	C		.19	✪	
25. Contacted about being due for vacc	B C		.33	●	
26. Contacted about missed vacc	C		.29	○	

Note. All items about vacc were about COVID-19 vaccines. Darker green shading shows higher quality.

● Main survey item. ✪ = Core item in main survey. ○ = Optional item.

"Information" column shows factors (A-C) that the items loaded on, with darker shading for items with higher information curves. Factor A = Thoughts and Feelings/Motivation, B = Social Processes, C = Practical issues.

"Stable" column shows whether participants' use of item was stable across subgroups (respondent country, being a health worker, and gender), based on differential item functioning.

"Predicts uptake" column shows correlation of item with intention to receive a Covid-19 vaccine.

One notable difference from the childhood vaccination survey is that most items differed in their functioning by country. The item functioning was also very different between health workers and other adults.

Discussion. The extension of the childhood vaccination survey to COVID-19 vaccination for adults and health workers was very effective. The same core items were useful, and the main survey has

substantial overlap. The religious leader norms item performed much better in this context so shifted from optional to a main survey item. As we were only able to correlate items with vaccine intentions, further evaluation should determine the association with vaccine uptake.

Table 6.4. *COVID-19 vaccination survey core items and indicators*

Domain	Construct	Question and response options	Indicator for reporting findings
Thinking and feeling	Confidence in COVID-19 vaccine benefits	How important do you think getting a COVID-19 vaccine will be for your health? Would you say… - Not at all important - A little important - Moderately important - Very important	% of adults / health workers who think a COVID-19 vaccine is "moderately or "very" important for their health
Motivation	Intention to get vaccinated	If a COVID-19 vaccine is available to you, will you get it? - No - Yes - Not sure	% of adults / health workers who will get a COVID-19 vaccine if it is available to them
Social processes	Family norms	Do you think most of your close family and friends would want you to get a COVID-19 vaccine? - No - Yes	% of adults / health worker who think most of their close family and friends would want them to get a COVID-19 vaccine
Practical issues	Know where to get vaccination	Do you know where to go to get a COVID-19 vaccine for yourself? - No - Yes	% of adults / health workers who know where to get a COVID-19 vaccine for themselves
Practical issues	Affordability	How easy is it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, plus the cost of taking time away from work. Would you say… - Not at all easy - A little easy - Moderately easy - Very easy	% of adults / health workers who say vaccination is "not at all" or "a little" easy to pay

Next steps for development and refinement of tools

The BeSD surveys are parsimonious tools usable in LMICs. They translated well into local languages and met the quality criteria that we established. They offer vaccination programmes brief, standardized surveys usable with minimal additional formative work. The surveys also provide a first opportunity for standardized data reporting to WHO to support multi-country comparisons and tracking of trends over time. As we identify a need for surveys in other areas, we will continue to expand the BeSD survey tools. At present, we have requests for surveys related to HPV vaccination in adolescents and seasonal influenza vaccination in older adults.

Tables 6.5 and 6.6 provide a summary of all constructs measured.

Summary tables listing all constructs measured

The following tables illustrate all constructs measured for both the childhood vaccination and COVID-19 vaccination tools.

Table 6.5. *Constructs measured in the childhood vaccination survey*

Thinking and feeling	Motivation	Social processes	Practical issues	Demographics
✪ Confidence in vaccine benefits	✪ Intention to get child vaccinated	✪ Family norms	✪ Know where to get vaccination	Gender
● Confidence in vaccine safety		● Provider recommendation	✪ Affordability	Age
○ Confidence in providers		● Descriptive social norms	● Took child for vaccination	Caregiver to child(ren) under 5 years old
		● Community leader norms	● Missed or delayed vaccine	Relationship to child
		○ Religious leader norms	● Ease of access	Child age
		○ Mother's travel autonomy	● Reasons for low ease of access	Child gender
			● Vaccination availability	Child vaccination status
			● Service satisfaction	
			● Service quality	
			● Information needs	

● Main survey item.
✪ Core item in main survey.
○ Optional item.

Table 6.6. *Constructs measured in the COVID-19 vaccination survey*

Thinking and feeling	Motivation	Social processes	Practical issues	Demographics
✪ Confidence in COVID-19 vaccine benefits	✪ Intention to get vaccinated	✪ Family norms	✪ Know where to get vaccination	Age
● Perceived risk - friends and family	● Vaccine confidence - brand	● *COVID-19 stigma	✪ Affordability	Gender
● *Perceived risk - patients	● *Willingness to recommend vaccine to others	● Gender equity - decision autonomy	● Past vaccination	Occupation
● Confidence in COVID-19 vaccine safety		● Gender equity - travel autonomy	● COVID-19 vaccine uptake	*Health worker role
● *Ability to answer patient questions		● Descriptive social norms	● Ease of access	COVID-19 risk
○ Perceived risk – self		● Religious leader norms	● Reasons for low ease of access	COVID-19 diagnosis
○ Confidence in providers		● Community leader norms	● Service satisfaction	
		● *Workplace norms	● Service quality	
			● On-site vaccination	
			○ Preferred site for vaccination	
			○ Reminder	
			○ Recall	

● Main survey item.
✪ Core item in main survey.
○ Optional item.

*Construct applies to health workers only

Section 7. Scoping review of interventions to increase uptake

Summary: This section presents initial findings on reviews of interventions to increase vaccination uptake. The number of reviews has accelerated, creating a problem for vaccination programmes to stay up to date. Of the reviews now available to programmes, few directly address LMICs settings and needs. In addition, a taxonomy of intervention types is needed to support ongoing syntheses of this literature.

Existing reviews

A substantial body of work has reviewed evidence on interventions to increase vaccination uptake. Some of the best-known reviews are by CDC's Community Guide to Preventive Services that periodically conducts and updates systematic reviews of vaccine uptake interventions.[38] Their reviews offer a summary judgement of whether evidence is strong enough to recommend an intervention and, when possible, estimate an effect size, evidence quality, and costs. For example, they found that cash payments to patients and parents are effective in increasing vaccine uptake by 8 percentage points and recommend such incentives as a best practice.[39] The Community Guide vaccination reviews were last updated in 2015 and 2016.

Other groups have taken a decentralized approach. For example, the Cochrane Collaborative has published several relevant reviews in the last decade on topics identified by individual researchers and research groups. Cochrane reviews, which go into detail about the strengths and weaknesses of study findings, are known for using rigorous methods for searching and summarizing literatures. The findings can also be difficult for many practitioners to use, particularly with more complex behavioural interventions where there is substantial heterogeneity of interventions and outcomes. There is also a dearth of evidence from LMICs. Efforts are underway to map these evidence gaps from 3ie[40] and separately by Yale Institute for Global Health to undertake a global systematic review of published intervention literature for behavioural insights interventions.

As the working group prepared a rubric for helping vaccination programmes turn BeSD data to action, a few questions came up. One was, "What works?" Another was, "How can practitioners stay current on what works?" And finally, "How can practitioners pivot from BeSD data to selecting interventions?" To establish a basis for answering these questions, we sought to comprehensively identify all existing reviews and systematically document their strengths and weaknesses. This work presents a foundation for integrating existing and future work.

Scoping review of reviews

We commissioned a scoping review of existing systematic reviews and meta-analyses of interventional studies to increase vaccine uptake, led by experts at the Centre for Evidence-Based Medicine, at the University of Oxford, UK. The registered review focused on pre-specified interventions (any intervention designed to increase vaccination uptake); outcomes (vaccine uptake, hesitancy, disease risk appraisal, confidence, social norms, provider recommendation, and availability); and populations (children, adolescents, adults, and older adults ages 65+).

Methods. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[41] We searched the following electronic databases: Cochrane Database of Systematic Reviews, EMBASE, Epistemonikos, Google Scholar, LILACs, MEDLINE, and TRIP database

(which covers guidelines and the grey literature) from 01 Jan 2010 until 01 July 2021 and hand-searched the reference lists of included articles. The searches combined free and thesaurus search terms and keywords related to vaccine uptake and used sensitive search filters to focus on systematic reviews and meta-analyses. The search terms appear in the protocol in Annex H. We also search the bibliographies of retrieved systematic reviews and screen all titles and abstracts of retrieved citations for inclusion.

We included systematic reviews and meta-analyses of interventional studies that reported quantitative data on the impact on vaccine uptake for any age group. We included systematic reviews that contained at least one randomized controlled trial (RCT); reviews could also contain observational studies and quasi-experiments (including interrupted time series and before-and-after studies). A reviewer extracted data from included reviews and a second reviewer independently checked the extraction. Where two reviews covered the same intervention and outcome with overlapping studies, we selected the more comprehensive and up-to-date review for inclusion.

List of Tables, Figures and Appendices for Interventions designed to improve vaccination uptake: Scoping review of systematic reviews and meta-analyses

(Reference to Figshare: https://figshare.com/s/5416371b9164af1ed716 files available to download)

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To assess the quality of the included reviews we used the AMSTAR score and considered items 3 and 7 as essential for GRADE assessment: item 3, was a comprehensive literature search performed; and item 7, was the quality of the included studies assessed and documented.[42] To assess the quality of studies in each review, we applied the "Grade of Recommendations Assessment, Development and Evaluation" (GRADE) for each outcome.[43,44] For the GRADE assessments, see Figshare, Table 4. GRADE assessment was based on assessing the risk of bias and an evaluation of inconsistency, indirectness, and imprecision of the results and other factors. See the Cochrane Handbook for further details on GRADE [45].

We prioritized outcomes according to the WHO Handbook for Guideline Development[46] as high (critical for decision making in the context of the WHO BeSD Working Group), moderate (important for decision-making) and low (not important for decision-making). Vaccination uptake was high priority. Constructs in the WHO BeSD Framework were moderate priority. Other constructs not in the framework were low priority (Annex G, Table 1. Outcomes of interest and prioritization). The protocol and findings are available at the Figshare site.

Results. The literature search identified 264 reviews for screening. The quantity of reviews increased markedly over time, accelerating around 2014 (Figure 7.1). In 2010, only 8 reviews were published. However, by 2021 (half year), 38 reviews were published. The increasing trend was statistically significant (r=.96, p<.001).

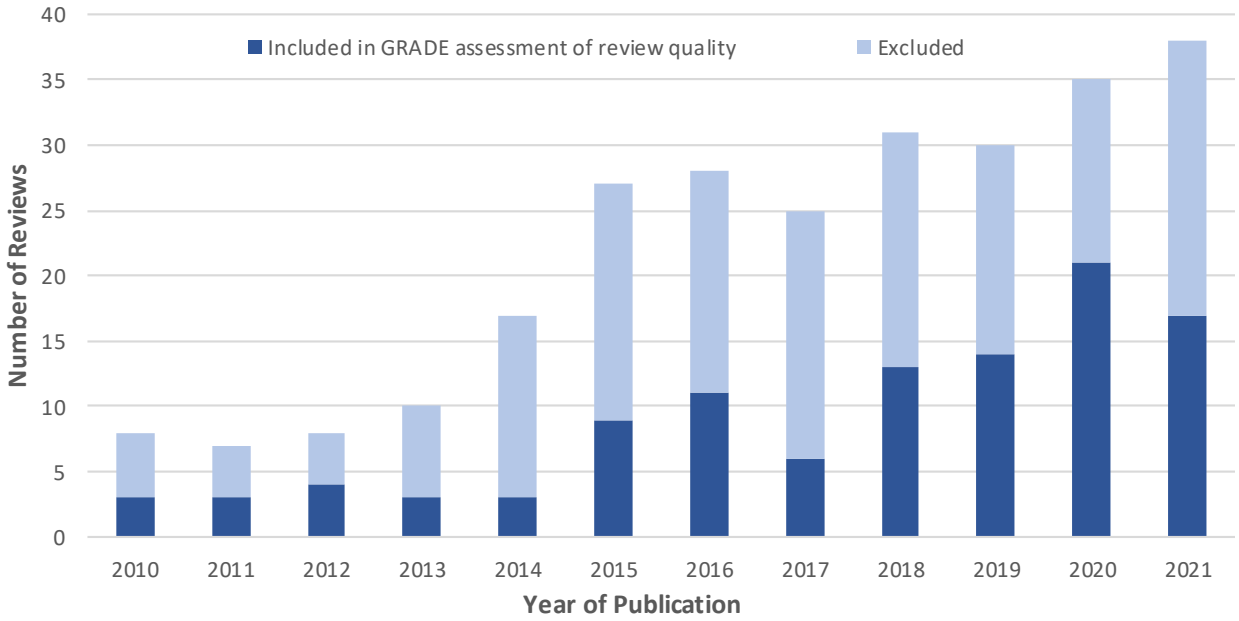


Figure 7.1. *Reviews identified by year.*

Of these reviews, 107 were relevant to our topic and were the most recent or complete (Figure 7.1). A list of excluded discordant review references is available on Figshare, Appendix 2, and included references for GRADE assessment are listed in Figshare, Appendix 3. Most reviews examined multiple kinds of vaccination (65 reviews). The remainder examined specific vaccines, with the most common being seasonal influenza (19 reviews) and HPV (12 reviews), and hepatitis (B or C, 4 reviews). The most common population was children, with 22 reviews investigating childhood vaccination (Figshare, Table 2). We found 13 reviews specifically reporting LMICs (Eze 2021, Yunusa 2021, Munk 2019, Lukusa 2018, Odendaal 2018, Bright 2017, Oyo-Ita 2016, Nelson 2016, Johri 2015, Jarrett 2015, Lassi 2015, Owusu-Addo 2014 and Bassani 2013)[47-59]; two reviews reporting on Africa (Linde 2019 and Johnson 2018, sub-Saharan Africa)[60,61] and 29 reviews reporting on HICs.

We identified 48 different interventions (listed in Figshare, Appendix 4). The most common vaccines studied were influenza (n=19) and HPV (n=12 reviews). We found four reviews for Hep B or C; Pertussis and Pneumococcal three reviews each; BCG two reviews and one each for MMR and Tetanus. The most common population included was children, with 14 reviews including childhood vaccines and eight including early childhood vaccines (See Figshare, Table 2). Intervention reporting for these reviews was often suboptimal, often making it difficult to accurately index the interventions.

With respect to review quality, we were able to evaluate 72 reviews. Of these, 40 (56%) were rated as good quality, and the rest were moderate quality (Figshare, Appendix 6 lists excluded reviews from

GRADE on full-text assessment). Table 3 on Figshare provides the AMSTAR scores reviews and table 4 provides the GRADE tables for the reviews.

With respect to outcome quality, we were able to evaluate 133 outcomes. The outcomes were primarily vaccine uptake (114/133, 86%) and knowledge (9/133, 7%). Quality was moderate for 25 of 133 outcomes (19%), low for 80 (60%), and very low for 28 (21%). Few outcomes (13 of 73) showed considerable beneficial effects with the interventions, defined as a mean pooled effect estimate (risk ratio, odds ratio, or risk difference) of at least 2. Of these, many (6 of 13, 46%) were very low quality (Figshare, **Table 5** reports the Study Characteristics for Vaccine Uptake Systematic Reviews).

Pooled effect estimates produced by authors' meta-analyses were available for 73 outcomes. In 52 of these reviews, the interventions led to higher vaccine uptake compared with controls that were statistically significant. To support work by vaccination programmes, we created a table of BeSD domains with promising interventions (Table 7.1). We also provide references to the relevant supporting reviews, especially in LMICs.

Table 7.1. *Interventions by BeSD domain*

Domain where problem is identified	Interventions shown to increase vaccination
Thoughts and feelings and Motivation	Educational interventions[53,62 63 51 58] Person-centered counseling for behaviour change[50,64]
Social processes	Community engagement[2 65 58 66] Positive social norm messages[9] Vaccine champions and advocates[67 68 66] Healthcare provider recommendations[69]
Practical issues	Free/affordable vaccination[70] Service quality improvements[71 70 58] Reminder for next dose /recall for missed dose[49 59,61 72] Onsite vaccination (e.g. work, home, school) [48,73 58 55 70 68] Default appointments[9] Incentives[51,57] School and work requirements (mandates) [70 74]

*Note. References are for systematic reviews or meta-analyses that show the intervention led to higher vaccine uptake. Where possible, reviews cited are for LMICs.

Discussion. Our literature search identified hundreds of reviews on interventions to increase vaccine uptake, with an acceleration around 2014. However, the quality of the reviews was at best good to moderate. Reviews may be becoming too numerous, low quality, and overlapping to be fully useful. Increasingly focused and strategic reviews to meet the needs of LMIC vaccination programmes are needed. The most common vaccines studied were seasonal influenza and HPV, with children eligible for childhood vaccination the most common population included. Few reviews provided separate findings for LMICs, an important area for future research. A common idea is that data from HICs may have limited relevance to work in LMICs. It will be important to examine whether equivalent interventions are

differently effective in LMICs and HICs, a question answerable using some of the large review datasets that are accumulating.

Many meta-analyses showed interventions with higher vaccine uptake compared with controls. The presence of some large effect estimates, however, should be treated with caution as half of these reviews were of low quality. In addition, reviews generally included multi-component interventions, which previous research has shown to be reliably more effective than single-component interventions. Thus, many reviews in the current literature may not offer actionable insights about which specific components of multi-component interventions drive these intervention effects. Such information would help vaccination programmes more efficiently use scarce resources.

We identified dozens of different interventions based on the review authors' descriptions, but the reporting on interventions in the reviews was problematic. Because many reviews did not clearly define the interventions, an in-depth analysis would have required retrieving the primary studies, which was beyond the scope of this scoping review. Thus, it was difficult to assess what the actual interventions were and challenging to identify those intervention components that inform practice. The use of a template for intervention description and replication [75] (the TIDieR checklists) is one potential way to improve the quality of reporting and aid implementation.

The curation of knowledge for vaccine uptake interventions needs improvement given the chaotic overlapping nature of the existing reviews and an assessment of the gaps in knowledge. Nearly three-quarters of the reviews subject to GRADE reported beneficial impacts of interventions. Yet, there is still a need to better understand what works in what settings, and how vaccination programmes can optimise the implementation of interventions dependent on their populations and the coverage to ensure optimal use of resources. This scoping review acts as a starting point for further analysis and consideration of how best to present the evidence for maximal impact.

Next steps

This information is the first step towards helping vaccination programmes to understand what works for whom and in what settings, particularly in LMICs and other settings where resources are scarce. The scoping review helped us to identify three specific needs for future efforts. First, this research field needs a taxonomy of vaccination interventions. The current reviews are not relying on a standard set of tools to summarize this literature, yielding non-comparability within and across reviews. Second, many primary studies use multicomponent interventions, making it unclear what the active ingredient was. For example, reminders are common in multi-component interventions and are likely to increase vaccination uptake by around 10%. Because so many multi-component interventions include reminders, it is unclear whether reminders alone would have yielded the reported effect. Third, the amount of research in LMICs settings is inadequate. A structured and funded program of research is necessary to address this shortfall. The BeSD working group has laid out a series of recommendations to address these gaps in Section 9.

Section 8. Guidance for gathering and use of data

Summary: To facilitate use of the tools for gathering data, the group developed a **'Data for action guidebook'** (or 'the guidebook'). A small sub-group adopted user-centred design principles which follows three key steps: Plan, Investigate and Act. This document has since been updated to a more generic version that will cover all BeSD tools, with provision for any future expansion of the tools to other vaccines. This updated version is also being revised to incorporate insights from user experiences with the original COVID-19 version.

Facilitating the quality and use of data

From the outset, the priority has been to develop user-friendly tools and guidance to offer programmes quality and actionable data. A large focus was also placed on integrating BeSD tools into existing data-collection processes, to enable triangulation with other programme data streams (Figure 8.1). The needs assessment findings affirmed this approach and offered useful directions, further supported by consultation conversations with programme data management colleagues and partners.

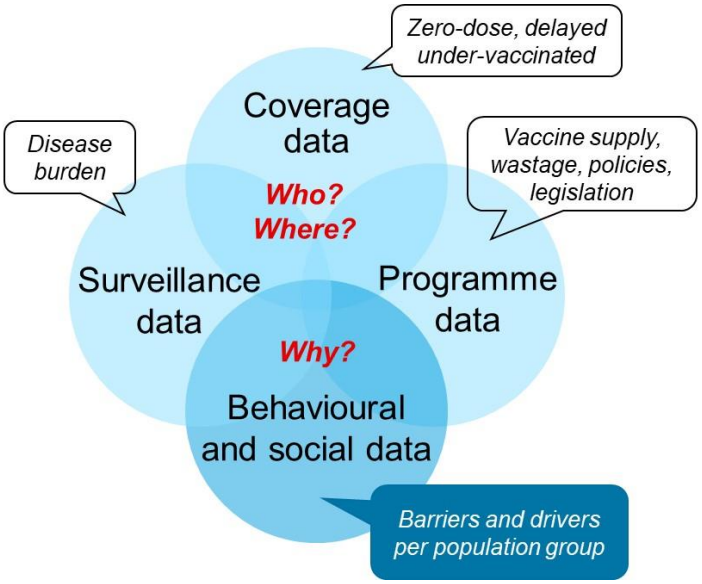


Figure 8.1. *Triangulation of insights on reasons for low uptake together with other programme data.*

We formed a small sub-group to develop the guidance. It included expertise in immunization programme implementation, data and processes, and user-centred design practices. Throughout the development process, the group frequently considered inputs from the initial stakeholder interviews. The primary output of this group was development of a practical guidebook with a scope from local adaptation of the tools through to data collection, analysis and use.

Putting the end-user at the centre

A structure was developed to offer clear stepwise recommendations on how to:

- Adapt and test the tools in the local context while retaining a level of global standardisation;
- Integrate items into existing data collection mechanisms and processes, such as coverage surveys, EPI reviews, MICS and DHS, and other nationally representative household survey programmes;
- Use agile processes for data analysis and reporting;
- Use the resulting data, triangulated with other sources to inform planning.

In keeping with the design thinking approach, the group developed end-user personas and a use case scenario matrix (Figure 8.2), based on the key informant interviews data (Section 1). While there are four likely end-user personas, two key personas are being prioritized: the immunization programme manager and a lead researcher. The programme manager persona represents national or sub-national policy-makers and programme implementers in planning and decision-making roles who require data to inform intervention design and evaluation. The lead researcher persona represents those with a role focused on local testing of the tools, data collection, analysis and reporting. To support these roles and the tasks relating to the use of the BeSD tools, we structured the guidebook around three main steps: plan, investigate, and act (Figure 8.3).

The current version of the guidebook is available as a separate document accessed via a link provided in Annex E. This will be updated shortly after the SAGE meeting in October 2021 to reflect conclusions and recommendations from SAGE, including the final core indicators. It will then be promptly disseminated. Activities to promote the guidebook and support implementation are described in Section 9.

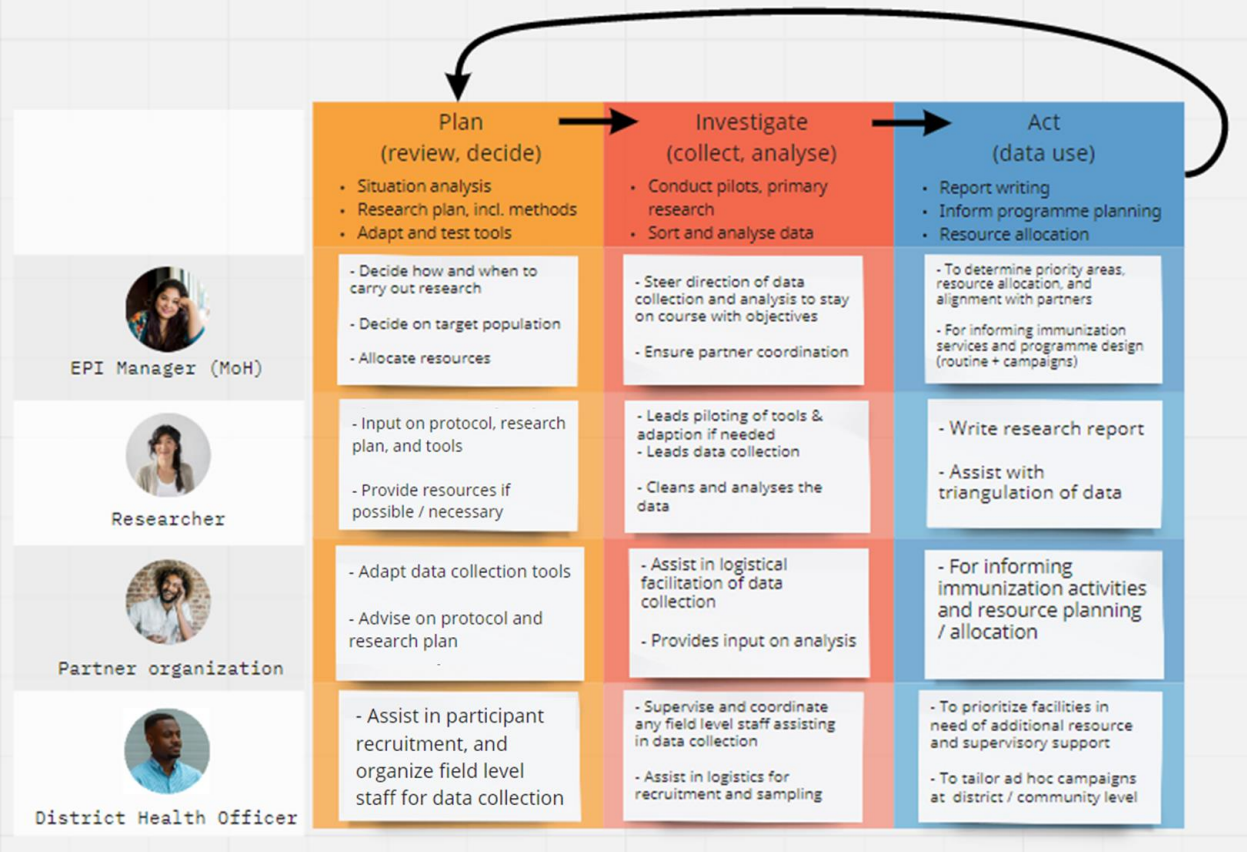


Figure 8.2. *Typical end-user personas and their corresponding role in relation to the main steps in planning, gathering and using data*

Based on the mapping of personas against actions, an initial summary outline of a "minimum viable product" (MVP) for the guidebook was developed as a first step. This captured the most essential content and was reviewed by partners and colleagues with in-depth programmatic expertise. The MVP was then developed iteratively with all of the necessary content as specified in the end-user feedback.

Developing the guidebook for COVID-19 vaccines

The advent of COVID-19 and the urgent demand for data on COVID-19 vaccine uptake meant that the sub-group set up specifically for the end-user guidebook had to pivot from their original childhood vaccine focus to work on a guidebook for the BeSD COVID-19 vaccination tools. The group contributed inputs to this guidebook, along with members of the BeSD COVID-19 vaccination tool sub-group.

We built on the work already completed and adapting where necessary for the specific requirements of the new COVID-specific tools. The "*Data for action: achieving high uptake of COVID-19 vaccines"* guidebook was published in February 2021, followed by an updated version in April 2021 that is currently in use and available on the WHO web site.

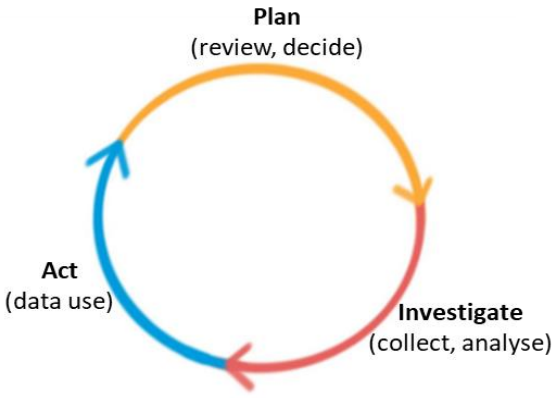


Figure 8.3. *The structure of the 'Data for action guidebook', Plan – Investigate – Act.*

Feedback from end-users is regularly being sought to inform future iterations of the guidebook. User feedback was gathered in the form of short calls or email exchanges probing at what elements were used, most or least helpful, and content that may be omitted. Further feedback on the guide was sought from members of the BeSD working group. Mechanisms for continuous feedback and learning will be integrated into activities outlined in Section 9 on implementation.

Example recommendations for quantitative research

Frequency. We recommend assessment of the core indicators annually.
Sampling. We recommend national probability sampling. If that is not possible, select 4 locations using purposive sampling (to include rural, transitional, and urban areas).
Interview mode. We recommend live interviews (face-to face or phone) to assist lower-literacy respondents and those with poor online access. Online is a back-up option.
Length. We recommend limiting the total survey length to 10-15 minutes. Longer surveys may risk people ending the survey early. However, we recommend adding the survey items to other planned national efforts that rely on population-based sampling to make efficient use of resources.
Payment. We do not have a recommendation on payment for completing the survey. Issues include paying a fair reimbursement, the logistics of payment, and interviewer safety if carrying cash for payments.

Developing version two of the guidebook and next steps

We adapted the next generation of the BeSD guidebook using insights from users of the COVID guidebook, along with input from the full expert working group and other stakeholders. This guidebook covers both the BeSD childhood vaccination and COVID-19 vaccination tools. It will be designed so that any future vaccine-specific BeSD tools can be easily incorporated. To address the feedback **received the new guidance also includes more information on integrating the BeSD tools into other data collection processes such as immunization coverage surveys, MICS, or DHS.** Some guidance on adapting the tools for online data collection has also been included to address new and emerging data collection modalities in the context of a pandemic. Finally, a "quick start guide" (Figure 8.4) is included in the guidebook for an overview of the guidebook and a rapid reference on the main steps.

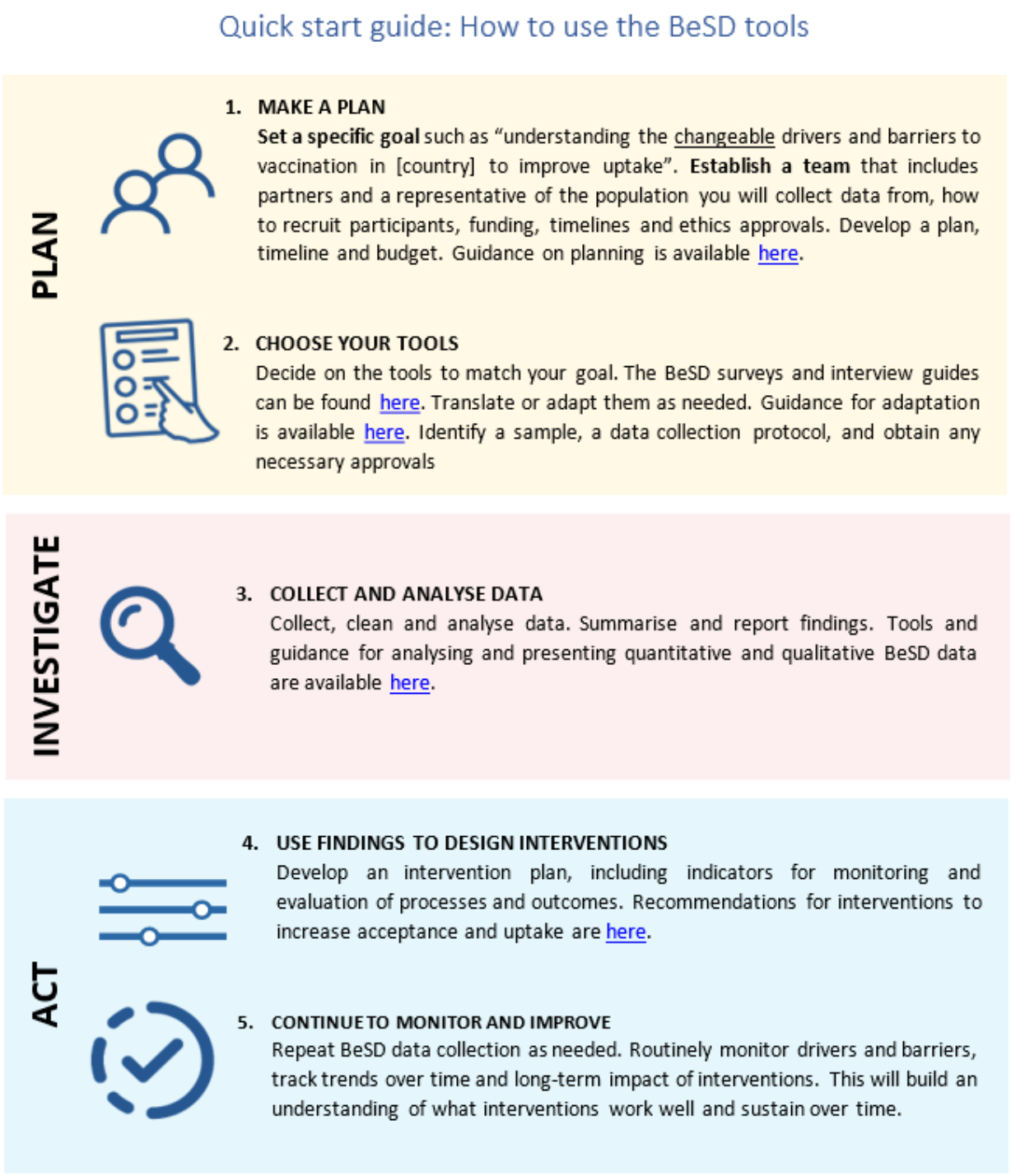


Figure 8.4. *The quick start guide is included in the guidebook and offers an at-a-glance summary of the main steps to gathering and using data.*

To further facilitate use of the BeSD tools in responding to different needs in different settings, the new guidebook offers linkages to the **new 'Human-Centered Design - Tailoring Immunization Programmes approach (HCD-TIP).** The HCD-TIP process, informed by the original guidance [76], is built around an

iterative cycle of 4 steps: Diagnose, design, implement, and evaluate. Both HCD-TIP and BeSD cross-reference each other and demonstrate their reciprocal value (Figure 8.5): the BeSD tools can be used to facilitate data-collection as part of the TIP/HCD process, and as part of the TIP/HCD process the BeSD tools can help to generate vital insights.

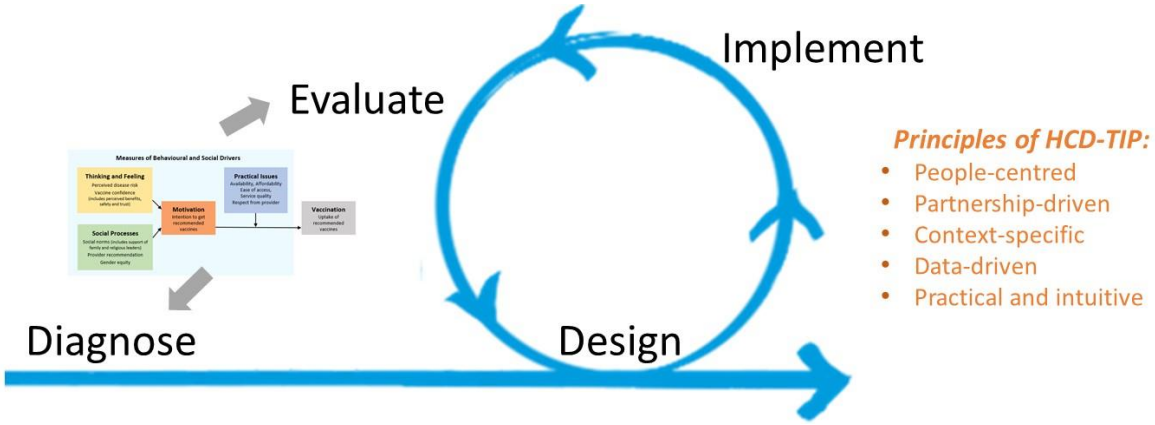


Figure 8.5. *Connections between the four steps of HCD-TIP and BeSD*

Further, **UNICEF's caregiver journey** can also be used in conjunction with the BeSD childhood vaccination tools, to facilitate interpretation of data or as a reference to further investigate the questions that need to be answered using the interview guides[77]. In most cases, the application will be driven by the needs of the community/communities involved and by the data currently available.

Focus on monitoring and evaluation for testing, learning and scaling

The guidebook will have a strong focus on monitoring and evaluation on an ongoing basis, to promote the importance of continuous measurement and learning. It will include a monitoring and evaluation framework (Table 8.1) such as the example below to facilitate evaluation of implementation.

Table 8.1. *Monitoring and evaluation framework (example) as included in the guidebook*

DOMAIN and INDICATORS	INTERVENTION	INPUTS	ACTIVITY / OUTPUTS	OUTCOMES
Practical Issues **% of adults/ HCWs who know where to get vaccines for themselves** **% of adults/HCWs who believe that accessing vaccination for themselves is "very" or "moderately" easy**	Improve access to vaccination. Mailed or phone offer of appointment Outreach Reminders, standing orders and walk-in clinics.	Messages to invite, remind, follow-up and inform Mechanisms for delivery of personal invitations	Messages are ready on schedule, pilot-tested, revised and ready for roll-out. Mechanisms are available and ready to be put into action.	↑ who know where to get vaccine ↑ who believe that accessing vaccination for themselves is "very" or "moderately" easy ↑ readiness to seek vaccination ↓ perceived barriers to access

Examples of the application of BeSD tools

To date, the BeSD tools for childhood vaccination and for COVID-19 vaccination have been used in various settings, with far greater application of the COVID-19 tools, given their publication in early 2021, prior to the formal field testing and validation process. The COVID-19 vaccination tools have not yet been formally published, however have been provided upon request for specific needs.

Examples of the application of the BeSD tools to date:

- COVID-19 survey of adults in Vietnam, supported by UNICEF
- COVID-19 surveys (13 total) of adults and health workers in 8 Eastern and Southern Africa countries, delivered through platforms such as Internet of Good Things and UReport, supported by UNICEF
- Integration of core questions into time-series and representative Community Rapid Assessments in 8 Eastern and Southern Africa countries, supported by UNICEF
- Use of selected questions on COVID-19 vaccination in a partnership between Gavi and Premise, offering learning on how BeSD tools can be implemented via a mobile-based self-complete survey
- Use of the BeSD framework within a COVID-19 Vaccination Field Guide published by the US CDC
- Childhood vaccination qualitative tools in Mozambique, supported by Village Reach
- COVID-19 health worker study in 14 countries in the Caribbean, supported by the WHO Office for the Americas
- COVID-19 surveys in the European Region, supported by the WHO Office for the European Region
- Rapid formative assessment for UNICEF in 8 Pacific Island Countries and Territories using the BeSD tools for COVID-19 vaccination and routine immunisation.

We extend our gratitude to the partners and collaborators who have used the tools to date and shared their lessons and insights.

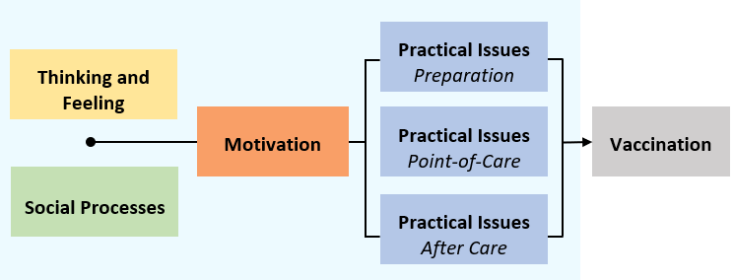
Case example: Mozambique – community-based participatory research with mothers

Objective: In Zambézia Province, Mozambique, only half of children were fully vaccinated in 2015. VillageReach and Zambézia Provincial Health Department (DPS) with support from Wellcome Trust conducted a participatory study that engaged health workers and caregivers of partially vaccinated and of fully vaccinated children between the ages of 25-34 months to better **understand the barriers to completing full vaccination** and **identify community-driven solutions to improve full vaccination.**

How BeSD data was collected: While previous studies had been conducted to identify barriers, under-vaccination persisted in the province. The BeSD framework was used to investigate the context-specific barriers and human-centred design (HCD) was used to fully engage community members and health workers in identifying solutions to affect change. Local caregivers interviewed 32 other caregivers by exploring photographs that caregivers took to represent their vaccination journeys. They also interviewed 12 health workers and collected their observations related to vaccinations via SMS over three weeks of providing vaccinations to children.

What BeSD findings revealed: Many caregivers began the vaccination process as highly motivated, active seekers of vaccination. At the start of their child's vaccination journey, **caregivers were willing to spend significant time, effort, and cost to bring their children to their initial vaccination appointment(s).**

Barriers at the point of care reduced motivation over time. Negative experiences such as being turned away due to stockouts and poor interactions with health workers resulted in fear of embarrassment and loss of faith in the health system. As a result of reduced motivation, caregivers were less willing to overcome preparation barriers and ultimately were more likely to drop out. The BeSD framework was expanded to illustrate the significance of practical issues.



Social processes were important facilitators of vaccination, boosting motivation and helping to overcome practical barriers. For example, some health workers intentionally group vaccination appointments for mothers from the same community to facilitate traveling together, knowing that those who have greater distances to walk will be less likely to return if they must walk alone.

How BeSD findings were used: The HCD workshops in each district with caregivers and health workers allowed for both groups to better understand the perspectives of the other through reviewing findings together and then designing solutions.

> *"We wanted to understand drivers of dropouts and move beyond just identifying barriers - BeSD provided a great foundation to explore connections within and between domains to develop those patterns."*
>
> *- Emily Lawrence, VillageReach*

BeSD provided a helpful framework to structure and organize results, including in guiding development of themes and categorizing codes. Data analysis showed the complex ways in which **social processes and practical barriers before, during and after the point of service interact to impact motivation to complete the vaccination schedule in full**.

Section 9. Support for implementation

Summary: This section provides an outline of the supporting activities that will be established to will facilitate the gathering and use of data at a national or sub-national level, as well as the availability of trend data at a global level.

The enablers outlined here are intended to ensure that the necessary conditions are in place to support timely use of quality data at all levels.

Dissemination of the BeSD tools and guidance

A plan for disseminating the BeSD CI tools is outlined here in brief, to roll out after the October 2021 session with SAGE. The primary objective of this plan will be to communicate the value of an evidence-based approach to immunization programmes and partners for understanding and improving uptake. Our dissemination plan will also promote an understanding of the tools, how to implement and incorporate them, and processes for data gathering, analysis and use. This plan will also consider the necessary technical support required to assist programmes and partners, as well as contribute to capacity building where needed.

Expected primary publications to result from this session:

- **Updated guidebook** (for RI and COVID-19 vaccines) with revised survey, indicators, intervention framework, and associated guidance
- **Session summary in WER** with SAGE conclusions and recommendations from the from October 2021 meeting
- **Position paper in WER** in mid-2022 with detail on the overall evidence, development process, and SAGE conclusions and recommendations

We plan to disseminate the tools through the WHO website, the WHO and UNICEF Regional and Country Offices, and through the many partner organizations represented on the expert group and global Demand Hub. Additional communications, such as peer-reviewed publications and presentations to public health practitioners, will help to raise general awareness of the tools and their benefit to programmes. These dissemination plans will be accompanied by technical support for implementation and capacity building, as well as feedback loops from end-users to continue to understand experiences, insights and learning from BeSD implementation to inform continued improvement of future versions.

Together with other global immunization partners, WHO will also consider a learning agenda to support the tools and inform any future updates. This may include a centralised database, case studies, added materials for capacity-building, and other documentation about country experiences on data gathering and use for programme planning and evaluation. The tools will also serve as a foundation for development of related and harmonized tools for other vaccines and target populations, or for added in-depth 'modules' on key domains, particularly in areas with a paucity of data.

Implementation support from a global level

A range of activities (summarized in Table 9.1) will be implemented to support the operationalisation of the BeSD tools and guidance and help to inform local data-gathering and use – with an equal emphasis on the surveys and interview guides. In addition to the tools and guidebook itself, activities will focus on enhancing capacity, technical assistance, global dissemination of comparable findings and trends, and

documentation of case examples to illustrate the tools in practice and value added. Where possible, these activities will be integrated into existing platforms (e.g. IA2030, WIISE, TechNet-21), and will be designed to be as additive and complementary as possible. They will also be designed in such a way as to simplify and optimise accessibility, and to minimise added burden on the end-user.

Throughout the various activities intended to support national programmes and partners, an emphasis will be placed on use of the interview guides (qualitative tools) more specifically, as this is an area where qualified capacity may not be available in some settings.

Table 9.1. *The different implementation support activities planned and corresponding audiences*.

Activity (and timeline)	**Description**
Primary audience: National and sub-national *programme staff and partners, NITAGs and RITAGs*	
Tools and guidebook (November 2021)	Tools and guidebook will be updated based on SAGE discussion, then disseminated and actively promoted. The guidebook is the practical and action-oriented 'how to' guide for local adaptation and use of tools, including summary recommendations on methods, data collection and analysis, and frameworks to facilitate planning, and monitoring and evaluation.
Capacity-building (From December 2021)	Training materials will contribute to enhancing capacity of the knowledge and skills to implement these tools – with an equal focus on the survey and interview guides. Training materials for specific phases of the 'Plan, Investigate, and Act' cycle are in the process of being developed and are expected to be finalised and disseminated before year end.
Technical support and community of practice (From Q1 2022)	Technical support will be available to programmes and partners to assist in data gathering and use, then subsequent implementation. Support will be available through a variety of mechanisms, however primarily centred through discussion boards and other moderated sites within the TechNet-21 platform. A network of experts and partners will be established to support the provision of technical assistance in different regions and languages, to ensure appropriate social/cultural sensitivity. An equal emphasis will be placed on use of both the survey and interview guides, to ensure that all needs are met.
Digital tools for data collection and analysis, and reporting templates (Q1 2022)	Digital tools will be developed using ODK and/or Qualtrics, based on consultation with UNICEF and WHO Regional Offices. Tools will be connected to Regional and Global immunization programme databases. This will benefit: 1) Quality collection and real-time analysis of findings, and; 2) Connectivity to Regional and Global immunization programme information management systems. Digital reporting templates will also be developed to facilitate integration with other data-collection platforms and facilitate rapid communication of actionable findings.
Intervention briefs (From Q2 2022)	Intervention briefs will be short documents that facilitate use of data for implementation and M&E of interventions. These templates will provide a description of the components of the intervention, and an outline of the considerations for implementation of the intervention, such as audience and setting. Links to the evidence and supporting materials will also be available and include any kind of analytic or measurement framework.

Primary audience: Global *immunization and public health community at all levels*	
Documentation of key case examples (From November 2021)	A collection of case examples will be developed to illustrate the process of gathering and using BeSD data, as well as the resulting insights and outcomes. This will feature a diverse range of populations and applications of the tools, including both quantitative and qualitative data. The value-add demonstrated will help to promote the use of these tools and associated data.
Global dashboard (Q1 2022)	A global dashboard or tracker will be launched on the WHO website, integrated to the WHO immunization information management system (WIISE). It will offer data on key trends presented through maps, charts, and other visuals, and eventually be updated monthly. Data will be gathered through the digital tools or through analysis of reports or data. Data may be disaggregated for different BeSD domains, locations and demographics. Data will guide global and regional planning and interventions, and serve as a complement to the operational use of data for planning and implementation at a national or sub-national level. In future, there may also be integration data from added workstreams (e.g., Infodemic management) to offer greater analysis of specific issues and trends.
BeSD data reports (Q2 2022)	To complement the above-mentioned dashboard, two-page summary reports will be disseminated on a monthly basis starting in early 2022, offering a short narrative and key findings from the global data reviews. Often specific geographies, populations or barriers may be featured. This will help to promote understanding of the barriers to vaccination uptake and guide appropriate action and investments.
WHO Position Paper on acceptance and uptake (Q2 2022)	A position paper on vaccine acceptance and uptake will be published in early 2022 (timelines being confirmed), and will summarise the latest evidence, tool development process and associated expert and end-user inputs, and final conclusions and recommendations. It will also put forth future directions for this field to support the expansion of learning and knowledge on the most effective measures and interventions.

Supporting adequate financial and human resources in countries

Implementation of these tools and associated interventions will require adequate human and financial resources. While the tools have been designed from the outset to integrate into existing programme data-collection and planning processes (and to therefore support triangulation with other programme data), some added investments may be required at the outset and on an ongoing basis. These added requirements will need to be included in national plans (including activities, budgets, roles and responsibilities), and will further need to be updated on an annual basis, as implementation and learning evolves.

NITAGs and RITAGs will play a critical role in supporting implementation and tracking progress on core indicators at regular intervals, e.g. twice per year. The addition of social and behavioural scientists to these groups will ensure that such data and related programmatic activities are well-advised and draw on the latest evidence and expertise. National cross-partner coordination mechanisms (and similar) that encompass vaccine demand, communications, advocacy and social mobilization will also need to take on a role in supporting implementation of these activities. Connections may need to be made with other national or regional groups that offer specialised expertise in the social and behavioural sciences, whether for technical assistance, training, or specific research support. These activities may also be

connected to the global community of practice to facilitate a scale-up of learning or exchanges between countries. It is in this way that feedback loops will be established for such sharing across all levels.

Above all, linkages to IA2030 (specifically strategic priority 2 on commitment and demand) and other regional or national strategies, with their associated targets, should provide an important reference to make the case for investment in these activities, and further serve to guide key priorities. For low-resource settings, funding may be sought through Gavi, the Vaccine Alliance, via the window of support for health system and immunization strengthening. Further opportunities may be available through other global or bilateral donors, particular in relation to the rollout of COVID-19 vaccines. Importantly these tools offer new potential for monitoring and evaluation of interventions and resulting outcomes, therefore offering all stakeholders essential insights to guide future investments.

Monitoring and learning: how will data be reported and used?

To facilitate rapid and actionable reporting, succinct templates will be developed, similar to the format shown in Figure 9.1. Templates will be connected to the digital tools available (through ODK and/or Qualtrics) and offer an easily adaptable basis for communication of results.

An emphasis will be placed on supporting integration of data with other forms of immunization programme data country, regional and global levels (e.g., data on coverage, disease surveillance, digital listening insights), to help guide the design and evaluation of more targeted interventions.

In addition to the gathering and use of data at a local level to guide planning and evaluation of interventions, a global tracker dashboard will be established. The global dashboard (Figure 9.2) will consolidate primary and secondary data identified through a range of streams, including the WHO/UNICEF JRF data reported annually (or monthly for COVID-19). The tracker will include both process and outcome indicators, i.e. indicators on countries using the tools and reporting on key findings, as well as insights from implementation of assessments. The tracker will include both quantitative data, as well as short narratives derived from qualitative research. To complement the data on trends presented via maps, charts, visuals and narratives, longer case examples will be made available to offer added detail on data-collection methods and subsequent interventions and outcomes.

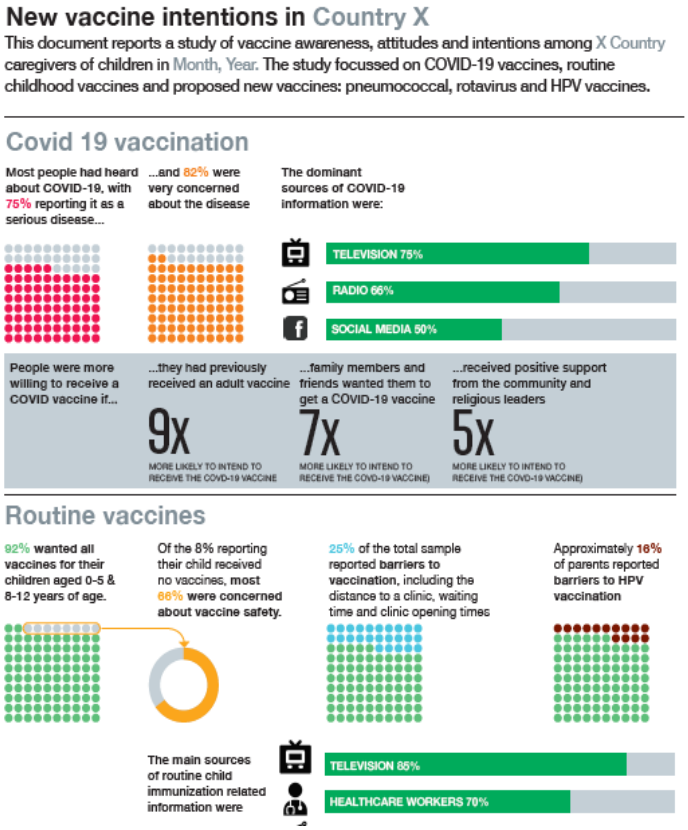


Figure 9.1. *Example of summary reporting template for Country X, intended to illustrate the planned format.*

Link to reporting for global strategies

Indicators will be linked to the monitoring framework for IA2030 and for Gavi 5.0 and will therefore serve as a basis for building global understanding on the exact reasons for under-vaccination. The

IA2030 monitoring and evaluation framework has an indicator on vaccination demand that may eventually derive from the BeSD indicators. Additionally, Gavi has an indicator for its current 5-year strategy that is focused on vaccination demand and eventual measurement of this indicator will draw from the BeSD tools. There is the added opportunity to align and coordinate on data-collection and reporting processes for these indicators to both minimise burden on countries but at the same time facilitate analysis of quality data at a Regional and Global level.

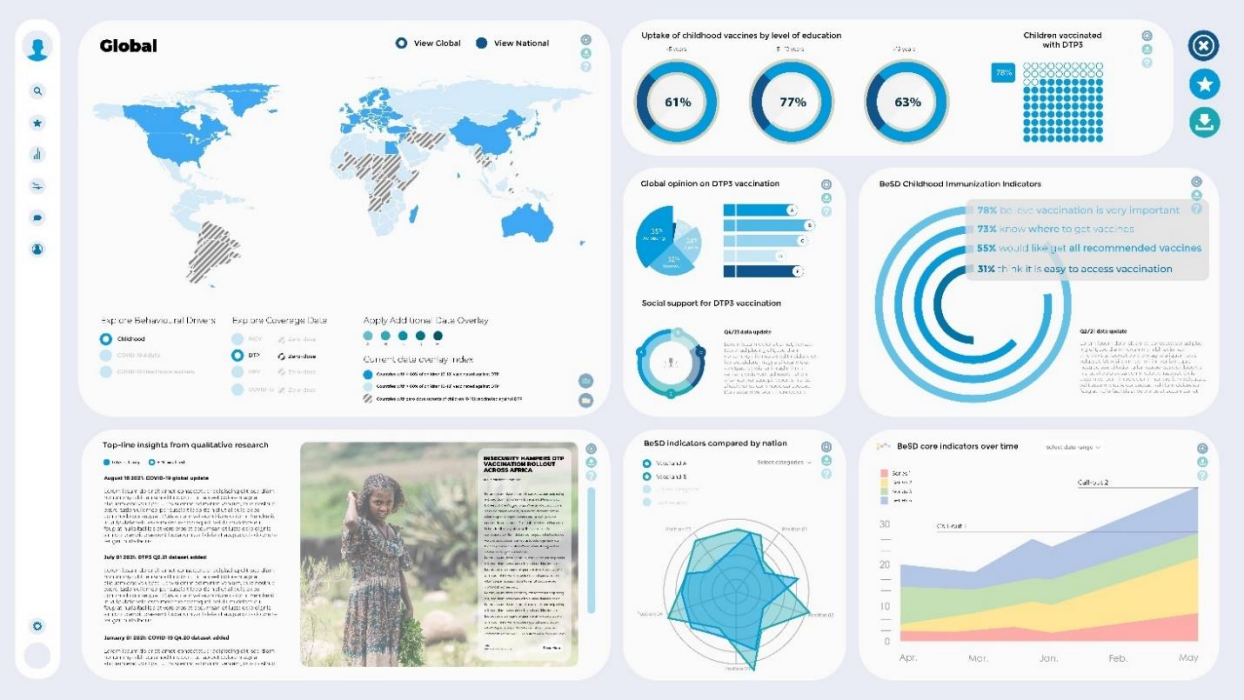


Figure 9.2. *Mock-up of the global dashboard with charts, maps and data with regularly updated trends by indicator and country, and by demographics, where available. This is an illustrative example only.*

Learning and future updates

To further enhance the communication and use of data and subsequent enhancements to the overall package of measures ad interventions, end-user feedback from implementers, researchers and partners will be actively sought on a routine basis (Figure 9.3). This will be done in different formats via a range of streams, such as through the community of practice, short targeted interviews and surveys.

End-user insights will be generated with two main areas of focus:

- On the **tools and measures**, to understand the performance of the items and response options and comparability between different settings. Data-collection methods will also be reviewed. These insights will be used to inform future updates to the tools and guidebook.
- On the **interventions**, with the objective to help ensure adequate M&E of implementation to determine what inventions are effective and where, as well as elements such as practicability, feasibility, cost effectiveness, and sustainability. Published and grey literature will also be reviewed on a routine basis to gather insights on existing and emerging interventions. An updated scoping review or other evidence review may be initiated in due course.

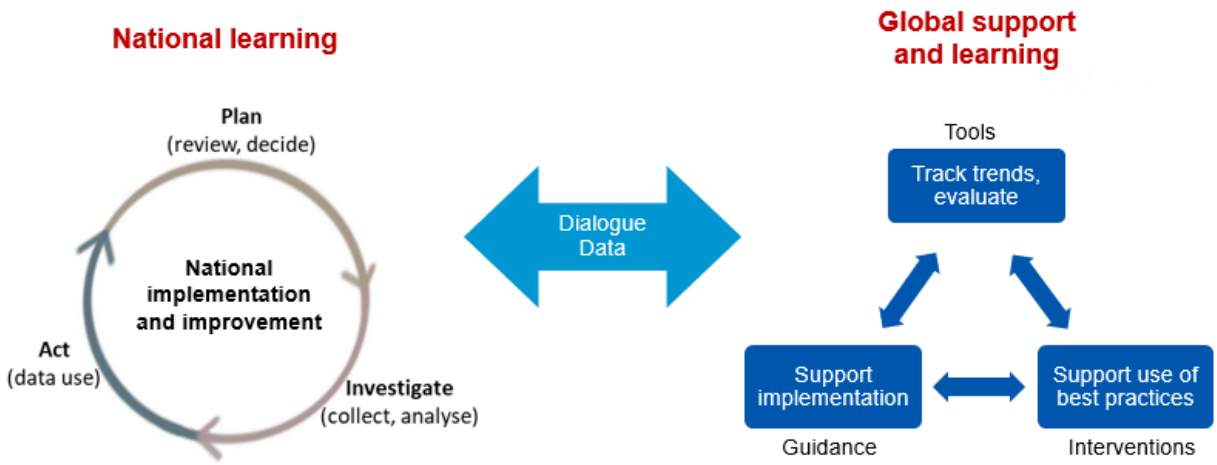


Figure 9.3. *This chart illustrates the different cycles of activity at a global and national level*

Evolution of the working group

To guide the evolution of implementation into the next phase as outlined in this section, the current working group will be reshaped to better respond to the new objectives and priorities of the work ahead. Rather than focused on development and validation of tools, the emphasis will be placed more on implementation research, data systems and monitoring and evaluation. The new group will be established in early 2022 and meet on a regular basis to review data and learning and advise on adjustments. A new group will also oversee the extension of the current tools to other vaccines and target populations, starting with influenza and HPV vaccination, with a harmonized approach.

Future research priorities: measurement and implementation

Our review of existing survey measures identified a lack of standardized tools for use globally to understand a broad range of the behavioural and social drivers of vaccination. The surveys and other BeSD tools address this gap. Additional longitudinal research is needed to confirm the utility of the tools in predicting who gets vaccinated. As the field evolves, it may be necessary to include new constructs. Finally, programmes have expressed interest in surveys to address HPV vaccination in adolescents and seasonal influenza vaccination in older adults – tools that will be developed in 2022.

Our review of the literature on interventions to increase vaccination identified important gaps. The most pressing gap is the lack of high-quality intervention research in LMICs. Most of what is known comes from high income settings and academic researchers. Outcome evaluations using the many interventions established in HICs is urgently needed. It may be that many of the ideas shown to work well in HICs also work well in LMICs, but at the very least implementation research will be needed to identify when, where, and for whom these interventions are successfully implemented. The BeSD working group will endeavour to continue to work closely with other Demand Hub workstreams to ensure a close integration in relevant areas.

An important open question is what new intervention approaches LMICs have developed that HICs and the published evaluation literature have not yet embraced. For example, a recent review protocol [78] identified community participation as a promising intervention approach, but evaluations that isolate this intervention component from other intervention efforts have not yet been conducted.

Finally, to successfully implement interventions requires adequate resourcing, but is often missing. Furthermore, programmes lack a standardised approach to budgeting activities in this area. Cost estimates from HICs may not be useful in LMICs, but information on staffing and materials could allow local production of cost estimates.

Section 10. Evidence to recommendation framework

This framework has been completed to support the translation from evidence to recommendations on the topic of acceptance and uptake. Recognizing that the PICO model and question types in the framework are oriented towards biomedical interventions, a commitment has been made to respon d to the intent of the questions. For application towards the behavioural and social sciences associated with acceptance and uptake, the intervention has been described as the **measurement** of drivers.

Question:	In countries seeking to increase uptake of vaccines, does use of standardized and validated tools provide a better mechanism to assess behavioural and social drivers than existing non-standardized tools?
Population:	Countries seeking to increase uptake of vaccines.
Intervention:	Standardized and validated tools to assess behavioural and social drivers of vaccination.
Comparison(s):	Nil or use of non-standardized and unvalidated tools.
Outcome:	Accurate assessment of behavioural and social drivers.

Background:

Behavioural science now offers several new ideas about what it takes to get people vaccinated. It is increasingly recognized that vaccination uptake results from a web of interconnected actors, resources, and behaviours, all of which follow predictable patterns. As we move into the new decade, and to guide the *Immunization Agenda 2030* (IA2030) strategic objective 2 (commitment and demand) and its measurement, it is essential to bring this new knowledge and evidence to the fore, and to ensure the ongoing success of vaccination programmes. To do this requires that programmes routin ely assess the full range of behavioural and social drivers of uptake and design and evaluate targeted interventions.

	CRITERIA	JUDGEMENTS				RESEARCH EVIDENCE	ADDITIONAL INFORMATION
PROBLEM	Is the problem a public health priority?	*No*	*Uncertain*	*Yes*	*Varies by setting*	Vaccine acceptance and uptake has been an escalating priority since the launch of the Global Vaccine Action Plan 2011-2020 (strategic objectives 2 and 3) and is again featured prominently in the Immunization Agenda 2030 (strategic objectives 2 and 3). With the need to achieve high coverage of COVID-19 vaccines, an evidence-based approach to this field is urgent.	
		☐	☐	x	☐		

BENEFITS & HARMS OF THE OPTIONS	Benefits of the intervention Are the desirable anticipated effects large?	*No* ☐	*Uncertain* ☐	*Yes* x		*Varies* ☐	A more people-centered and holistic assessment of the drivers of uptake is likely to improve vaccination uptake and reduce inequities in coverage. Coverage is below-target for routine immunization coverage and backsliding in some countries with the disruption from the pandemic. Hence a more data-driven approach can ensure coverage improvements are well targeted and prioritized with data. The tools have been developed to enable adaptation and addition of certain items where indicated while aiming for standardization of core items.	At this stage, data is not available to quantify the proportion of reasons for under-vaccination that relate to behavioural or social factors, however with a more structured approach in future this will be feasible.
	Harms of the intervention Are the undesirable anticipated effects small?	*No* ☐	*Uncertain* ☐	*Yes* x		*Varies* ☐	Assessing the behavioural and social drivers of vaccine uptake is generally low risk. There is a small risk that the methods fail to fully account for the factors influencing uptake leading to potentially mistargeted interventions. There is an additional risk that findings are not shared for public scrutiny and accountability. Finally, there is a risk that in small samples, a participant is identifiable, e.g., programme manager completing an in-depth interview.	
	Balance between benefits and harms	*Favours intervention* x	*Favours comparison* ☐	*Favours both* ☐	*Favours neither* ☐	Unclear ☐	Measuring the BeSD of vaccination is low-risk and its benefits far outweigh any potential adverse effects.	
	What is the overall quality of this evidence for the critical outcomes?	**Effectiveness of the intervention** *No included studies* ☐	*Very low* ☐	*Low* ☐	*Moderate* X	*High* ☐	There is evidence from the Tailoring Immunization Programmes approach for use of setting-specific data in improving uptake of vaccination through enabling a more precise selection of evidence-based interventions. The comparison is usually from the same setting prior to the data collection.	
		Safety of the intervention						

		No included studies ☐	*Very low* ☐	*Low* ☐	*Moderate* x	*High* ☐	For the childhood and COVID-19 vaccination survey measures, see validation findings in Section 6 of this document. These demonstrate the core items are moderately correlated with uptake. The interventions identified in the scoping review come with varying levels of evidence. (Refer to the GRADE tables in table 4 here: https://figshare.com/s/5416371b9164af1ed716?file=30654135). However, there remains an overall paucity of evidence, particularly with low- and middle-income countries under-represented in the evidence base.	
VALUES & PREFERENCES	How certain is the relative importance of the desirable and undesirable outcomes?	*Important uncertainty or variability* ☐	*Possibly important uncertainty or variability* ☐	*Probably no important uncertainty or variability* x	*No important uncertainty or variability* ☐	*No known undesirable outcomes* ☐	Available evidence varies but overall suggests that there are no important undesirable outcomes based on these interventions.	
	Values and preferences of the target population: Are the desirable effects large relative to undesirable effects?	*No* ☐	*Probably No* ☐	*Uncertain* ☐	*Probably Yes* ☐	*Yes* x	*Varies* ☐	The target population is countries and Regional Offices using the BeSD tools. The demand for such tools has come from countries, been endorsed by them and with strong input throughout. The desirable effects are large relative to undesirable ones.	
RESOURCE USE	Are the resources required small?	*No* ☐	*Uncertain* ☐	*Yes* ☐		*Varies* x	Varies depending on setting. There is a long and short form of the survey available.		
	Cost-effectiveness	*No*	*Uncertain*	*Yes*		*Varies*	Given the lack of standardization in the activity lines of budgets in this field,		

		☐	☐	☐		x	formal cost-effectiveness analyses have been explored, however have not been conducted. Better targeted and evaluated interventions are more likely to be cost effective.[79] In future, cost effectiveness should be assessed by country, given the cost-saving potential (in comparison to no intervention, and cost of illness/death).	
EQUITY	What would be the impact on health inequities?	*Increased* ☐	*Uncertain* ☐	*Reduced* x		*Varies* ☐	Inequities will be reduced through better understanding of exact reasons for low uptake in specific settings and enhanced ability to target those reasons. This package will help contribute to increasing uptake in all populations from an equity perspective, with particular relevance for reducing barriers to access and service quality.	
ACCEPTABILITY	Which option is acceptable to key stakeholders (e.g. ministries of health, immunization managers)?	*Intervention* x	*Comparison* ☐	*Both* ☐	*Neither* ☐	*Un-clear* ☐	These tools are eagerly awaited by partners and many programmes. It is understood that key stakeholders are in favour of their use.	
	Which option is acceptable to target group?	*Intervention* ☐	*Comparison* ☐	*Both* ☐	*Neither* ☐	*Un-clear* ☐	N/A	

FEASIBILITY	Is the intervention feasible to implement?	*No* ☐	*Probably* No ☐	*Uncertain* ☐	*Probably* Yes ☐	*Yes* x	*Varies* ☐	Given the design of the tools facilitates integration into existing data collection processes, or easily enables use in specific local settings. In many settings similar tools are already in use therefore a shift to the new and validated BeSD tools is expected to be feasible.		
BALANCE OF CONSEQUENCES	Undesirable consequences *clearly outweigh* desirable consequences in most settings ☐		Undesirable consequences *probably outweigh* desirable consequences in most settings ☐		The balance between desirable and undesirable consequences *is closely balanced or uncertain* ☐		Desirable consequences *probably outweigh* undesirable consequences in most settings ☐		Desirable consequences *clearly outweigh* undesirable consequences in most settings x	
TYPE OF RECOMMENDATION	We recommend the intervention x		We suggest considering recommendation of the intervention ☐ Only in the context of rigorous research ☐ Only with targeted monitoring and evaluation ☐ Only in specific contexts or specific [11]populations		We recommend the comparison ☐		We recommend against the intervention and the comparison ☐			

RECOMMENDATION (TEXT)

Recommendations to consider

For Member States:

To bring data on behavioural and social drivers of vaccine uptake into routine immunization programme planning processes, to guide local implementation and evaluation, and to facilitate reporting for IA2030 and Gavi 5.0 through the eJRF.

1. **Regularly collect quality data** using a validated survey and field-tested qualitative tools, focusing on districts and sub-groups with coverage gaps and inequities:
    - **All countries:** Integrate core indicators into the appropriate routine data-collection processes, coverage surveys, EPI reviews, MICS, DHS and other nationally representative surveys
    - **Countries with low coverage** (for childhood vaccination or COVID-19 vaccination): Implement the full survey every 2-3 years or annually if triggered by a vaccine-related event
    - **Countries with specific inequities to address** (e.g. zero dose, specific populations with low coverage, outbreaks, gender-related barriers): Implement the full survey and/or qualitative tools in sub-national settings every 2-3 years

2. **Analyse, disaggregate and use findings in planning processes, triangulated with other programme data,** to improve programme implementation and address reasons for low uptake, considering interventions to increase service quality, decrease access barriers, and build on positive motivations and social norms

3. **Conduct monitoring and evaluation on an ongoing basis** to track and assess trends on core indicators, to expand/enhance interventions to improve uptake for specific populations

4. **Establish or strengthen partner coordination** mechanisms for routine gathering and use of data in programme planning and implementation (including involvement of social scientists and representatives from civil society and communities), making connections to digital listening platforms and relevant initiatives

5. **For NITAGs,** draw on data collected to use in their local programme deliberations and recommendations, and to add social scientists and representatives from civil society to their membership to strengthen their work

For the Regional level:

1. **RITAGs**
    - Analyse and use data from surveys and qualitative tools (triangulated with other programme data, including digital listening insights) to guide regional planning and prioritization, and to support similar efforts at a country level
    - Add social scientists and representatives from civil society to their membership to strengthen this work

2. **Regional partners: technical assistance**
    - Assist with technical assistance, capacity-building, and coordination of data collection and its use for planning and M&E in specific contexts
    - Facilitate documentation and sharing of successes and learning, to support the effective use of local resources, inform planning and any wider scale-up

	For the Global level: 1. **IA2030 Coordination Group and SO2 Working Group** • Review global trends on indicators to identify areas requiring attention/action and guide effective planning and prioritization. Through the IA2030 Coordination Group, to report findings to SAGE for its review • Facilitate documentation and sharing of successes and learning 2. **Partners and donors** • Assist regions and countries in building capacity and systems for data collection, analysis and use (including through alternate modes of data collection) to help guide implementation of intervention strategies and regular M&E and scale-up of what works • Strengthen knowledge on what intervention(s) work in what settings to improve uptake, with a longer-term view to enhance their sustainability, resiliency and contributions towards improving the quality of primary health care • Actively promote the use of validated surveys and field-tested interview guides in their work with regions and countries to ensure more standardization and better intercountry/subgroup comparisons for factors influencing vaccine uptake 3. **WHO HQ** • Reshape the existing working group towards a new focus on implementation of tools and support for data-collection and use at all levels, including the delivery of enablers such as training modules, a community of practice, digital tools and dashboards, etc. As part of this work to establish a learning agenda around tools and indicators to assess low uptake
IMPLEMENTATION CONSIDERATIONS	Please see Sections 8 and 9.
MONITORING, EVALUATION AND RESEARCH PRIORITIES	Please see Section 8 and 9.

Acknowledgements

The WHO Secretariat would like to gratefully acknowledge all working group members past and present (listed in Annex I); all colleagues and partners in the Regional and Country Offices who supported this work and contributed inputs; SAGE members Noni Macdonald and Ezzeddine Mohsni; Kerrie Wiley and Gilla Shapiro for research support; Nisha Gottfredson who carried out the psychometric validation; Gavi for the financial support; and above all Julie Leask and Noel Brewer for their leadership and expertise.

All inputs are acknowledged with sincere gratitude.

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Annex A. Reviews of frameworks and measures (tables 1-3)

Table 1. Comparing different frameworks and constructs as applicable to the social and behavioural drivers of vaccination

Barriers and facilitators identified in qualitative reviews of factors affecting childhood vaccine uptake among caregivers	**COM-B [22]**	**5 A's [23]**	**5 C's [24]**	**UNICEF journeys [25]**	**Social Ecological Model [25]**
Medically contraindicated on indicated for child	Capability-physical	N/A	Constraint	Seeking Care	Individual
Child under recommended age	Capability-physical	N/A	Constraint	Accepting / intending	Individual
Information needs not met	Capability-Psychological	Awareness	Calculation	Awareness	Individual
HCP not aware of recommendation	Capability-Psychological	N/A	Constraint	Point of vaccination	Interpersonal
Lack of knowledgeable health practitioner (regarding recommendation or administration)	Capability-psychological	Awareness	Constraint	Point of vaccination	Organizational
Incorrect recall and/or documentation about which vaccines have been received, unaware of need to return for additional doses	Capability-psychological	Awareness	Constraint	Awareness	Individual
Practical knowledge- Unaware of immunization schedule	Capability-psychological	Awareness	Constraint	Aware	Individual
Practical knowledge- Unaware of place/time of immunization	Capability-psychological	Awareness	Constraint	Aware	Individual
Aware/Unaware of need to return for subsequent doses (of multiple dose regimes)	Capability-psychological	Awareness	Constraint	Aware	Individual
Lack of national guideline/WHO recommendation	Capability-psychological	Awareness	Constraint	Aware	Policy
Parent forgot appointment	Capability-psychological	Awareness	Constraint	Seeking care	Individual
Incorrect contraindications applied by provider	Capability-psychological	N/A	Constraint	Seeking care	Interpersonal

Barriers and facilitators identified in qualitative reviews of factors affecting childhood vaccine uptake among caregivers	COM-B [22]	5 A's [23]	5 C's [24]	UNICEF journeys [25]	Social Ecological Model [25]
Incorrect contraindications applied by parent	Capability-psychological	Awareness	Constraint	Aware	Individual
Complacency/delay- postponed until another time, parent forgot	Capability-psychological	Activation	Complacency	Seeking Care	Individual
No healthcare provider or service	Opportunity-physical	Access	Constraint	Seeking Care	Organizational / Policy
Larger family	Opportunity-physical	Access	Constraint	Seeking care	Interpersonal
Cost (of transport, or new vaccination card)	Opportunity-physical	Affordability	Constraint	Seeking care	Individual
Mandatory vaccination requirements	Opportunity -physical	Activation	N/A	N/A	Policy
Vaccinator absent, or too busy	Opportunity -physical	Access	Constraint	Point of vaccination	Organizational
Parent absent, working, or too busy	Opportunity -physical	Activation	Constraint	Seeking care	Individual
Mother/parent too busy, family problem (including illness of mother/parent); lack of time to take the child	Opportunity-physical	Affordability	Constraint	Accepting / intending	Individual / interpersonal
Long waiting time at vaccination site	Opportunity -physical	Activation	Constraint	Point of vaccination	Organizational
Having to pay for lost vaccination card	Opportunity-physical	Affordability OR Activation	Constraint	Seeking care	Individual OR Interpersonal
Not being able to access vaccine due to shortages at the facility, vaccine not available	Opportunity-physical	Access	Constraint	Point of vaccination	Organizational / Policy
Difficult to access health facility	Opportunity-physical	Access	Constraint	Seeking Care	Individual
Child caregiver unavailable (child away/not available, travelling, absent from home or school during vaccination visit, Migration, Family problem including illness) [GATES COMBINED FACTOR]	Opportunity-physical	Access	Constraint	Seeking Care	Individual
Child born overseas on a different schedule	Opportunity-physical	Access	Constraint	N/A	Individual

Barriers and facilitators identified in qualitative reviews of factors affecting childhood vaccine uptake among caregivers	COM-B [22]	5 A's [23]	5 C's [24]	UNICEF journeys [25]	Social Ecological Model [25]
Outstanding debts to the facility	Opportunity-physical	Activation	Constraint	Point of vaccination	Individual
Needing to pay for transport to facility	Opportunity-physical	Access OR Affordability	Constraint	Seeking care	Individual
Long distance to get to vaccination site	Opportunity-physical	Access	Constraint	Seeking care	Individual
Vaccine not available (not licensed or not recommended)	Opportunity-Physical	Access	Constraint	Point of vaccination	Organizational
Card not available	Opportunity-Physical	Access??	Constraint	Point of vaccination	Individual
Not enough children to open a vaccine programme	Opportunity-Physical	Access	Constraint	Point of vaccination	Community / Organizational
School-based vaccine programme*	Opportunity-Physical	Access	N/A	Point of vaccination	Organizational
Service times inconvenient	Opportunity-Physical	Access	Constraint	Seeking Care	Organizational
Service Cost	Opportunity-Physical	Affordability	Constraint	Seeking Care	Individual
Lack of transport	Opportunity-Physical	Access	Constraint	Seeking Care	Individual
Place of immunization too far	Opportunity-Physical	Access	Constraint	Seeking Care	Individual
Child ill-not brought to clinic	Opportunity-Physical	Access??	Constraint	Seeking Care	Individual
Child ill- brought but not given immunization	Opportunity-physical	Access	Constraint	Point of vaccination	Interpersonal
Long wait times	Opportunity-physical	Access	Constraint	Seeking Care	Organizational
Logistical complexity	Opportunity-physical	Access and Activation	Constraint	Seeking Care	Interpersonal, Community, and Organizational

Barriers and facilitators identified in qualitative reviews of factors affecting childhood vaccine uptake among caregivers	COM-B [22]	5 A's [23]	5 C's [24]	UNICEF journeys [25]	Social Ecological Model [25]
Availability of leave at work+	Opportunity-Physical	Affordability and Access	Constraint	Seeking care	Organizational
Older siblings	Opportunity-Physical	N/A	Constraint	Seeking care	Interpersonal
Norms/Social context (cultural/religious beliefs against vaccination, rumours or misinformation) [GATES COMBINED FACTOR]	Opportunity-Social	Acceptance	Constraints	Accepting/intending	Interpersonal, Community
Agency/self-efficacy (family members did not allow, no female vaccinator at the clinic)	Motivation-reflective	Access	Constraints	Accepting/intending	Individual OR Interpersonal
Confidence (caregiver does not believe in vaccination; fears about side effects, safety; fear of needles) [GATES COMBINED FACTORS]	Motivation-reflective	Acceptance	Confidence	Accepting/intending	Individual
Complacency (lack of motivation, vaccination not seen as important/necessary) [GATES COMBINED FACTOR]	Motivation-reflective	Activation	Complacency	Accepting/intending	Individual
Adverse media reports	Motivation-reflective	Acceptance	Constraint	Accepting / Intending	Community
Child individualism	Motivation-reflective	Acceptance	Constraint	Accepting / Intending	Individual
Anticipated regret / guilt	Motivation-reflective	Acceptance	Constraint	Accepting / Intending	Individual
Experienced reaction in the past, real or perceived; Negative past experience	Motivation-reflective	Activation	Confidence	Accepting / Intending	Individual
Fear of being scolded for losing the vaccination card, and having to pay for a new one	Motivation-reflective	Activation	Constraint	Point of vaccination	Interpersonal
Believes there is inadequate evidence that vaccines are safe	Motivation-reflective	Acceptance	Confidence	Accepting / Intending	Individual
Doesn't believe in necessity	Motivation-reflective	Acceptance	Complacency	Accepting / Intending	Individual
Believes disease to be beneficial	Motivation-reflective	Acceptance	Calculation	Accepting / Intending	Individual
Prefers alternative methods of protection	Motivation-reflective	Acceptance	Calculation OR Confidence	Accepting / Intending	Individual

Barriers and facilitators identified in qualitative reviews of factors affecting childhood vaccine uptake among caregivers	COM-B [22]	5 A's [23]	5 C's [24]	UNICEF journeys [25]	Social Ecological Model [25]
Belief in vaccine effectiveness	Motivation-reflective	Acceptance	Confidence	Accepting / Intending	Individual
Applies a belief system that contradicts vaccination, e.g., Steiner/Waldorf	Motivation-reflective	Acceptance	Confidence	Accepting / Intending	Individual, Community
Religious Beliefs	Motivation-reflective	Acceptance	Confidence	Accepting / Intending	Individual OR Community
Question why some diseases like polio are targeted when there are others requiring attention	Motivation-reflective	Acceptance	Confidence	Accepting / Intending	Individual
Culture	Motivation-reflective	Access OR Acceptance	N/A	Accepting / Intending	Community
Influence of important others in favour of the vaccination (partner, child (adolescent), family, friends, community, doctor…)	Motivation-reflective	Activation	N/A	Accepting / Intending	Interpersonal
Healthcare provide or service unwelcoming/discriminatory	Motivation-reflective	Activation	Constraint	Point of vaccination	Interpersonal
Health value	Motivation-reflective	Activation	Calculation	Accepting / Intending	Individual
Wrong ideas about contraindications	Motivation-reflective	Awareness	Constraint	Seeking care	Individual, Interpersonal
Overwhelming or conflicting information	Motivation-reflective	Awareness	Constraint OR Calculation?	Accepting / Intending	Individual
Perceptions of parenthood	Motivation-reflective	Activation	N/A	Accepting / Intending	Individual
Previous experience of vaccination and previous vaccination behaviour	Motivation-reflective	Activation	Confidence	Accepting / Intending	Individual
Experience of others in the family with vaccines	Motivation-reflective	Activation	Confidence	Accepting / Intending	Interpersonal
Fear of needles	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual
Fear of adjuvants	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual

Barriers and facilitators identified in qualitative reviews of factors affecting childhood vaccine uptake among caregivers	COM-B [22]	5 A's [23]	5 C's [24]	UNICEF journeys [25]	Social Ecological Model [25]
Fear side effects/ reactions	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual
Belief that vaccines cause new disease strains	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual
Belief that vaccine causes the disease for which it is meant to prevent	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual
Provider not recommending specific vaccines for population group (e.g., not identifying that child is Aboriginal or Torres Strait Islander)	Motivation-automatic	Awareness		Point of vaccination	Organisational
Concern that children are too fragile	Motivation- automatic	Acceptance	Constraint	Accepting / Intending	Individual
Reminders from service/school / Triggers and reminders to vaccinate	Motivation-Automatic	Awareness	N/A	Accepting / intending	Organizational
Health staff unpleasant	Motivation- automatic	Activation	Constraint	Point of vaccination	Interpersonal
Perceived risks outweigh perceived benefits	Motivation- automatic	Acceptance	Calculation	Accepting / Intending	Individual
Mistrust of vaccine, doctor, medicine, government, pharmaceutical companies, health authorities	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Interpersonal OR Community OR Organizational
Concern about quality of vaccines (e.g. expired, broken cold chain, re-used syringes, that the government would purchase low-quality vaccines)	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual OR Organizational
Distrust in vaccine programmes(e.g. vaccines are a "tool of western powers" to control or harm communities)	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual OR Interpersonal
Trust (vaccinators unfriendly, poorly trained, not trusted) [GATES COMBINED FACTOR]	Motivation-automatic	Activation	Confidence	Accepting/intending	Interpersonal
Rumours in the community about harmful side effects (e.g. sterility)	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Interpersonal
Conspiracy beliefs	Motivation- automatic	Acceptance	Confidence	Accepting / Intending	Individual

Table 2. Measures of childhood vaccination confidence identified through literature review, developed from 2010-2019

Name of measure	Authors	Year published (citations)	Country developed	Development method as described by the authors NOT REPORTED EXISTING EXPERT CONSULT COGNITIVE INTERVIEW QUAL/ FG PILOT TESTED	Conceptual basis	Constructs included in the final measure, as named by the authors	Number of items
The Immunization Beliefs and Intentions Measure (IBIM) [80 a]	Tickner and colleagues	2010 (34)	England	EXISTING COGNITIVE INTERVIEW PILOT TESTED Developed using initial items based on central components of the Theory of Planned Behaviour, which were refined through cognitive interviews and pilot testing.	Theory of Planned Behaviour	1. Behavioural intention (3 items) 2. Attitude (8 items) 3. Subjective norm (3 items) 4. Perceived behavioural control (2 items) 5. Beliefs (23 items): a) Behavioural beliefs (6 items), Normative beliefs (3 items), and Control beliefs (14 items)	39 items
Parent Attitudes about Childhood Vaccines (PACV) survey [81,82]	Opel and colleagues	2011 (205)	United States	EXISTING EXPERT CONSULT COGNITIVE INTERVIEW PILOT TESTED Developed using a four-step process: a) Review of previous studies and surveys on parental health beliefs to develop content domains and draft initial survey items (17 items, 12 from previous instruments and 5 constructed *de novo*); b) Two focus groups of parents and two of pediatricians generated additional themes and survey items (10 additional items, 27 items total); c) Six immunization experts reviewed the items and ranked them on a 1–5 scale. The lowest third of ranked items were dropped (18 items); d) The revised survey was pretested with 25 parents to assess face validity, usability and item understandability. Psychometric evaluation of the measure resulted in 15 items.	Health Belief Model	1. Safety and efficacy (4 items) 2. General attitudes (9 items) 3. Behaviour (2 items)	15 items in long form, 5 items in short form

Vaccine Confidence Scale (VCS) [83] [b]	Gilkey and colleagues	2014 (71)	United States	EXISTING PILOT TESTED Developed using items that were drawn from an existing large national survey (2010 National Immunization Survey-Teen). Eleven items were conceptualised according to the Health Belief Model, with two items of the Parental Attitudes Module assessing parents' relationship with healthcare providers also included. Psychometric evaluation using data from a nationally representative sample of parents of adolescents reduced items to 8, corresponding to three constructs.	Health Belief Model	1. Benefits of vaccination (4 items) 2. Harms of vaccination (2 items) 3. Trust in healthcare providers (2 items)	8 items in long form, 4 items in short form
Vaccine Conspiracy Beliefs Scale (VCBS) [84] [b]	Shapiro and colleagues	2014 (45)	Canada	EXISTING Developed by conducting a scan of the literature. Six items were drawn from existing study on vaccine-specific conspiracy beliefs [85] and one item added by the authors [84].	Not reported	1. Vaccine conspiracy beliefs (7 items)	7 items
Concerns, attitudes, beliefs and intentions of parents about vaccines for their child (CABI-V) [86] [a]	Shoup	2015 (205)	United States	EXISTING EXPERT CONSULT COGNITIVE INTERVIEW PILOT TESTED Developed in three phases: 1) literature review, expert consultation and cognitive interviews; 2) pilot test with 120 pregnant mothers, followed by revisions; 3) revised survey administered to pregnant mothers and parents of children under twelve months of age, and psychometrically evaluated.	Theory of Planned Behavior & Health Belief Model	1. Beliefs about vaccinating (6 items) 2. Evaluation of vaccine-preventable diseases (VPD) / vaccine adverse events (VAE) (8 items) 3. Subjective norms about vaccinating (5 items) 4. Perceived control of vaccinating decisions (4 items)	23 items
Vaccine Hesitancy Scale (VHS) [87,88] [b]	The SAGE Working Group on Vaccine Hesitancy	2015 (216)	Switzerland	EXISTING EXPERT CONSULT PILOT TESTED Developed by conducting a systematic review of existent research, piloting questions in the WHO/UNICEF Joint Reporting Form, and through expert consultation. Three different types of survey questions were included: Core Closed Questions; Likert-type Scale Questions (evaluated below); and a set of Open-Ended Questions.	Health belief Model & Theory of Planned Behaviour; gaps in these	1. Confidence (7 items) 2. Risks (2 items)	10 items (9 in subsequent validation)

					models also identified		
Vaccination Scale (VS) [89]	Horne and colleagues	2015 (221)	United States	NOT REPORTED Method of development not described. Intention of this study was not specifically to develop a measure but to evaluate intervention to counter antivaccination attitudes.	Not reported	1. General vaccine attitudes (5 items)	5 items
Vaccine Confidence Project™[90]	Larson and colleagues	2016 (498)	67 countries	NOT REPORTED The measure is reportedly adapted from the ten-question Likert-type survey proposed by SAGE. Intention of this study was not specifically to develop a measure but to develop a global monitoring tool. It has been applied in multiple countries; the data are publicly available (www.vaccineconfidence.org).	Not reported	1. Vaccine importance (1 item) 2. Vaccine safety (1 item) 3. Vaccine effectiveness (1 item) 4. Religious compatibility (1 item)	4 items
Vaccination Psychological Empowerment Scale (VPES) [91,92]	Fadda and colleagues	2017 (5)	Italy	EXISTING EXPERT CONSULT QUAL/ FG PILOT TESTED Developed an initial item list by examining previous qualitative data (on themes of meaning, competence, impact, and self-determination), literature about psychological empowerment, existing validated empowerment scales and feedback from expert psychologists. The initial item pool was evaluated for content and face validity by a panel of experts in 2015 (57 items). A pretest reduced the initial pool to 9 items, eliminating items without an endorsement frequency between 0.2 and 0.8, and those items without an item-total value higher than 0.3. Three additional items were excluded due to their loading on multiple factors in the principal component analysis.	Empowerment Theory	1. Perceived influence of personal and family experience (2 items) 2. Desire to know peers' opinion and experience (2 items)	4 items
The Vaccination Attitudes Examination (VAX) Scale [93]	Martin and Petrie	2017 (33)	United States	EXISTING QUAL/ FG Developed an initial item-list pool (45 items) by conducting: 1) three 30-min focus groups (one with a group of individuals who favoured vaccination and two with groups of individuals who identified as vaccine-hesitant) recruited from GP waiting rooms, and organized responses into themes; 2) literature review on attitudes towards vaccination; and 3) informal evaluation of the	Not reported; Used Necessity-Concerns Framework to frame findings	1. Mistrust of vaccine benefit (3-items) 2. Worries about unforeseen future effects (3-items) 3. Concerns about commercial profiteering (3-items)	12 items

				content of anti-vaccination websites and blogs. Developed items underwent psychometric evaluation and they retained the three items that best reflected each subscale.		4. Preference for natural immunity (3-items)	
5C Antecedents of Vaccine Acceptance (5C) [24 b]	Betsch and colleagues	2018 (81)	Germany	EXISTING Developed using definitions derived from psychological theories, health behaviour models and existing measures, an item pool (of 35 items) was developed and underwent psychometric evaluation.	Health Belief Model, Theory of Planned Behaviour, 3Cs, 5As	1. Confidence (1 or 3 items) 2. Constraints (1 or 3 items) 3. Complacency 1 or 3 items) 4. Calculation (1 or 3 items) 5. Collective Responsibility (1 or 3 items)	15 items in long-form and 5 items in short form
Vaccine Acceptance Instrument (VAI) [94]	Sarathchandra and colleagues	2018 (24)	United States	EXISTING PILOT TESTED Developed by reviewing literature on existing instruments used to measure vaccine confidence, employing expertise in an iterative fashion to identify most important facets of vaccine acceptance or hesitancy, and producing a set of Likert-type scale items that tap five theoretical and empirical dimensions of vaccine acceptance. Each dimension is measured by 4-item sub-scale of forward-worded and reversed-worded statements. Pilot tested instrument with 196 American Adults in 2015.	Not reported	1. Perceived safety of vaccines (1 or 2 items) 2. Perceived effectiveness and necessity of vaccines (1 or 2 items) 3. Acceptance of the selection and scheduling of vaccines (1 or 2 items) 4. Positive values and affect toward vaccines (1 or 2 items) 5. Perceived legitimacy of authorities to require vaccinations (1 or 2 items)	20 items in long-form and 10 items in short form
Caregiver Vaccination Attitudes Scale (CVAS) [95]	Wallace and colleagues	2019 (7)	Ghana	EXISTING EXPERT CONSULT QUAL/ FG Developed items in a multi-step process: 1) initial draft developed with expert study team; 2) review of existing measures; 3) addition of six items based on discussions with immunization professionals with expertise in African countries; 4) input from caregiver focus group discussions;	Not reported	1. Vaccine benefits (2 items) 2. Past vaccination behaviour (2 items) 3. Vaccine efficacy and safety (2 items)	6 items

				5) final review by Ghana Health Service immunization programme focal points; 6) pilot tested (reducing 11-item version to 6-items based on validity testing).			
Emory Vaccine Confidence Index (EVCI) [96]	Frew and colleagues	2019 (6)	United States	NOT REPORTED Classified 30 individual survey items as they corresponded to the constructs 'Information Environment', 'Trust', 'Healthcare Provider', 'Attitudes and Beliefs', and 'Social Norms', key components of vaccine confidence as defined by the United States National Vaccine Advisory Committee. Methods for developing the specific items are not described. These 30 items were narrowed to 8 items using factor analysis, assessment of coefficients of variation, and the deliberate retention of items related to healthcare providers in order that the measure remained aligned with the advisory committee's definition.	Not reported; items classified according to the advisory committee's definition of vaccine confidence	1. Trust 2. Importance 3. Confidence	8 items

Source. Shapiro et al. 2021.[6]

Note. This table includes only measures for childhood vaccination in general (and not for specific vaccines such as measles, mumps, and rubella). Number of citations from Google Scholar as of January 30, 2021.

[a] Measure added to our review based on expert feedback.

[b] Measure that authors of this review developed.

Table 3. Psychometric properties examined in studies establishing childhood vaccine confidence measures

Measure, year published	Factor structure	Internal consistency reliability	Test-retest reliability	Content validity (Refer to Table 2)	Convergent and discriminant validity	Criterion validity
The Immunization Beliefs and Intentions Measure (IBIM), 2010 [80 a]	X	✓	X	✓	X	✓
Parent Attitudes about Childhood Vaccines (PACV) survey, 2011 [81,82,97-105]	✓	✓	✓	✓	✓	✓
Vaccine Confidence Scale (VCS), 2014 [83,106,107b]	✓	✓	X	X	X	✓
Vaccine Conspiracy Beliefs Scale (VCBS), 2014 [84 b]	✓	✓	X	X	✓	✓
Concerns, attitudes, beliefs and intentions of parents about vaccines for their child (CABI-V), 2015 [86 a]	✓	✓	✓	✓	X	✓
Vaccine Hesitancy Scale (VHS), 2015 [87,88,108-110b]	✓	✓	X	X	✓	✓
Vaccination Scale (VS), 2015 [89]	X	✓	X	X	X	✓
Vaccine Confidence Project™, 2016 [90]	X	X	X	X	X	X
Vaccination Psychological Empowerment Scale (VPES), 2017 [91,92]	✓	✓	X	✓	✓	✓
The Vaccination Attitudes Examination (VAX) Scale, 2017 [93,111]	✓	✓	✓	✓	✓	✓
5C Antecedents of Vaccine Acceptance (5C), 2018 [24 b]	✓	✓	X	X	✓	✓
Vaccine Acceptance Instrument (VAI), 2018 [94]	✓	✓	X	X	✓	X
Caregiver Vaccination Attitudes Scale (CVAS), 2019 [95]	✓	✓	X	✓	X	✓
Emory Vaccine Confidence Index (EVCI), 2019 [96]	✓	✓	X	X	X	✓

Source. Shapiro et al. 2021.[6]

Note. ✓ = Examined in at least one study. X = Not examined. Internal consistency reliability: Examined a measure of the average correlations between pairs of items in the measure. Test-retest reliability: Examined the correlation of the measure administered at two different times. Cognitive interviewing: Used cognitive interviewing techniques to see whether participants assigned the same meaning to the items that researchers intended (see Table 1). Convergent and discriminant validity: Examined whether the measure correlated with conceptually similar scales and not with conceptually unrelated measures. Criterion validity: Examined the correlation of the measure with vaccination intention or behaviour. These definitions came primarily from two sources.[27,28] The codes are based on two coders independent evaluation of the studies. Supplementary Material S2 of the manuscript provides more information on the measures' reliability and validity (see Shapiro et al. 2021).[6]

Factor structure: Examined whether the measure had subscales.

[a] Measure added to our review based on expert feedback.

[b] Measure that authors of this review developed.

Annex B. Key informant interview summary findings and other end-user inputs

Key informant interview summary based on:

K.E. Wiley, D. Levy, G.K. Shapiro, E. Dube, G.K. SteelFisher, N. Sevdalis, F. Ganter-Restrepo, L. Menning, J. Leask. (2021). A User-centered approach to developing a new tool measuring the behavioural and social drivers of vaccination. *Vaccine, [accepted for publication September 4, 2021]*

1. End-users are central to the development and implementation of the BeSD tools

A user-centered approach focuses on the needs of key end-users of an envisioned product and seeks to include their perspectives in the development process. Keeping the end-users central to the development process ensures that their needs will be met by the developed product, increasing the likelihood that those products will be routinely used.

The envisaged end-users of the BeSD tools include in-country and regional immunization programme managers, in-country health authorities, immunization partner organizations and researchers collaborating with programme managers. The BeSD working group has sought to engage these users from the outset, beginning with a scoping exercise to inform design plans for the BeSD tools. We continue to engage with a range of these stakeholders globally, incorporating both solicited and unsolicited feedback as we move through the BeSD development process, iteratively improving the tools as they are tested and used in the field.

2. Initial key informant interviews informed the structure and scope of the tools

The first detailed needs assessment of the envisaged end-users of the BeSD multi-component tool was undertaken between April and August 2019.

We sought to achieve a maximum variation among participant views and experiences, and thematic saturation in the overall findings. We purposively sought participants responsible for immunisation activities in GAVI-eligible and middle-income countries, as well as input from individuals within other health organisations who held roles with a global focus. Semi-structured qualitative interviews explored participant's roles and responsibilities, and what measures and systems they currently use regarding vaccine acceptance and demand. Input was then sought on the structure, envisaged use, and implementation and support requirements for the proposed BeSD tools. A Framework analytical approach was used. A coding framework was developed deductively and inductively based on the interview schedule and themes that emerged from the data as the study progressed.

The twenty interviews were conducted, including six pilot (April-May) and 14 final (June-August). Six participants held roles with regional-level responsibility for WHO, thirteen held roles with responsibility at a country-level within one of those regions, and one held a role in a health agency with global responsibility. Participants included Communication for Development (C4D) Specialists, National Ministry of Health Expanded Programme on Immunization (EPI) Managers, and other WHO and UNICEF staff from all five WHO regions.

Two high-level streams of inquiry arose from this study: (1) the systems and practices currently in use for collecting vaccine-related data and the challenges faced; and, (2) reflections on the proposed BeSD tools (see Table 1).

Table 1. *Streams of inquiry and main thematic findings from participant's responses*

Interview Question Areas	**Main Thematic Findings**
CURRENT SYSTEMS, DATA AND CHALLENGES - Current data uses and practices - Most pressing questions to answer that will help with programme prioritisation	Current systems: - Wide variation in types of data and systems between jurisdictions - Wide variation in frequency of data collection - Wide variation in how data used for programme planning. - Mainly quantitative data used, little qualitative Current challenges: - Data collection and quality o Inaccurate denominator data o Difficult to triangulate different sources o Security issues limiting data collection ability - Technical capacity o Varied between jurisdictions o High staff turnover can impact skill retention within jurisdictions o Use external consultants if no internal capacity. This presents challenge of balancing technical expertise with local cultural knowledge (hard to find both) - Barriers to advocacy for change o Cultural / political sensitivities can present challenges o Sometimes limited capacity for using data to affect change - Areas currently in focus and areas that need to be o Health care provider perspectives also important o Specific reasons for vaccine refusal o Comparable data to enable view of global trends
REFLECTIONS ON THE PROPOSED TOOLS: - Foreseeable barriers to using the tools - Foreseeable uses of the tools and the data they generate - Capacity to conduct qualitative research - Implementation of the tools	- Resources needed o Funding o Capacity - Required attributes of the tools o Cover practical and community factors as well as individual attitudes o Balance between flexibility and standardization o Easy to use - User guidance requirements o Clear, easy to follow o Address sampling, analysis and guidance on how to apply to local cultural settings - Rollout and implementation o Include proof of concept example o Provide facility for continual updates based on learnings from field use o Provide periodic "refresher" updates on the tools

The key informant interviews identified three key areas for support:

1. ***Integration*** **of BeSD into existing systems and processes**
2. **Easy or auto *analyses* of raw data and *presentation* of data for greatest impact**
3. ***Operationalisation*** **of data (how to use it to inform decision-making)**

These findings highlighted the following requirements for the BeSD tools:

- The tools will need to offer a balance between flexibility and standardization: they must be standardized enough to provide a mechanism for global reporting and comparison of data, while flexible enough to be locally adaptable.
- There was an appetite for qualitative and quantitative methods, and a need for capacity building to be able to execute these locally
- The perspectives of healthcare workers, community influencers, and programme managers are needed in addition to caregivers. This informed the inclusion of qualitative interview guides for these groups in the suite of tools.
- The need for a clear user guidance that covers how to modify the tools to be setting-specific; how to sample and analyze the data; how to effectively communicate the findings; and how to make the findings actionable regarding programme planning.

3. End-users continue to occupy a central place in learning about the BeSD tools

End-users have been consulted throughout the iterative process for developing the BeSD tools. This has been achieved through the BeSD working group, where partners involved include prospective end-users, through dissemination of drafts to WHO Regional Offices for comment, input and feedback.

With the publication of the Data for Action Guidebook for COVID-19 vaccination uptake, it has also been possible to solicit feedback from actual end-users. Feedback was sought over informal means (email communication, telephone consultations) and later more formally, in the form of a short survey sent out to users. These probed at what components of the guidebook were used, what worked well, what could be improved, and finally were there any gaps in content.

Actual end-users of the published guidebook included a range of partner organizations and researchers at national, regional and global level supporting health authorities to collect BeSD data. From our end-users we learned that BeSD tools throughout the pandemic have been almost exclusively implemented online, with a few exceptions. This insight has supported narrowing of the guidebook for ease of use, and informed plans for building the various digital components, e.g. tools and templates for analysis.

The end-users continue to have input into the BeSD tool development in the following ways:

- Feedback is actively sought from those who have used the tools in the field, which is documented and incorporated into the next iteration of tool development
- Unsolicited feedback from users is also documented and incorporated
- The results of the initial Key Informant Interviews informed the development of detailed end-user "personas"; these fictional personas are returned to repeatedly to check assumptions and guide the ongoing development of the tools and guidance
- Further iterative developments of implementation plans and the user guidance document will include workshopping activities with groups of end-users
- Working groups responsible for decision-making in the development of the various components of the tools include key end-users, in addition to technical experts

Annex C. Tools for childhood immunization

Childhood vaccination interview guides

There are four adaptable qualitative interview guides indented for use with different audiences: caregivers, health workers, community influencers, and programme managers (national or sub-national level). These guides can be used for in-depth interviews with individuals or used to guide focus group discussions. Questions should be adapted to suit the cultural context of the people being interviewed, and the research question being investigated.

CHILDHOOD VACCINATION INTERVIEW GUIDES – FOR PARENTS AND CAREGIVERS (of children under 5)

BeSD domain	Question / [Instruction]	Rationale
General	*Introduction: Hello, I am [INTERVIEWER'S NAME] with [INSTITUTION OR ORGANIZATION NAME]. We are interviewing people to help improve vaccination services in [NAME OF COUNTRY].* *The interview is expected to take __ minutes. Your participation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me? [if audio recording the interview] Would you be happy for me to record our conversation?*	- Clear introduction to ensure true informed consent for participation is obtained before proceeding
	Tell me a little about yourself and your family Probe: - Who lives in your household with you? - How old is your child / are your children? - Are your children up to date with their vaccines?	- Warm-up question - Enables understanding of the participant's family situation and personal context
Motivation **Social Processes**	**Thinking back to the first time you had your child vaccinated, tell me why you decided that you would go ahead with it.** [If first vaccine was administered at birth, ask about the first time they took their child back for their next set of scheduled vaccines] Probe: - Did anyone suggest it? - Who decided that you should take your child to have their vaccines? - Who usually takes your child(ren) to have their vaccines?	- Aim to understand how the caregiver came to the decision about whether or not to vaccinate their child - Aim to understand who else was involved in the decision

BeSD domain	Question / [Instruction]	Rationale
Social Processes	**Do you talk about vaccination with anyone else?** Probe: - Who do you talk to? - What do they say? - Do other parents you know vaccinate their children?	- Aim to understand what the social norms are for this caregiver (i.e. what is the usual vaccination behaviour of other caregivers in their community)
Practical Factors	**Thinking back to the first time you took your child to have their vaccines, tell me how you knew it was time to do so?** Probe: - What kind of reminders do you use?	- Aim to understand what prompts the caregiver to seek vaccination for their child
Practical Factors	**Thinking about vaccination day for your child, tell me about what happens before you arrive at the place where your child gets their vaccine. Start with before you leave home.** Probe: - What do you need to do to prepare before you leave home? - How do you travel to the vaccination place? **Once you arrive at the vaccination place, tell me what happens next.** Probe: - Who do you talk to when you get there? - What happens in the waiting room or queue? - Do you need to pay a fee? - Are other health checks done while you're there? **What happens when it's your child's turn to get their vaccine?** Probe: - What happens first? - [probe for each step until the vaccination is completed] - What do the health workers talk to you about while you're there? How do you feel when you talk with them? **After your child has had their vaccine, tell me what happens next.** Probe: - What happens when you leave the vaccination place? - How do you travel home? - What happens after you arrive home?	- Aim to understand the practical and logistic considerations the caregiver must address or overcome to get their child vaccinated. - Describe the process they follow on vaccination day - [note: "vaccination place" should be substituted with the correct word for the particular vaccination service the caregiver uses, for example, hospital, clinic etc]
Practical Factors	**What do you like about what happens on vaccination day?** Probe: - Ask about each step described by the caregiver in the question above - [If there is something identified that they like] Why do you like it?	- Aim to understand positive aspects of the vaccination process described

BeSD domain	Question / [Instruction]	Rationale
Practical Factors	**What don't you like about what happens on vaccination day?** Probe: - [If the response is "nothing", list the steps described in the process they describe and ask is there anything they don't like about them individually] - Is there anything you find difficult? Why do you find it difficult?	- Aim to understand any barriers to getting their child vaccinated in detail
Thinking and feeling	**Tell me how you feel about childhood vaccination?** Probe: - Why do you feel this way? - Do you think it's a good thing? Why? - Do you think it's important? Why? - Is there anything you feel isn't good about vaccination? Can you tell me more about it?	- Aim to understand underlying feelings about childhood vaccination in general
Thinking and feeling	**How do you feel when your child is vaccinated?** Probe: - Do you think it's good for your child? Why? - Is there anything that worries you? Why does it worry you?	- Aim to understand their feelings when it comes to vaccinate their child specifically (different from the question above which aims to understand how they feel about vaccination in general)
General	**Is there anything g else you'd like to say?**	- Aim to capture any other issues or thoughts that haven't been captured in previous questions.

CHILDHOOD VACCINATION INTERVIEW GUIDES – FOR HEALTH WORKERS

Question / [Instruction]	Rationale
Introduction: Hello, I am [INTERVIEWER'S NAME] with [INSTITUTION OR ORGANIZATION NAME]. We are interviewing people to help improve vaccination services in [NAME OF COUNTRY]. *The interview is expected to take __ minutes. Your participation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me? [if audio recording the interview] Would you be happy for me to record our conversation?*	- Clear introduction to ensure true informed consent for participation is obtained before proceeding
Tell me a little about yourself and what you do Probe: - What are you responsible for? - How many days do you work in this role?	- Warm-up question - Enables understanding of the participant's professional role - Understanding of the breadth of the participant's responsibilities

Question / [Instruction]	Rationale
- Where do you perform your duties?	- Understanding how many days per week the participant works and where they are situated physically (e.g. do they work at multiple sites)
To what extent does your role involve immunisation? Probe: - What parts of your job involve immunisation? - Can you tell me more about that?	- To understand how much of the participant's role is immunisation-related - To understand in some detail what those immunisation-related responsibilities are
I'd like to understand the process you follow to immunize a child, starting from the very beginning. Probe: - Does it involve work for you even before the family arrives at the center for vaccination? - Can you summarize the procedure of immunization in around 5 steps starting once a family arrives at the center for vaccination? [note: adjust this question for non-clinic settings if required] - Are there are follow ups or steps involved once they leave the center? [note: other probes such on going door-to-door, systems of recording vaccinations, making vaccination cards and so on could be added, as required.]	- This question is for workers who administer immunizations to children. - Aim is to understand the work processes followed by the participant o may shed light on logistic or practical barriers they may encounter when delivering immunization services o may shed light on facilitators that could be applied elsewhere - [Note: The wording of this question is currently framed for a health worker in a clinic-type setting. The wording will have to be adjusted for the approach used in the setting being researched, for example, outreach or mobile vaccination services]
What do you find works in helping families stay up to date with immunisation? Probe: - What helps them not miss doses or appointments? [Note: this is to probe for practical issues] - What helps those who are hesitant about getting their children vaccinated?	- This question is designed to find out what, in the participant's experience, helps keep families up to date with immunizations for their children - [Note: the question is intentionally broad and open-ended so that all possible answers are gathered].
What do you find difficult when it comes to helping families stay up to date with immunisation? Probe: - Which part of the process you described before do you find the hardest to complete? Why is that? - Can you give some examples of reasons people give when their child has fallen behind the vaccination schedule? - Can you give some examples of reasons that people give for refusing vaccines for their children?	- This question is designed to help identify and understand difficulties the participant faces in helping families to keep up to date with vaccinations. - [Note: The suggested probes are to help separate differences between difficulties in the process they describe above, and difficulties they think families experience.]
If you had the chance, what would you do to improve immunisation services in your area?	- Aim to identify any other issues or suggestions not identified in the previous line of questioning - Closing question

CHILDHOOD VACCINATION INTERVIEW GUIDES – FOR COMMUNITY INFLUENCERS (who promote vaccination for children under 5)

Question / [Instruction]	Rationale
Introduction: Hello, I am [INTERVIEWER'S NAME] with [INSTITUTION OR ORGANIZATION NAME]. We are interviewing people to help improve vaccination services in [NAME OF COUNTRY]. *The interview is expected to take __ minutes. Your participation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me? [if audio recording the interview] Would you be happy for me to record our conversation?*	- Clear introduction to ensure true informed consent for participation is obtained before proceeding
Tell me a little about yourself and your role here in the community Probe: - To what extent does your work involve immunization? - Can you tell me more about that? - Who do you work with to do that work?	- Warm-up question - Enables understanding of the participant's role in the community - Understanding of the breadth of the participant's responsibilities

Can you take me through the process you follow when you work in a community?
Probe:
- [Note this probe is for participants who work with families] When you visit a family,
  o What do you talk about?
  o What information can you not leave without saying?
  o Do you follow up with the families afterward? How do you do that?
- [Note: this question is for participants who work with other people and organizations, use as appropriate for the participant]
  o How do you help the front-line health workers in working with families?
  o How do you help with routine immunization?
	- To understand the details of the participant's immunization-related activities
	- [Note: some participants may work directly with families, others work with NGO's and other agencies. The suggested probe questions should be adjusted to suit the participant's setting and role]

What do you find works in helping families stay up to date with their children's immunizations? Probe: - What helps them not miss doses or appointments? [Note: this is to probe for practical issues] - What helps those who are hesitant about getting their children vaccinated?	- This question is designed to find out what, in the participant's experience, helps keep families up to date with immunizations for their children - [Note: the question is intentionally broad and open-ended so that all possible answers are gathered].
What makes it difficult for families stay up to date with immunization? Probe: - Can you give some examples of reasons people give when their child has fallen behind the vaccination schedule? - Can you give some examples of reasons that people give for refusing vaccines for their children? - Are you able to overcome these challenges? How?	- This question is designed to help identify and understand difficulties the participant sees for families to keep up to date with vaccinations in their community.
If you had the chance, what would you do to improve immunisation services in your area?	- Aim to identify any other issues or suggestions not identified in the previous line of questioning - Closing question

CHILDHOOD VACCINATION INTERVIEW GUIDES – FOR PROGRAMME MANAGERS

Question / [Instruction]	Rationale
Introduction: Hello, I am [INTERVIEWER'S NAME] with [INSTITUTION OR ORGANIZATION NAME]. We are interviewing people to help improve vaccination services in [NAME OF COUNTRY]. We're seeking input from people like you who know the processes and the work well. Your views are crucial and very valuable. *The interview is expected to take __ minutes. Your participation is completely voluntary and anonymous. The answers you give will be completely confidential. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take part in an interview with me? [if audio recording the interview] Would you be happy for me to record our conversation?*	- Clear introduction to ensure true informed consent for participation is obtained before proceeding
Tell me a little about yourself and your current role Probe: - To what extent does your work involve childhood immunization? - What kinds of immunization-related activities are you responsible for (e.g. surveillance, campaigns, communications etc) - Can you tell me more about those?	- Warm-up question - Enables understanding of the participant's overall current role - Understanding of the breadth of the participant's responsibilities - Understanding the extent of their immunization-related activities and what those entail.
What makes the provision of childhood immunization a success in your area? Probe: - Are there specific examples you can describe?	- This question is designed to find out what, in the participant's experience, helps keep families up to date with immunizations for their children - [Note: the question is intentionally broad and open-ended so that all possible answers are gathered].
What do you think are the difficulties when it comes to providing childhood immunization in your area? Probe: - Do you face difficulties with children falling behind the vaccination schedule in your area? Can you describe them? - Do you face difficulties with parents refusing vaccines for their children? - Are you able to overcome these challenges? How?	- This question is designed to help identify and understand difficulties the participant sees for families to keep up to date with vaccinations in their jurisdiction.
If you had the chance, what would you do to improve the childhood immunization situation in your area?	- Aim to identify any other issues or suggestions not identified in the previous line of questioning - Closing question

Childhood vaccination survey (and item rationale)

The table below compiles survey items for parents and caregivers to children under 5 (0-59 months). Table cell colours are indicative of the domain (thinking and feeling, social processes, motivation and practical issues).

The BeSD childhood vaccination survey is made up of a total of 20 questions and corresponding response options. To support analyses and use of the BeSD items, included below are also recommended consent script (S0) with adaptable fields for countries to modify and use as appropriate, and six socio-demographic items (S1–S9) for country adaptation. These supplementary items (S0–S9) are considered the minimum necessary for quality data collection and analysis. These can be used and adapted as needed to support the research objectives.

Researchers may also carefully choose to add specific new socio-demographic items to support more granular interpretation of the data. The survey flow adopts the logic of "facts" before "attitudes", and "attitudes" before "intentions", and moves from general immunization items to COVID-19 vaccine specific items. The column "item rationale" contains important information for translation and local adaption of items, including how to adapt items for post-vaccine introduction.

Wording in [square brackets] is to indicate terminology that will likely need to be locally adapted.

Text all in CAPITALS is an instruction for the interviewer and must not be read aloud for participants.

No.	Construct and indicator	Item rationale	Childhood vaccination survey item
S0	**Consent**	This item serves as an example of text to be included to capture respondent's informed consent to their participation in the study. The wording in [square brackets] can be adapted at the local level to reflect accurate information in the relevant fields. Text in ALL CAPITALS is an instruction for the interviewer and must not be read aloud for participants.	Hello, I am [INTERVIEWER'S NAME] with [INSTITUTION OR ORGANIZATION NAME]. We are interviewing people to help improve vaccination services in [NAME OF COUNTRY]. I know you are busy, so this will take only a few minutes. Your participation is completely voluntary and anonymous. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take the survey? ☐ Yes ☐ No IF "YES" TO S0: Thank you very much. Do you have any questions for me before we begin?

			PROCEED TO SURVEY SCREENER AFTER ADDRESSING ANY QUESTIONS. IF “NO” TO S0: Thank you very much. END INTERVIEW.
S1	**Gender**	Item collects gender identity of respondents to allow for stratified analysis. The third response option can be included in contexts where specific third gender categories are culturally recognized; this response option can be adapted as appropriate based on in-country considerations or consultation.	What is your gender? □ Woman □ Man □ Non-binary □ Prefer not to say
S2	**Age**	Item collects age in number of completed years, this will allow for stratified analysis by age of respondents. This item can also serve to screen in or screen out participants for inclusion based on the study sampling methodology.	How old are you? _____ years
S3	**Parent/ caregiver**		Are you the parent or primary caregiver of any children who are younger than 5 years old? □ Yes □ No IF “NO” TO S0: Thank you very much. END INTERVIEW.
S4	**Total number of children**		How many children do you have in total? □ _____ RECORD NUMBER OF CHILDREN
S5	**Number of children under 5**		How many children do you have who are younger than 5 years old? □ _____ RECORD NUMBER OF CHILDREN
S6	**Relationship to child**		What is your relationship to your child? □ Mother □ Father □ Grandparent □ Uncle or Aunt □ Brother or Sister □ Other [IF “OTHER”: Please specify _____]

S7	**Ages of child**		How old is your child? □ _____ years
S8	**Gender of child**		Is your child……? □ Female □ Male □ Non-binary
S9	**Vaccinations status**		[COUNTRY NAME] has a schedule of vaccines for children. As far as you know, has your child had **none** of these vaccines, **some** of these vaccines, or **all** of these vaccines? □ **None** □ **Some** □ **All**
1	**Confidence in vaccine benefits** ***CORE ITEM*** % of parents who think that vaccines are "moderately" or "very" important for their child's health	This item assesses positive attitude toward vaccination of the child. The main idea is that vaccination is good, important, and valuable. A related idea is that vaccination is effective, prevents disease, saves lives, and protects children vaccinated.	How important do you think vaccines are for your child's health? Would you say… □ Not at all important □ A little important □ Moderately important □ Very important
2	**Confidence in vaccine safety** % of parents who think vaccines are "moderately" or "very" safe for their child	This item assesses negative attitude toward vaccination of the child. The main idea is the belief that that vaccination is safe and is not dangerous or harmful. "Do you think" is included so that parents do not see the survey as a test or demeaning them for what they may not know.	How safe do you think vaccines are for your child? Would you say… □ Not at all safe □ A little safe □ Moderately safe □ Very safe
3	**Know where to go to get vaccination** ***CORE ITEM*** % of parents who know where to get their child vaccinated	This item assesses whether the parent knows where to take the child for vaccination. The item is about knowing that the facility or vaccine provider exists and where it is located. The item is not about ability to access or use the services.	Do you know where to go to get your child vaccinated? □ No □ Yes

4	**Took child for vaccination** % of parents who have taken child for vaccination	This item assesses whether the parent, personally, has been with the child when the child went a vaccine provider. This item sets up a skip pattern for later items about their experience with the providers.	Have you personally ever taken your youngest child to get vaccinated? ☐ No ☐ Yes
5	**Missed or delayed vaccination** % of parents who have never missed or delayed child's vaccination % of parents who have been contacted about missed or delayed vaccination for child	This item has two purposes, it assesses follow-up mechanisms in place when parents who missed or delayed vaccines for their child. "Missed" refers to parents who skipped a vaccination session intentionally or unintentionally; either because they forgot, were unable to make the appointment, or did not want the vaccine "Delayed" includes parents who intentionally postpones vaccination having made a conscious decision to get a vaccine later than what was recommended.	Have you ever been contacted about missed or delayed vaccination for your youngest child? ☐ No ☐ Yes ☐ I have never missed or delayed my child's vaccination
6	**Intention to get child vaccinated** ***CORE ITEM*** % of parents who want their child to get "all" of the recommended vaccines	This item assesses intention to get the child vaccinated. "Want" is similar to desire, prefer, like, plan, and intend. It might identify a plan for future action but can also be about willingness. "Recommended" is similar to advised, suggested, standard or nationally recommended; it refers to the national vaccination schedule of recommended vaccines for children. The text in square brackets is to be locally adapted to include the country name.	[COUNTRY NAME] has a schedule of recommended vaccines for children. Do you want your child to get **none** of these vaccines, **some** of these vaccines, or **all** of these vaccines? ☐ None ☐ Some ☐ All
7	**Mother's travel autonomy** ***OPTIONAL ITEM*** % of mothers who do not need permission to take child for vaccination	This item assesses freedom of women to leave the home to get the child vaccinated. "Time to get vaccinated" is similar to the child being due for vaccines. "Clinic" refers to the clinic, doctor's office, primary care practice, vaccination clinic, centre, or mobile service that delivers the vaccines for the child.	IF RESPONDENT IS THE MOTHER OF THE CHILD: If it was time for your child to get vaccinated, would you need permission to take your child to the clinic? IF RESPONDENT IS **NOT** THE MOTHER OF THE CHILD: If it was time for your child to get vaccinated, would the mother need permission to take your child to the clinic? No Yes
8	**Descriptive social norms** % of parents who think most parents they know will get their children vaccinated	This item assesses descriptive social norms—beliefs about what other parents are doing. "Most parents you know" includes friends, people at work, and people in the neighbourhood who they may not have close social ties to. It does not include people they have never met.	Do you think most parents you know get their children vaccinated? No Yes

9	**Family norms** ***CORE ITEM*** % of parents who think most of their close family and friends want their child to be vaccinated	This item assesses injunctive social norms— beliefs about what close social contacts want the parent to do. "Close family and friends" include people with opinions the parent would listen to or feel some degree of pressure to heed.	Do you think most of your close family and friends want you to get your child vaccinated? No Yes
10	**Religious leader norms** ***OPTIONAL ITEM*** % of parents who think their religious leaders support vaccination	This item assesses injunctive social norms—beliefs about what opinion leaders want the parent to do. "Religious leader" includes priests, clerics, imams, rabbis and others in similar roles.	Do you think your religious leaders want you to get your child vaccinated? Yes No
11	**Community leader norms** % of parents who think their community leaders support vaccination	This item assesses injunctive social norms—beliefs about what opinion leaders want the parent to do. "Community" may refer to a neighbourhood or region or a social group defined by a characteristic such as race or national origin. "Community leader" includes people who represent a neighbourhood, region, or subgroup of people.	Do you think your community leaders want you to get your child vaccinated? No Yes
12	**Confidence in providers** ***OPTIONAL ITEM*** % of parents who trust the health care providers who give children vaccines "moderately" or "very much"	This item assesses confidence in people who provide vaccines. "Trust" refers to belief that the provider will be competent, reliable and give good health care. "Health care provider" will need local adaptation to indicate the medical professionals responsible for recommending and administering childhood vaccination (i.e. general practitioner, or paediatrician and assisting nurses or vaccinators)	IF RESPONDENT ANSWERED "NONE" TO WHICH VACCINES THEIR CHILD HAS HAD: How much do you trust the health care providers who give children vaccines? Would you say you trust them… IF RESPONDENT ANSWERED "ALL" OR "SOME" TO WHICH VACCINES THEIR CHILD HAS HAD: How much do you trust the health care providers who give your child vaccines? Would you say you trust them… Not at all A little Moderately Very much
13	**Provider recommendation** % of parents who say a health care provider has recommended vaccines for their child	This item assesses whether the parent recalls a medical professional or health provider recommending vaccination. "Recommended" includes raising the topic during a clinic visit, saying the child is due, and offering advice to get the child vaccinated. The term health care provider must be locally adapted to indicate the medical professional most likely to	Has a health care provider recommended your child be vaccinated? ☐ No ☐ Yes

		/responsible for recommending childhood vaccination (i.e. general practitioner, or paediatrician)	
14	**Ease of access** % of parents who say it is "very" or "moderately" easy to get vaccination services	This item assesses the degree to which vaccination is easy to get for child. The item looks at ease-of-access in general and leads-into the next question. "Easy" refers to achievable, possible without great effort, not hard, and not difficult. "Vaccination services" refers to access to vaccination.	How easy is it to get vaccination services for your child? Would you say… ☐ Not at all easy ☐ A little easy ☐ Moderately easy ☐ Very easy
15	**Reasons for low ease of access** % of parents who say "nothing" makes it hard to access vaccination % of parents who say "getting to the clinic is hard" % of parents who say "clinic opening times are inconvenient" % of parents who say sometimes the clinic "turns people away" % of parents who say the "waiting time takes too long"	This item assesses the reasons why vaccination is difficult to get for the child. "hard to get to" refers to geographical distance and barriers related to transportation. "Inconvenient" refers to opening hours that do not suit the parent. "turns people away" refers to the clinic sending people, who came specifically for vaccination, home without vaccination. "Takes too long" refers to the waiting times at the clinic.	ASK IF "NOT AT ALL", "A LITTLE", OR "MODERATELY" AT CVS_14, OTHERWISE SKIP: What makes it hard to get vaccination services for your child? Check all that apply. ☐ Nothing. It's not hard. ☐ Getting to the clinic is hard ☐ The clinic opening times are inconvenient ☐ The clinic sometimes turns people away without vaccinating ☐ The waiting time in the clinic takes too long ☐ Something else, please specify: _____
16	**Affordability** ***CORE ITEM*** % of parents who say vaccination is "moderately" or "very" easy to pay for	This item assesses the perceived cost of vaccination. Cost is the monetary value associated with vaccination. "easy to pay" refers to the total costs associated with vaccinating being something the parent can pay for, costing an amount the parent can pay for, and being within the parent's means.	How easy is it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, plus the cost of taking time away from work. Would you say… Not at all easy A little easy Moderately easy Very easy
17	**Vaccination availability** % of parents who have never been turned away from vaccination	This item assesses the experience of going to the vaccination clinic and not receiving vaccination for the child that day. "Turned away" refers to staff at the clinic saying the vaccine is not available, a sign saying the clinic is out of	Have you ever been turned away when you tried to get your child vaccinated? ☐ No ☐ Yes

		stock, or being unable to see a vaccine provider because of other problems at the clinic.	
18	**Service satisfaction** % of parents who are "very" or "moderately" satisfied with vaccination services	This item assesses satisfaction with vaccination services received during the last visit. "Satisfied" refers to how good the services and experience was for the parent, how pleased or happy they felt about the visit and the interactions that took place. "Vaccination services" refers to work done by vaccination clinic staff who greet the patient, handle paperwork and payment, and administer the vaccine. "Not at all" is bad and not acceptable. "Not very" is okay, adequate, and not bad. "Somewhat" is positive but not the best possible. "Very" is great, fantastic and outstanding.	ASK IF "YES" AT CVS_4, OTHERWISE SKIP: During your last visit, how satisfied were you with the vaccination services? Would you say… ☐ Not at all satisfied ☐ A little satisfied ☐ Moderately satisfied ☐ Very satisfied
19	**Service quality** % of parents who say "vaccine was not available" % of parents who say "the clinic did not open on time" % of parents who "waited a long time" % of parents who say "the clinic was not clean" % of parents who say "staff was poorly trained" % of parents who say "staff were not respectful" % of parents who say "staff did not spend enough time" with them	This item assesses reasons why the parent was not satisfied with their last vaccination visit. "the clinic did not open on time" refers to the clinic not operating as per the hours advertised. "I waited a long time" is the perception that the service was poorly organised for time, staff unable to prioritize efficient, quick service. "the clinic was not clean" refers to any complaint about the place where vaccines are given; including location and building structure. This includes lack of cleanliness, poor maintenance. This could include vaccine vials, needles, fridges for storing vaccines but also furniture in the clinic, reception and waiting rooms, or even appearance of personnel, such as appropriate attire, clean appearance, and uniforms. "Staff seemed poorly trained" is the perception that the service received is not as promised, the quality of service is not reliable or consistent. The perception that staff did not fulfil their role very well, that the staff is not well trained or prepared for their responsibilities, lacked confidence or skill to deliver the service expected. "Staff were not respectful" is inability to inspire confidence, put parents at ease and communicate competence. It includes staff being discourteous, impolite and unable to	ASK IF "NOT AT ALL" OR "A LITTLE" AT CVS_18, OTHERWISE SKIP: What was not satisfactory about the vaccination services? Check all that apply. ☐ Vaccine was not available ☐ The clinic did not open on time ☐ I waited a long time ☐ The clinic was not clean ☐ Staff seemed poorly trained ☐ Staff were not respectful ☐ Staff did not spend enough time with me ☐ Something else, please specify: _____

		reassure parents. Staff can show respect in verbal and non-verbal ways. "Staff did not spend enough time with me" is the perceived lack of empathy a parent may experience from vaccination clinic staff, and perception of a rushed service or lack of time dedicated to reassure parents and or answer any of their questions.	
20	**Information needs** % of parents who say their concerns about vaccination were addressed during vaccination appointment	This item assesses unmet informational needs from parents. "Concern" is similar to worry or thinking about a problem; it is not directly about fear or anxiety or emotion, it could relate to any questions the parent had at the time of the appointment related to vaccines and vaccination.	Do you have any concerns about vaccination for your child that were not addressed at your last visit to the vaccination clinic? ☐ No ☐ Yes

Annex D. Tools for COVID-19 vaccination

COVID-19 vaccination interview guides for adults and health workers

The questions below are designed to be asked in a context where a COVID-19 vaccine is available. In contexts where multiple vaccines are available for use, questions should be modified and refer to "the COVID-19 vaccine**s**" accordingly. In this instance it may be useful to understand whether perceptions, norms and willingness to accept a COVID-19 vaccine is dependent on which vaccine is being offered; interviewers should use probes for all vaccines available in the local context.

If these questions are to be used in a context where a COVID-19 vaccine is not yet available, then the questions will need to be modified accordingly. For example, the COVID-19 vaccine confidence question, "How do you feel about the COVID-19 vaccine" would be modified for a pre-vaccine rollout context by adjusting the wording to, "How do you think you'll feel about the COVID-19 vaccine when it becomes available?".

Some questions will be worded differently, depending on whether the interviewee has had the vaccine or not. In these questions wording for both scenarios is included. Choose the wording that is appropriate for the interviewee.

Table cell colours are indicative of the domain (thinking and feeling, social processes, motivation and practical issues).

Construct	Adult	Health worker	Rationale
General	Tell me a little about yourself	Tell me a little about yourself Tell me a little about your role	— Warm-up question — Orients interviewer to participant's situation
Thoughts and feelings			
Perceived COVID-19 risk – self	Tell me, how concerned are you about getting COVID-19? Probe: — Why do you feel that way? — How likely do you think it is? — How severe do you think it would be?	Tell me, how concerned are you about getting COVID-19? Probe: — Why do you feel that way? — How likely do you think it is? — How severe do you think it would be?	— Understand the participant's perceived risk due to COVID-19 (disease, not vaccine) — Will tie in with later question about getting COVID-19 vaccine when available
Perceived risk – to patients	n/a	Tell me what you think about the risk that you could give COVID-19 to your patients?	— Understand participant's perceived risk of infecting others
COVID-19 stigma **(social pressures)**	n/a	Being a health care worker, how are you usually treated by others in the community? Probe: - Have you noticed anything different in how you're treated since the pandemic?	— Enables probing for the presence of/experience of stigma, which will tie in with vaccine question below
COVID-19 vaccine information	What have you heard about the COVID-19 vaccine(s)? Probe: — Have you heard anything that worries you? — Who did you hear this from? — Do you think it's true? Why? — Have you heard anything that makes you feel positive about the vaccines that are being developed?	What have you heard about the COVID-19 vaccine(s)? Probe: — Have you heard anything that worries you? — Who did you hear this from? — Have you heard anything that makes you feel positive about the vaccines that are being developed?	— Ask what they know about the vaccine – enables probing for positive or negative information

COVID-19 vaccine confidence	How do you feel about the COVID-19 vaccine(s)? Probes: — If multiple vaccines available, what are the perceptions of each? — Relate back to perceived COVID-19 risk, and how important it is — Importance in protecting others — Alignment with spiritual or religious beliefs (ask for all COVID-19 vaccines available) — What are your thoughts about the safety of the vaccine? (ask for all COVID-19 vaccines available) — Newness — Thoughts on whether it works (ask for all COVID-19 vaccines available)	How do you feel about the COVID-19 vaccine(s)? Probes: — If multiple vaccines available, what are the perceptions of each? — Relate back to perceived COVID-19 risk, and how important it is — Importance in protecting others — Alignment with spiritual or religious beliefs (ask for all COVID-19 vaccines available) — What are your thoughts about the safety of the vaccine? (ask for all COVID-19 vaccines available) — Newness — Thoughts on whether it works (ask for all COVID-19 vaccines available)	— Elicits the participant's confidence in the vaccine, probe questions will cover the different aspects, such as safety, importance etc.
COVID-19 vaccine confidence in providers	n/a	n/a	Trust in health providers will be covered in service satisfaction below
Motivation			
COVID-19 vaccine intention	Have you thought about getting a COVID-19 vaccine? What did you decide? (Why?) *Follow on to next question (combine)*	Have you thought about getting a COVID-19 vaccine? What did you decide?? (Why?) *Follow on to next question (combine)*	— Elicits what their intentions and decisions are towards the vaccine. "Why" probe may be repetitive of questions answered above, might be a good point to triangulate their responses
Social processes			
COVID-19 vaccine – decision process	Take me through how you will or have decided whether to get a COVID-19 vaccine Probe: — Was there anyone else involved in the decision? — Who else did you discuss it with?	Take me through how you will or have decided whether to get a COVID-19 vaccine Probe: — Was there anyone else involved in the decision? — Who did you discuss it with? — Is it a requirement from your employer?	— Covers decision autonomy, but also the decision-making process more broadly, with a view to understanding what kinds of social processes might be involved

COVID-19 vaccine – safe to see family and friends	(if already had the vaccine) Has getting a COVID-19 vaccine changed things for you? (If haven't had the vaccine) How do you think getting a COVID-19 vaccine might change things for you? Probe: — See family and friends — going out in public — Going back to work	(if already had the vaccine) Has getting a COVID-19 vaccine changed things for you? (If haven't had the vaccine) How do you think getting a COVID-19 vaccine might change things for you? Probe: — See family and friends — Going out in public	— This covers the item in the survey, but has been expanded to look for unexpected ways a COVID-19 vaccine might impact people
COVID-19 vaccine stigma	n/a	(If they answered in the affirmative to the stigma question above): Do you think having the COVID-19 vaccine will help / has helped with the stigma we spoke about earlier? Why?	This question is really only relevant if the participant describes any kind of stigma in the question above. Suggest not asking if they don't report having experienced or heard of it happening
COVID-19 vaccine – travel autonomy	n/a	n/a	Travel autonomy covered in practical factors below
COVID vaccine — Descriptive social norms — Family norms — Religious leader norms — Workplace norms	If a COVID-19 vaccine is recommended by health care workers, what do you think other people will do? Probe: — Family and friends — Religious or community leaders recommend? — If more than one vaccine available; is this true for all COVID-19 vaccines or does it depend on which vaccine is recommended?	If a COVID-19 vaccine is recommended by health care workers, what do you think other people will do? Probe: — Family and friends — Religious or community leaders recommend? — What do you think your work colleagues will do? — If more than one vaccine available; is this true for all COVID-19 vaccines or does it depend on which vaccine is recommended?	— Elicits what they anticipate will be the social norms regarding uptake of COVID-19 vaccination
Provider recommendation	What do you think your health care provider's recommendation will be to you about the COVID-19 vaccine(s)?	What do you think your health care provider's recommendation will be to you about the COVID-19 vaccine(s)?	— Anticipated recommendations
General provider recommendation (any adult vaccine)	n/a	n/a	General provider recommendation covered in practical issues below

Practical issues			
Ever gone to get vaccines	Did you have any vaccines as a child? What do you remember about it? Probe: — Experiences, good and bad Have you ever had a vaccine as an adult? Have you ever had one recommended to you by a health care worker? (If previously vaccinated as an adult): Thinking about when you got that vaccine, what did you think was good about what happened in the clinic? Was there anything that wasn't good?	Have you ever had a vaccine as an adult? Have you ever had one recommended to you by a health care worker? What about your employer? (If previously vaccinated as an adult): When you got that vaccine, what did you think was good about what happened in the clinic? Was there anything that wasn't good? What do you think might work better for you next time?	— Start with past general vaccination experiences, including, if applicable, service satisfaction in past experiences
COVID-19 vaccine – — On-site vaccine availability — access — General vaccination – know where to get vaccines — Vaccination availability — General vaccine – affordability — General vaccine – service satisfaction — General vaccine – service quality	Can you take me through how you would get / how you got a COVID-19 vaccine? Start at the beginning Probe: — Would / did you need to ask permission? — Where would / did you go to get it? — How would / did you get there? — What other things would / did you need to do (e.g. find care for young children, find someone to take care of livelihood/get up earlier to take care of household duties) — Would there be / was there any cost involved for you (not just for vaccine, but things like transport) — How much do you trust the health care worker who will give you the vaccine? What would make it easy for you to get a COVID-19 vaccine if it was recommended and available? / What would make it easier for you to get a COVID-19 vaccine?	Can you take me through how you would get / how you got a COVID-19 vaccine? Start at the beginning Probe: — Would / did you need to ask permission? — Where would / did you go to get it? (Is the vaccine available at your workplace?) — How would / did you get there? — Would / did you have to do it in your own time (not while you're on duty)? — Would there be / was there any cost involved for you (not just for vaccine, but things like transport) — How much do you trust the health care worker who will give you the vaccine? What would make it easy for you to get a COVID-19 vaccine if it was recommended and available? / What would make it easier for you to get a COVID-19 vaccine?	— Ask for a narrative of how they might access the vaccine, covering things like cost, missed workdays, transport, any permissions needed etc. — Also cover what they feel might make accessing the vaccine easier for them
Close	Is there anything else you'd like to say?	Is there anything else you'd like to say?	Leave option for unexpected findings, or elaboration on things expressed previously.

COVID-19 vaccination survey (and item rationale)

The table below compiles survey items for both adults and health workers. Table cell colours are indicative of the domain (thinking and feeling, social processes, motivation and practical issues).

A total of 21 BeSD items apply to adults, and up to 28 BeSD items can apply to respondents who are health workers. To supplement the BeSD COVID-19 items, included below are also recommended consent script (S0) with adaptable fields for countries to modify and use as appropriate, and six socio-demographic items (S1–S6) for country adaptation. These supplementary items (S0–S6) are considered the minimum necessary for quality data collection and analysis. These can be used and adapted as needed to support the research objectives.

Researchers may also carefully choose to add specific new socio-demographic items to support more granular interpretation of the data. The survey flow adopts the logic of "facts" before "attitudes", and "attitudes" before "intentions", and moves from general immunization items to COVID-19 vaccine specific items. The column "item rationale" contains important information for translation and local adaption of items, including how to adapt items for post-vaccine introduction.

Wording in [square brackets] is to indicate terminology that will likely need to be locally adapted. Countries may also adapt the term "COVID-19" throughout the survey where a colloquial term is better understood, such as "corona virus".

Text all in CAPITALS is an instruction for the interviewer and must not be read aloud for participants.

	Construct and indicator	**Item rationale**	**Adult item**	**Health worker item**
S0	**Consent**	This item serves as an example of text to be included to capture respondent's informed consent to their participation in the study. The wording in [square brackets] can be adapted at the local level to reflect accurate information in the relevant fields. Text in ALL CAPITALS is an instruction for the interviewer and must not be read aloud for participants.	Hello, I am [INTERVIEWER'S NAME] with [INSTITUTION OR ORGANIZATION NAME]. We are interviewing people to help improve vaccination services in [NAME OF COUNTRY]. I will be asking you questions about COVID-19. I know you are busy, so this will take only a few minutes. Your participation is completely voluntary and anonymous. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take the survey? ☐ Yes ☐ No	[same as Adult]

			IF "YES" TO S0: Thank you very much. Do you have any questions for me before we begin? PROCEED TO SURVEY SCREENER AFTER ADDRESSING ANY QUESTIONS. IF "NO" TO S0: Thank you very much. END INTERVIEW.	
S1	**Age**	Item collects age in number of completed years, this will allow for stratified analysis by age of respondents. This item can also serve to screen in or screen out participants for inclusion based on the study sampling methodology.	How old are you? _____ years	[same as Adult]
S2	**Gender**	Item collects gender identity of respondents to allow for stratified analysis. The third response option can be included in contexts where specific third gender categories are culturally recognized; this response option can be adapted as appropriate based on in-country considerations or consultation. For in-person interviews the question should be rephrased to: "This may seem obvious, but I have to ask, what is your gender?"	What is your gender? ☐ Woman ☐ Man ☐ Nonbinary ☐ Prefer not to say	[same as Adult]
S3	**Occupation**	This item enables sorting of respondents for the right survey as needed. Inclusion of this item will allow analysis for intentions to be stratified by whether someone is a priority occupational group or not. This item can also serve to screen in or screen out participants for inclusion based on the study sampling methodology. "Essential services worker" refers to other non-health frontline workers (e.g. police, transport service workers, grocery store staff, etc.). The categories may be locally adapted to ensure they are appropriate to the specific context and allow for disaggregated data as needed. Some countries may choose to delineate between frontline and non-frontline health workers.	Which of the following best describes your work during the COVID-19 pandemic? ☐ Health worker ☐ Essential services worker ☐ Educator ☐ Other worker ROUTE TO HCW SURVEY IF "Health worker" SELCTED, OTHERWISE ADULT SURVEY.	[same as Adult]
S4	**Health worker**	This item allows for categorization of health workers into common roles or functions within the health system. If included, this item enables more detailed analysis of health worker role and stratification of results.	N/A	What is your current role? ☐ Doctor ☐ Nurse ☐ Paramedic/first responder

		The response options offered should be adapted in-country at national or even subnational level to reflect the most appropriate role categorizations based on the types of health workers most likely to be at risk of COVID-19 infection/most exposed to COVID-19.		☐ Allied health ☐ Community health worker ☐ Traditional healer ☐ Other health worker
S5	**COVID-19 risk**	This item assesses whether the respondent has any underlying illness, comorbidities or health conditions that make the respondent a higher priority for vaccination. Inclusion of this item would allow for stratification of results by comorbidities. This item can also serve to screen in or screen out participants for inclusion based on the study sampling methodology.	Do you have a chronic illness? This could include for example obesity, diabetes, lung disease, or another long-term illness? ☐ No ☐ Yes ☐ Not sure	[same as Adult]
S6	**COVID-19 diagnosis**	Previous infection with COVID-19 can be perceived as a reason to not vaccinate, and countries may want to stratify data on intentions to be vaccinated according this. This item can also serve to screen in or screen out participants for inclusion based on the study sampling methodology. When a COVID-19 vaccine becomes available in-country, researchers may choose to include an item to assess whether the respondent has received a COVID-19 vaccine. If several are available in the country, an item to ask which vaccine the respondent received may also be added.	To your knowledge, are you, or have you been, infected with COVID-19? ☐ No ☐ Yes IF "YES": Was it mild or severe? ☐ Mild ☐ Severe Was it confirmed by a test? ☐ Confirmed by a test ☐ Not confirmed by a test	[same as Adult]
1	**Past vaccination** % of adults / health workers who received adult vaccines (answered "yes")	This item assesses whether the respondent has ever received any vaccine (including e.g. seasonal influenza vaccine) as an adult. This refers to existing vaccines, already on the immunization programme schedule in countries where a life course approach is taken. A "not sure" response option is included here as it is likely some older adults may not easily be able to recall such information. In some contexts, it may be helpful to add the following text: "In case you are not aware, vaccines prevent people from getting diseases like COVID-19 or tetanus. Vaccines are usually given by a needle or orally."	Have you ever received a vaccine as an adult? ☐ No ☐ Yes ☐ Not sure	[same as Adult]

		This is text to introduce the next set of questions and facilitate the flow of the survey. Countries may choose the list the names of the COVID-19 vaccines available If COVID-19 vaccines are not yet available in your country this prime should be removed.	The next questions are about COVID-19 vaccines.	[same as Adult]
2	**Know where to get vaccination** ***CORE ITEM*** % of adults / health workers who know where to get a COVID-19 vaccine for themselves	This item assesses whether the respondent knows where to go for vaccination. The item is about knowing that the facility or vaccine provider exists and where it is located. The item is not about ability to access or use the services. If COVID-19 vaccines are not yet available in your country, adapt the item to: Do you know where to go to get yourself vaccinated? ☐ Yes ☐ No	Do you know where to go to get a COVID-19 vaccine for yourself? ☐ No ☐ Yes	[same as Adult]
3	**COVID-19 vaccine uptake** % of adults / health workers who received a COVID-19 vaccine (answered "yes")	This item assesses whether the respondent has ever received any dose of a COVID-19 vaccine. A "not sure" response option is included here as it is likely some older adults may not easily be able to recall such information.	Have you received a COVID-19 vaccine? ☐ No ☐ Yes ☐ Not sure	[same as Adult]
4	**COVID-19 vaccine series completion** % of adults / health workers who are fully vaccinated	This item assesses whether the respondent has completed their COVID-19 vaccination schedule in full.	IF "YES" HAS RECEIVED COVID-19 VACCINE, ASK: Do you still need another dose of COVID-19 vaccine or are you fully vaccinated? ☐ Fully vaccinated ☐ Need another dose	[same as Adult]
5	**Reminder** ***OPTIONAL ITEM*** % of adults / health workers who have been contacted about being due for a COVID-19 vaccine (answered "yes")	This item assesses mechanisms in place to reach and remind adults due for vaccination. If these systems/mechanisms are not in place in country, we recommend that this item not be included.	Have you ever been contacted about being due for a COVID-19 vaccine? ☐ No ☐ Yes ☐ Not sure	[same as Adult]

6	**Recall** ***OPTIONAL ITEM*** % of adults / health workers who have been contacted about missed COVID-19 vaccination	This item assesses mechanisms in place to recall adults who may have missed a COVID-19 vaccine. If these systems/mechanisms are not in place in country, we recommend that this item not be included.	Have you ever been contacted about a *missed* COVID-19 vaccination? ☐ No ☐ Yes ☐ Not sure	[same as Adult]
7	**Service satisfaction** % of adults / health workers who were "very" or "moderately" satisfied with the COVID-19 vaccination services (answered "yes")	This item assesses satisfaction with vaccination services received during the last visit. "Satisfied" refers to how good the services and experience was for the parent, how pleased or happy they felt about the visit and the interactions that took place. "Vaccination services" refers to work done by vaccination clinic staff who greet the patient, handle paperwork and payment, and administer the vaccine. "Not at all" is bad and not acceptable. "Not very" is okay, adequate, and not bad. "Somewhat" is positive but not the best possible. "Very" is great, fantastic and outstanding.	ASK IF RECEIVED AT LEAST ONE DOSE OF COVID-19 VACCINE, OTHERWISE SKIP: How satisfied were you with the COVID-19 vaccination services? ☐ Not at all satisfied ☐ A little satisfied ☐ Moderately satisfied ☐ Very satisfied	[same as Adult]
8	**Service quality** % of adults / health workers who say vaccine was not available % of adults / health workers who say the vaccination site did not open one time % of adults / health workers who say they waited a long time % of adults / health workers who say the vaccination site was not clean	This item assesses reasons why the parent was not satisfied with their last vaccination visit. "site did not open on time" means that the service operating hours were not functioning as scheduled or advertised. "I waited a long time" is the perception that the service was poorly organised for time, staff unable to prioritize efficient, quick service. "the clinic was not clean" refers to any complaint about the place where vaccines are given; including location and building structure. This includes lack of cleanliness, poor maintenance. This could include vaccine vials, needles, fridges for storing vaccines but also furniture in the clinic, reception and waiting rooms, or even appearance of personnel, such as appropriate attire, clean appearance, and uniforms.	ASK IF "NOT AT ALL" OR "A LITTLE" SATISFIED WITH SERVICES DURING LAST VISIT, OTHERWISE SKIP: What was not satisfactory about the vaccination services? Check all that apply. ☐ Vaccine was not available ☐ The vaccination site did not open on time ☐ I waited a long time ☐ The vaccination site was not clean ☐ Staff seemed poorly trained ☐ Staff were not respectful ☐ Staff did not spend enough time with me ☐ Something else, please specify: _____	[same as Adult]

	% of adults / health workers who say staff seemed poorly trained % of adults / health workers who say staff were not respectful % of adults / health workers who say staff did not spend enough time with them	"Staff seemed poorly trained" is the perception that the service received is not as promised, the quality of service is not reliable or consistent. The perception that staff did not fulfil their role very well, that the staff is not well trained or prepared for their responsibilities, lacked confidence or skill to deliver the service expected. "Staff were not respectful" is inability to inspire confidence, put parents at ease and communicate competence. It includes staff being discourteous, impolite and unable to reassure parents. Staff can show respect in verbal and non-verbal ways. "Staff did not spend enough time with me" is the perceived lack of empathy a parent may experience from vaccination clinic staff, and perception of a rushed service or lack of time dedicated to reassuring parents and or answer any of their questions.		
9	**On-site vaccination** % of adults / health workers who have access to a COVID-19 vaccine at their place of work (answered "yes")	This item assesses availability or existence of vaccination services at work (on site) for health workers only. This item can also be applied to adults in countries where it is not uncommon to offer adult vaccines in workplaces. A "not sure" response option is included here as some may not be aware of the presence of any on-site vaccination in their place of work. If COVID-19 vaccines are not yet available in your country, adapt the item to: Have any vaccines ever been available for you to get at your place of work? Yes No Not sure	Is a COVID-19 vaccine available for you to get at your place of work? ☐ No ☐ Yes ☐ Not sure	[same as Adult]
10	**Ease of access** % of adults / health workers who say getting COVID-19	This item assesses the degree to which vaccination is easy to get for themselves. The item looks at ease of access in general and leads into the next question.	How easy is it to get a COVID-19 vaccine for yourself? Would you say… ☐ Not at all easy ☐ A little easy	[same as Adult]

	vaccination is "moderately" or "very" easy	"Easy" refers to achievable, possible without great effort, not hard, and not difficult. "Vaccination services" refers to access to vaccination. If COVID-19 vaccines are not yet available in your country, adapt the item to: How easy is it to get vaccination services for yourself? Not at all easy A little easy Moderately easy Very easy	☐ Moderately easy ☐ Very easy	
11	**Reasons for low ease of access** % of adults / health workers who say COVID-19 vaccination is not yet available for them % of adults / health workers who say making an appointment is hard % of adults / health workers who say they can't go on their own % of adults / health workers who say the vaccination site is hard to get to % of adults / health workers who say vaccination opening	This item assesses the reasons why vaccination is difficult to get. Respondents can choose multiple response options here. There is no skip logic for this item, it must be asked of all respondents. Response options explained: ▪ "I can't go on my own" is to capture people with mobility impairment who cannot travel without assistance. ▪ "Too far away" refers to geographical distance. ▪ "Inconvenient" refers to opening hours that do not suit the respondent. ▪ "Turns people away" refers to sending people, who came specifically for vaccination, home without vaccination. ▪ "Takes too long" refers to the waiting times at the place of vaccination. ▪ "Costs too much" refers to the cost of the vaccine as well as any additional costs associated with vaccination (transport, the cost of taking time away from work, or payments to the vaccine provider/clinic). ▪ "Unable to leave work duties" refers to the health worker being unable to make time	What makes it hard for you to get a COVID-19 vaccine? Check all that apply. ☐ COVID-19 vaccination is not yet available for me ☐ Making an appointment is hard ☐ I can't go on my own (I have a physical limitation) ☐ The vaccination site is hard to get to ☐ The opening times are inconvenient ☐ Sometimes people are turned away without vaccination ☐ The waiting time takes too long ☐ Something else, please specify: _____ ☐ Nothing. It's not hard	What makes it hard for you to get vaccines? Check all that apply. ☐ Nothing. It's not hard ☐ Making an appointment is hard ☐ The opening times are inconvenient ☐ I am unable to leave work duties ☐ There is no on-site vaccination at my place of work ☐ Mobile vaccination is not available ☐ The waiting time is too long ☐ Something else, please specify: _____

	times are inconvenient % of adults / health workers who say sometimes people are turned away without vaccination % of adults / health workers who say the waiting time takes too long	for vaccination along their work responsibilities. ▪ "No on-site vaccine" addressed here as a barrier to vaccination to allow for discrete analysis within this item. ▪ "Mobile vaccination" refers to outreach immunization services for health workers in the community. If COVID-19 vaccines are not yet available in your country, adapt the item to: What makes it hard for you to get vaccines? Choose all that apply. REMOVE THE RESPONSE OPTION: COVID-19 vaccination is not yet available for me		
12	**Affordability** ***CORE ITEM*** % of adults / health workers who say vaccination is "moderately" or "very" easy to pay for.	This item assesses the perceived cost of vaccination. Cost is the monetary value associated with vaccination. "easy to pay" refers to the total costs associated with vaccinating being something the parent can pay for, costing an amount the parent can pay for, and being within the parent's means.	How easy it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, and plus the cost of taking time away from work. Would you say… Not at all easy A little easy Moderately easy Very easy	[same as Adult]
13	**Perceived risk – self** ***OPTIONAL ITEM*** % of adults / health workers who are "moderately" or "very" concerned about getting COVID-19	This item assesses the degree to which the respondent perceives a risk of getting COVID-19 themselves. "Concern" is similar to worry or thinking about a problem; it is not directly about fear or anxiety or emotion.	How concerned are you about getting COVID-19? Not at all concerned A little concerned Moderately concerned Very concerned	[same as Adult]
14	**Perceived risk – family and friends** % of adults / health workers who are "moderately" or "very" concerned about their close family and friends getting COVID-19 from them	This item assesses the degree to which the respondent perceives a risk of giving COVID-19 to their close family and friends; the people in their immediate social circles, with whom they have frequent and close contact. This item only applies to health care workers. "Concern" is similar to worry or thinking about a problem; it is not directly about fear or anxiety or emotion.	How concerned are you about your close family and friends getting COVID-19 from you? Not at all concerned A little concerned Moderately concerned Very concerned	[same as Adult]

15	**Perceived risk – patients** % of health workers who are "moderately" or "very" concerned about patients getting COVID-19 from them	This item assesses the degree to which the respondent perceives a risk of giving COVID-19 to their patients. This item only applied to health care workers. "Concern" is similar to worry or thinking about a problem; it is not directly about fear or anxiety or emotion.	N/A	How concerned are you about patients getting COVID-19 from you? ☐ Not at all concerned ☐ A little concerned ☐ Moderately concerned ☐ Very concerned
16	**COVID-19 stigma** % of health workers who have been treated poorly during the COVID-19 pandemic because of their work	This item assesses whether a health worker believes they have been treated negatively, discriminated against, or stigmatized because of their job as a health worker during the COVID-19 pandemic. This could include treatment such as harassment or even social exclusion (the belief that others avoid them because they are at risk of getting and infecting others with COVID-19).	N/A	Have you been treated poorly during the COVID-19 pandemic because you are a health worker? ☐ No ☐ Yes ☐ Not sure
17	**Confidence in COVID-19 vaccine benefits** ***CORE ITEM*** "moderately or "very"% of adults / health workers who think a COVID-19 vaccine is "moderately" or "very" important for their health	This item assesses positive attitude toward COVID-19 vaccination. The main idea is that vaccination is good, important and valuable. A related idea is that vaccination is effective, prevents disease, saves lives and protects those vaccinated.	How important do you think getting a COVID-19 vaccine will be for your health? Would you say… ☐ Not at all important ☐ A little important ☐ Moderately important ☐ Very important	[same as Adult]
19	**Confidence in COVID-19 vaccine safety**	This item assesses negative attitude toward COVID-19 vaccination for themselves. The main idea is the belief that the vaccine is safe and is not dangerous or harmful. BeSD offers two items (19&20) that assess this general concept, acknowledging that the word "safety" may not translate well across all languages. Countries should choose whether they want to include one or both. If the concept "safety" translates satisfactorily we recommend use of this question (19) over question 20.	How safe do you think a COVID-19 vaccine will be for you? Would you say… ☐ Not at all safe ☐ A little safe ☐ Moderately safe ☐ Very safe	[same as Adult]
21	**Intention to get vaccinated** ***CORE ITEM***	This item assesses intention to receive a COVID-19 vaccine, if a medical professional advises them to do so.	ASK ONLY IF NOT ALREADY RECEIVED A COVID-19 VACCINE If a COVID-19 vaccine is available to you, will you get it?	[same as Adult]

	% of adults / health workers who will get a COVID-19 vaccine if it is available to them	Countries can choose to add an open text follow up question for those who answer "no": What is the main reason you would not get a COVID-19 vaccine if it were available to you?? [OPEN TEXT RESPONSE]	☐ No ☐ Yes ☐ Not sure	
23	**Vaccine confidence – brand** % of adults / health workers who will take a COVID-19 vaccine recommended to them regardless of brand	This item assess whether the availability of particular vaccine brands make a difference to the individual's willingness to accept COVID-19 vaccines. Where only one brand is available in the country, we recommend countries do not include this item as it may cause confusion or misleading perceptions.	Does the brand of vaccine matter to you? ☐ No, I will take the COVID-19 vaccine recommended to me regardless of brand. ☐ No, I don't plan to have a COVID-19 vaccine at all. ☐ Yes, I plan to only accept a specific brand of vaccine.	[same as Adult]
24	**Willingness to recommend vaccine to others** % of health workers who would recommending a COVID-19 vaccine to eligible individuals (answered "yes")	This item assesses health workers' willingness to recommend or promote a COVID-19 vaccine to persons who are eligible candidates for COVID-19 vaccines. If COVID-19 vaccines are not yet available in your country, adapt the item to: Would you recommend a COVID-19 vaccine to eligible individuals, when it becomes available? Yes No Not sure	N/A	Would you recommend a COVID-19 vaccine to eligible individuals? ☐ No ☐ Yes ☐ Not sure
25	**Preferred site for vaccination** % of adults / health workers who would prefer to get a COVID-19 vaccine at a hospital % of adults / health workers who would prefer to get a COVID-19 vaccine at a health centre / clinic	This item assesses respondents' preferred location to receive a COVID-19 vaccine. There is no skip logic for this item, it must be asked of all respondents. Response options must be locally adapted to reflect the sites or locations most likely to be considered for the administration or delivery of a COVID-19 vaccine.	Where would you prefer to get a COVID-19 vaccine? Check all that apply. ☐ Hospital ☐ Health centre/clinic ☐ Workplace ☐ Pharmacy ☐ Community centre, meeting hall, or local shop ☐ School ☐ Somewhere else, please specify: _____ ☐ I don't want the vaccine	[same as Adult]

	% of adults / health workers who would prefer to get a COVID-19 vaccine at their workplace % of adults / health workers who would prefer to get a COVID-19 vaccine at a pharmacy % of adults / health workers who would prefer to get a COVID-19 vaccine at a community centre, meeting hall or local shop % of adults / health workers who would prefer to get a COVID-19 vaccine at a school			
26	**Ability to answer patient questions** % of health workers who are "moderately" or "very" confident they could answer patient questions about getting a COVID-19 vaccine	This item measures positive attitude of health workers' capacity to support patients with their information needs about a COVID-19 vaccine once it becomes available. If COVID-19 vaccines are not yet available in your country, adapt the item to: How confident are you that you could answer patient questions about getting a COVID-19 vaccine, once it is available? Not at all confident A little confident Moderately confident Very confident	N/A	How confident are you that you could answer patient questions about getting a COVID-19 vaccine? ☐ Not at all confident ☐ A little confident ☐ Moderately confident ☐ Very confident
27	**Gender equity – decision autonomy** % of adults who have decision making	This item assesses whether respondents have autonomy or joint decision-making abilities for COVID-19 vaccination. "Final say" refers to the last word, the main decider, a decision that no one else in the family can easily override.	In your family, who makes the decision about whether you get a COVID-19 vaccine? ☐ Me ☐ My spouse/partner	N/A

	autonomy about whether they get a COVID-19 vaccine	Data can be stratified by gender to assesses women's role in decisions about vaccination.	☐ My mother ☐ My father ☐ My mother-in-law ☐ My father-in-law ☐ My daughter(s) ☐ My son(s) ☐ Someone else, please specify: _____	
28	**Gender equity – travel autonomy** % of adults who do not need permission to go and get a COVID-19 vaccine	This item assesses freedom of the respondent to leave the home to get a COVID-19 vaccine. Data can be stratified by gender to assesses women's travel autonomy.	If it was time for you to get a COVID-19 vaccine, would you need permission to go and get it? ☐ No ☐ Yes	N/A
	Prime	This is text to introduce the next set of questions and facilitate the flow of the survey.	For the next questions, imagine that a COVID-19 vaccine is recommended for you.	[same as Adult]
29	**Family norms** ***CORE ITEM*** % of adults / health workers who think most of their close family and friends would want them to get a COVID-19 vaccine	This item assesses injunctive social norms—beliefs about what close social contacts want the respondent to do. "Close family and friends" include people with opinions the respondent would listen to or feel some degree of pressure to heed.	Do you think most of your close family and friends would want you to get a COVID-19 vaccine? No Yes Not sure	[same as Adult]
30	**Religious leader norms** % of adults / health workers who think their religious leaders would want them to get a COVID-19 vaccine (answered "yes" or "not sure")	This item assesses injunctive social norms—beliefs about what opinion leaders want the respondent to do. "Religious leader" includes priests, clerics, imams, rabbis and others in similar roles.	Do you think your religious leaders would want you to get a COVID-19 vaccine? No Yes Not sure	[same as Adult]
31	**Community leader norms** % of adults / health workers who think	This item assesses injunctive social norms—beliefs about what opinion leaders want the respondent to do.	Do you think other community leaders would want you to get a COVID-19 vaccine? No Yes Not sure	[same as Adult]

	their community leaders would want them to get a COVID-19 vaccine (answered "yes" or "not sure")	"Community" may refer to a neighbourhood or region or a social group defined by a characteristic such as race or national origin. "Community leader" includes people who represent a neighbourhood, region or subgroup of people.		
32	**Descriptive social norms** % of adults who think most adults they know will get a COVID-19 vaccine (answered "yes")	This item assesses descriptive social norms—beliefs about what other people are doing. "Most adults you know" includes friends, people at work, and people in the neighbourhood who they may not have close social ties to. It does not include people they have never met. This item does <u>not</u> apply to health workers, a specific health worker item is offered below to correspond.	Do you think most adults you know will get a COVID-19 vaccine, if it is recommended to them? No Yes Not sure	N/A
33	**Workplace norms** % of health workers who think most of the people they work with will get a COVID-19 vaccine	This item assesses descriptive social norms—beliefs about what other people are doing. "Most people you work with" includes all colleagues and people at their place of work who could be eligible for a COVID-19 vaccine. This item does <u>not</u> apply to adults, a specific adult item is offered above to correspond.	N/A	Do you think most of the people you work with will get a COVID-19 vaccine? No Yes Not sure I am not currently working
35	**Confidence in providers** ***OPTIONAL ITEM*** % of adults / health workers who trust the health care providers who give COVID-19 vaccines "moderately" or "very"	This item assesses confidence in the people responsible for recommending and administering vaccines. "Trust" refers to belief that the provider will be competent, reliable and give good health care. "Health care provider" will need local adaptation to indicate the medical professionals responsible for recommending and/or administering adult vaccination (i.e. general practitioner, or primary health care physician and assisting nurses or vaccinators).	How much do you trust the health care providers who would give you a COVID-19 vaccine? Would you say you trust them… ☐ Not at all ☐ A little ☐ Moderately ☐ Very much	[same as Adult]

Annex E. Data for Action Guidebook

The Data for Action Guidebook is available at the following link:

https://drive.google.com/drive/folders/12RNby1fyLBcfJnmW5Pm4GcRdD2MOEVuf

(A WHO web page will soon make all tools and guidance easily available – and will serve as a place for future sharing of key trends and all related documentation.)

Annex F. Report on validation of the childhood vaccination survey

1 Overview

Our goal was to select a long- and short-subset of items measuring the behavioral and social drivers of parents' decision about whether to vaccinate their children in LMICs. The selected items should maximize power to predict child vaccination uptake with little overlap between items and without large variation in measurement quality across country or responder characteristics. This report describes how we used a calibration sample (N=1212) to quantify individual item importance for predicting vaccination, conduct exploratory and confirmatory factor analyses to identify overlap and to visualize item information curves, and to assess differential item functioning and prediction by respondent gender, education, and country. We also assess generalizability of prediction results using a confirmatory sample (N=613).

2 Dataset descriptions

The childhood vaccination survey was conducted in 6 LMICs: Angola (N=300), Ethiopia (N=301), DRC (N=309), Nigeria (N=300), India (N=305), and Pakistan (N=304). In total, there were survey responses from N=1819 parents of young children. About 22% of respondents (N=408) reported attaining lower secondary school education or less, 42% of respondents (N=773) reported attaining more than upper-secondary education, and 35% of respondents (N=638) reported attaining an upper-secondary school education. All respondents selected either "male" (44%, N=799) or "female" (56%, N=1020) gender. Most respondents (71%, N=1295) indicated that their children were up to date on all of the recommended immunizations, 26%(N=466) indicated that their children had received some of the recommended immunizations, and a minority (3%, N=58) indicated that their children had received none of the recommended immunizations.

3 Preliminary Data Checking and Cleaning

Items were coded so that higher values indicate more positive (pro-vaccine) responses. Q19 (What makes it hard to get vaccination services for your child?) was only asked if a respondent said that it was "not at all" or "a little" easy to get vaccination services for their child (Q18). Q22 (During your last visit, how satisfied were you with your vaccination services?) was only asked if parents reported having personally taken their youngest child to get vaccinated (Q5). In turn, Q23 (What was not satisfactory about your vaccination services?) was only asked if a respondent answered Q22 and indicated that they were "not at all" or "a little" satisfied. Given these dependencies, Q19, Q22, and Q23 were eliminated from the current analysis. The items included in this analysis, and their response frequencies, are listed on Table 1.

Sparseness in the lowest category was common and response categories with sparse cell counts were collapsed. Even after collapsing the two lowest categories, answers tended to be heavily skewed in favor of "pro-vaccination" responses. Low endorsement of lower categories was particularly notable in Q1TFIMP, Q24TFCON, Q4PWHERE, Q7MWANT, Q9SPWHO, Q14SPREL, and Q15SPCOM. We will keep this in mind as one criteria on which to base our decision about which items to eliminate for our short scales.

We used a stratified random sampling approach to randomly select 2/3 of cases (N=1213) within each country to serve as the *calibration sample* to examine the psychometric properties of the items. The other 606 cases were reserved for use as the *confirmation sample* to confirm the added predictive value of the shorter item sets.

Table 1: Childhood vaccination survey item frequencies

Label	Item Response Option	Frequency (%)
Thoughts and Feelings		
Q1TFIMP	How important do you think vaccines are for your child' s health?	
	Not at all or a little (collapsed)	44 (2)
	Moderately	182 (10)
	Very	1592 (88)
Q2TFPRO	How much do you think vaccinating children protects other people in your community from diseases? Not at all or a little (collapsed)	82 (5)
	Moderately	312 (17)
	Very	1425 (78)
Q3TFSAFE	How safe do you think vaccines are for your child?	
	Not at all or a little (collapsed)	70 (4)
	Moderately	325 (18)
	Very	1424 (78)
Q24TFCON	Do you have any concerns about vaccination for your child that were not addressed at your last visit to the vaccination clinic?	
	Yes No	273 (15)
	How much do you trust the health care providers who give children vaccines?	1546 (85)
	Not at all or a little (collapsed)	
Q16SPTRU	Moderately	183 (11)
	A lot	536 (29)
		1100 (60)
Social Processes		
Q9SPWHO	Who made the decision about getting your child vaccinated?	
	Father alone, grandparent, or other	296 (16)
	Mother alone or mother and father jointly	1523 (84)
Q12SPPAR	Do you think most parents you know get their children vaccinated?	
	No	323 (18)
	Yes	1450 (82)
Q13SPCLO	Do you think most of your close family and friends want you to get your child vaccinated?	
	No	147 (8)
	Yes	1629 (92)
Q14SPREL	Do your religious leaders want you to get your child vaccinated?	
	No	219 (13)
	Yes	1428 (87)
Q15SPCOM	Do you think your community leaders or religious leaders want you to get your child vaccinated?	
	No	178 (10)
	Yes	1537 (90)
Q10SPPER	Would mother need permission to get child vaccinated	
	Yes	709 (39)
	No	1110 (61)
Q17MREC	Has a health care provider recommended your child be vaccinated?	
	No	477 (26)
	Yes	1342 (74)
Q11MBAD	In the last year, have you seen or heard anything bad about vaccines?	
	Yes	378 (21)
	No	1441 (79)
Intentions		
Q7MWANT	Your country has a schedule of vaccines for children. Do you want your children to get...	
	None	65 (4)
	SomeAll	209 (11)
	How willing are you for your child to get these vaccines?	1545 (85)
Q8MWILL	Not at all or a little (collapsed)	
	Moderately	44 (3)
	Very	256 (15)
		1454 (83)
Practical Issues		
Q4PWHERE	Do you know where to go to get your child vaccinated?	
	No	145 (8)
	Yes	1674 (92)
Q5PTAKE	Have you ever personally taken your child to get vaccinated?	
	No	477 (26)
	Yes	1342 (74)
Q18PEASY	How easy is it to get vaccination services for your child?	
	Not at all or a little (collapsed)	180 (10)
	Moderately	559 (31)
	Very	1080 (59)
Q20PPAY	How easy it to pay for vaccination (includes any payments to the clinic, the cost of getting there, and the cost of taking time away from work)	
	Not at all A	109 (6)
	little	236 (13)
	Moderately	638 (35)
	Very	836 (46)
	Have you ever been turned away when you tried to get your child vaccinated?	
Q21PAWAY	Yes	285 (16)
	No	1534 (84)

Table 2: Bivariate item - vaccination association

Label	Item	Polychoric Correlation
Thoughts and Feelings		
Q1TFIMP	How important do you think vaccines are for your child's health?	***.27***
Q2TFPRO	How much do you think vaccinating children protects other people in your community from diseases?	***.24***
Q3TFSAFE	How safe do you think vaccines are for your child?	***.16***
Q24TFCON	Do you have any concerns about vaccination for your child that were not addressed at your last visit to the vaccination clinic?	**.12**
Q16SPTRU	How much do you trust the health care providers who give children vaccines?	**.11**
Social Processes		
Q9SPWHO	Who made the decision about getting your child vaccinated?	.08
Q12SPPAR	Do you think most parents you know get their children vaccinated?	***.22***
Q13SPCLO	Do you think most of your close family and friends want you to get your child vaccinated?	***.24***
Q14SPREL	Do your religious leaders want you to get your child vaccinated?	-.05
Q15SPCOM	Do you think your community leaders want you to get your child vaccinated?	-.01
Q10SPPERM	Would mother need permission to get child vaccinated	***.18***
Q17MREC	Has a health care provider recommended your child be vaccinated?	**.12**
Q11MBAD	In the last year, have you seen or heard anything bad about vaccines?	.06
Intentions		
Q7MWANT	Your country has a schedule of vaccines for children. Do you want your children to get...	***.52***
Q8MWILL	How willing are you for your child to get these vaccines?	***.21***
Practical Issues		
Q4PWHERE	Do you know where to go to get your child vaccinated?	***.32***
Q5PTAKE	Have you ever personally taken your child to get vaccinated?	***.21***
Q18PEASY	How easy is it to get vaccination services for your child?	***.18***
Q20PPAY	How easy it to pay for vaccination (includes any payments to the clinic, the cost of getting there, and the cost of taking time away from work)	***.30***
Q21PAWAY	Have you ever been turned away when you tried to get your child vaccinated?	**.22**

Note. Bold correlations are significant at $p < .05$. Italicized correlations are significant at $p < .01$.

3 Prediction Quality

3.1 Bivariate Associations

An item's ability to predict vaccine uptake is its most important feature. Table 2 displays polychoric correlations between an ordinal measure of vaccine uptake (S9VAXED: child has had none of the recommended vaccines, some of the recommended vaccines, or all of the recommended vaccines) and each of the items. Since all of the items are either ordinal or binary and S9VAXED is ordinal, a polychoric correlation is the most appropriate measure of association. As shown in Table 2, items range from a near-zero association with vaccination (r = .01 for Q15SPCOM, r = .05 for S15SPREL, r = .06 for Q11MBAD, and r = .08 for Q9SPWHO) to a moderate association of r = .52 with Q7MWANT.

3.2 Multivariate Associations and Variable Importance

While bivariate associations are informative, patterns of collinearity amongst items are also important to consider when choosing an item set for prediction. We calculated the *importance* of each of the items in predicting vaccination status (fully vaccinated) or not using a random forest model. Random forest models iterate across many subsamples within the data, generating a decision tree each time. Results from these simple decision tree models are combined in a random forest model to identify which predictors were highly predictive of vaccination status in many models. Item importance is depicted in Figure 1.

Results from the random forest show that Q7MWANT (which had a polychoric correlation with vaccination status ρ = .52) is the most important predictor of vaccine uptake, followed by Q20PPAY (ρ = .30). Q8MWILL (ρ = .21), Q18PEASY (ρ = .18), and Q2TFPRO (ρ = .24) are tied for the third position. While all of these important items have moderately high bivariate polychoric correlations with vaccine uptake, not all of the items with moderately high bivariate polychoric correlations with vaccine uptake were identified as being uniquely important for prediction of vaccine uptake. In particular, Q4PWHERE (ρ = .32), Q21PAWAY (ρ = .22), and Q13SPCLO (ρ = .24) have moderately bivariate correlations with vaccine uptake, but when considered jointly with the full set of items, they are not important.

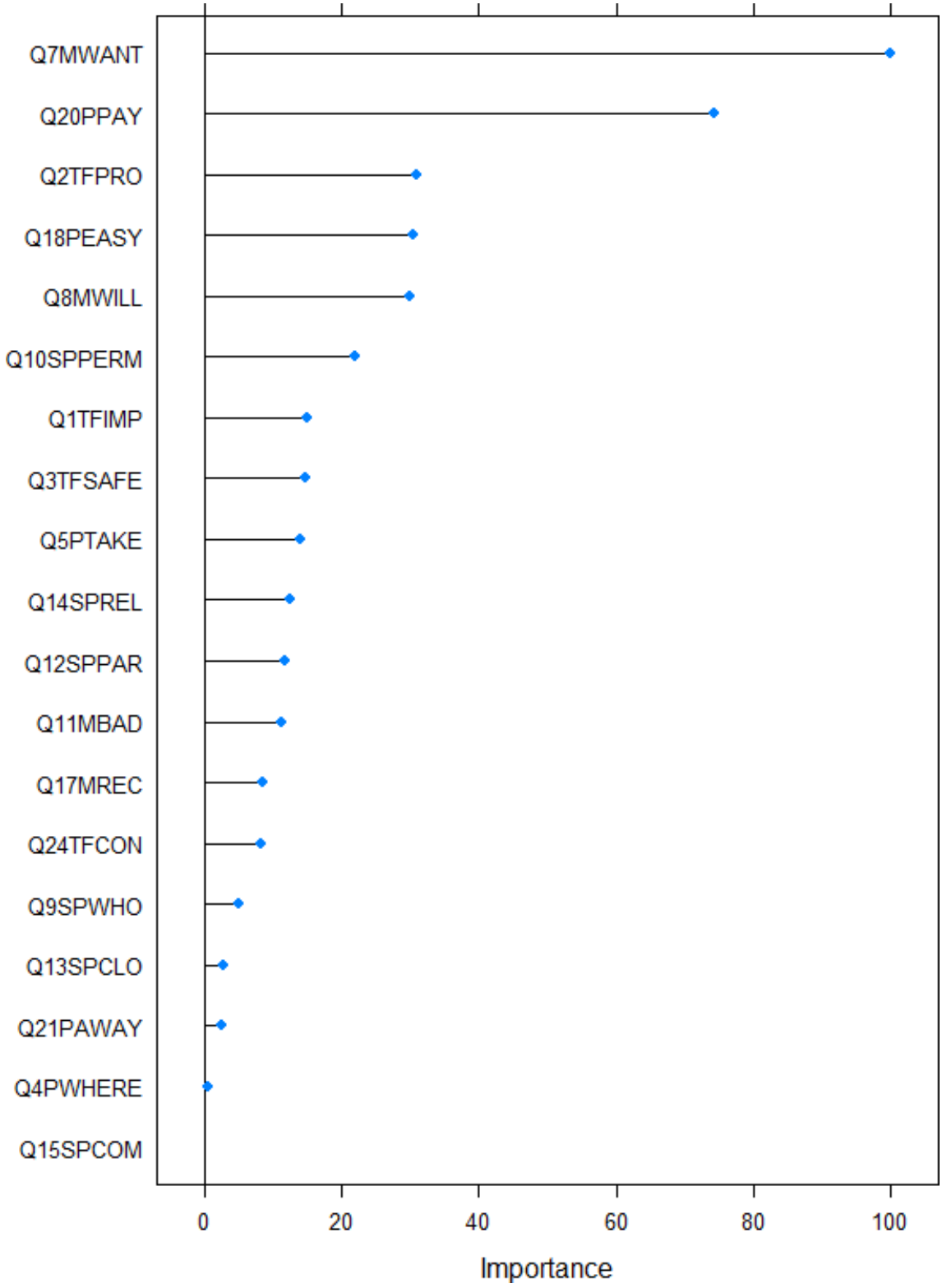


Figure 1: Item importance

3.3 Differential Prediction

To evaluate whether any item's association with child vaccination status varied as a function of country, gender, or educational status, we tested the significance of the global effect of each of these factors as a moderator in a logistic regression analysis by using a chi-square difference test between the fit of a logistic regression model that included main effects only versus a logistic regression model that included main effects and interactions between each item and country, education level, or gender. We used a separate model for each item to avoid problems with multicollinearity. We used a conservative alpha level of .01 due to concern about multiple testing. Only one item, Q5PTAKE, was differentially associated with child vaccination status. Gender and country significantly moderated its association with childhood vaccination status. Given this information, Q5PTAKE could be a candidate for removal. It is reassuring that the predictive quality of the items under consideration does not appear to be strongly influenced by country, gender, or educational status of the respondent.

4 Exploratory Factor Analysis

Items on the childhood vaccination survey were developed using scientific expertise, cognitive interviews, and theory to suggest that *Thoughts and Feelings*, *Practical Issues*, *Motivation*, and *Social Processes* are the intervenable factors that give rise to vaccination uptake. Ideally, each of these concepts should be represented in our reduced item sets. To aid with this, we conducted an exploratory factor analysis (EFA) to: 1) determine whether items load as expected (because unexpected loading patterns might be a concern); and 2) to identify local dependence between items due to shared loading on the underlying latent construct, or due to some shared measurement noise. We used robust standard errors to account for clustering within countries. We used WLSMV estimation with a probit link function for modeling response probabilities for the binary and ordinal items. We extracted 1- to 6-factor solutions with oblique (promax) rotation. The resulting scree plot is shown in Figure 2.

The scree plot suggests that one primary factor accounts for most of the covariance between items, but that there are several additional subfactors. A common rule-of-thumb is to extract factors with eigenvalues greater than one. We note that there are 6 factors with eigenvalues over one but conduct additional in- depth analysis to determine dimensionality. Table 2 compares fit indices for 1- through 6-factor solutions. The 6-factor solution was significantly better than the 5-factor solution. Results from the 6-factor solution are shown in Table 3. Factor loadings indicate how closely an item is related to the latent construct (i.e., "discrimination"). A standardized loading of 1 indicates that 100% of the variance in the item is attributable to the latent construct. Items with lower loadings are explained by other factors not associated with the latent variable(s) on which they load.

Factor inter-correlations for the 6-factor solution ranged from -.08 to .45 (between factors 2 and 3). Factors 1 and 2 were correlated .39 and factors 3 and 4 were correlated .32. All other correlations were small in magnitude.

The first factor appears to be associated with *Thoughts and Feelings* (including the "want" and "willing" items that were considered to be *Motivation* items. The second factor has to do with familiarity with the clinic location and having taken a child to get a vaccine before. The third factor has to do with convenience and feasibility of going to the clinic (*Practical Issues*). The fourth factor has to do with concerns or negative feelings about the clinic or the vaccine. Interestingly, the item assessing maternal choice in children's vaccine decisions loads on this factor. The fifth factor has to do with normative beliefs, and the sixth factor has to do with identification as a person within a group who gets their children vaccinated.

An item's communality is a measure of the degree to which the item correlates with the latent variables that underlie the covariance amongst the full set of items. An item with low communality may contain a lot of noise unrelated to the theoretical behavioral or social drivers of interest, but low communality does not necessarily give us justification to reject an item in this case since our goal is to identify a set of *unique*, relatively uncorrelated items. Thus, we may decide to select one item from each factor that is both reflective of the underlying construct *and* has high predictive power.

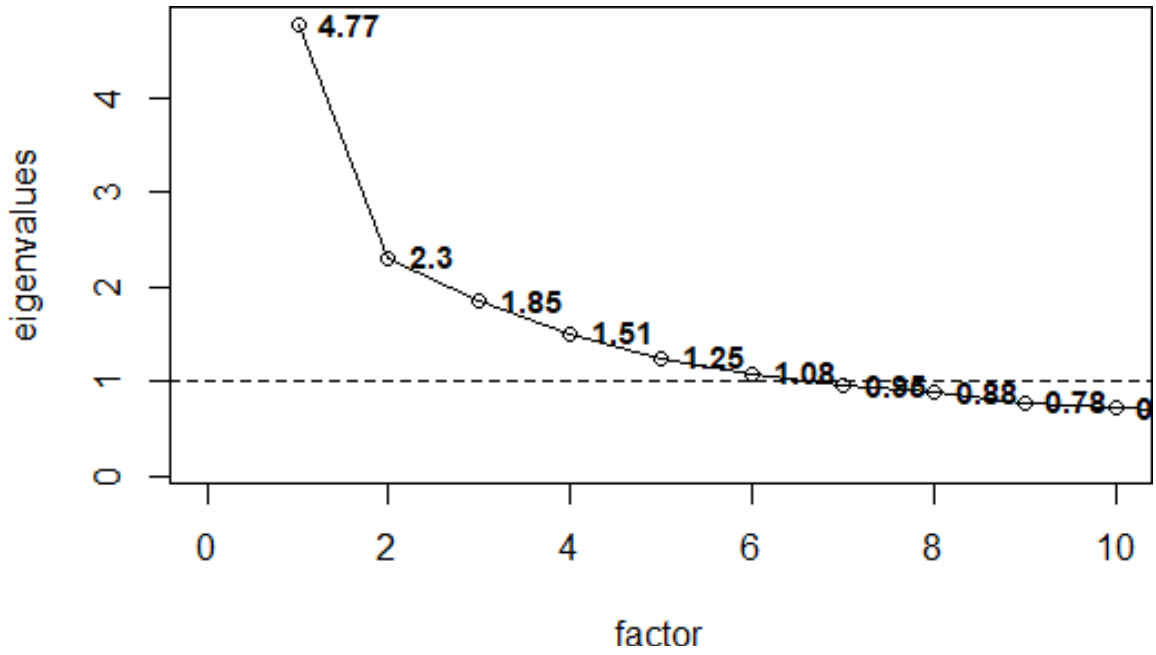


Figure 2: Scree plot

Table 3: Exploratory Factor Analysis Results

***k* Factors**	**Chi-Square "Badness of Fit" Test (vs. Saturated Model): χ^2 (df), *p*-value**	**Chi-Square Difference Test (vs. k-1 solution): χ^2 (df), *p*-value**	**CFI**	**TFI**	**RMSEA (90% CI)**
1	315.15 (170) $p < .001$	-	.75	.73	.03 (.02,.03)
2	220.36 (151) $p < .001$	231.54 (19) $p < .001$	.88	.85	.02 (.01,.03)
3	201.91 (133) $p < 0.001$	34.45 (18) $p = 0.011$	.88	.83	.02 (.02,.03)
4	159.13 (116) $p = 0.005$	76.14 (17) $p < .001$	.93	.88	.02 (.01,.02)
5	124.305 (100) $p = 0.050$	45.508 (16) $p < 0.001$	.96	.92	.01 (0,.02)
6	100.239 (85) $p = 0.124$	32.873 (15) $p = 0.005$	.97	.94	.01 (0,.02)

Note. Chi-square difference tests apply the Satorra-Bentler scaling correction necessary for use with WLSMV
CFI=Confirmatory Fit Index; TLI=Tucker Lewis Indiex; RMSEA=Root Mean Square Error of Approximation

Table 4: Factor loadings for 6-factor EFA solution

Item	Factor						Communality
	1 *Confidence and Intentions*	2 *Familiarity*	3 *Access*	4 *Negativity*	5 *Community Norms*	6 *Family Norms*	
Q1TFIMP	.87						.77
Q2TFPRO	.77						.64
Q3TFSAFE	.74						.68
Q24TFCON				.55			.33
Q4PWHERE		.80					.69
Q5PTAKE		.82					.63
Q18PEASY			.79				.74
Q20PPAY			.54				.42
Q21PAWAY			.40	.58			.41
Q7MWANT	.33					.39	.45
Q8MWILL	.67					.41	.43
Q11MBAD				.41			.72
Q17MREC							.24
Q9SPWHO		.35		.36			.33
Q12SPPAR						.67	.51
Q13SPCLO					.52	.87	.95
Q14SPREL					.89		.83
Q15SPCOM					1.00		1.00
Q10SPPERM							.12
Q16SPTRU	.38		.37				.53

Note. Loadings under .3 are suppressed. All reported loadings are statistically significant.

Q10SPPERM (whether the mother needs permission to vaccinate her child), Q17MREC (whether a provider has recommended the vaccine), Q9SPWHO (whether the mom decides to get the child vaccinated), Q24TFCON (whether there are concerns that have not been addressed by the provider), Q20PPAY (how easy it is easy topay), Q21PAWAY (being turned away), and Q7MWANT (wanting all of the vaccines) have low communality.

When we take information from the predictive analysis and the EFA together, Q4PWHERE, Q9SPWHO, Q15SPCOM, and Q21PAWAY are candidate items for discarding to form a shorter instrument.

5 Confirmatory Factor Analysis and Item Information

We now consider the strength and nature of the relationship of each item to its underlying factor(s). We conducted confirmatory factor analysis (CFA) models, which impose restrictions on factor loadings to arrive at a "simple structure," meaning that most items are associated with only one underlying factor. The association between each item and all other factors is fixed to zero. Item means and correlations are explained by their loading on a shared factor, as well as by the correlations between factors. As in the EFA, we used WLSMV estimation and accounted for dependence within country with robust standard errors.

As a first step, a 4-factor model with the hypothesized structure shown in Tables 1 and 2. This modeldid not converge. Next, we tested the 6-factor model suggested by the EFA (depicted in Table 4). The items Q17MREC and Q10SPPERM was not included in this model because it did not load on any of the factors. Q16SPTRU cross-loaded on both *Confidence and Intentions* and on *Access*. Q21PAWAY cross-loaded on *Access* and *Negativitiy*. Q9SPWHO cross-loaded on *Familiarity* and *Negativity*. Q7MWANT and Q8MWILL cross-loadedon *Confidence and Intentions* and *Family Norms*. The 6-factor model fit well, but Q21PAWAY did not load significantly on *Access*, so this cross-loading was

dropped from the model. The final model fit quite well $\chi^2(134) = 162.58 (p = .05)$; $CFI = .95$; $TLI = .94$; $RMSEA = .01 (90\% CI: 0, .02)$. Factor inter-correlations are shown in Table 5. Item parameters are shown in Table 6. The strongest correlation is between *Access* and *Confidence and Intentions* ($r = .52$), followed by *Access* and *Family Norms* ($r = .48$).

Table 5: Factor Inter-correlations

	Confidence and Intentions	*Familiarity*	*Access*	*Negativity*	*Community Norms*	*Family Norms*
Confidence and Intentions	1					
Familiarity	.30	1				
Access	.52	.16	1			
Negativity	.13	-.07	.26	1		
Community Norms	.29	.22	.27	.18	1	
Family Norms	.06	.30	.48	.15	.16	1

All other correlations are .3 or below. This pattern of inter-factor correlations supports the finding that 6 distinct factors underlie the item responses.

Table 6 shows standardized factor loadings and thresholds. Thresholds indicate how "difficult" a response category is to endorse. Items with multiple thresholds have multiple response categories. Most of the thresholds in Table 6 are negative, indicating that even a person who has a low score on the latent variable has a reasonably high chance of endorsing higher levels of the item. This is consistent with the ceiling effects evident in the frequencies shown in Table 1.

Item information curves are plotted in Figure 3 for each factor. An item's information curve is highest near its thresholds; items that are frequently endorsed provide little information at high levels of the latent variable but more information at lower levels. The height of the information curve is a function of the item'sfactor loading.

In five of the six factors, one clear item emerges as the single most informative item. The exception is *Confidence and Intentions*: four of the six items are nearly equally informative for this factor. Interestingly, the items that emerge as most informative are not always items with high importance in the predictive analyses. Specifically, Q24TFCON provides the most information about *Negativity*, Q4PWHERE is most informative about *Familiarity*, and Q15FCON is the most informative about *Community Norms*. Also interestingly, these three factors were not hypothesized in the theoretical model. The remaining factors: *Confidence and Intentions*, *Access*, and *Family Norms* are well aligned with *Thoughts and Feelings* and *Intentions*, *Practical Issues*, and *Social Processes*. The most informative items for these factors are also important predictors of vaccine uptake (i.e., Q7MWANT, T2FPRO, Q18PEASY, Q8MWILL, Q1TFIMP, Q3TFSAFE).

6 Assessing Differential Prediction and Item Functioning by Country, Gender, and Educational Status

Table 7 shows patterns of differential item functioning (DIF) due to country, gender, and education. The presence of intercept DIF means that people with different covariate values have different endorsement probabilities even at the same value of the latent variable. Intercept DIF is generally considered to be a problem because it can lead to biased (i.e., systematically different) scores depending on the respondent's demographic characteristics. For instance, gender intercept DIF implies that a male and female respondent with the same underlying level of familiarity and negativity would have a different probability of endorsing the question about whether the mother was involved in decisions about child vaccination (Q9SPWHO). Similarly,

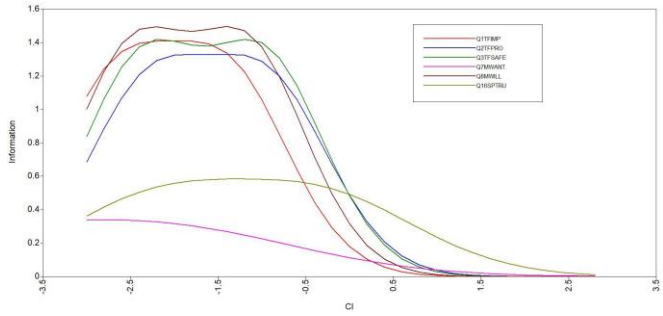
individuals from different countries may be more or less likely to endorse the mother being involved in vaccine decisions over and above the respondent's underlying familiarity or negativity.

Loading DIF indicates that an item is more or less discriminating depending on the covariate value. For instance, the questions Q18PEASY and Q20PPAY are more informative about access for people living in some countries than for people living elsewhere.

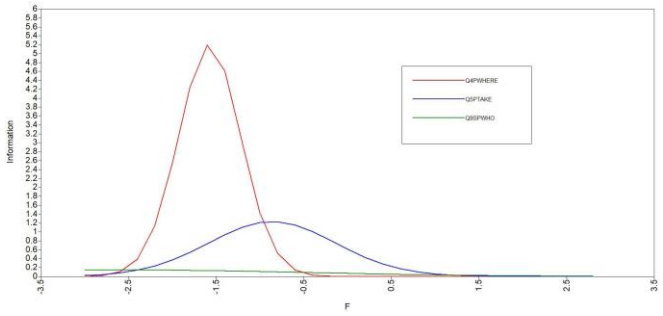
Table 6: Confirmatory Factor Analysis Results (Standardized)

	Loading (SE)	Thresholds
Confidence and Intentions		
Q1TFIMP	.79 (.03)	-2.01/-1.13
Q2TFPRO	.79 (.04)	-1.71/-.77
Q3TFSAFE	.82 (.04)	-1.83/-.79
Q7MWANT	.44 (.09)	-1.82/-1.05
Q8MWILL	.71 (.05)	-1.94/-.82
Q16SPTRU	.37 (.05)	-1.27/-.26
Familiarity		
Q4PWHERE	.97 (.08)	-1.46
Q5PTAKE	.75 (.03)	-.67
Q9SPWHO	.40 (.04)	-.98
Access		
Q18PEASY	.77 (.04)	-1.31/-.24
Q20PPAY	.68 (.05)	-1.56/-.86/.11
Q16SPTRU	.45 (.06)	-1.27/-.26
Negativity		
Q24TFCON	.64 (.07)	-1.03
Q21PAWAY	.58 (.11)	-.99
Q11MBAD	.42 (.14)	-.82
Q9SPWHO	.22 (.08)	-.98
Community Norms		
Q15SPCOM	1.00 (0)	-1.23
Q13SPCLO	.38 (.07)	-1.40
Q14SPREL	.90 (.05)	-1.06
Family Norms		
Q12SPPAR	.80 (.08)	-.90
Q13SPCLO	.69 (.11)	-1.40
Q7MWANT	.40 (.05)	-1.82/-1.05
Q8MWILL	.19 (.06)	-1.94/-.82

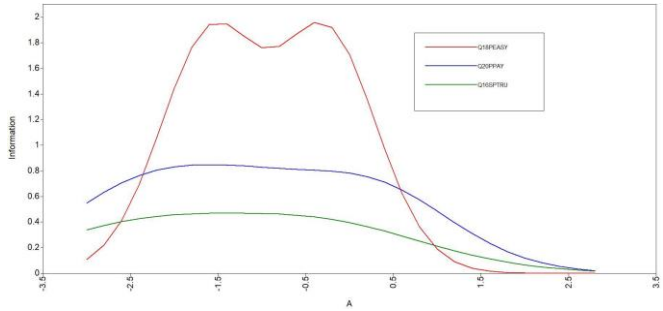
Note. All factor loadings were significant at $p < .001$ except Q11MBAD ($p = .002$)and Q9SPWHO ($p = .004$) on *Negativitiy* and Q8MWILL ($p = .001$) on *Family Norms*.Thresholds indicate how "difficult" a response option is to endorse (i.e., the level of the underlying latent variable at which a response is expected to shift into a higher category). The higher the threshold, the lower the endorsement probability. Items with multiple thresholds are ordinal. The loading of Q15SPCOM on *Community Norms* was fixed to 1 because its estimate was slightly above 1, which is not a plausible value.



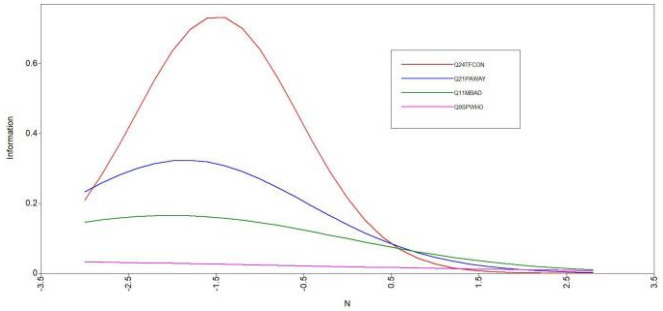
(a) Confidence and Intentions. `Q1TFIMP`, `Q2TFPRO`, `Q3TFSAFE`, and `Q8MWILL` have more information than `Q7MWANT` or `Q16SPTRU`. `Q3TFSAFE` has the best combination of height and range.



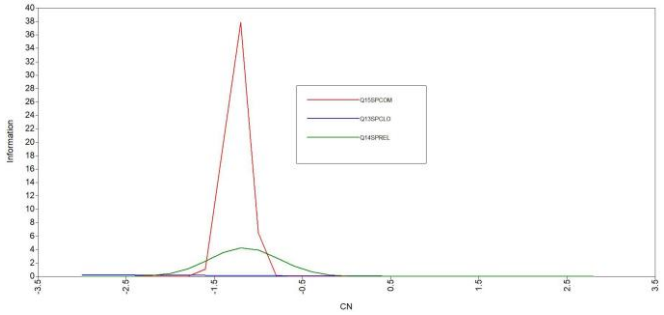
(b) Familiarity. Q4PWHERE is the most informative item.

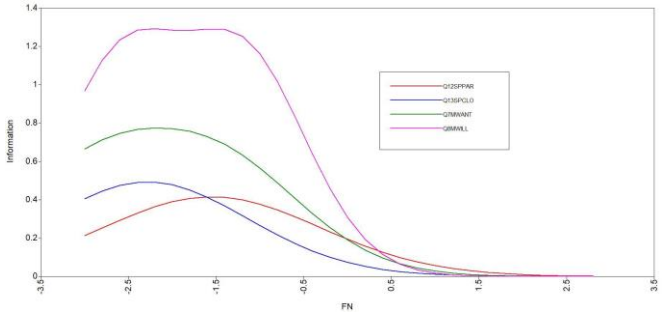


(c) Access. Q18PEASY is the most informative item.



(d) Negativity. Q24TFCON is the most informative item.





(e) Community Norms. Q15SPCOM is the most informative item. (f) Family Norms. Q8MWILL is the most informative item, followed by Q7MWANT.

Figure 3: Item information curves by factor

Table 7: Patterns of differential item functioning

		Country		Gender		Education	
	Label	Intercept	Loading	Intercept	Loading	Intercept	Loading
Confidence and Intentions							
	Q1TFIMP						
	Q2TFPRO						
	Q3TFSAFE						
	Q7MWANT						
	Q8MWILL						
	Q16SPTRU	*	*				
Familiarity							
	Q4PWHERE						
	Q5PTAKE						
	Q9SPWHO	*		*			
Access							
	Q18PEASY		*				
	Q20PPAY		*				
	Q16SPTRU						
Negativity							
	Q24TFCON						
	Q21PAWAY	*					
	Q11MBAD						
	Q9SPWHO	*		*			
Community Norms							
	Q15SPCOM						
	Q13SPCLO						
	Q14SPREL						
Family Norms							
	Q12SPPAR	*					
	Q13SPCLO						
	Q7MWANT						
	Q8MWILL						

Note. Asterisks indicate statistical significance after using a correction for the family-wise Type I error rate.

Table 8: Final item sets

Item	Core	Main	Optional
Q1TFIMP	C		
Q3TFSAFE		M	
Q16SPTRU			O
Q7MWANT	C		
Q12SPPAR		M	
Q13SPCLO	C		
Q14SPREL			O
Q15SPCOM		M	
Q17MREC		M	
Q10SPPERM			O
Q4PWHERE	C		
Q5PTAKE		M	
Q18PEASY		M	
Q20PPAY	C		
Q24TFCON		M	
Q21PAWAY		M	

The items Q16SPTRU, Q9SPWHO, Q21SPAWAY, and Q12SPPAR have intercept DIF by country. Q9SPWHO also has intercept DIF for gender. Q16SPTRU, Q18PEASY, and Q20PPAY have loading DIF by country.

7 Confirmation Analysis

After considering all of the evidence above, we decided on 13 items to retain for the main survey, with 3 additional option items. Of the 13 items in the main survey, 5 were marked as "core items." These items are listed in Table 8.

We used the confirmation sample of $N = 606$ individuals to determine how well the core, main, and expanded item sets predict child vaccination in a new sample. We used logistic regression to predict whether respondents' children had been fully vaccinated from the core, main, and expanded item sets. When the 5 core (T1TFIMP, Q13SPCLO, Q7MWANT, Q4PWHERE, and Q20PPAY) items were included in a multiple logistic regression, the pseudo $R^2 = .15$. Q1TFIMP was the most important predictor, followed by Q20PPAY and Q7MWANT. Q13SPCLO and Q4PWHERE were not significantly associated with vaccination status after accounting for the other items.

The main item set of 13 items (core plus Q18PEASY, Q24TFCON, Q21PAWAY, Q5PTAKE, Q15SPCOM, Q12SPPAR, and Q17MREC) had a pseudo $R^2 = .18$. A chi-square difference test comparing the fit of the core item set as predictors to the main item set as predictors was not significant, indicating that the main item set does not provide significantly better predictive value compared with the core set. Adding the three optional items (Q16SPTRU, Q14SPREL, and Q10SPPERM) also resulted in a nonsignificant model improvement (pseudo $R^2 = .19$).

Annex G. Report on validation of the COVID-19 vaccination survey for adults and health workers

1 Overview

Our goal was to select a long- and short-subset of items measuring the behavioral and social drivers of COVID-19 vaccination in LMICs. The selected items should maximize power to predict COVID-19 vaccination uptake amongst health workers and the general adult population with little overlap between items and without large variation in measurement quality across country or responder characteristics. This report describes how we quantify individual item importance for predicting vaccination, conduct factor analyses to identify overlap and to visualize item information curves, and to assess differential item functioning and prediction by respondent gender, education, and country. This report builds upon and draws from the results of the item analysis for the BeSD-CHILDHOOD VACCINATION SURVEY.

2 Sample and descriptives

A total of N=3692 individuals from six countries responded to the COVID-19 vaccination survey. Of these, N=1817 were health workers (HW) and N=1875 were adults who did not work in healthcare. Data were from Angola (N=606; 306 adult, 300 HW, 54% male), the DRC (N=618; 315 adult, 303 HW, 64% male), Ethiopia (N=628; 324 adult, 304 HW, 49% male), India (N=618; 318 adult, 300 HW, 68% male), Nigeria (N=608; 300 adult, 308 HW, 48% male), and Pakistan (N=614; 312 adult, 302 HW; 67% male). Amongst the general adult population, 61% of respondents were male.

Amongst HWs, 69% were vaccinated, 20% were unvaccinated and intended to be vaccinated, and 11% were unvaccinated with no intentions to be vaccinated. Amongst other adults, 35% were vaccinated, 43% were unvaccinated and intended to be vaccinated, and 22% were unvaccinated with no intentions to be vaccinated.

All survey items were coded so that higher values are positively associated with vaccination. Table 1shows the item prompts, response options, and frequencies for respondents in the general adult population and HWs.

3 Prediction Quality

3.1 Bivariate Associations

Table 2 presents polychoric correlations between each BeSD COVID-19 vaccination item in the item pool and both intentions to receive the COVID-19 vaccine (Q16TFPLAN) and actual vaccination status (none versus any). Intentions was included as the proxy criterion variable alongside actual vaccination status for this analysis because not all respondents had been given the opportunity to receive a vaccination at the time ofthis survey.

Upon viewing Table 2, it is clear that questions about concern for spreading COVID-19 is reduced amongst people who have already received their vaccination; thus, item responses for the concern items are confounded with vaccination status in these data. Second, practical issues are more highly correlated with actual vaccination status than with intentions to vaccinate, whereas social processes and thinking and feeling items are more highly correlated with intentions than with vaccination status. In general, patterns of results are very similar across the two criterion variables.

Table 1: COVID-19 Item Pool

		Adult	HW
Label	**Item**	**N (%)**	**N (%)**
Q11TFCONCE	How concerned are you about getting COVID-19?		
	Not at all A	302 (16%)	193 (11%)
	little	252 (13%)	200 (11%)
	Moderately	371 (20%)	384 (21%)
	Very	950 (51%)	1040 (57%)
Q11aCONF	How concerned are you about your close family and friends getting COVID-19 from you?		
	Not at all A		150 (8%)
	little		213 (12%)
	Moderately		353 (19%)
	Very		1101 (61%)
Q11bCONP	How concerned are you about patients getting COVID-19 from you?		
	Not at all A		129 (7%)
	little		224 (12%)
	Moderately		374 (21%)
	Very		1090 (60%)
Q12TFIMP	How important do you think getting a COVID-19 vaccine will be for your health?		
	Not at all A	179 (10%)	52 (3%)
	little	140 (7%)	105 (6%)
	Moderately	363 (19%)	357 (20%)
	Very much	1193 (64%)	1303 (72%)
Q13TFPRO	How much do you think getting a COVID-19 vaccine for yourself will protect other people in your community from COVID-19?		
	Not at all A	169 (9%)	63 (3%)
	little	179 (10%)	156 (9%)
	Moderately	505 (27%)	526 (29%)
	Very much	1022 (55%)	1072 (59%)
Q14TFSAFE	How safe do you think a COVID-19 vaccine will be for you?		
	Not at all A	190 (10%)	78 (4%)
	little	215 (11%)	205 (11%)
	Moderately	536 (29%)	556 (31%)
	Very much	934 (50%)	978 (54%)
Q15TFREACT	How concerned are you that a COVID-19 vaccine could cause a serious reaction?		
	Not at all A	423 (23%)	391 (22%)
	little	347 (19%)	343 (19%)
	Moderately	355 (19%)	409 (23%)
	Very much	750 (40%)	674 (37%)
Q26TFTRUP	How much do you trust the health workers who would give you a COVID-19 vaccine?		
	Not at all A	172 (9%)	49 (3%)
	little	242 (13%)	128 (7%)
	Moderately	563 (30%)	499 (27%)
	Very much	898 (48%)	1141 (63%)
Q27TFTRUA	How much do you trust the health authorities who provide information on COVID-19 vaccines?		
	Not at all A	181 (10%)	72 (4%)
	little	230 (12%)	149 (8%)
	Moderately	591 (32%)	534 (29%)
	Very much	873 (46%)	1062 (58%)
Q28TFBAD	Have you seen or heard anything bad about COVID-19 vaccines?		
	Yes No	1057 (44%)	1096 (60%)
	Do you know where to get a COVID-19 vaccine for yourself?	818 (44%)	721 (40%)
Q2PWHERE	*Yes No*		
	How easy is it to get a COVID-19 vaccine for yourself?	1319 (70%)	1672 (92%)
	Not at all A	556 (30%)	145 (8%)
Q8PEASY	*little*		
	Moderately	294 (16%)	136 (7%)
	Very much	156 (8%)	115 (6%)
		664 (35%)	549 (30%)
		761 (41%)	1017 (56%)

Label	Item	General Adult N (%)	HW N (%)
Q10PPAY	How easy it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, and plus the cost of taking time away from work.		
	Not at all A	288 (15%)	190 (10%)
	little	220 (12%)	216 (12%)
	Moderately	611 (33%)	546 (30%)
	Very much	756 (40%)	865 (48%)
Q25TFSEE	Do you think that getting a COVID-19 vaccine will allow you to safely see your family and friends again?		
	Yes No	1423 (76%)	1525 (84%)
	Not sure	245 (13%)	133 (7%)
	How willing are you to get a COVID-19 vaccine?	207 (11%)	159 (9%)
Q17TFWILL*	*Not at all A*		
	little	260 (14%)	106 (6%)
	Moderately	152 (8%)	127 (7%)
	Very much	265 (14%)	135 (7%)
	If a COVID-19 vaccine is available to you, will you get it?	1196 (64%)	1449 (80%)
Q16TFPLAN*	*Yes No*		
	Not sure	1460 (78%)	1616 (89%)
	Have you ever been contacted about being due for COVID-19 vaccination?	285 (15%)	124 (7%)
Q4PCONT	*Yes*	128 (7%)	77 (4%))
	No or not sure (collapsed)		
	Have you ever been contacted about a missed COVID-19 vaccination?	377 (20%)	775 (43%)
Q5PMISS	*Yes*	1498 (80%)	1042 (57%)
	No or not sure (collapsed)		
	In your family, who makes the decision about whether you get a COVID-19 vaccine?	231 (12%)	321 (18%)
Q19WDEC	*Self Other*	1644 (88%)	1496 (82%)
	If it was time for you to get a COVID-19 vaccine, would you need permission to go and get it?		
	Yes No	1442 (77%)	
Q20PERM	Do you think most of your close family and friends would want you to get a COVID-19 vaccine?	433 (23%)	
	Yes	504 (27%)	
	No or not sure (collapsed)	1371 (73%)	
Q21SPCLOFF	Do you think your religious leaders would want you to get a COVID-19 vaccine?		
	Yes	1235 (66%)	1402 (77%)
	No or not sure (collapsed)	640 (34%)	415 (23%)
Q22SPRELIG	Do you think other community leaders would want you to get a COVID-19 vaccine?		
	Yes	1104 (59%)	1256 (69%)
	No or not sure (collapsed)	771 (41%)	561 (31%)
Q23SPCOMMU	Do you think most adults you know will get a COVID-19 vaccine, if it is recommended to them?		
	Yes	1236 (66%)	1461 (80%)
	No or not sure (collapsed)	639 (34%)	356 (20%)
Q24SPMOST	Do you think most of the people you work with will get a COVID-19 vaccine?		
	Yes	1206 (64%)	
	No or not sure (collapsed)	669 (36%)	
Q24SP$_1$WRK	Is a COVID-19 vaccine available for you to get at your place of work?		
	Yes		1514 (84%)
	No		298 (16%)
Q8P_1AVL			
			644 (36%)
			1143 (64%)

Label	Item	General Adult N (%)	HW N (%)
Q17TF_2REC	Would you recommend a COVID-19 vaccine to eligible individuals?		
	Yes		1584 (87%)
	No or not sure (collapsed)		233 (13%)
Q18_1ANS	How confident are you that you could answer patient questionsabout getting a COVID-19 vaccine?		
	Not at all A		88 (5%)
	little Moderately		230 (13%)
	Very much		454 (25%)
			1045 (58%)

*The original question was skipped for individuals who reported already having received the vaccine. Responses to this item were recoded from missing to "very much" for these individuals.

3.2 Multivariate Associations and Variable Importance

Figures 1-4 show item importance rankings for predicting COVID vaccination intentions and vaccination amongst HWs and other adults. Q17TFWILL and Q16TFPLAN were removed from these analyses.

Amongst the general adult population, Q14TFSAFE, Q25SPSEE, Q21SPCLOFF, Q12TFIMP, Q27TFTRUA, Q24SPMOST, and Q26TRUP had the highest importance for predicting intentions. Q2PWHERE, Q8PEASY, Q4PCONT, Q5PMISS, and Q21SPCLOFF had the highest importance for predicting vaccination status.

Amongst HWs, Q25TFSEE, Q21SPCLOFF, Q27TFTRUA, Q24SP_1WRK, Q14TFSAFE, Q26TFTRUP, and Q12TFIMP had the highest importance for predicting intentions. Q24_1SPWRK, Q21SPCLOFF, Q2PWHERE, Q4PCONT, and Q14TFSAFE had the highest importance for predicting vaccination status.

These results mirror the bivariate correlations in that they suggest that thoughts and feelings and social processes are more closely associated with vaccination intentions, but that practical concerns are more closely associated with whether a person has already been vaccinated. However, there is some question about reverse causality confounding the association for some of these items (e.g., knowing where to get vaccinatedmay be driven by vaccination status rather than the reverse).

In addition to using the plots to confirm final item sets, these plots are also useful for determining whether we can eliminate items that do not overlap across HWs and the general adult sample since these variables add complexity to the analysis. The only non-overlapping item from the HW survey that appears to be important is Q24SP_1WRK. The only non-overlapping item from the general adult survey that is important is Q24SPMOST. Interestingly, these items are variations on one another. Moving forward, these items will be combined to represents descriptive normative beliefs about peers and all other non-overlapping items will be eliminated from consideration (Q24SPDNORMS).

3.3 Differential Prediction

We ran a logistic regression analyses, regressing the log odds of vaccination intentions on each item in the item pool. We compared the fit of these main effects-only models to a model including an interaction between each item and HW, gender, or country. Table 3 shows when the interaction models fit significantly better than the main effect only model at $p < .01$. The "x"s in Table 3 indicate that the predictive accuracy of each item varies as a function of the demographic variable in that column. Many item effects are significantly moderated by country. The effect of Q17TFWILL varies by HW status and the effect of Q24SPMOST varies by gender. Items that exhibited stable prediction across demographics were: Q12TFIMP, Q14TFSAFE, Q26TFTRUP, Q28TFBAD, Q10PPAY, Q16TFPLAN, and Q22SPRELIG.

Table 2: Bivariate polychoric correlations with intention to vaccinate* and vaccination status

		Intentions			Vaccination		
Label	**Item**	**Adult**	**HW**	**Overall**	**Adult**	**HW**	**Overall**
Q11TFCONCE	How concerned are you about getting COVID-19?	***.14***	-.03	***.10***	-.05	***-.22***	***-.07***
Q11aCONF	How concerned are you about your close family and friends getting COVID-19from you?		-.02			***-.19***	
Q11bCONP	How concerned are you about patients getting COVID-19 from you?		-.02			***-.20***	
Q12TFIMP	How important do you think getting a COVID-19 vaccine will be for yourhealth?	***.65***	***.53***	***.62***	***.44***	***.35***	***.42***
Q13TFPRO	How much do you think getting a COVID-19 vaccine for yourself will protect other people in your community from COVID-19?	***.52***	***.43***	***.50***	***.33***	***.30***	***.32***
Q14TFSAFE	How safe do you think a COVID-19 vaccine will be for you?	***.68***	***.59***	***.65***	***.44***	***.43***	***.43***
Q15TFREACT	How concerned are you that a COVID-19 vaccine could cause a serious reaction?	***.27***	***.27***	***.27***	***.24***	***.37***	***.28***
Q26TFTRUP	How much do you trust the health workers who would give you a COVID-19 vac-cine? Would you say you trust them...	***.62***	***.49***	***.60***	***.41***	***.34***	***.43***
Q27TFTRUA	How much do you trust the health authorities who provide information on COVID-19 vaccines? Would you say you trust them...	***.63***	***.56***	***.62***	***.41***	***.40***	***.43***
Q28TFBAD	Have you seen or heard anything bad about COVID-19 vaccines?	***.41***	***.54***	***.43***		***.46***	***.25***
Q2PWHERE	Do you know where to get a COVID-19 vaccine for yourself?	***.30***	***.41***	***.38***	***.75***	***.64***	***.76***
Q8PEASY	How easy is it to get a COVID-19 vaccine for yourself?	***.20***	.12	***.21***	***.51***	***.22***	***.42***
Q10PPAY	How easy it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, and plus the costof taking time away from work.	***.22***	.10	***.19***	***.41***	***.11***	***.42***
Q25TFSEE	Do you think that getting a COVID-19 vaccine will allow you to safely see your family and friends again?	***.71***	***.67***	***.28***	***.42***	***.46***	***.45***
Q17TFWILL	How willing are you to get a COVID-19 vaccine?	***.91***	***.95***	***.92***			
Q4PCONT	Have you ever been contacted about being due for COVID-19 vaccination?	***.24***	***.33***	***.33***	***.51***	***.43***	***.54***
Q5PMISS	Have you ever been contacted about a missed COVID-19 vaccination?	***.31***	***.22***	***.29***	***.43***	***.27***	***.42***
Q19WDEC	In your family, who makes the decision about whether you get a COVID-19 vac-cine? (Self)	-.06			-.11		
Q20PERM	If it was time for you to get a COVID-19 vaccine, would you need permission to go and get it?	.05			-.05		

		Intentions			Vaccination		
Label	Item	Adult	HW	Overall	Adult	HW	Overall
Q21SPCLOFF	Do you think most of your close family and friends would want you to get aCOVID-19 vaccine?	***.69***	***.74***	***.72***	***.45***	***.58***	***.53***
Q22SPRELIG	Do you think your religious leaders would want you to get a COVID-19 vaccine?	***.40***	***.45***	***.43***	***.15***	***.23***	***.22***
Q23SPCOMMU	Do you think other community leaders would want you to get a COVID-19 vaccine?	***.34***	***.45***	***.38***	***.14***	***.22***	***.25***
Q24SPMOST	Do you think most adults you know will get a COVID-19 vaccine, if it is recommended to them?	***.55***			***.43***		
Q24SP_1WRK	Do you think most of the people you work with will get a COVID-19 vaccine?		***.68***			***.67***	
Q8P_1AVL	Is a COVID-19 vaccine available for you to get at your place of work?		***.19***			***.40***	
Q17TF_2REC	Would you recommend a COVID-19 vaccine to eligible individuals?		***.39***			***.31***	
Q18_1ANS	How confident are you that you could answer patient questions about getting aCOVID-19 vaccine?		***.37***			***.30***	

*If a COVID-19 vaccine is available to you, will you get it? (Q16TFPLAN). Bold and italics font indicates $p < .01$

Table 3: Differential prediction of vaccination intentions by HW status, gender, and country of residence

Item	HW	Gender	Country
Q11TFCONCE			x
Q12TFIMP			
Q13TFPRO			x
Q14TFSAFE			
Q15TFREACT			x
Q26TFTRUP			
Q27TFTRUA			x
Q28TFBAD			
Q2PWHERE			x
Q8PEASY			x
Q10PPAY			
Q25TFSEE			x
Q16TFPLAN			
Q17TFWILL	x		x
Q4PCONT			x
Q5PMISS			x
Q21SPCLOFF			x
Q22SPRELIG			
Q23SPCOMMU			x
Q24SPMOST	-	x	x
Q24SP_1WRK	-		x

Note. "x" indicates significant moderation by demographic factor at $p < .01$;"-" indicates that adifferent item was asked for HWs and general adults.

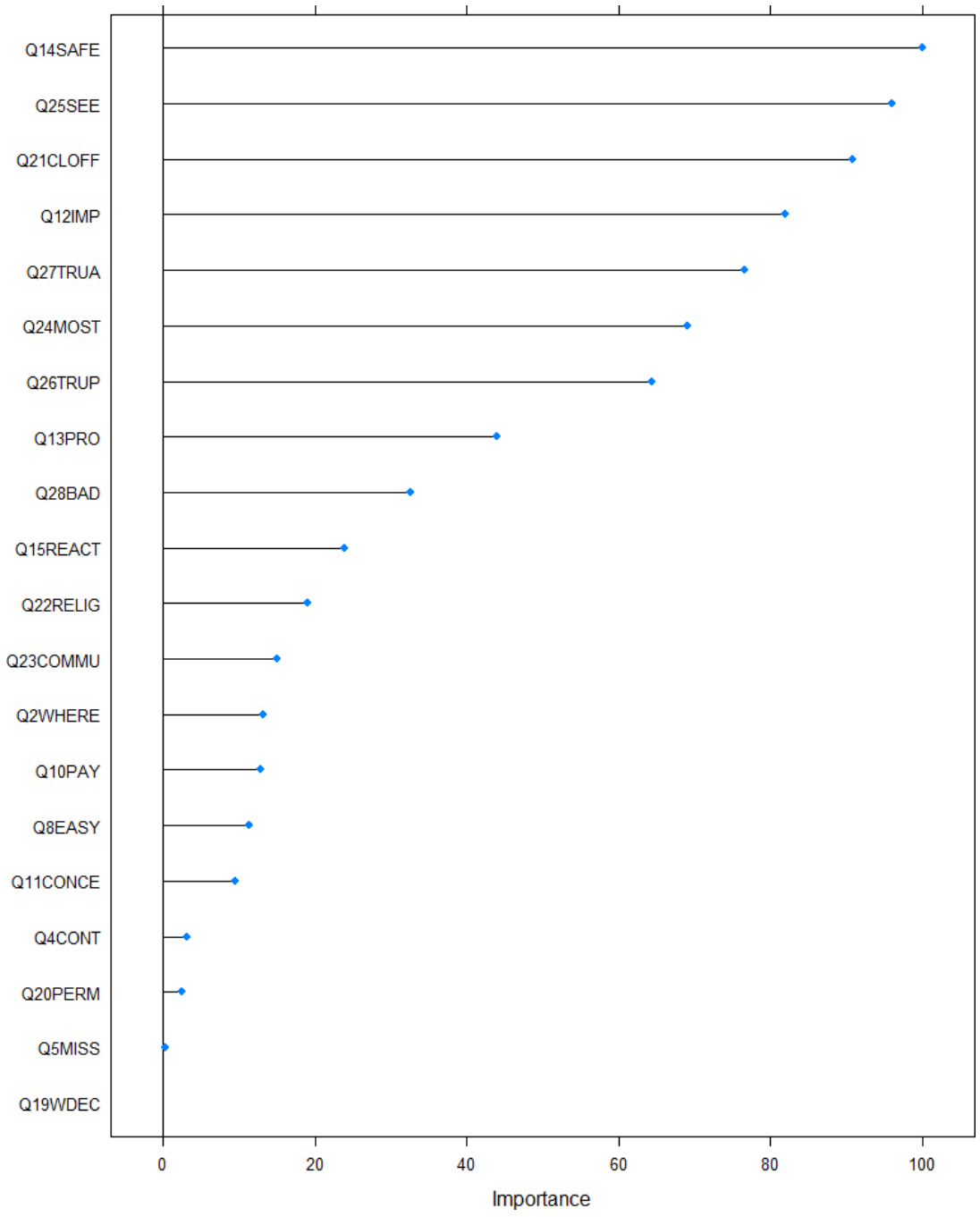


Figure 1: Item importance for predicting COVID vaccination intentions using random forest models foradults

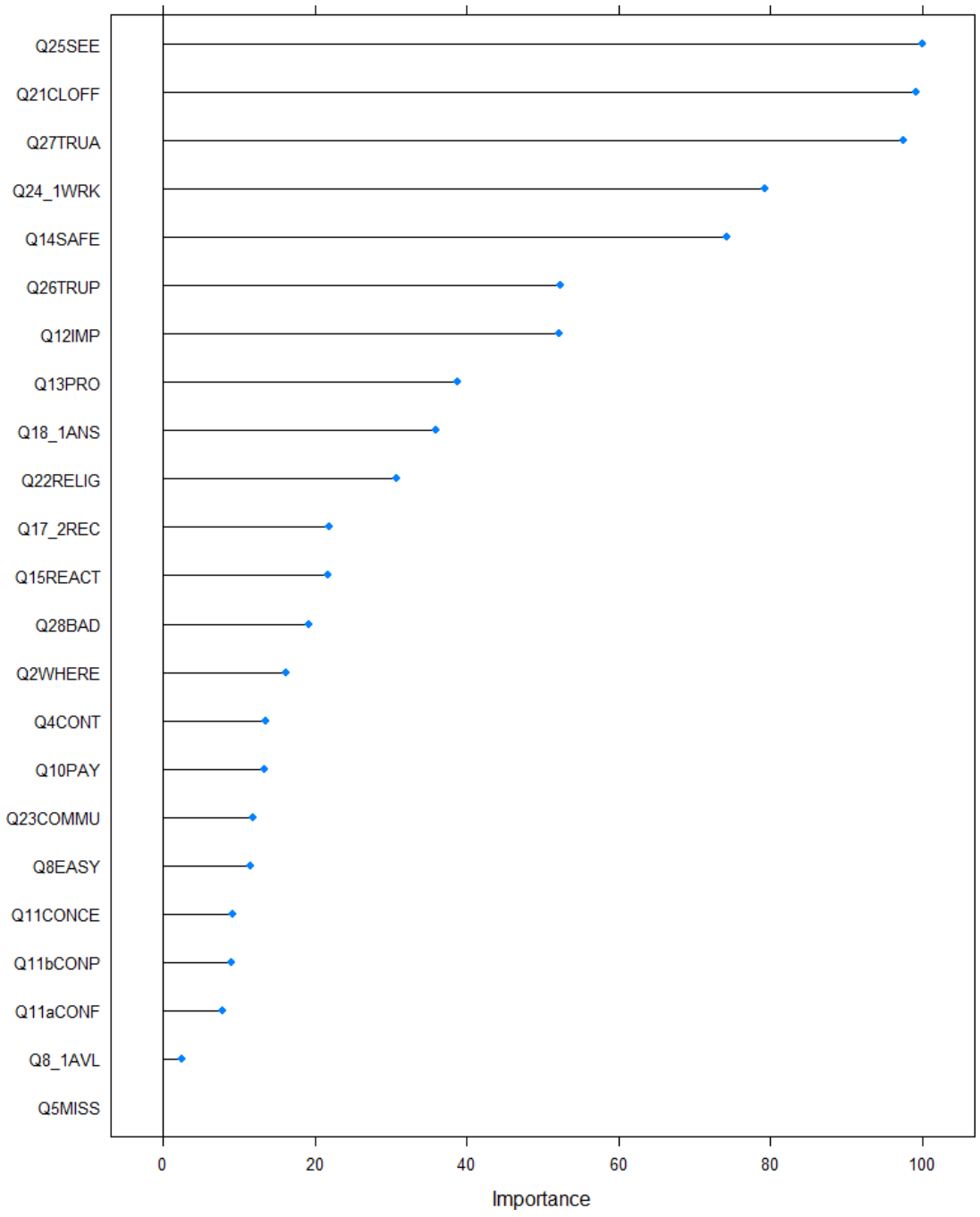


Figure 2: Item importance for predicting COVID vaccination intentions using random forest models forhealth workers

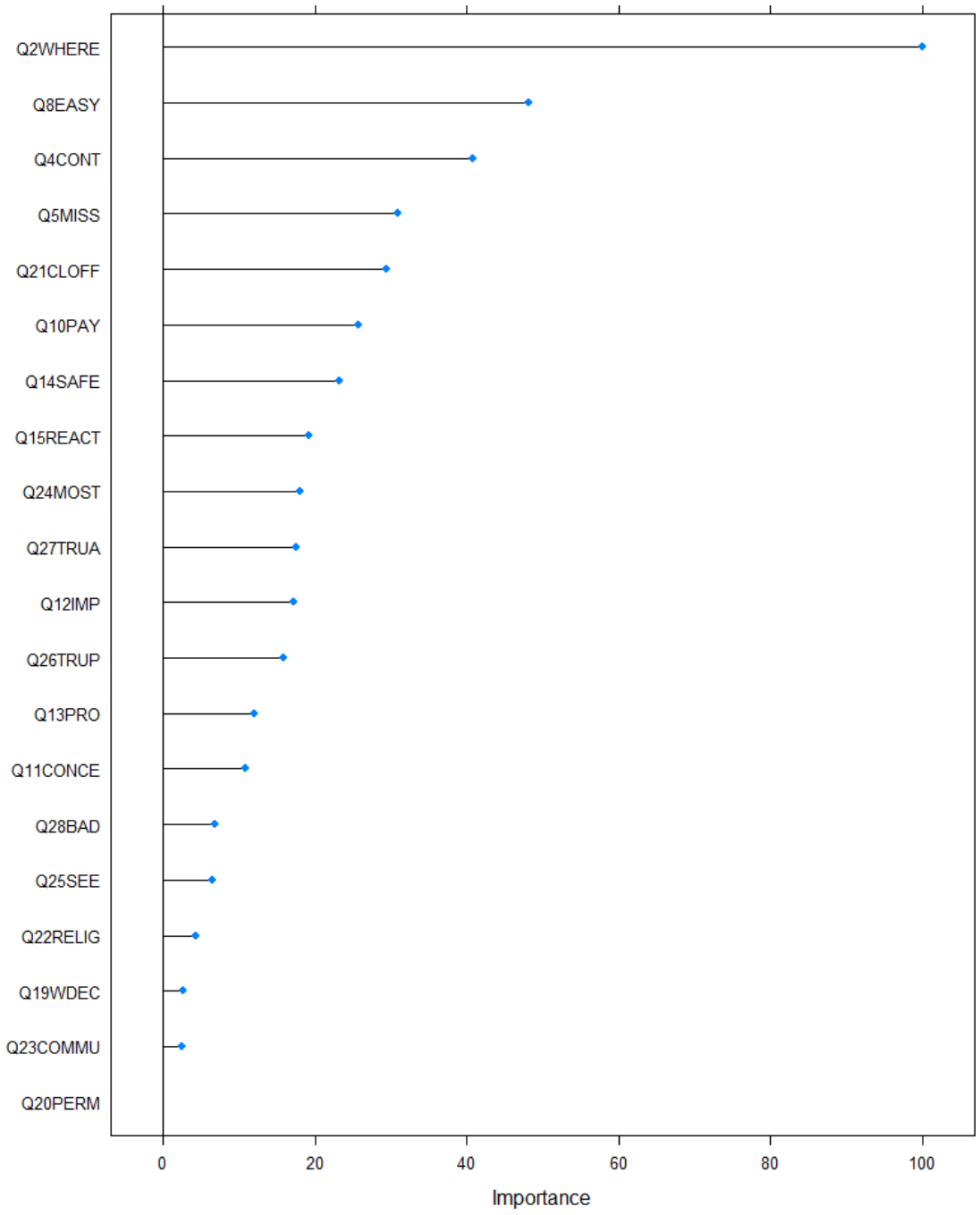


Figure 3: Item importance for predicting COVID vaccination using random forest models for adults

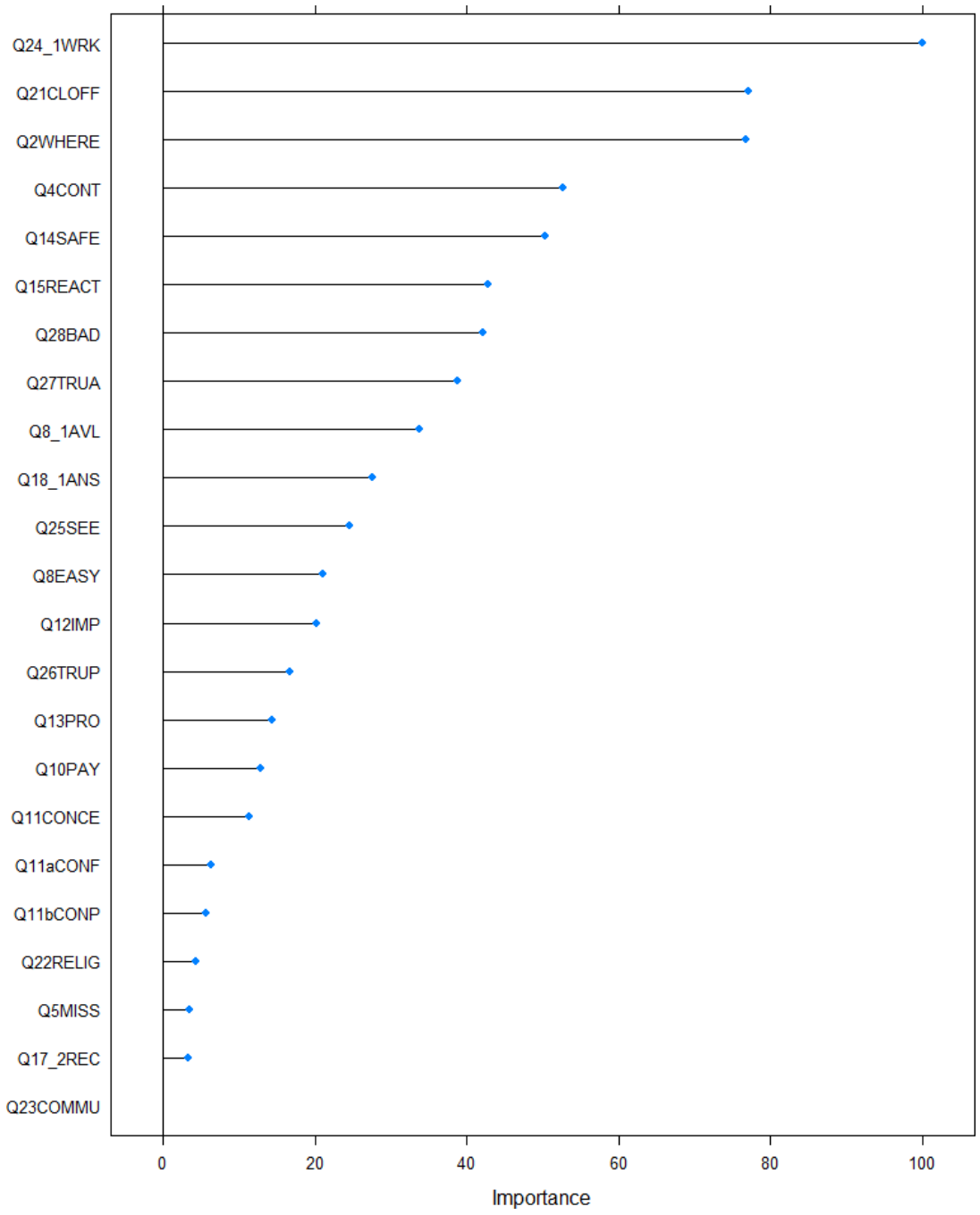


Figure 4: Item importance for predicting COVID vaccination using random forest models for health workers

Table 4: CFA results

	Item	Standardized Factor Loading (SE)
Thoughts, Feelings, & Intentions		
	Q12TFIMP	.70 (.02)
	Q13TFPRO	.64 (.04)
	Q14TFSAFE	.83 (.04)
	Q15TFREACT	.21 (.05)
	Q26TFTRUP	.72 (.06)
	Q27TFTRUA	.73 (.07)
	Q28TFBAD	.39 (.08)
	Q25TFSEE	.78 (.04)
	Q16TFPLAN	.86 (.02)
	Q17TFWILL	.86 (.04)
	Q21SPCLOFF*	.54 (.07)
Practical Concerns		
	Q2PWHERE	.65 (.04)
	Q8PEASY	.74 (.08)
	Q10PPAY	.57 (.04)
	Q4PCONT*	.20 (.05)
	Q5PMISS	.27 (.09)
Social Processes		
	Q21SPCLOFF*	.38 (.06)
	Q22SPRELIG	.92 (.03)
	Q23SPCOMMU	.83 (.07)
	Q24SPDNORMS	.23 (.08)
	Q4PCONT*	.24 (.06)

*Cross-loads

4 Confirmatory Factor Analysis and Item Information

Using theory and the EFA results (not presented) as a guide, we tested a 3-factor confirmatory factor analysis (CFA) model with a *Thoughts, Feelings, & Intentions* factor, a *Practical Concerns* factor, and a *Social Processes* factor. We allowed for some cross-loadings and residual correlations based on EFA findings. The final model fit reasonably well (RMSEA=.01, CFI=.94, TLI=.92). Results are shown in Table 4. The item Q11TFCONCE did not load significantly on the *Thoughts, Feelings, & Intentions* factor so it was removed from the model. Residual correlations were permitted for Q26TFTRUP and Q27TFTRUA, Q2PWHERE and Q4PCONT, Q2PWHERE and Q5PMISS, Q4PCONT and Q5PMISS, Q17TFWILL and Q16TFPLAN, and Q12TFIMP and Q13TFPRO.
The presence of residual correlations generally indicates item redundancy.

The *Thoughts, Feelings, & Intentions* factor correlates .58 (SE=.07) with *Practical Concerns* and .50 (SE=.07) with *Social Processes*. *Practical Concerns* is not significantly correlated with *Social Processes* (r = .09 (SE=.07)).

Item information curves were inspected for each of the three factors. The two best-performing items for *Thoughts, Feelings, & Intentions* were Q12TFIMP and Q14TFSAFE. Whereas Q12TFIMP provided very high information between -1.5 and -.5 standard deviations below the mean on *Thoughts, Feelings, & Intentions*, Q14TFSAFE provided moderately high information from -2.0 standard deviations below the mean to .5 standard deviations above the mean. See Figure 5 to visualize the item information curves for *Thoughts, Feelings, & Intentions*.

Figure 6 shows item information curves for *Practical Concerns*. Q8PEASY was by far the most informative item, providing good information from -2.0 to .5 standard deviations around the mean.

Figure 7 shows item information curves for *Social Processes*. Q22SPRELIG provided high information

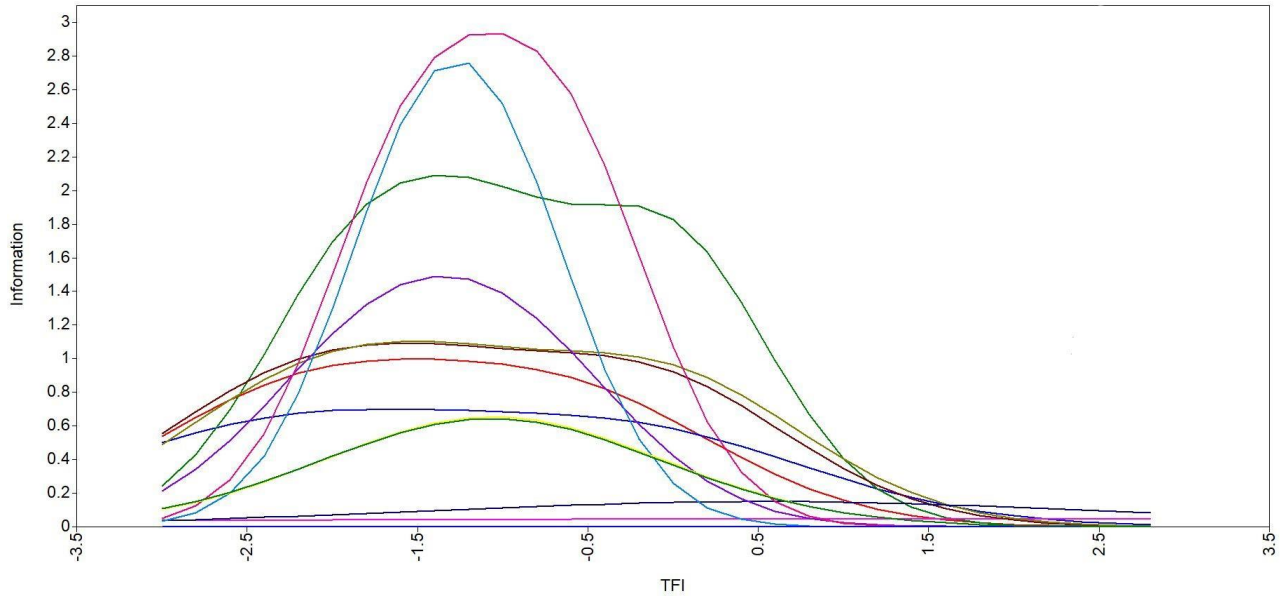


Figure 5: Item information curves for the *Thoughts, Feelings, & Intentions* factor. Q12TFIMP is red and Q14TFSAFE is dark green.

in a narrow range from .5 SD below the mean to the mean. Q23SPCOMMU provides moderate information from -1.25 SDs below the mean to the mean.

5 Assessing Differential Prediction and Item Functioning by Country, Gender, and HW Status

We used the aMNLFA package in R to generate Mplus script for testing differential item functioning (DIF)by item as a function of country, gender, and HW status. Results are summarized in Table 5.

Intercept DIF implies that an item is easier or harder to endorse on the basis of respondent demographic characteristics, holding the underlying level of the latent factor constant. For instance, endorsementrates for the item Q2PWHERE depend on HW status, gender, and country *over and above* differences on underlying *Practical Concerns*. Loading DIF implies that the item's ability to accurately characterize a respondent's level on the latent variable given their response to that item depends on characteristics of therespondent. For instance, the quality of the item Q26TFTRUP for understanding a respondent's underlying *Thoughts, Feelings, & Intentions* depends on their HW status.

As shown in Table 5, all *Thoughts, Feelings, & Intentions* and *Practical Concerns* items had significant levels of intercept and loading DIF by country of residence. The latent structure of these constructs (e.g., the rank ordering of factor loadings) may vary by country. There was also substantial DIF related to HW status on several items. Gender DIF was only observed for item intercepts on Q2PWHERE, Q8PEASY, and Q24SPDNORMS.

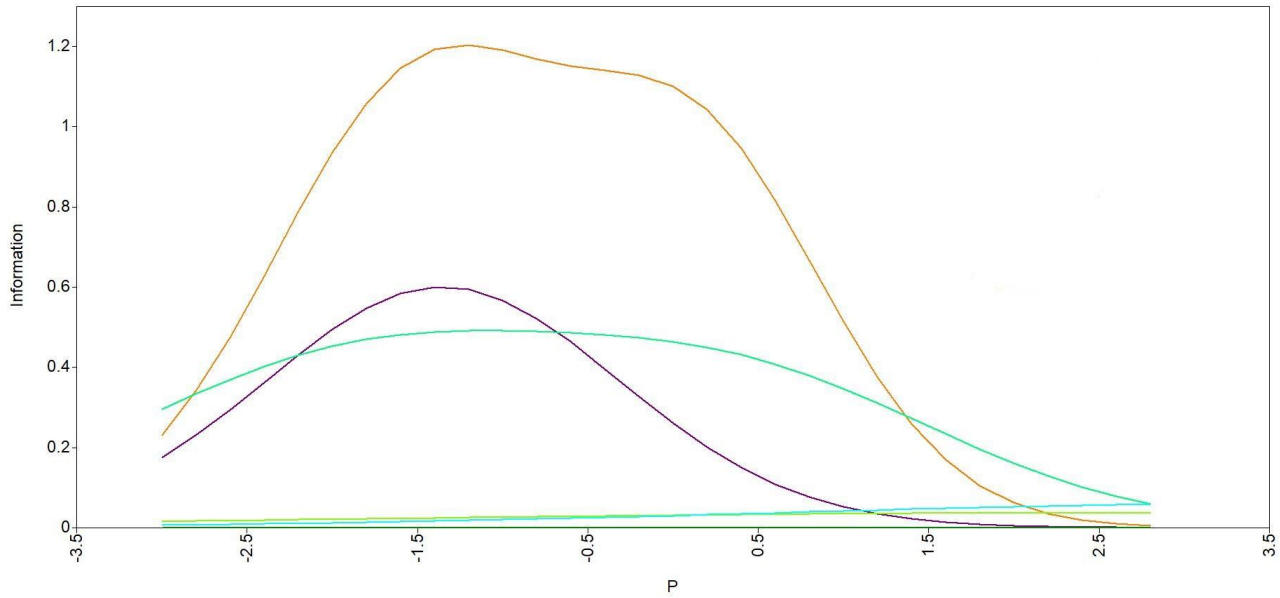
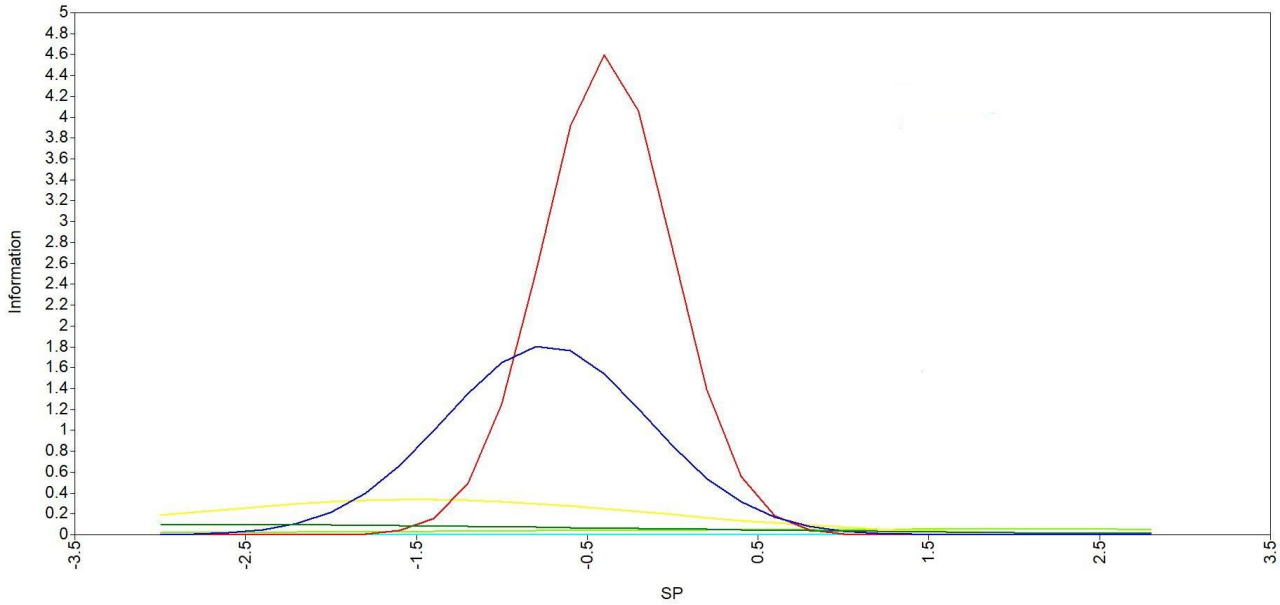


Figure 6: Item information curves for the *Practical Concerns* factor. Q8PEASY is orange.



Item info SP.jpg

Figure 7: Item information curves for the *Social Processes* factor. Q22SPRELIG is red and Q23SPCOMMU is blue.

Table 5: Differential item functioning by HW status, gender, and country of residence

	HW		Gender		Country	
Item	**Intercept**	**Loading**	**Intercept**	**Loading**	**Intercept**	**Loading**
Thoughts, Feelings, & Intentions						
Q12TFIMP					x	x
Q13TFPRO					xx	xx
Q14TFSAFE	x				xx	xx
Q15TFREACT					xx	xx
Q26TFTRUP		xx			xx	xx
Q27TFTRUA					xx	xx
Q28TFBAD	x					
Q25TFSEE						
Q16TFPLAN	xx					
Q17TFWILL	x					
Q21SPCLOFF						
Practical Concerns						
Q2PWHERE	x		x		x	x
Q8PEASY			x		x	xx
Q10PPAY	xx	xx				xx
Q4PCONT	x	x			xx	
Q5PMISS						
Social Processes						
Q21SPCLOFF						x
Q22SPRELIG	x					
Q23SPCOMMU						
Q24SPDNORMS		x	x		xx	x
Q4PCONT	x					

Note. "x" indicates significant moderation by demographic factor at $p < .01$

Annex H. Interventions to improve uptake (protocol)

Interventions designed to improve vaccination uptake: Scoping review of systematic reviews and meta-analyses – protocol (version 1)

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Abstract

Background

Vaccine uptake varies substantially, and resources to promote the uptake of vaccines differ widely by country and income level. As a result, immunization rates are often suboptimal. There is a need to understand what works, particularly in low- and middle-income countries and other settings where resources are scarce.

Methods: We plan to conduct a scoping review of interventions designed to increase vaccination uptake

We will include systematic reviews and meta-analyses of interventional studies that address the question of vaccine uptake. We will search the following electronic databases: MEDLINE, Cochrane Database of Systematic Reviews, EMBASE, Epistemonikos, Google Scholar, LILACs and TRIP database (which covers guidelines and the grey literature) until 01 July 2021 and hand-search the reference lists of included articles. We will include systematic reviews that comprise studies of all ages if they report quantitative data on the impact on vaccine uptake. To assess the quality, we will use a modified AMSTAR score and ate the quality of the evidence in included reviews using-the "Grade of Recommendations Assessment, Development and Evaluation" (GRADE).

Expected results We intend to present the evidence using summary tables to present the evidence stratified by vaccine coverage, the specific population, e.g., children, adolescents and

older adults, and by setting, e.g. healthcare, community. We will also present when low middle-income subgroups are reported.

Keywords: Vaccine uptake, Vaccine hesitancy, Immunization, systematic reviews

Background

Vaccine uptake varies substantially by age, gender, ethnicity, geographical location, and socioeconomic status. Research has established that some of these differences are due to variations in vaccination's behavioural and social drivers [6]. [1] In addition, the resources required to successfully promote the uptake of vaccines varies widely by country and income level. As a result, immunization programmes often struggle to achieve optimal coverage of the target population.

WHO seeks to complement its ongoing work on the measurement of BeSD with information on effective interventions to increase vaccine uptake. This information can help vaccination programmes to understand what works for whom and in what settings, particularly in low- and middle-income countries and other locations where resources are scarce.

Therefore, we plan to do a scoping review of systematic reviews of published evidence on interventions designed to increase vaccine uptake. We will categorize the interventions and their components across different populations and geographical regions. The WHO plans to use the scoping review results to guide immunization programmes' selection of interventions to promote vaccine uptake.

Methods

Objectives: To conduct a scoping review of interventions designed to increase vaccination uptake.

The specific focus of the review

- Population: e.g., children, adolescents, adults and older adults (age 65+;
- Interventions: any intervention designed to improve participation in vaccination;
- Outcomes: Uptake, Hesitancy, Disease risk appraisal, Confidence, Social norms, Provider recommendation, Availability.

Type of studies

We will include systematic reviews and meta-analyses of interventional studies that address the question of vaccine uptake.

Search strategy

We will search the following electronic databases: MEDLINE, Cochrane Database of Systematic Reviews, EMBASE, Epistemonikos, Google Scholar, LILACs and TRIP database (which covers guidelines and the grey literature) until 01 July 2021 and hand-search the reference lists of included articles. The searches will combine free and thesaurus search terms and keywords related to vaccine uptake (vaccin* OR innocul OR immunis* OR immuniz*). In the first instance, we will use sensitive search filters developed by the Health Information Research Unit at McMaster University, Canada, to focus on systematic reviews and meta-analyses. [2] We will also search the bibliographies of retrieved systematic reviews. We will screen all titles and

abstracts of retrieved citations for inclusion. Based on the results of the initial filter for systematic reviews, we will review the need for further search terms (see Appendix for sample search terms). The final search strategy will be developed with advice from information specialists and an iterative process adapted for each database. Two reviewers will independently evaluate the full text of articles potentially meeting eligibility criteria. Discrepancies will be resolved through discussion. Where a consensus cannot be reached, a third reviewer will arbitrate.

Eligibility criteria
We will include systematic reviews that comprise studies of all ages if they report quantitative data on the impact on vaccine uptake. In addition, we will include systematic reviews that contain randomized controlled trials (RCTs) and quasi-experimental (including interrupted time series and before-and-after studies). We will exclude reviews that assess only vaccine efficacy or effectiveness and reviews that do not include any RCTs.

Types of interventions
Interventions that aim to increase vaccine uptake in a specific population or the overall population.

Quality assessment
To assess the quality, we will use modified AMSTAR score items 3 and 7. [3] Item 3: "Was a comprehensive* literature search performed?" At least two electronic sources should be searched. The report must include years and databases used (e.g. Central, EMBASE, and MEDLINE), plus keywords or MESH terms. Item 7: "Was the scientific quality of the included studies assessed and documented?" 'A priori' assessment methods should be provided (e.g., for effectiveness studies if the author(s) chose to include only randomized, double-blind, placebo-controlled studies, or allocation concealment as inclusion* consistent with a systematic review search.

One reviewer will record and assess the reporting of the quality of included systematic reviews and report the assessments, and a second reviewer will independently check the quality ratings. Disagreements will be resolved through discussion with a third reviewer, who will arbitrate where a consensus cannot be reached. We will rate the quality of the evidence in included reviews using-the "Grade of Recommendations Assessment, Development and Evaluation" (GRADE). [4] We will downgrade or upgrade the rating for the quality of the evidence, based on the amount of potential bias due to study design and other criteria specified in the GRADE, and provide a summary of findings tables by the outcomes of interest. GRADE assessment will be based on assessing the risk of bias and an evaluation of inconsistency, indirectness, and imprecision of the results and other factors (see the GRADE Table in the Appendix for more information). We will check the rating, where GRADE has been used to assess primary studies included in the reviews. Where another tool has been used to assess quality, one reviewer will convert this to a GRADE assessment, and a second reviewer will independently check the assessment.

Data extraction
We will conduct the review according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. [5] Data from included reviews will be extracted by one reviewer and independently checked by a second reviewer. We will structure the outcomes by intervention type and create categories using an iterative process to extract objectives and self-reported outcomes. In addition, we will extract data on the population, study characteristics

(e.g., number of trials, location etc.) and the intervention and comparator and the outcomes of interest as well as the type of meta-analysis effect model used in the meta-analysis (fixed or random) and between-study heterogeneity estimates (I^2 values).

Where two reviews cover the same intervention and outcome with overlapping studies, we will select the most relevant review (i.e. more comprehensive and up-to-date) for inclusion; and include the historical reviews in an appendix. We will also use the Jadad decision algorithm to interpret discordant reviews and select the most appropriate review evidence for interventions (see figure 1). Two authors will independently apply the algorithm to reach a consensus over which review/meta-analysis is included. [6]

Outcomes of interest

We will prioritize outcomes according to the WHO handbook for guideline development [7] as High (critical for decision making), Moderate (important for decision making) and Low (not important for decision making). Vaccination uptake is the highest priority. Constructs in the WHO BeSD Framework are deemed moderate. Other constructs not in the framework are low priority.

Table 1. Outcomes of interest and prioritization

Priority	Construct	Definition	Includes
High	Uptake	Receipt of vaccine	Initiation, completion, coverage and behaviour
Moderate	Hesitancy	Motivational state of being conflicted about, or opposed to, getting vaccinated	Intentions, willingness, openness, stage
Moderate	Disease risk appraisal	The belief that one is at risk for an infectious disease that vaccination can prevent	Perceived risk, perceived susceptibility, concern, perceived severity, anticipated regret, worry, fear
Moderate	Confidence	Attitudes and beliefs that vaccines work are safe and are part of a trustworthy medical system	Perceived importance, benefit, and effectiveness; concerns about safety, harm, side effects, and adverse events; trust in providers and the system of vaccination
Moderate	Social norms	Shared expectations of acceptable vaccination behaviour by a group	Descriptive norms, injunctive norms
Moderate	Provider recommendation	Advice from a health care worker to receive vaccination	Advice in clinical and non-clinical settings

Moderate	Availability	Low/unavailable stocks may play a role in vaccine uptake	The vaccine is unavailable in the country or just the specific clinic
Moderate	Access	Perceived and actual access to immunization services	Distance, travel, timing, location, ease, convenience, opportunity costs, financial costs
Low	Knowledge	An accurate understanding of facts about vaccination	It does not include awareness, but we will assess it where reported

We will use summary tables to present the evidence stratified by vaccine coverage, the specific population, e.g., children, adolescents and older adults, and by setting, e.g. healthcare, community. We will also present when low middle-income subgroups are reported. We will present the data as reported in the paper and. Where significant heterogeneity exists, assessed using expert judgement, we will extract the reasons. Once the data is mapped out, we will attempt to present the findings for categories of interventions mapped onto the BeSD Framework. The Thinking and Feeling domain will include interventions that use education, confidence building, persuasion, motivational interviewing, and decision aids. The Social Processes domain will include interventions that use social norms, social networks, altruism and healthcare provider communication. The Practical Factors domain will include interventions that use reminder/recall, implementation intentions, mere measurement, default appointments, onsite vaccination (including work and school), incentives, requirements (mandates), and sanctions.

Funding

This work is part-funded by the World Health Organization: To carry out a scoping review of systematic reviews and meta-analyses of interventions to improve vaccination uptake. WHO Registration 2021/1138353-0. CH, EAS, and AP receive funding support from the NIHR School of Primary Care.

Authors' contributions

All authors contributed in equal part to the conceptualization and development of the content. TJ and CH wrote the first draft and edited this version. All authors contributed to the subsequent drafts and approved the final version. The authors acknowledge the substantial intellectual contribution of Dr Lisa Menning, Dr Julie Leask, and the WHO BeSD working group in conceptualizing the research question, outcomes, and intervention types.

Conflict of interest statements

TJ received a Cochrane Methods Innovations Fund grant to develop guidance on the use of regulatory data in Cochrane reviews (2015 to 2018). From 2014 to 2016, he was a member of three advisory boards for Boehringer Ingelheim. TJ was a member of an independent data monitoring committee for a Sanofi Pasteur clinical trial on an influenza vaccine. Market research companies occasionally interview TJ about phase I or II pharmaceutical products for which he receives fees (current). TJ was a member of three advisory boards for Boehringer Ingelheim (2014 to 16). TJ was a member of an independent data monitoring committee for a Sanofi Pasteur clinical trial on an influenza vaccine (2015 to 2017). TJ is a relator in a False Claims Act lawsuit on behalf of the United States that involves sales of Tamiflu for pandemic stockpiling. If resolved in the United States favour, he would be entitled to a percentage of the recovery. TJ is coholder of a Laura and John Arnold Foundation grant for the development of a RIAT support

centre (2017 to 2020) and Jean Monnet Network Grant, 2017 to 2020 for The Jean Monnet Health Law and Policy Network. TJ is an unpaid collaborator to the Beyond Transparency in Pharmaceutical Research and Regulation led by Dalhousie University and funded by the Canadian Institutes of Health Research (2018 to 2022). TJ consulted for Illumina LLC on next-generation gene sequencing (2019 to 2020). TJ was the consultant scientific coordinator for the HTA Medical Technology programme of the Agenzia per I Servizi Sanitari Nazionali (AGENAS) of the Italian MoH (2007 to 2019). TJ is Director Medical Affairs for BC Solutions, a market access company for medical devices in Europe. TJ was funded by NIHR UK and the World Health Organization (WHO) to update Cochrane review A122, Physical Interventions to interrupt the spread of respiratory viruses. Oxford University funds TJ to carry out a living review on the transmission epidemiology of COVID-19. Since 2020, TJ receives fees for articles published by The Spectator and other media outlets. TJ is part of a review group carrying out a Living rapid literature review on the modes of transmission of SARS CoV 2 (WHO Registration 2020/1077093 0). He is a member of the WHO COVID 19 Infection Prevention and Control Research Working Group, for which he receives no funds. TJ is funded to co-author rapid reviews on the impact of COVID restrictions by the Collateral Global Organisation.

CJH holds grant funding from the NIHR, the NIHR School of Primary Care Research, the NIHR BRC Oxford and the World Health Organization for a series of Living rapid reviews on the modes of transmission of SARs CoV 2 reference WHO registration No2020/1077093. He has received financial remuneration from an asbestos case and given legal advice on mesh and hormone pregnancy tests cases. He has received expenses and fees for his media work, including occasional payments from BBC Radio 4 Inside Health and The Spectator. He receives expenses for teaching EBM and is also paid for his GP work in NHS out of hours (contract Oxford Health NHS Foundation Trust). He has also received income from the publication of a series of toolkit books and appraising treatment recommendations in non-NHS settings. He is the Director of CEBM, an NIHR Senior Investigator and an advisor to Collateral Global.

DE holds grant funding from the Canadian Institutes for Health Research and Li Ka Shing Institute of Virology relating to the development of COVID-19 vaccines and the Canadian Natural Science and Engineering Research Council concerning COVID-19 aerosol transmission. He is a recipient of World Health Organization and Province of Alberta funding which supports the provision of BSL3 based SARS CoV 2 culture services to regional investigators. He also holds public and private sector contract funding relating to the development of poxvirus based COVID-19 vaccines, SARS CoV 2 inactivation technologies, and serum neutralization testing.

JMC holds grants from the Canadian Institutes for Health Research on acute and primary care preparedness for COVID-19 in Alberta, Canada and was the primary local Investigator for a Staphylococcus aureus vaccine study funded by Pfizer, for which all funding was provided only to the University of Calgary. He is a co-investigator on a WHO funded study using integrated human factors and ethnography approaches to identify and scale innovative IPC guidance implementation supports in primary care with a focus on low resource settings and using drone aerial systems to deliver medical supplies and PPE to remote First Nations communities during the COVID-19 pandemic. He also received support from the Centers for Disease Control and Prevention (CDC) to attend an Infection Control Think Tank Meeting. He is a member of the WHO Infection Prevention and Control Research and Development Expert Group for COVID-19 and the WHO Health Emergencies Programme (WHE) Ad hoc COVID-19 IPC Guidance Development Group, both of which provide multidisciplinary advice to the WHO, for which no funding is received and from which no funding recommendations are made for any WHO contracts or grants. He is also a member of the Cochrane Acute Respiratory Infections Group.

JB is a major shareholder in the Trip Database search engine (www.tripdatabase.com) as well as being an employee. In relation to this work, Trip has worked with a large number of organizations over the years; none have any links with this work. The main current projects are with AXA and Collateral Global.

ECR was a member of the European Federation of Neurological Societies(EFNS) / European Academy of Neurology [108] Scientist Panel, Subcommittee of Infectious Diseases (2013 to 2017). Since 2021, she is a member of the International Parkinson and Movement Disorder Society (MDS) Multiple System Atrophy Study Group, the Mild Cognitive Impairment in Parkinson Disease Study Group, and the Infection Related Movement Disorders Study Group. She was an External Expert and sometimes Rapporteur for COST proposals (2013, 2016, 2017, 2018, 2019) for Neurology projects. She is a Scientific Officer for the Romanian National Council for Scientific Research.

NB serves as a paid consultant for the US Centers for Disease Control and Prevention, World Health Organization, and Merck. He is a member of the Lancet Commission on Vaccine Acceptance in the United States. He is a member of the COVID-19 Vaccine Communications Advisory Group, North Carolina Department of Health and Human Services. He is a Member of the Vaccine Confidence Work Group, Board of Scientific Counselors, Deputy Director of Infectious Disease, Centers for Disease Control and Prevention, 2020-present. He is a member of the Vaccine Confidence Working Group, National Vaccine Advisory Committee. He is a member of the Research Working Group, Vaccine Acceptance Research Network.

IJO, EAS, and AP have no interests to disclose.

Ethics committee approval.

No ethics approval was necessary.

Data Availability

All data included in the review will be provided in the tables and text.

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6. Jadad AR, Cook DJ, Browman GP. A guide to interpreting discordant systematic reviews. CMAJ1997;156:1411-6.pmid:9164400

7. WHO handbook for guideline development (2012), Figure 5.1, Scale for rating outcomes. https://apps.who.int/iris/bitstream/handle/10665/75146/9789241548441_eng.pdf;sequence=1

Figures

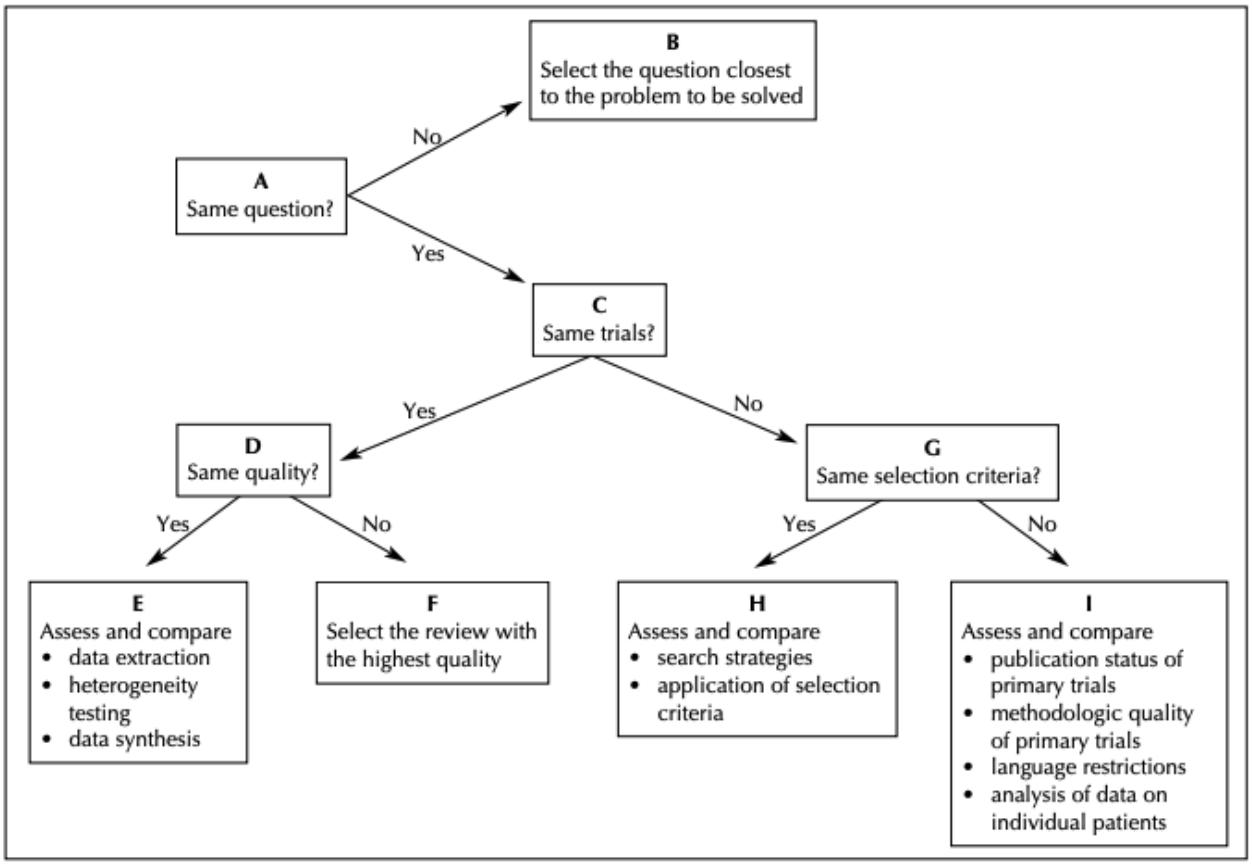

Fig. 1: A decision algorithm for interpreting discordant reviews (assuming that the reviews have few and minimal flaws).

CAN MED ASSOC J • MAY 15, 1997; 156 (10) 1413

Jadad AR, Cook DJ, Browman GP. A guide to interpreting discordant systematic reviews. CMAJ1997;156:1411-6.pmid:9164400

Appendix

Search terms

Additional search terms that we might include but not be limited to are:

(vaccine OR innocul OR immunis∗ OR immuniz*) [s1]

AND

Uptake	uptake OR behaviour OR behavior OR coverage OR initiation OR complet* OR follow-through OR up to date OR dose OR adherence OR compliance OR accept* OR refusal OR delay OR declin* OR
Hesitancy	hesitan* OR motivation OR intention OR willing OR willingness OR plan OR openness OR stage OR readiness OR
Disease risk appraisal	risk appraisal OR risk judgment OR risk perception OR perceived risk OR perception of risk OR perceived likelihood OR perceived susceptibility OR perceived vulnerability OR outcome expectation OR perceived threat OR perceived severity OR fear OR afraid OR sacred OR worry OR concern OR (anticipat* regret*) OR (expect* regret*) OR (prospective regret*) OR (regret* avoid*) OR (regret* avers*) OR (action regret*) OR (inaction regret*) OR
Confidence	confidence OR belief OR concern OR perceived (importance OR effectiveness OR safe* OR harm* OR side effect*) OR attitude OR trust OR
Social norms	social norm* OR injunctive norm* OR descriptive norm* OR normative belief
Provider recommendation	((provider OR doctor OR nurse OR health worker) AND (recommendation OR advice OR discussion) OR
Access	access OR perceived barrier* OR barrier* or enabler* or equalit* or inequalit* or facilitat* or obstruct* or limit* or imped* or hinder* or inhibit* or bottleneck* or equit* or inequit*)
Availability	availab* OR unavailab* OR stock out OR out of stock OR
Knowledge	knowledge OR know OR understanding OR awareness

The research team considered including a third grouping of search terms for intervention (e.g., intervention* OR reminder* OR incentive*). However, we prefer to have a larger body of studies and not to narrow the search results in this way.

S1: 'Vaccination coverage' is also a Medical Subject Heading (MeSH) term in Medlin

GRADE tables.

Quality assessment							Summary of findings					Importance
							No of patients		Effect		Quality	
No of studies	Design	Limitations	Inconsistency	Indirectness	Imprecision	Other considerations	Intervention	Usual care	Relative (95% CI)	Absolute		
Intervention (ID)												
Outcome 1												
Outcome 2												

- **Limitations - assessing risk of bias**
  - Lack of allocation concealment: Those enrolling patients are aware of the group (or period in a crossover trial) to which the next enrolled patient will be allocated (major problem in "pseudo" or "quasi" randomized trials with allocation by day of week, birth date, chart number, etc)
  - Lack of blinding: Patient, care givers, those recording outcomes, those adjudicating outcomes, or data analysts are aware of the arm to which patients are allocated (or the medication currently being received in a crossover trial)
  - Incomplete accounting of patients and outcome events: Loss to follow-up and failure to adhere to the intention-to-treat principle in superiority trials; or in non-inferiority trials, loss to follow-up, and failure to conduct both analyses considering only those who adhered to treatment, and all patients for whom outcome data are available
  - Selective outcome reporting bias: Incomplete or absent reporting of some outcomes and not others on the basis of the results
  - Other limitations: Stopping early for benefit; Use of unvalidated outcome measures (e.g., patient-reported outcomes); Carryover effects in crossover trial; Recruitment bias in cluster-randomized trials
- **Inconsistency**
  - Reviewers should consider rating down for inconsistency when: 1.Point estimates vary widely across studies; 2.Confidence intervals (CIs) show minimal or no overlap;3.The statistical test for heterogeneity—which tests the null hypothesis that all studies in a meta-analysis have the same underlying magnitude of effect—shows a low P-value; 4.The I2—which quantifies the proportion of the variation in point estimates due to among-study differences—is large.
- **Indirectness**
  - We are more confident in the results when we have direct evidence. By direct evidence, we mean research that directly compares the interventions in which we are interested delivered to the populations in which we are interested and measures the outcomes important to patients. Thus, we can have concerns about indirectness when the population, intervention, or outcomes differ from those in which we are interested. In general, evidence based on surrogate outcomes should usually trigger rating down, whereas the other types of indirectness will require a more considered judgment.
- **Imprecision**
  - When considering the quality of evidence, the issue is whether the CI around the estimate of treatment effect is sufficiently narrow. If it is not, we rate down the evidence quality by one level (for instance, from high to moderate). If the CI is very wide, we might rate down by two levels.
- **Other**
  - A number of factors may rate the quality of evidence up or down. These include presence or absence of publication bias, when a large magnitude of effect exists, when there is a dose–response gradient, and when all plausible confounders or other biases increase our confidence in the estimated effect.

Annex I. Working group members and terms of reference

(Membership as of June 2021)

Members

Julie Leask (Chair)	University of Sydney, Australia
Noel Brewer (Deputy chair)	University of North Carolina, US
Neetu Abad	Centers for Disease Control and Prevention, US
Sohail Agha	Bill and Melinda Gates Foundation, US
Helena Ballester-Bon	UNICEF, East and Southern Africa Regional Office, Kenya
Cornelia Betsch	University of Erfurt, Germany
Vinod Bura	World Health Organization, Indonesia
Ève Dubé	Laval University, Canada
Michelle Dynes	UNICEF East Asia and Pacific Regional Office, Thailand
Melissa Gilkey	University of North Carolina
Wenfeng Gong	Bill and Melinda Gates Foundation, US
Monica Jain	International Initiative for Impact Evaluation [40], New Delhi, India
Mohamed Jalloh	Centers for Disease Control and Prevention, US
Abdul Momin Kazi	Aga Khan University, Pakistan
Anna Lisa Ong-Lim	University of the Philippines, Philippines
Saad Omer	Emory University, US
Jennifer Requejo	UNICEF, HQ
Deepa Risal Pokharel	UNICEF, HQ, New York
Aaron Scherer	University of Iowa, US
Holly Seale	University of New South Wales, Australia
Nick Sevdalis	Kings College London, UK
Smita Singh	Gavi, the Vaccine Alliance, Switzerland
Riswana Soundardjee	Gavi, the Vaccine Alliance, Switzerland
Gillian SteelFisher	Harvard University, US
Charles Shey Wiysonge	South African Medical Research Council, South Africa

Members and research support

Gilla Shapiro	University of Toronto, Canada
Kerrie Wiley	University of Sydney, Australia

Secretariat

Lisa Menning	World Health Organization Headquarters
Francine Ganter-Restrepo	World Health Organization Headquarters

Ex-members (previous members but stepped back due to changing role)

Gustavo Correa	Gavi, the Vaccine Alliance, Switzerland
Wenfeng Gong	Bill and Melinda Gates Foundation, US
Mohamed Jalloh	Centers for Disease Control and Prevention, US

CONFLICT OF INTEREST STATEMENT (from COVID-19 interim guidance)

"For the development of this document, a global and multidisciplinary group was established by WHO

consisting of individuals with expertise spanning multiple areas of specialization and regional representation (see above list of names and affiliations). Many of the group members have a longstanding affiliation with WHO as members of a related and broader working group on measuring BeSD of childhood vaccination. For the latter group, declarations of interest have been collected from all external contributors and assessed for any conflicts of interest. Potential conflicts of interest have been managed according to WHO's policies and procedures.

Terms of reference for both groups described the required set of duties and contributions of the members, in addition to scope, objectives and expected outputs. In the process of developing this guidebook, it was recognized that working group members acted in good faith and in the best interests of the group, WHO and its purposes. All procedures were followed in accordance with ethical standards. The document was developed via a cyclical, iterative, open and transparent process of development and review, with the full working group being offered the opportunity to comment at the end of reach round of revisions. All working group members contributed in their individual capacity and no one member was ever given added preference. At each stage of content development, inputs were collectively reviewed by the working group or a subgroup of the broader group. It was expected that group members acted honestly and fairly in the interests of WHO, as was the case. Discussions were managed by the working group chair in a manner to ensure that scientific integrity, process and reputation were sustained.

These actions together helped to ensure that working group members brought their best experience, expertise and commitment to the discussions."

Working group on data for vaccination acceptance and uptake

Terms of Reference – December 2018

This working group will provide a set of measures, tools and guidelines (henceforth referred to as "tools") for national immunization programmes and partners to boost the **availability, quality, and use** of data on vaccination acceptance and demand[2] across global settings, with a focus on low- and middle-income countries. The data generated from these tools will meet the needs of both programmes and partners in various ways, e.g. for diagnosing and addressing local reasons of under-vaccination, and tracking consistent and comparable data over time.

Background

There are many barriers and facilitators which affect vaccine uptake, from the logistics of ensuring access and affordability, to the psycho-social factors that influence service-seeking behaviours and individual and community-level acceptance. Efforts to boost coverage frequently rely on an intuitive or anecdotal understanding of under-vaccination, rather than evidence grounded in perspectives of caregivers. However, a broad consensus is emerging that reliable measures to better understand why people do not vaccinate are needed to ensure that evidence informs the design and evaluation of more tailored and targeted interventions to increase vaccine uptake.

Review of data from the WHO/UNICEF Joint Reporting Form – that since 2014 has asked countries to monitor and report on *vaccine hesitancy* – has shed light on some dimensions. However, each year only about one third of countries[3] reported based on the evaluation of actual data. Furthermore, hesitancy is only one contributor to under-vaccination. In addition to the demand-side dimensions, supply-side constraints include inadequate availability and access challenges. Standardized, validated measures to measure reasons for under-vaccination will also make future research results easier to compare across and within countries/regions, improve data quality over time, and facilitate the development and evaluation of evidence-based interventions. Qualitative tools will complement these measures with rich insights on the complex and interwoven factors influencing uptake.

With escalating concerns related to vaccine hesitancy and learning from programmes that have seen safety or other events contribute to declines in coverage, WHO Technical Advisory Groups on Immunization have put forward recommendations to all countries, emphasizing the importance of conducting assessments:

> *"Each country should develop a strategy to increase acceptance and demand for vaccination, which should include ongoing community engagement and trust-building, active hesitancy prevention, regular national assessment of vaccine concerns, and crisis response planning."*
>
> - SAGE GVAP assessment report, October 2017

[2] Demand is the actions of individuals to seek and support vaccines and immunization services (Hickler et al, Vaccine 2017). Given the interaction between human behaviours and system- and service-side dynamics, relevant dimensions of the latter will also be considered throughout this work.

[3] Countries reporting reasons for hesitancy based on an assessment: 29% in 2014; 36% in 2015; 33% in 2016; 37% in 2017.

"Countries should recognise the potential for vaccine hesitancy and understand the importance of data on the confidence that populations have in vaccination. If adequate information is not available, countries should conduct assessments"

- South East Asia Regional Immunization Technical Advisory Group meeting report, June 2017

Also in 2017, during a meeting to share lessons learned on the roll-out of the updated WHO Vaccination Coverage Survey Reference Manual and identify research needs, a request was made to define a standard set of questions on barriers and facilitators to uptake that could be added to surveys, based on social science methodologies (meeting report).

There is now a need to rapidly make available a package of adaptable tools (both quantitative and qualitative) to inform responsive and tailored interventions.

While some valid scales have been developed to measure vaccine hesitancy, acceptance, and confidence, these efforts have been predominantly carried out in high-income countries, and mostly not focused on demand. Building on available instruments and learning, there is a need to develop tools and guidance for **measuring vaccination demand and acceptance in low and middle-income countries, including the interaction between caregivers and service providers.**

The development of these tools will take into consideration the practicalities and costs of implementing such assessments, and endeavour to minimize added burden on resources and systems where possible.

Objectives

Through the formation of this time-limited working group (consisting of a multi-disciplinary and global group of experts, partners, and implementers), **a comprehensive and modular package of tools, with corresponding guidance, will be developed for assessing vaccination demand and acceptance-related determinants.**

The package will include a layered range of quantitative items (survey questions) that provide national programmes and partners with validated measures of demand and acceptance that could be used in standalone assessments, which could be done in rapid or in-depth fashion at country level. It will also include qualitative data collection tools such as in-depth interview schedules.

The tools will also be developed and presented in such a way to enable efficient integration into various existing national administrative and WHO data collection processes. These include routine reporting of administrative data, AEFIs, coverage surveys, EPI reviews, National Regulatory Authority assessments and the JRF. Further, the tools may be incorporated into existing knowledge, attitudes, and practices (KAP) surveys being carried out by countries and partners. The working group will also consider qualitative approaches for in-depth assessments regarding nuanced and varied underlying factors influencing vaccination acceptance and demand.

The time-limited working group will support this effort by:

- Providing an opportunity for partners to regularly interact and contribute throughout the process, and share relevant work to inform development of the tools and measures.
- Synthesising or, where needed, developing the expected tools as described below, and considering their validation and guiding any subsequent revisions.

- Making available supporting guidance to facilitate adaptation and use of the measures across location and time (for consistent and comparable data), with feedback mechanisms to generate learning and guide improvements on an iterative basis.
- Offering recommendations on the integration and triangulation (or standardization) between demand measures from surveys that may be carried out by partners and national administrative processes, to avoid any discrepancies between data-gathering activities.
- Ensuring linkages to entities such as the Demand Hub, Gavi Demand SFA and its programming guidance, the Gavi Data SFA, the equity/gender working groups, the global vaccine safety observatory (a clearinghouse for data on global safety systems), and the International Collaboration on Vaccine Acceptance (ICVA).

Expected outputs

The primary outputs expected are as follows:

- Modular and layered package of domains and items:
    - Targeted to caregivers, service providers, and influential community members
    - For rapid or in-depth assessments
    - As a stand-alone or integrated survey within a KAP, EPI programme review, coverage survey, or other assessment
- User-friendly and practical guidance for:
    - Adaption and programmatic use of the questions in diverse settings to generate consistent, comparable, and quality data across time and location
    - Application of data to: 1) inform a local diagnosis of under-vaccination and; 2) identify potential areas of intervention to improve programme planning and implementation
- Review of the JRF hesitancy questions and proposal of any revisions
- Review and potential recommended revisions to the SAGE vaccine hesitancy survey questions[4]
- A framework to link research findings to potential areas of policy/practice interventions, to facilitate use of the data to inform programme planning and design
- Guide development of a demand data repository, to make readily available relevant tools, guidance, findings, reports, and related literature.

The measures will be designed to enable incorporation into the following data collection mechanisms:

- JRF indicators on hesitancy and demand
- WHO guide for conducting an EPI review[5]
- WHO coverage survey methodology[6], MICS[7] and DHS[8] to the extent possible
- The AEFI core variables and reporting form[9], as possible
- KAP tools

[4] SAGE vaccine hesitancy working group survey questions: https://www.who.int/immunization/programmes_systems/vaccine_hesitancy/en/

[5] Guide for conducting an EPI review: http://www.who.int/immunization/documents/WHO_IVB_17.17/en/

[6] Coverage survey manual: www.who.int/immunization/monitoring_surveillance/routine/coverage/en/index2.html

[7] Multiple Indicator Cluster Surveys: http://mics.unicef.org/

[8] Demographic Health Surveys: https://dhsprogram.com/

[9] AEFI core variables and AEFI reporting form: http://www.who.int/vaccine_safety/core-variable/en/

As a separate and secondary phase of work, testing in multiple countries (including low- and middle-income countries) will be required before the core outputs may be considered validated. Currently it is envisaged that the group will help guide and support this validation process to help in understanding how the determinants of demand relate to immunization outcomes.

Suggested organization of the working group

Area	Considerations
Leadership and membership The group will be established in November 2018.	Chair: Professor Julie Leask (consideration will be given to rotation of the chair should the lifespan of this group extend beyond two years.) Members at the time of establishing the group will represent: - **Agencies:** one each from CDC, UNICEF, Gavi Secretariat, BMGF, WHO - **Experts:** with technical and geographic diversity (10-12) - **Implementers:** EPI managers and WHO/UNICEF country staff (2)
Coordination	Lisa Menning, technical focal point for acceptance and demand at WHO HQ, will support the chair in group coordination and related tasks.
Meetings	Teleconferences will be scheduled at regular and pre-determined times, and two in-person meetings organised in the first 12-18 months. Frequency may vary depending on intensity of efforts, envisaged at monthly in the initial stages. A draft agenda will be agreed with the chair and deputy chair and circulated to members in advance. A summary of the discussion and actions will also be shared after each call.
Decision-making	Decisions regarding the organization and activities of the working group will be made by the group and in consultation with other entities as appropriate.
Resources	The working group will be supported by funding secured by WHO from Gavi, the Vaccine Alliance.