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RESEARCH ARTICLE

The Impact of the COVID-19 Pandemic on Uptake of Routine Childhood Immunization: How a Behavioral Science Led Analysis Can Strengthen Vaccination Policy

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ABSTRACT

In addition to the direct health and economic impacts of the COVID-19 pandemic, routine immunization of children for vaccine-preventable diseases has also suffered. Quantitative studies have shown evidence of backsliding in routine immunization, i.e., children failing to receive their vaccinations on schedule. Pandemic restrictions were the cause for some of this behavior, and there are signs that subsequent campaigns and supply-side initiatives have influenced trends toward routine immunization catch-up. However, limited qualitative research indicates that the pandemic may have disrupted parents/caregivers' decision-making processes around routine immunization, and their attitudes toward vaccination, in ways that could have long-term effects on rates of immunization. Further behavioral research can help elucidate this and provide guidance to policymakers to boost immunization uptake.

This policy article explores the decision dynamics leading to missed routine immunization doses during the pandemic, through an analysis of secondary literature, a summary of primary-research studies on COVID-19 vaccine hesitancy conducted during the pandemic across Côte d'Ivoire, Burkina Faso, Kenya and Pakistan, and a summary of a study on the impact of COVID-19 on routine immunization uptake in South Africa.

We found that the COVID-19 pandemic severely disrupted prior patterns of engagement with the health system, turning routine immunization from a default decision for parents/caregivers into an "active decision-making" moment. Restrictions on movement, limited routine immunization supplies and other practical impediments combined with fear of contracting COVID-19 at health facilities, misinformation, and fear of vaccine side-effects, creating an emergent behavior of missed immunization doses during the pandemic period. We also found that hesitancy about COVID-19 vaccines may be transferred onto previously accepted vaccines, impacting routine immunization.

We identified three decision-making pathways for routine immunization uptake among South African parents/caregivers once the lockdowns were lifted: the "path of procrastination," the "path of doubt," and the "path of persistence." We highlight the policy implications of these, and suggest potential interventions to increase routine immunization uptake for parents/caregivers on each path, as well as for general communications, service delivery, and pandemic readiness.

Introduction

The COVID-19 pandemic has had a devastating impact on the world. Directly and indirectly, it caused an estimated 15 million excess deaths in 2020 and 2021.¹ The direct effects of the pandemic include mortality and long-term morbidity attributed to SARS-CoV-2 infection, and economic effects such as the costs of medical treatment. Indirect effects include broader economic and societal impacts of COVID-19 restriction measures, and the prioritization of healthcare for COVID-19 over other health measures, which led to severe disruption to other essential health services.²

The World Health Organization (WHO) has reported alarming disruptions in routine childhood immunization programs against preventable diseases such as diphtheria, polio, measles, and tetanus. In 2021, 25 million children under the age of 1 year missed basic routine vaccinations against preventable diseases. This was the highest number since 2009, and 5.9 million more than in 2019, the year before the start of the COVID-19 pandemic.³ Furthermore, the decline in immunization was greater in low- and middle-income countries, where the burden of vaccine-preventable disease (VPD) is greater.^{4,5} The drops in routine immunization (RI) also explain the increasing number of outbreaks of some preventable diseases, such as measles outbreaks in Uganda, South Africa, and India.⁶

RI is seen by the global health community as one of the most impactful public health measures,³ reducing the burden of infectious disease and associated mortality in children, and bringing VPDs under control. It is estimated that between 2000 and 2019, vaccine programs in 98 low- and middle-income countries saved the lives of 36 million children under the age of 5 years.⁷ However, in the space of just two years, the disruption caused by the COVID-19 pandemic has threatened to reverse years of progress made on VPDs. The experience of past epidemics like Ebola in west Africa (2014-2015) provides evidence of the negative consequences of suspending RI programs: in west Africa, lower RI coverage led to more deaths from VPDs like measles than from Ebola, showing that Ebola's indirect effects were more severe than of the epidemic itself.⁸ Similarly, modeling has suggested that the deaths prevented by maintaining RI programs for children in Africa outweigh the risk of death from COVID-19 associated with visiting vaccination clinics.⁹

There has been mounting evidence of backsliding of RI (i.e., children failing to receive their vaccinations

on schedule) during the COVID-19 pandemic, driving concern and calls for urgent action and recovery.^{4,5,10,11} Most of this evidence has been from quantitative studies based on large data sets or surveys, but there is a need to understand the deeper decision-making dynamics and the behavioral drivers for RI drop-offs or missed doses during the pandemic from an end-user perspective, in order to develop effective policy approaches to increase rates of RI.

In many countries that experienced disruption to RI during the initial phase of the COVID-19 pandemic, restrictions were lifted as the pandemic became more “manageable” and COVID incidence fell, driving greater access to RI. Catch-up efforts for RI have been aided by specific WHO guidance,¹² as well as shorter-term supply-side interventions such as increased supply, mass vaccination campaigns, and concerted efforts by healthcare workers.¹³ Quantitative studies have shown trends toward RI catch-up,^{6,11} although most countries still await data and analysis to understand the overall impact of the pandemic upon RI.⁵

From a policy perspective, qualitative behavioral research can better help in understanding the long-term impact of the RI backsliding that quantitative data might not be able to reveal, and it can also provide insights into demand generation for RI, which is important since most other interventions have been supply-side focused. In-depth qualitative studies informed by behavioral science can uncover insights into the behaviors behind drop-offs and missed doses, in order to better design recovery mechanisms and interventions, and to prepare the health system to respond better to future pandemics.

Some qualitative studies on the impact of the COVID-19 pandemic upon RI have been helpful in uncovering the reasons for missed doses during the pandemic.¹⁴⁻¹⁷ However, most are from the perspective of healthcare providers rather than users, or use a relatively small sample of users which may not be generalizable.

This policy paper describes critical learnings from our study of COVID-19 vaccine hesitancy in four countries – Côte d'Ivoire, Burkina Faso, Kenya, and Pakistan – as a way of understanding the dynamic COVID-19 context, drivers of vaccine hesitancy, psycho-behavioral segments and the potential implications for other programs such as RI. We then describe the outcomes of our research on the impact of the COVID-19 pandemic on RI in South Africa, to decode the decision-making of caregivers, including

key emotional barriers of procrastination and doubt. (Both studies will be presented at the 2nd Annual Vaccination Acceptance Research Network conference in Bangkok, Thailand, in June 2023.) We use these insights to make recommendations about interventions in communications, service delivery, and pandemic preparedness that will address psycho-behavioral barriers to RI and help to sustain RI programs.

Decoding the decision dynamics of COVID-19 vaccine hesitancy

Vaccine hesitancy is defined as a “delay in acceptance or refusal of vaccines despite availability of vaccine services.”¹⁸ The WHO has categorized vaccine hesitancy as one of the top ten threats to global health.¹⁹ But our research found that vaccine hesitancy is characterized by a range of attitudes and behaviors that differ among population groups, rather than there being a single definable group of “anti-vaxxers”. Our study in Burkina Faso, Côte d’Ivoire, Kenya and Pakistan used psycho-behavioral segmentation to derive a nuanced understanding of vaccine hesitancy among discrete subgroups of each country’s population based on specific barriers, in order to design segment-targeted interventions to drive vaccine confidence and therefore uptake (Sharma S et al. Segment-targeted interventions for uptake of COVID-19 vaccine through psycho-behavioral segmentation in Kenya, Côte d’Ivoire, Burkina Faso and Pakistan. Accepted for presentation at 2nd Annual Vaccination Acceptance Research Network conference; June 2023; Bangkok). The mixed-method approach began with qualitative formative research with a sample of 160 participants across

4 countries, conducted by a trained moderator using a validated pre-tested discussion guide. The research output informed the subsequent stage of research, a quantitative survey assessing psycho-behavioral drivers of decision-making and preference construction. This face-to-face survey was administered with trained enumerators nationally on a representative sample drawn from a probability-based stratified random cluster design, with a total sample size of 11,000 adults aged 18 years and older across the 4 countries.

Our formative research found that the COVID-19 pandemic created a dynamic, uncertain context, within which a novel vaccine was introduced. Within this, the COVID-19 vaccine decision is an “active” decision, i.e. one that is considered and evaluated, as opposed to a RI decision that is defaulted to without much thought. This active decision compels people to seek information in the dynamic and uncertain COVID-19 context, leading to a “decision journey” toward uptake of the COVID-19 vaccine. Building on vaccine frameworks like the determinants of vaccine decision-making of Betsch et al²⁰ and the WHO framework for behavioral and social drivers of vaccination,²¹ this journey consists of decision stages through which an individual progresses in their effort to make a decision about receiving the COVID-19 vaccine (Figure 1). While certain enabling factors help the person progress, barriers that lead to an unfavorable assessment of COVID-19 vaccines can deflect them from the path and lead them to drop off from the journey. Various drop-off points showcase the diverse barriers and drivers of COVID-19 vaccine hesitancy (Figure 1).

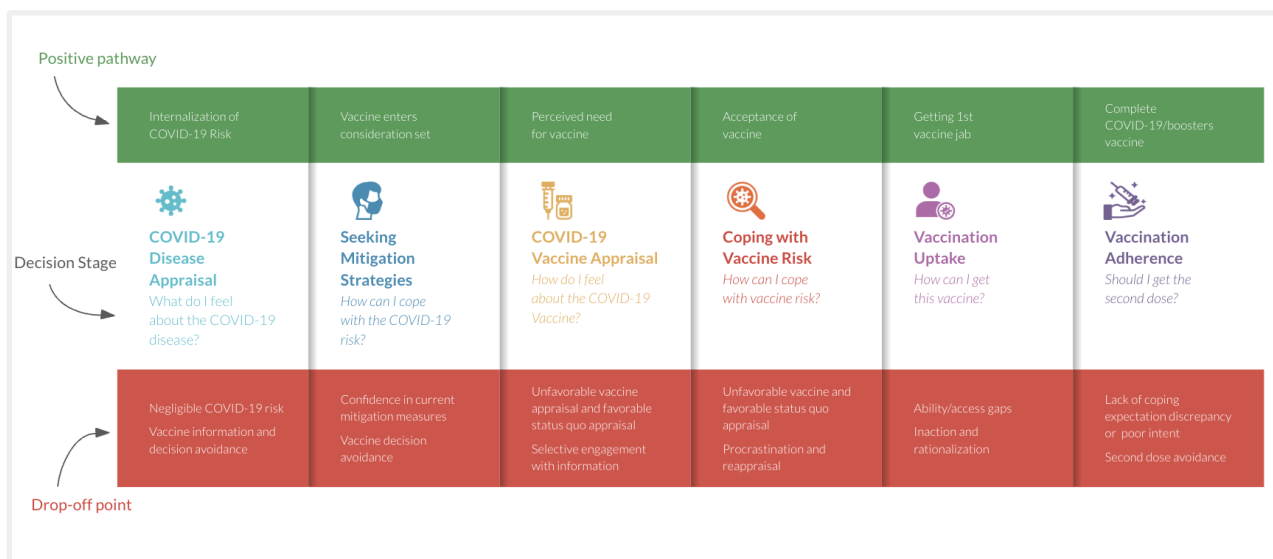


Figure 1. Decision journey to COVID-19 vaccine uptake

Semi-supervised machine learning tools were used to build predictive models and perform cluster segmentation. We found 7 psycho-behavioral segments in Kenya, 3 in Côte d'Ivoire and 5 each in Burkina Faso and Pakistan. Each segment represents a discrete portion of the population whose beliefs,

attitudes, and behaviors toward the COVID-19 vaccine differ from those of the other segments. Figure 2 shows the segments uncovered in Kenya as an example.

SEGMENT NAME AND POPULATION SIZE						
The Hopeful 16%	The Relieved 12%	The Indifferent 18%	The Doubtful 21%	The Anxious 11%	The Skeptic 10%	The Distrustful 12%
The Hopeful comprises of a majority of women with high engagement, trust and risk perception of COVID. They have suffered from substantial economic distress during the pandemic and so hope that things can get back to normal soon.	The Relieved is skewed towards an older cohort of women who are educated and have a higher number of dependents. They have a high risk perception of the disease despite facing low economic hardships.	The Indifferent has the most young and educated populace with high accessibility and trust in health facilities but low engagement with the same. Family plays a big role in influencing them.	The Doubtful has a high number of people in the reproductive age. They have high access but low engagement with health facilities and believe that COVID is serious but not risky for themselves.	The Anxious comprises of mostly uneducated mothers who have strong institutional trust which is offset with some COVID context doubt. They also suffered from severe economic hardship.	The Skeptic is mostly young people with low interaction with health system, low trusting behaviors coupled with low economic hardship. They have low risk perception of the disease and endorse COVID related myths.	The Distrustful have low access to health facilities and lowest risk perception of COVID. They have very low trust in government and mandated laid out by them and also think that the health system is inefficient.
ZERO DOSAGE						
34%	36%	43%	40%	51%	59%	62%

Figure 2: Seven psycho-behavioral segments for COVID-19 vaccine uptake in Kenya

In each country, the segments ranged from high to low potential for COVID-19 vaccine uptake. Similarities across the countries allowed us to divide the segments into 4 categories:

- 1. High uptake potential:** Skews toward older age groups and women of reproductive age. High engagement with the health system and concerned about the risk of COVID. High trust in institutions reinforces their trust in vaccine efficacy and safety. High uptake potential driven by emotions of hope and relief.
- 2. High to mid uptake potential:** Skews toward younger age group and healthy status. High institutional trust but do not perceive significant risk of COVID to themselves. Moderate uptake potential is driven by emotions of indifference and complacency.
- 3. Medium to low uptake potential:** Skews toward middle-aged group with chronic health conditions. Engaged with the health system and concerned about the risk of COVID. Concerns about vaccine safety, given their pre-existing conditions, making them vulnerable to misinformation, adversely impacting institutional trust. Lower uptake potential is driven by emotions of doubt, confusion, and anxiety.
- 4. Low uptake potential:** Skews toward the middle to younger age group, with low health-seeking behavior irrespective of health status. High level of institutional distrust leads to

engagement with misinformation about COVID risk and vaccine safety. Low uptake potential driven by emotions of fear, anger, suspicion, and disappointment.

The psycho-behavioral segments we identified not only cover attitudes and beliefs directly related to the COVID-19 pandemic, such as endorsing myths about COVID-19, or levels of COVID-19 risk perception; they also reflect broader aspects related to health policy such as trust in authorities, especially the government and the health system; degree of access to and engagement with the health system; receptivity to misinformation; and economic vulnerability.

Population segments in the medium- and low-potential categories for uptake of COVID-19 vaccines show both latent and overt signs of impact on other health-related behaviors as well. This is due to engagement with misinformation leading to low trust, or distrust, in the government and the health system. In Kenya, for example, the “Anxious” – a population segment with medium to low uptake potential for COVID-19 vaccines – were previously very trusting of the health system, but because of misinformation they are hesitant to receive the COVID-19 vaccine, and strongly hold misconceptions about the supposed profit motive of the government and the healthcare system. Similarly, for the low-uptake segments like the “Distrustful” and “Skeptics,” the experience of

COVID-19 has further cemented their distrust in the government and health system and distance from the health system. This further reinforces motivated negative information-seeking and higher engagement with fringe, non-credible sources for health information. Such attitudes and behaviors have the potential to affect attitudes and behaviors towards RI as well, particularly in situations where routine access to RI is disrupted.

Decoding the decision dynamics of RI missed doses during the COVID-19 pandemic in South Africa

We undertook a qualitative study to understand the demand and supply issues that negatively impacted RI during the COVID-19 pandemic period 2020-2022 in South Africa (Moyo S, Ashok A, Sharma S, Meyers L. Impact of COVID-19 pandemic on uptake of routine child immunization in South Africa: a qualitative study. Accepted for poster presentation at 2nd Annual Vaccination Acceptance Research Network conference; June 2023; Bangkok). South Africa experienced a decline in the number of children who were fully immunized in 2020 compared with 2019.²² We conducted research with 51 parents or caregivers of children below the age of 6 who missed/delayed 1 or more RI doses at a public health facility during 2020-2022, and with 12 health-care providers working in immunization during the pandemic period. The sample was drawn from three rural and urban provinces: Gauteng (urban), Mpumalanga (rural), and KZN (mixed rural and urban). We used South African Demographic and Health Survey (SADHS) data to identify locations with children under 6. Door-to-door recruitment was conducted using a screening tool to identify caregivers or parents of children under 6 who already accessed RI at public health facilities. The interviews were conducted via phone in English or Zulu, and were facilitated through trained moderators with a validated discussion guide. The interviews lasted 1 hour and included verbal informed consent, and were recorded and transcribed. The transcripts were analyzed using thematic analysis by a trained group of researchers.

We found that prior to the COVID-19 pandemic, RI had become a norm in communities in South Africa, thanks to successful immunization campaigns. Other research has found this norm to prevail in most societies.²³ Immunization was largely a default behavior, happening without much thought on the part of parents, given the salient need to protect their baby from infections. Parents therefore followed all instructions given by the doctor or

nurse, and vaccine refusal appeared to be the exception, not the rule.²³

When decoding the decision dynamics for missed RI doses during the COVID-19 emergency, it is important to note that the COVID-19 context was dynamic, and decision-making is complex and not linear, impacted by multiple factors rather than any single factor. National lockdowns, restricted mobility, transport issues, RI supply shortages, fear of contracting COVID-19 at health facilities, closure of creches, misinformation, COVID-19 vaccine hesitancy, and fear of side-effects co-existed, creating an emergent behavior of missed RI doses during the pandemic period.^{10,14-17} Caregivers reported that children missed scheduled vaccines due to prolonged shortages at facilities. Accurate information was rarely provided about when doses would be available, making it difficult for caregivers to plan accordingly. Motivated caregivers made multiple visits or traveled to different public health facilities in search of missing child doses.¹⁴⁻¹⁷

For these reasons, the covid-19 pandemic severely disrupted prior patterns of engagement with the health system. It created an “active decision-making” moment for RI, because lockdowns caused a gap between the original date for vaccination and the time when it could actually occur, therefore providing time for more deliberation and requiring effortful action. This led some parents not to take action that had previously been almost a default or automatic behavior.

Our research in South Africa uncovered significant gaps in parents’ knowledge about RI that may be a contributing factor in this calculation and that have policy implications. Many parents did not fully understand the purpose of vaccination, which diseases the vaccine protects their children against (for example, the DPT [diphtheria-pertussis-tetanus] vaccine was referred to by parents simply as the “three-month vaccine”), and which vaccinations had been administered or were pending. When RI is a default behavior, these knowledge gaps are less important, but they became salient in the context of active decision-making during the pandemic emergency.

During the peak of the pandemic, caregivers were faced with the dilemma of appraising the risk of COVID-19 exposure from taking their child for RI, vs the risk of their child developing a VPD.⁹ In this decision dynamic, the salience of COVID-19 outweighed the risk of the missed dose of immunization against a VPD that was invisible and

that most parents had not seen or experienced in their lifetime due to the success of immunization programs in curtailing the spread of VPDs in their communities. Furthermore, caregivers experienced no direct consequences of delaying vaccines during COVID-19. These circumstances resulted in some caregivers underestimating the risk from their children remaining unvaccinated.

A systematic review found that the most frequently reported reason for parents not following through with RI during the pandemic was fear of contracting COVID-19 (themselves or their babies) in healthcare settings,¹⁰ and negative experiences at overburdened facilities.^{10,15} Furthermore, due to the lockdown and restrictions on movement at the peak of the pandemic, caregivers perceived that the government was communicating that RI was not urgent during the lockdown, and they therefore deprioritized it.^{10,17,24,25}

Our study also found that skepticism about the COVID-19 vaccine can be unconsciously transferred to other vaccines. Prior to COVID-19, most vaccines were viewed positively, since they were familiar and safe. However, the COVID-19 vaccine was introduced in a pandemic context characterized by novelty, ambiguity, and uncertainty of efficacy. This, along with the speed of the vaccine's development and introduction, the salient experience of varied side-effects of vaccination, and misinformation around adverse events, created

a “bad vaccine” mental model (a set of strongly held beliefs reinforced through experience). While this mental model is initially applied only to the COVID-19 vaccine, other newer vaccines may also be seen in this way, and for some caregivers this reinforces a mental model that all vaccines may be bad vaccines.

Three pathways for routine immunization uptake in South Africa

Through a thematic analysis of the transcribed data, we identified three decision-making pathways for RI uptake among South African parents/caregivers once the lockdowns were lifted: the “path of procrastination,” the “path of doubt,” and the “path of persistence” (Figure 3). Of the three pathways, only one – the path of persistence – led to consistent RI uptake. An unvaccinated status quo emerged for the other two groups, who missed immunizing their children on schedule. “Procrastinating” caregivers either intended to immunize their children but unconsciously delayed doing so, despite viewing RI in a positive light; or they did not take further action due to small barriers such as low prioritization, status quo bias, or fear of judgment by the service provider. For “doubtful” caregivers, COVID-19 triggered skepticism about the necessity and safety of RI, with hesitancy about vaccines prompted or reinforced by emerging concerns about COVID-19 vaccines (Figure 4). The pathways are described in more detail below, followed by policy implications for addressing them.

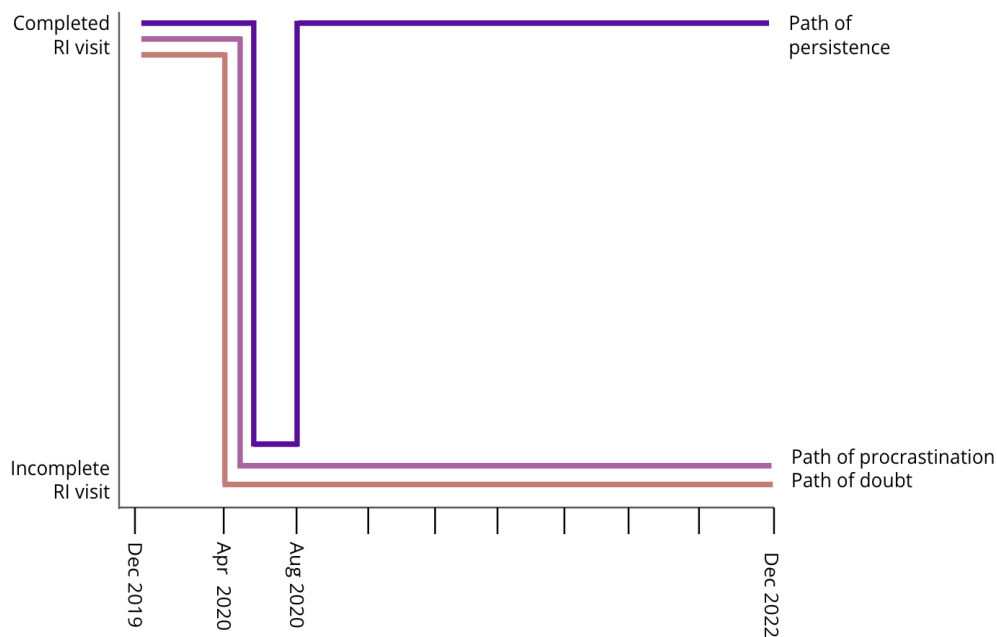


Figure 3. Three decision paths for RI uptake

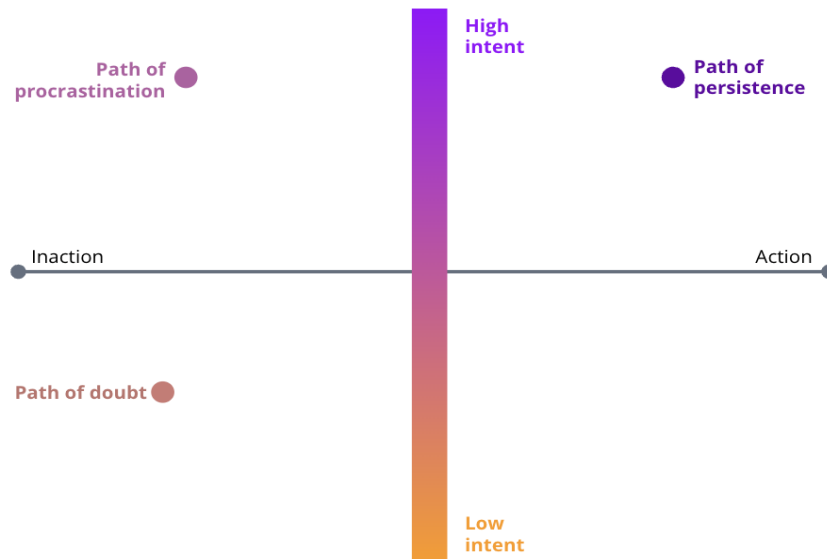


Figure 4. Three distinct active decision pathways for routine immunization, differentiated by degrees of intent and action

Path of procrastination: Despite having a positive view of RI and intent to vaccinate, inaction results from having missed scheduled visits, low prioritization, status quo bias, lack of RI education, “cost” of travel to facility and fear of judgment from health providers. A low urgency to vaccinate can result in complete drop-off of vaccination as time and rationalization increase, disrupting previous habits.

While some caregivers on the path of procrastination may regard COVID-19 vaccines as bad, they continue to regard RI vaccines as good, but do not actively seek out RI services. Reasons for the gap between their intent and their actions include:

- Immunization becomes a task they consider tedious, stressful, or inconvenient, and they therefore procrastinate to avoid negative feelings.
- Some caregivers who missed RI visits for two years think it is too late to catch up or are opting to wait until the next vaccination “deadline” requires them to act (i.e., for school enrollment).
- Some express a desire to catch up on the doses their child missed, but a more salient fear of health-provider judgment contributes to their avoidance.
- Given the economic hardship many caregivers experience, taking a day off from work is regarded as a difficult trade-off when their children seem to be doing fine without the vaccination.

- Having an unvaccinated child creates cognitive dissonance and guilt, given social norms supporting child immunization; caregivers thus find ways to rationalize the risks their children face due to their inaction.

Despite starting from a place of high intent to immunize their children, there is a real risk of caregivers completely dropping off from RI due to prolonged inaction, and of this dissonance ultimately shifting their beliefs about RI.

Path of doubt: Rarely expressed as an outright refusal to vaccinate children, some caregivers articulate doubt about the safety and necessity of RI that results in their avoiding immunizing their children until required (i.e., for school enrollment)

For caregivers on the path of doubt, there is skepticism deriving from the “bad” COVID-19 vaccine mental model that may increasingly impact decisions about other vaccines, including “good” child vaccines. They are more likely to have avoided the COVID-19 vaccines and to believe strongly in vaccination myths and conspiracy theories.

For them, the unvaccinated status quo is seen as more rewarding than the risks they associate with vaccination. Some caregivers fear their children will be involuntarily injected with the COVID-19 vaccine instead of the scheduled immunization. These caregivers tend to seek information from untrustworthy channels that confirms their concerns about vaccines. Their beliefs are strengthened by

knowing unvaccinated children who appear healthy, and by taking actions they believe will keep their children healthy, like feeding them vitamins and nutritious food.

Path of persistence: *Motivated by a desire to keep their children healthy, these caregivers tend to have a stronger awareness of and trust in RI, are influenced by others who encourage them to vaccinate their children, have positive engagements with the health system, and have greater economic resources or socio-economic status, which helps them keep their children's RIs up to date.*

For caregivers on the path of persistence, the perceived threat of VPDs is at least as salient as COVID-19, and thus the benefits of seeking RI are seen to outweigh the risks of potential exposure to COVID-19 at health facilities. Another qualitative study found a similar trend, whereby parents continued to seek RI for their children because they had been educated on the importance of these prior to the COVID-19 pandemic.¹¹

Some caregivers persisted by making repeated visits to health facilities to ensure their children stayed up to date, despite constraints on RI supplies. Knowing children who experienced health problems as a result of not being immunized heightened their risk perception.

Factors that enable persistency include:

- Experience of having immunized older children; this is sometimes beneficial, but not in all cases.
- The presence of influencers such as grandmothers, other mothers, sisters, etc. helps overcome concerns about visiting health facilities and/or the safety of vaccines. Fear of being judged and stigmatized by others in the community for not vaccinating their children is also enabling.
- Caregivers with higher economic status could seek RI at a pharmacy or private doctor rather than having to take a day or more off from work to repeatedly enquire about and wait for RI vaccines.

Policy implications and potential solutions to RI backsliding during a pandemic

Based on our research in South Africa, we recommend several interventions at the level of communication, service delivery, and health systems, as well as interventions specific to caregivers on the paths of procrastination or doubt.

Communication interventions:

1. *Highlight the risks of children remaining unvaccinated at facilities.* Educate pregnant women and new mothers about the importance of RI at all points of prenatal and postnatal service delivery. Shift terminology from “the three-month vaccine” to “the vaccine that protects against diphtheria, whooping cough, and tetanus” to emphasize the specific purpose of each immunization and the serious disease it prevents.
2. *Capacity-building and communication scripts for healthcare workers in facilities.* Offer capacity-building workshops to help frontline healthcare workers respond to caregivers who are newly in active information-seeking mode, by communicating the vaccine risk/reward trade-off more clearly and convincingly, and addressing their questions and concerns.
3. *Disseminate RI-positive messaging across a range of information channels.* Identify community leaders, parenting groups, and other community influencers to promote child immunization. Draw on community health workers to educate caregivers about RI within communities and when they are queuing at health facilities, taking time to address questions and concerns. Use mixed communication channels with tailored messaging to reach all segments of caregivers, including mass media (television, national and community radio, billboards, newspapers, drama series storylines), internet (disseminating RI messaging via targeted advertising on social media, Department of Health social media), interpersonal engagement (via community health workers, door-to-door outreach, peer educators/mentor mothers), and social mobilization campaigns and immunization drives.
4. *Improve current RI artifacts.* Provide more detailed information about specific child immunizations and the potential consequences of not vaccinating children in the printed materials that are given to new parents, to address existing knowledge gaps and build commitment to RI among new parents using public health services. Display posters at health facilities and other community venues that speak to the importance of RI and caregivers' desire to keep children healthy. Include information about the importance of not missing individual doses, the long-standing safety and efficacy of RI, and the potential severe consequences of not immunizing their children.

Service delivery:

1. *Reduce the guilt of vaccination.* Reduce fear of health-provider judgment by communicating a “grace period” for children to catch up on missed doses that assures caregivers they will be welcomed and not criticized for falling behind schedule in immunizing their children. Further catch-up strategies should focus on vulnerable communities that were at higher risk before the pandemic with several risk factors for poor health outcomes.⁴
2. *Create a new deadline.* Create new deadlines and urgency for vaccination. Schedule phone campaigns to proactively provide all caregivers with the new vaccination date.
3. *Make vaccination easy.* Increase ease of child vaccination through social mobilization campaigns that offer community-based RI services in addition to facility-based services. Reinforce proactive vaccination status-checking and suggest vaccination when children are at the health facility for other health issues, and in schools.
4. *Cover the costs of vaccination.* Offset the cost by providing coupons for catch-up vaccination at private pharmacies. Provide paid time off from organizations/employers to help caregivers create time for vaccination, and reimburse travel to facilities for vaccination.

Path-specific interventions:

- **Path of procrastination:** *Since delay stems from low urgency, this can result in complete drop-off from RI as time elapses and rationalizations increase, disrupting previous habits. Interventions should decrease the gap between intent and action by easing access to RI services, and following up with and educating parents who have missed RI visits.* Institute phone campaigns inviting all caregivers who have missed doses to urgently schedule RI visits, and strongly encourage caregivers to catch up on missed immunizations when they seek other health services (or make RI appointments if the child is not well enough to be vaccinated on that visit). Create “grace periods” to encourage caregivers to resume immunizing their children and counter a commonly-held perception they will be punished for having missed RI visits.
- **Path of doubt:** *Doubt about the safety, necessity, and effectiveness of RI results in an active decision to avoid immunizing children or to postpone until required for school enrollment.* Draw on the historical trust in RI that many doubters still feel, emphasizing that immunization has been the best way to protect

children from VPDs for generations. Leverage those who have the strongest influence on caregivers, including grandmothers and other family influencers, partners, and community leaders to build community support for RI and counter misinformation. Ensure that immunization campaigns offering RI services use emotionally salient data to explain the consequences of non-vaccination (e.g., potential outbreaks of deadly measles or disabling polio variants), and address myths and misinformation without being perceived as coercive.

- **Path of persistence:** *RI persistence should not be taken for granted; vaccine hesitancy, service delivery barriers, and limited RI education may negatively impact caregivers’ motivation and trust in RI.* Provide recognition for caregivers who persist with immunizing their children and protecting their children’s health. Healthcare workers should praise caregivers who persist with RI, and publicly recognize those who immunize their children on schedule, to build positive social norms and pride. Examples include giving caregivers an “I protect my child’s health” button, postcard, or sticker to take home or put on their clinic folder. Identify caregivers who are passionate and committed to RI and train them as peer educators to educate and encourage other parents.

For pandemic readiness:

Since the COVID-19 pandemic was declared in March 2020, we have learned many important lessons that should inform future pandemic preparedness plans to help mitigate the many risks and challenges that are likely to be faced, including minimizing the impact on RI programs. Vaccine hesitancy should continue to be addressed, as its impact is not limited to pandemic vaccines but extends to routinely recommended vaccines.^{22,26}

1. *Communication of urgency and importance.* Communicate the availability and urgent importance of continuing to seek RI to caregivers during future disease outbreaks, via presidential addresses, media, and health-facility communications.
2. *Ensure supply of vaccination.* Consider public-private partnerships to expand service points and improve dose procurement and supply management during future pandemics. Ensure supply-side logistics during a pandemic, and a mechanism to proactively inform caregivers about vaccine availability and dates. Countries and global agencies need to be aware during

the COVID-19 vaccine rollout – or during a future pandemic – of the need to maintain essential immunization services despite the inevitable repurposing of human and financial resources.⁵

3. *Address infection concerns.* Address underlying fears of infection, including by re-organizing service areas and providing immunization camps within the community, in large community centers and other venues away from health-care facilities.

Conclusion

During the peak of the COVID-19 pandemic, the prioritization of preventing and treating COVID-19 led to the disruption of other essential health services, including RI, putting the health of tens of millions of children at risk from VPDs in both the short and long terms. While we see trends of recovery in RIs, it is important to understand the policy implications of the impact of the pandemic, and of COVID-19 vaccine hesitancy, on caregivers' trust and engagement with the health system, and to understand the various decision pathways for RI uptake during a pandemic. Deeper behavioral research can provide a nuanced understanding of the decision-making dynamics that result in missed RI doses, in order to design effective policies and interventions to get back on track with RI, and enhance readiness to prevent RI backsliding in future pandemics. It can also help drive new understanding around demand generation for caregivers and families of zero-dose children (i.e., those who never have their children vaccinated), to

drive uptake of life-saving vaccines. Future research should include psycho-behavioral segmentation of caregivers in order to target specific barriers around uptake of RI. These insights and interventions will help us get back on track with RI, and help prevent RI backsliding during future pandemics.

Looking at the broader implications, behavioral studies can also help us understand how negative beliefs about COVID-19 vaccines among some segments of the population may impact beliefs about more recently developed vaccines such as for HPV, or vaccines that may be developed in the future, such as for cancer or HIV. This may help policymakers design effective interventions for uptake of vaccinations for these illnesses too.

Conflicts of interest

The authors have no conflicts of interest to declare.

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References

1. World Health Organization. 14.9 Million Excess Deaths Associated With The COVID-19 Pandemic In 2020 And 2021. Who.int. Published May 5, 2022. Accessed March 27, 2023. <https://www.who.int/news/item/05-05-2022-14.9-million-excess-deaths-were-associated-with-the-covid-19-pandemic-in-2020-and-2021>.
2. Verikios G. The dynamic effects of infectious disease outbreaks: the case of pandemic influenza and human coronavirus. *Socioecon Plann Sci*. 2020;71:100898. Published June 10, 2020. doi:10.1016/j.seps.2020.100898
3. World Health Organization. Immunization Coverage. Who.int. Published July 14, 2022. Accessed March 27, 2023. <https://www.who.int/news-room/fact-sheets/detail/immunization-coverage>.
4. UNICEF. COVID-19 Pandemic Leads To Major Backsliding On Childhood Vaccinations, New WHO, UNICEF Data Shows. Unicef.org. Published July 15, 2021. Accessed March 27, 2023. <https://www.unicef.org/press-releases/covid-19-pandemic-leads-major-backsliding-childhood-vaccinations-new-who-unicef-data>.
5. Shet A, Carr K, Danovaro-Holliday MC, et al. Impact of the SARS-CoV-2 pandemic on routine immunisation services: evidence of disruption and recovery from 170 countries and territories. *Lancet Glob Health*. 2022;10(2):e186-e194. Published December 21, 2021. doi:10.1016/S2214-109X(21)00512-X
6. Roberton T, Carter ED, Chou VB, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *Lancet Glob Health*. 2020;8(7):e901-e908. Published May 12, 2020. doi:10.1016/S2214-109X(20)30229-1
7. Li X, Mukandavire C, Cucunubá ZM, et al. Estimating the health impact of vaccination against ten pathogens in 98 low-income and middle-income countries from 2000 to 2030: a modelling study [published correction appears in *Lancet*. 2021;397(10275):670]. *Lancet*. 2021;397(10272):398-408. doi:10.1016/S0140-6736(20)32657-X
8. Elston JW, Cartwright C, Ndumbi P, Wright J. The health impact of the 2014-15 Ebola outbreak. *Public Health*. 2017;143:60-70. doi:10.1016/j.puhe.2016.10.020
9. Abbas K, Procter SR, van Zandvoort K, et al. Routine childhood immunisation during the COVID-19 pandemic in Africa: a benefit-risk analysis of health benefits versus excess risk of SARS-CoV-2 infection. *Lancet Glob Health*. 2020;8:e1264-72. Published July 17, 2020. doi:10.1016/S2214-109X(20)30308-9
10. Cardoso Pinto AM, Shariq S, Ranasinghe L, et al. Reasons for reductions in routine childhood immunisation uptake during the COVID-19 pandemic in low- and middle-income countries: a systematic review. *PLOS Glob Public Health*. 2023;3(1):e0001415. Published January 24, 2023. doi:10.1371/journal.pgph.0001415
11. Ota MOC, Badur S, Romano-Mazzotti L, Friedland LR. Impact of COVID-19 pandemic on routine immunization. *Ann Med*. 2021;53(1):2286-2297. doi:10.1080/07853890.2021.2009128
12. World Health Organization. *Guiding Principles for Immunization Activities during the COVID-19 Pandemic: Interim Guidance*, 26 March 2020. World Health Organization; 2020. Accessed March 27, 2023. <https://apps.who.int/iris/handle/10665/331590>.
13. World Health Organization. How WHO Is Supporting Ongoing Vaccination Efforts During The COVID-19 Pandemic. Who.int. Published July 14, 2020. Accessed March 27, 2023. <https://www.who.int/news-room/feature-stories/detail/how-who-is-supporting-ongoing-vaccination-efforts-during-the-covid-19-pandemic>.
14. Khatiwada AP, Maskey S, Shrestha N, et al. Impact of the first phase of COVID-19 pandemic on childhood routine immunisation services in Nepal: a qualitative study on the perspectives of service providers and users. *J Pharm Policy Pract*. 2021;14(1):79. Published September 29, 2021. doi:10.1186/s40545-021-00366-z
15. Saso A, Skirrow H, Kampmann B. Impact of COVID-19 on immunization services for maternal and infant vaccines: results of a survey conducted by Imprint – the Immunising Pregnant Women and Infants Network. *Vaccines (Basel)*. 2020;8(3):556.

- Published September 22, 2020. doi:10.3390/vaccines8030556
16. Bimpong KA, Nuertey BD, Seidu AS, Ajinkpang S, Abdul-Mumin A. Decline in uptake of childhood vaccinations in a tertiary hospital in northern Ghana during the COVID-19 pandemic. *Biomed Res Int.* 2021;2021:6995096. Published December 14, 2021. doi:10.1155/2021/6995096
 17. Wale Tegegne A, Kassie Gidafie A, Girma Mamo D, Tilahun Wassie S, Abita Mengie Z. Immunization status and challenges during COVID-19 and associated factors among children aged 10-23 months in South Region, Ethiopia 2020. *Pediatric Health Med Ther.* 2021;12:101-109. Published March 8, 2021. doi:10.2147/PHMT.S294739
 18. MacDonald NE; SAGE Working Group on Vaccine Hesitancy. Vaccine hesitancy: definition, scope and determinants. *Vaccine.* 2015;33(34):4161-4164. doi:10.1016/j.vaccine.2015.04.036
 19. World Health Organization. 10 Threats To Global Health In 2019. Who.int. No publication date. Accessed March 27, 2023. <https://www.who.int/news-room/spotlight/ten-threats-to-global-health-in-2019>.
 20. Betsch C, Böhm R, Chapman GB. Using behavioral insights to increase vaccination policy effectiveness. *Policy Insights Behav Brain Sci.* 2015;2(1):61-73. doi:10.1177/2372732215600716
 21. World Health Organization. *Behavioural and Social Drivers of Vaccination: Tools and Practical Guidance for Achieving High Uptake.* World Health Organization; 2022. Accessed March 27, 2023. <https://apps.who.int/iris/handle/10665/354459>.
 22. Pillay Y, Pienaar S, Barron P, Zondi T. Impact of COVID-19 on routine primary healthcare services in South Africa. *S Afr Med J.* 2021;111(8):714-719. Published May 17, 2021. doi:10.7196/SAMJ.2021.v111i8.15786
 23. Oraby T, Thampi V, Bauch CT. The influence of social norms on the dynamics of vaccinating behaviour for paediatric infectious diseases [published correction appears in *Proc Biol Sci.* 2016;283(1840):20161859]. *Proc Biol Sci.* 2014;281(1780):20133172. Published February 12, 2014. doi:10.1098/rspb.2013.3172
 24. Shapiro GK, Gottfredson N, Leask J, et al. COVID-19 and missed or delayed vaccination in 26 middle- and high-income countries: an observational survey. *Vaccine.* 2022;40(6):945-952. doi:10.1016/j.vaccine.2021.12.041
 25. Rizwan W, Duggal MN, Rana MN, Rafique M, Ghaffar J, Sadiq M. Effect of COVID-19 pandemic on vaccination of children under two years of age. *Pak Pediatr J.* 2021;45(2):161-168.
 26. Badur S, Ota M, Öztürk S, Adegbola R, Dutta A. Vaccine confidence: the keys to restoring trust. *Hum Vaccin Immunother.* 2020;16(5):1007-1017. doi:10.1080/21645515.2020.1740559